To: Clint Woods[cwoods@csg.org]
From: Clint Woods
Sent: Mon 3/13/2017 6:42:33 PM
Subject: AAPCA Comments on 2015 Ozone NAAQS Preliminary Interstate Transport Modeling Data
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Today, the Association of Air Pollution Control Agencies (AAPCA) submitted comments to the U.S. Environmental Protection Agency (EPA) on its Preliminary Interstate Ozone Transport Modeling Data for the 2015 Ozone National Ambient Air Quality Standard (NAAQS), which was signed on December 28, 2016 and published in the Federal Register on January 6, 2017 This letter raises concerns about several technical and policy issues, and asks EPA to clarify Agency plans and provide updated, credible national modeling results for 2023, utilizing state inputs, by August 1, 2017 in order to provide the technical analysis needed for air agencies to meet the October 26, 2018 deadline for Good Neighbor State Implementation Plans (SIPs). The deadline to comment on this preliminary data is April 6, 2017, and AAPCA is compiling state and local air agency comments here.

This letter includes several suggestions for a more cooperative approach to addressing the requirements of Clean Air Act section 110(a)(2)(D)(i)(I) for the 2015 Ozone NAAQS:

•□□□□□□□□ Providing credible tools and clear direction for development of approvable Good Neighbor SIPs for the 2015 Ozone NAAQS will allow U.S. EPA Administrator Pruitt to carry out the goal to “engage in a transparent process that will allow states to have a meaningful opportunity to understand their obligations with regard to reducing emissions that cause or contribute to nonattainment or interference with maintenance in other states through the SIP process.”

•□□□□□□□□ Air agencies have received mixed messages from U.S. EPA regarding future interstate transport actions and the reliability of this preliminary information as a basis for state analyses.

•□□□□□□□□ AAPCA disagrees with EPA’s inclusion of implementation of the Clean Power Plan in projections for 2023.

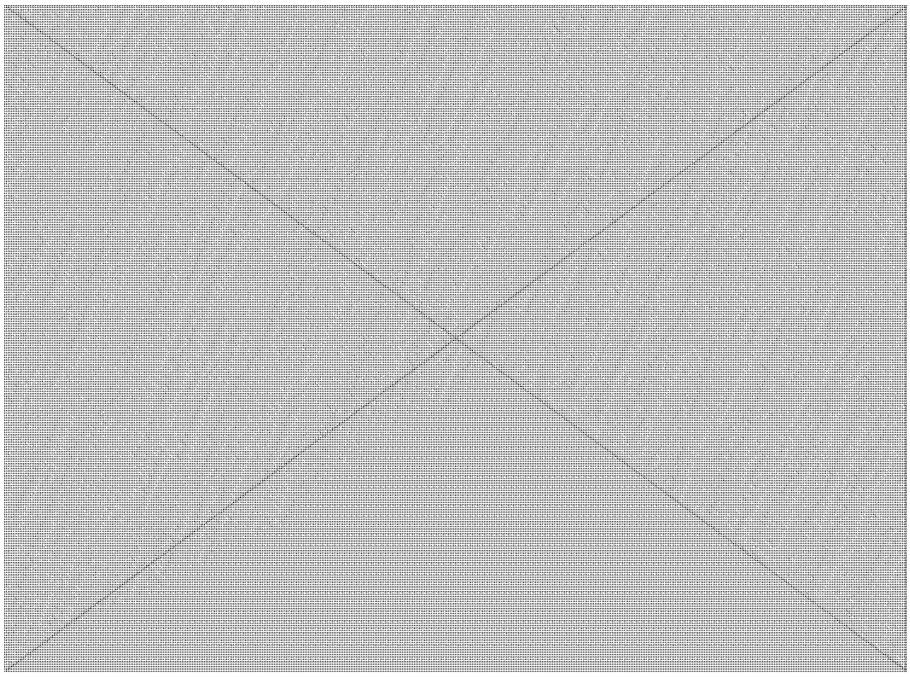
•□□□□□□□□ Although EPA has “historically found that the 1 percent threshold is appropriate” in determining significant contributions, this approach is not preordained. EPA should consider whether an alternative threshold above 0.7 parts per billion is appropriate, particularly as this preliminary modeling includes complex, uncertain, six-year projections for linkages across long distances for contributions virtually undetectable by monitors.

•□□□□□□□□ AAPCA is concerned about the continued reliance on the Integrated Planning Model, a proprietary model that often forces air agencies to guess about key

inputs and assumptions.

In addition to tracking state and local environmental agency comments on this preliminary data, AAPCA is also compiling relevant comments on EPA's proposed rule, Implementation of the 2015 National Ambient Air Quality Standards for Ozone: Nonattainment Area Classifications and State Implementation Plan Requirements (comment period ended February 13, 2017), and EPA's proposed Response to December 9, 2013 CAA Section 176A Petition From Connecticut, Delaware, Maryland, Massachusetts, New Hampshire, New York, Pennsylvania, Rhode Island and Vermont (updated comment deadline: April 13, 2017). As a reminder, AAPCA has compiled state and local agency comments on the Interstate Transport Rule for the 2008 Ozone NAAQS ("CSAPR Update"), state designation recommendations for the 2015 ozone NAAQS, state/local comments on the proposed 2015 revisions to the ozone NAAQS, and surveys of state perspectives on background ozone and the need for timely NAAQS implementation tools.

This month, AAPCA also posted an updated version of the timeline, State Clean Air Act Deadlines, 2016 - 2021:



AAPCA is a consensus-driven organization focused on assisting state and local air quality agencies and personnel with implementation and technical issues associated

with the federal Clean Air Act. The Association represents more than 40 state and local air agencies, and senior officials from 20 state environmental agencies currently sit on AAPCA's Board of Directors. AAPCA is based in Lexington, Kentucky as an affiliated association of the Council of State Governments (CSG). You can find more information about AAPCA at http://www.cleanairact.org or follow the Association on Twitter (@AAPCA_States).

Thanks!

Clint Woods

Executive Director

Association of Air Pollution Control Agencies

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To: Konkus, John[konkus.john@epa.gov]; Bangerter, Layne[bangerter.layne@epa.gov]
From: Schnare, David
Sent: Thur 2/9/2017 9:46:55 PM
Subject: FW: EPA Executive Orders
Final - Climate Change.docx
Final - Cost-Benefit and Domestic Benefits EO.docx
Final - Critical Infrastructure Protection EO.docx
Final - LNG Export PM.docx
Final - Offshore PM.docx
Final - Onshore Energy PM.docx
Final - Ozone.docx
Final - Regional Haze NAAQS EO.docx
Final - RFS PM.docx
Final - Scientific Rigor EO.docx
Final - WOTUS EO.docx

From: Jackson, Ryan (Inhofe) [mailto:Ryan_Jackson@inhofe.senate.gov]
Sent: Thursday, February 9, 2017 1:03 PM
To: Schnare, David <schnare.david@epa.gov>
Subject: FW: EPA Executive Orders

David, what kind of media prep is the press office (and I guess I mean Doug and John) preparing for to explain these?

---------- Forwarded message ----------
From: **David Schnare** < Personal Email/Ex. 6 >
Date: Thu, Feb 2, 2017 at 4:10 PM
Subject: EPA Executive Orders
To: ryan_jackson@inhofe.senate.gov, patrickwyrick(Personal Email/Ex. 6

Patrick and Ryan:

Attached are the Executive Orders as approved by Andrew Bremberg, now the President's Domestic Policy Advisor. We have prepared directives for the Mr. Pruitt's signature to implement each element of these EO's, directives he can sign on day 1 if he wants to.

I will send the action plan under separate cover as the length of this material clogs the internet pipes and may not otherwise make it through to you.

d.

--

David W. Schnare, Esq. Ph.D.

EXECUTIVE ORDER

War on Coal:
Restoring the Rule of Law, Federalism, and Economic Growth
by Rescinding Climate Change Directives

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in recognition of Congress's power to determine whether and how to effectuate Federal regulation of greenhouse gas emissions, or otherwise respond to the potential for climate change; the opportunity costs imposed by federal climate change activities that diminish the ability of Departments and Agencies to meet their core responsibilities; the States' traditional power to regulate electricity generation, distribution, and use; the principle that the U.S. Environmental Protection Agency (EPA) shall, when implementing the Clean Air Act programs of this nation, work cooperatively with the States to achieve shared environmental goals; and the imperative to promote policies in the national interest and for the benefit of American workers and their families; it is hereby ordered as follows:

Section 1. *Policy.*

It is in the national interest to ensure that the nation's electricity is affordable, reliable, safe, secure, and clean, and available to be produced from coal, natural gas, nuclear power, hydropower, other renewables, and other domestic sources.

It is the policy of the United States that executive departments and agencies including the EPA shall take appropriate actions, to the extent consistent with applicable law, to ensure clean air and clean water for the American people in cooperation with the States and according to standards both as set forth by Congress, in respect of the proper roles of Congress and the States concerning these matters in our constitutional republic.

It is the policy of the United States that federal regulations and directives be based on careful consideration of science and principles of science reflecting input from the entirety of the scientific community; and that those agencies with statutory responsibility for regulation and formulation of directives integrate scientific knowledge in the first instance, rather than rely on that conducted by other units of government or international bodies.

It is the policy of the United States that when promulgating federal regulations for the environment, it is necessary to ensure that policy solutions comport with the law, provide substantially more benefits than the costs imposed, accurately gauge those costs, reflect the opportunity costs of policy solutions, achieve meaningful environmental improvements for the American people, and are developed through transparent procedures using the best available science.

Sec. 2. *Rescission of Certain Climate-Related Actions.*

(a) The following Presidential actions are hereby revoked:

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Executive Order 13754 of December 9, 2016, which addressed Northern Bering Sea Climate Resilience.

Executive Order 13653 of November 1, 2013, which required certain actions by the Federal government and other entities concerning climate change;

Executive Order 13677 of September 23, 2014 (Climate-Resilient International Development), which set requirements for systematically integrating climate-resilience considerations into U.S. international development work;

The Presidential Memorandum of June 25, 2013, concerning "Power Sector Carbon Pollution Standards", 78 Fed. Reg. 39,535 (July 1, 2013);

The Report of the Executive Office of the President entitled, "The President's Climate Action Plan," dated June 2013; and,

The Presidential Memorandum of September 21, 2016, entitled, "Climate Change and National Security".

The Presidential Memorandum of December 5, 2013, entitled "Federal Leadership on Energy Management."

The Presidential Memorandum of February 03, 2010, entitled, "A Comprehensive Federal Strategy on Carbon Capture and Storage.

(b) Executive Order 13693 of March 19, 2015, (Planning for Federal Sustainability in the Next Decade), which directed Federal actions to improve environmental performance and Federal sustainability, is amended by deleting: (1) section 1 through section 15; (2) the first sentence of section 16(a); (3) "Therefore," of the second sentence of section 16(a); (3) sections 16(d) through 16(e); and sections 17 through 20.

(c) The Administrator of EPA, the Council on Environmental Quality (CEQ), and heads of all executive departments and agencies shall (i) promptly identify every order, rule, regulation, guideline, or policy implementing or enforcing the Presidential actions listed in subparagraph (a); (ii) specify the source of authority for each; (iii) shall terminate, effective today, any actions based on said Presidential actions immediately, and otherwise stay and move to rescind each such activity (including funding) until the Office of Management and Budget authorizes/directs reinvestment, modification or cessation of the program/project, unless required unambiguously by statute.

Sec. 3. United Nations Framework Convention on Climate Change (UNFCCC).

(a) On March 17, 2016, the State of Palestine became a Party to the UNFCCC, an affiliated organization of the United Nations. Since March 17, 2016, the United States has continued to make contributions, including financial contributions, to the Convention, which are contrary to section 410(1) of Public Law 103-236, the Foreign Relations Authorization Act, Fiscal Years

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1994 and 1995, and are violations of the Antideficiency Act.

(b) Each Executive Department or Agency shall immediately terminate, effective today, all contributions, including financial contributions, to the UNFCCC, including its subsidiary bodies, its financial mechanisms (Green Climate Fund and Global Environment Facility), the Least Developed Countries Fund, the Special Climate Change Fund, the Adaptation Fund, as well to the Intergovernmental Panel on Climate Change (IPCC) for any UNFCCC-requested Special Report, Methodological Report, or Technical Report.

(c) Each Executive Department or Agency who have made contributions, including financial contributions, to the UNFCCC, from March 17, 2016 to today, are directed to report immediately the amounts of those contributions to the Office of Management and Budget and to make every effort to recover those amounts from the UNFCCC, including its subsidiary bodies, its financial mechanisms (Green Climate Fund and Global Environment Facility), the Least Developed Countries Fund, the Special Climate Change Fund, the Adaptation Fund, as well from the Intergovernmental Panel on Climate Change (IPCC), as appropriate.

(d) Pursuant to Article 25 of the UNFCCC, the United States withdraws from the UNFCCC, including the "Paris Agreement" of 2015.

(e) The Department of State is directed to immediately give written notification of its withdrawal to the Depository per Article 25(1) of the UNFCCC, to wit, the Secretary-General of the United Nations.

Sec. 4. *Withdrawal of the EPA's "Clean Power Plan" and Related Rules.*

(a) On February 10, 2015, the United States Supreme Court stayed implementation of EPA's "Clean Power Plan", which regulation remains stayed by that Court's order. Section 705 of the Administrative Procedures Act, 5 U.S.C. 705, provides further legal authority for this Administration to establish an additional executive stay of the Clean Power Plan. In particular, Section 705 authorizes the Administration, when it "finds that justice so requires," to postpone the effective date of agency action pending judicial review.

For the reasons justifying the stay order of the Supreme Court, and other pertinent reasons set forth by the States opposing the Clean Power Plan and related rules, I hereby find that justice requires a permanent, administrative stay and consideration for revision or withdrawal of the Clean Power Plan and similar and related rules. To that end, the Administrator of EPA shall promptly administratively stay the final rules listed in subparagraph (b) pursuant to the authority recognized by Section 705 of the Administrative Procedure Act.

The Administrator of the EPA shall also consider petitions filed with the Agency to reconsider the Clean Power Plan and, where appropriate, grant such petitions where the effect of such grants would effectuate the purposes of this Executive Order.

The Administrator of EPA shall immediately take all steps necessary to effectuate the lawful withdrawal and rescission of the final rules listed in subparagraph (b) below, along with any orders, rules, regulations, guidelines, or policies implementing or enforcing those final rules, to the extent consistent with law, and shall terminate, effective today, any actions based on those rules. The Administrator shall also promptly take final action to withdraw the proposed rules

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listed in subparagraph (b) below. Where appropriate, the Administrator shall simultaneously take action to promulgate in revised form any of the rules listed in subparagraph (b) below.

(b) Final or proposed rules for withdrawal or recession pursuant to subparagraph (a):

Final Rule, "Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units," published at 80 Federal Register 64661 (October 23, 2015) (also known as the "Clean Power Plan").

Final Rule, "Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units," published at 80 Federal Register 64509 (October 23, 2015).

Final Rule, "Standards of Performance for Municipal Solid Waste Landfills" published at 81 Federal Register 59332 (August 29, 2016).

Final Rule, "Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources," published at 81 Federal Register 35824 (June 3, 2016).

Final Rule, "Source Determination for Certain Emission Units in the Oil and Natural Gas Sector," published at 81 Federal Register 35622 (June 3, 2016).

Final Rule, "Finding That Greenhouse Gas Emissions From Aircraft Cause or Contribute to Air Pollution That May Reasonably Be Anticipated To Endanger Public Health and Welfare," published at 81 Federal Register 54421 (August 15, 20167); and the associated EPA denial of the Biogenic CO2 Coalition's petition for reconsideration of this final action.

Revised Guidance, "Guidance for Implementing Section 141 of the Energy Independence and Security Act of 2007, Federal Vehicle Fleets and Low Greenhouse Gas-Emitting Vehicles," published at EPA-420-B-16-055 (May 2016).

Proposed Rule, "Federal Plan Requirements for Greenhouse Gas Emissions From Electric Utility Generating Units Constructed on or Before January 8, 2014; Model Trading Rules; Amendments to Framework Regulations; Proposed Rule," 80 Federal Register 64966 (October 23, 2015).

Proposed Rule, "Revisions to the Prevention of Significant Deterioration (PSD) and Title V Greenhouse Gas (GHG) Permitting Regulations and Establishment of a Significant Emissions Rate (SER) for GHG Emissions Under the PSD Program," published at 81 Federal Register 68110 (October 3, 2016).

(c) The Administrator shall have the discretion to commence administrative proceedings both to reconsider and to rescind the rules listed in subparagraph (b) in a manner that is consistent with the Clean Air Act and other applicable law including the limitations on the Administrator's discretion and consistent with constitutional principles of federalism and separation of powers, while also providing for significant interagency input in the Administrator's reconsideration processes and any subsequent related rulemaking processes, if any.

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(d) The Administrator shall rescind EPA's "Legal Memorandum Accompanying Clean Power Plan for Certain Issues," which was published in conjunction with the Clean Power Plan, and said memorandum shall be of no further force or effect.

(e) With respect to litigation before the Federal courts related to rules listed in subparagraph (b) of this Section, the Administrator shall take all available measures to effectuate the directive in subparagraph (a), including by promptly directing the U.S. Department of Justice to seek remand of the final rules listed in subparagraph (b) by judicial orders holding all litigation concerning the final rules listed in subparagraph (b) in abeyance until such time as the Administrator takes final action to rescind the Clean Power Plan. The Administrator shall immediately cease all efforts related to implementation of the actions listed in subparagraph (b), including without limitation by immediately ceasing any expenditures related to implementation of the final rules listed in subparagraph (b) except as directly required by applicable appropriations.

(f) The Secretary of the Interior shall immediately take all steps necessary to effectuate the lawful withdrawal and recission of the Final Rule, "Oil and Gas: Hydraulic Fracturing on Federal and Indian Lands," published at 80 Federal Register 16128 (March 26, 2016), and all other rules and guidance published pursuant thereto.

Sec. 5. *Withdrawal of the Greenhouse Gases Endangerment Finding*

Pursuant to Section 705 of the Administrative Procedures Act, 5 U.S.C. 705, I hereby find that justice requires a permanent, administrative stay and revision or withdrawal of the "Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act" published at 74 Federal Register 66496 (December 15, 2009).

The Administrator of the EPA shall also consider petitions filed with the Agency to reconsider the this or any other related endangerment finding and, where appropriate, grant such petitions where the effect of such grants would effectuate the purposes of this Executive Order.

In conducting its reconsideration, revision or withdrawal of endangerment findings, EPA shall rigorously apply EPA and OMB "Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies."

Sec. 6. *GHG Reporting Rule*

The EPA Administrator shall review and, unless not justified by sound science or legal constraints, grant requests or petitions for reconsideration of the Subpart W Greenhouse Gas Reporting rule, and engage in rule-making intended to remedy that rule's most onerous requirements.

Sec. 7. *Social Cost of Greenhouse Gases*

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(a) I find that multiple independent reviews of the basis for estimating a social cost of carbon or greenhouse gases document the fundamental weaknesses in these estimators. They fail to meet the requirements of appropriate use of information disseminated by federal agencies under the Information Quality Act guidelines and as such are without sufficient quality, objectivity, utility, and integrity to support decision-making regarding the value of greenhouse gas reductions.

(b) The Interagency Working Group on Social Cost of Greenhouse Gases shall be dissolved immediately.

(c) The guidance document titled "Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866" (July 2015), and all predecessor or successor documents, and any other guidance or policies promulgated thereto are hereby rescinded.

(d) The guidance document titled "Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide" (August 2016), and all predecessor or successor documents, and any other guidance or policies promulgated thereto is hereby rescinded.

(e) All regulatory agencies and any Executive Branch Department or Agency preparing environmental assessments or impact statements shall immediately suspend use of "Social Cost of Carbon" or the "Social Cost of Greenhouse Gases" or the "Social Cost of Methane" or the "Social Cost of Nitrous Oxide" estimates in any regulatory or National Environmental Policy Act (NEPA) analyses.

(f) Each Agency or Department shall (i) report to OMB, CEQ and CEA each instance in which the "Social Cost of Carbon" or the "Social Cost of Greenhouse Gases" or the "Social Cost of Methane" or the "Social Cost of Nitrous Oxide" has been used (specifying the regulation, guidance or analysis); (ii) amend any environmental assessments or environmental impact analyses prepared under NEPA, withdrawing any reliance upon an estimated "Social Cost of Carbon" or the "Social Cost of Greenhouse Gases" or the "Social Cost of Methane" or the "Social Cost of Nitrous Oxide"; and (iii) amend any regulatory impact analysis for any major rule to eliminating any reliance upon "Social Cost of Carbon" or the "Social Cost of Greenhouse Gases" or the "Social Cost of Methane" or the "Social Cost of Nitrous Oxide" estimates.

Sec. 8. NEPA

Consonant with other sections of this Executive Order, the following memorandum and guidance promulgated by the Council on Environmental Quality is hereby revoked:

> Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews, Dated August 1, 2016.

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Each Agency or Department shall (i) report to CEQ and CEA each instance in which NEPA analyses incorporated or otherwise applied the above identified Final Guidance, or drafts of that Guidance (specifying the regulation, guidance or analysis); (ii) amend any environmental assessments or environmental impact analyses prepared under NEPA, withdrawing any reliance upon the Draft or Final Guidance; and (iii) amend any regulatory impact analysis for any major rule to eliminating any reliance upon the Draft or Final Guidance.

Sec. 9. *General Provisions*

(a) Nothing in this order shall be construed to impair or otherwise affect (i) authority granted by law to a department or agency, or the head thereof; or (ii) functions of the Director of the Office of Management and Budget relating to budget, administrative, or legislative proposals.

(b) This order shall be implemented consistent with applicable law and subject to the availability of appropriations.

(c) This order is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

THE WHITE HOUSE,
January 20, 2017

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EXECUTIVE ORDER

Improving Cost-Benefit Analysis of Energy and Environmental Regulation

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:

Section 1. *Policy*

Under Executive Order 12866, or in the event that Order is rescinded, the currently approved regulatory analysis Order, and other orders and guidance promulgated pursuant thereto, the Office of Information and Regulatory Affairs is entrusted with ensuring that executive agencies promulgate regulations based on sound analysis of regulatory costs and benefits and consistent with the legal constraints imposed on the agencies by Congress.

Sec. 2. *Definition*

"Co-benefit" is defined as a favorable impact of the regulatory action or alternative under consideration that is unrelated or secondary to the primary purpose of the action.

Sec. 3. *Reforming the Inclusion of Co-Benefits in Cost Benefit Analysis*

(a) For purposes of complying with Executive Order 12866 and all other Executive Orders issued pursuant thereto, the "benefits" of a regulatory action shall only include those benefits directly associated with the regulatory purpose of the action and shall not include any alleged co-benefits of that action, unless unambiguously required by federal statute.

(b) Nothing in subparagraph (a) shall be construed as prohibiting an agency from separately estimating the alleged co-benefits of a regulatory action, but such benefits may not the basis or purpose of regulatory decision-making and shall not be taken into account during such decision-making.

Sec. 4. *Comparing Domestic Costs to Domestic Benefits*

In complying with Executive Order 12866 and all other executive orders or OMB guidance pertaining to the costs and benefits of regulatory action, an agency shall calculate the action's domestic costs and domestic benefits. Non-domestic costs and benefits shall be excluded from the agency's analysis unless unambiguously required by statute.

Sec. 5. *General Provisions*

(a) Nothing in this order shall be construed to impair or otherwise affect (i) authority granted by law to a department or agency, or the head thereof; or (ii) functions of the Director of the Office of Management and Budget relating to budget, administrative, or legislative proposals.

(b) This order shall be implemented with applicable law and subject to the availability of appropriations.

(c) This order is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

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THE WHITE HOUSE
January 20, 2017

Executive Order----Expediting Critical Infrastructure Projects

EXECUTIVE ORDER

Expediting Environmental Review and Permitting of Critical Infrastructure Projects

By the authority vested in me as President by the Constitution and the laws of the United States of America, I hereby direct as follows:

Section 1. *Purpose.*

The National Environmental Policy Act declares "it is the continuing responsibility of the Federal Government to use *all practicable means, consistent with other essential considerations of national policy,* to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may . . . *attain the widest range of beneficial uses of the environment* without degradation, risk to health or safety, or other undesirable and unintended consequences." 42 USC§433l(b)(3). Today the United States faces a crisis in maintaining and improving its critical infrastructure. In order to achieve beneficial uses of the environment by all practical means, it is necessary to streamline the environmental review and permitting process so that critical infrastructure projects, such as updating our electrical grid, and repairing and upgrading our ports, airports, pipelines, bridges and highways, can be accomplished with reasonable expedition in order to provide for the General Welfare.

Section 2. *Declaration of Infrastructure Projects as Critical.*

Upon application by the Governor of a State, or the head of any federal agency or department, or on his or her own initiative, the Chairman of the White House Council on Environmental Quality (CEQ) shall, within no more than 30 calendar days after an application is received, designate infrastructure projects as "critical" or "non-critical" after consideration of their importance to the General Welfare, their likely environmental and other net benefit, and such other factors as CEQ deems relevant. This Order does not apply to infrastructure projects funded under the Clean Water Act and Safe Drinking Water Act grant and revolving funds.

Section 3. *Deadlines.*

Upon designation of an infrastructure project as critical, CEQ shall establish a deadline for completion of environmental assessment and permitting of the project, and all agencies and instrumentalities of the federal government shall give their highest priority to completing environmental assessment and permitting by the established deadline, which may be shorter but shall not be longer than two (2) years after designation as critical except in extraordinary cases approved by CEQ. During the assessment and permitting period established by CEQ, notwithstanding any other provision of law or regulations, all agencies and instrumentalities of the federal government shall prioritize their analysis first on the environmental and other issues anticipated to be most material and important to whether the project should go forward.

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Section 4. *Decision.*

At the end of the assessment period established by CEQ, the decision-maker authorized by law to approve the project shall review the available information and decide whether it is sufficient to approve the project on the grounds that the project will provide net benefits to the environment or will provide benefits to other important national priorities that are substantially in excess of its costs or adverse effects, or whether a request to CEQ for an extension of the assessment period is necessary. In deciding whether to request or grant an extension, both the decision-maker and CEQ shall consider not only the benefits of additional study, but also the costs of delay.

Section 5. *Procedures.*

This Executive Order establishes procedures and priorities for internal management of the Executive Branch and does not create any rights for any persons outside the Executive Branch, including but not limited to right to notice and comment or judicial review. This order is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

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Executive Order---Expediting Critical Infrastructure Projects **[Day 1]**

EXPLANATORY STATEMENT

Delays and other inefficiencies in the environmental review and permitting process are severely impeding critically important projects to rebuild and modernize our nation's infrastructure, such as highways, bridges, tunnels, the electrical grid, ports, water systems, airports, railways and pipelines. As a result of our cumbersome permitting process , America's infrastructure is crumbling: half of traffic accidents are due to road conditions, the antiquated power grid wastes the equivalent of 200 coal-fired power plants, gridlock on roads and railroads wastes $300 billion annually, and ancient water pipes leak two trillion gallons of water. The accompanying Executive order would establish a process and assign responsibilities to expedite environmental review and permitting for critical infrastructure projects.

Add CWA/~~[illegible]~~ SDWA

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MEMORANDUM FOR THE ADMINISTRATOR OF THE ENVIRONMENTAL PROTECTION AGENCY

SUBJECT: LNG Export Licensing

Thanks to the shale revolution, the U.S. is now the world's largest natural gas producer and has become one of the world's lowest cost gas producers. This provides the U.S. with a real opportunity to sell its gas on the global market through LNG exports, and in turn help ensure the long-term viability for domestic natural gas production and related infrastructure projects. A single LNG facility can result in billions of dollars in infrastructure development and economic growth at the national, state and local levels. A project can result in 9,000 construction jobs over a five year period and many permanent jobs that pay well above the national average. LNG exports can also provide U.S. allies in Europe and Asia with an alternative source of energy, lessening their dependency on natural gas from the Middle East and Russia. It is an opportunity not only for U.S. companies to benefit, but for our allies around the world to become less reliant on energy from hostile, less-reliable sources.

The Natural Gas Act provides the Department of Energy with the authority to authorize natural gas exports. For exports to non-Free Trade Agreement countries, DOE conducts an informal adjudication and grants LNG export applications unless it finds that doing so is not in the public interest. Final decisions on applications cannot be rendered before a NEPA review is completed. For LNG terminals onshore or in state waters, FERC serves as the lead agency in the NEPA review, and for offshore facilities, MARAD serves as the lead agency (DOE serves as a cooperating agency in both cases).

In 2014, the Department of Energy announced that rather than continuing to act on applications based on the order of precedence posted on the DOE website (and then issuing conditional decisions prior to completion of NEPA reviews, as needed), it would act on applications to export LNG from the lower-48 to non-Free Trade Agreement countries only after completing NEPA reviews. Under this new regime some authorization requests are still awaiting resolution more than four years after having been submitted to the federal government.

Accordingly, I request that they Secretary move as expeditiously as possible to review and either approve or deny all pending export authorization requests within 180 days. Further, I request the Secretary of Energy to initiate a review of the Department's LNG Export Authorization Program and report back to me within 180 days with recommendations for ensuring timely decision making on authorization requests made to the Department.

Nothing in this memorandum shall be construed to require the disclosure of classified, proprietary, law enforcement sensitive, or other information protected under governing law. This memorandum shall be implemented consistent with applicable law and subject to the availability of appropriations. This memorandum is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

Presidential Memorandum – ***American Energy and American Jobs***

January 20, 2017

MEMORANDUM FOR THE SECRETARY OF THE INTERIOR AND THE SECRETARY OF COMMERCE

SUBJECT: American Energy and American Jobs through Regulatory Certainty and Shared Conservation Stewardship.

Consistent with principles of responsible public land stewardship entrusted to this office, with due consideration of the critical importance of energy security, job creation, and conservation stewardship, and the traditional role of the States in managing wildlife, I hereby direct the Secretary of the Interior and the Secretary of Commerce to undertake the following actions and produce within 90 calendar days a report both summarizing progress and providing recommendations for any actions, if appropriate:

Endangered Species Act:

Endangered Species Act (ESA) decisions have become untethered from both their statutory and congressional directives. In order to overturn the abuses of the previous administration, the Secretary of the Interior and the Secretary of Commerce shall work together to modify existing ESA regulations, create greater transparency, and provide clear policy direction to their agencies and employees. Further, the Secretary of the Interior and the Secretary of Commerce shall evaluate ways in which the federal government and state governments can collaborate to focus limited resources on the most effective means of helping species which are actually on the brink of extinction rather than using the ESA as a tool to harm American energy security and American jobs without demonstrating a benefit to the listed species.

Accordingly, I request the Secretary of the Interior and the Secretary of Commerce to direct all agencies within their respective Departments to make all information – scientific and otherwise – which they rely on for listing or critical habitat designations publicly available to the maximum degree possible.

I further request that the Secretary of the Interior and the Secretary of Commerce initiate a comprehensive review of their respective Departments' implementation of the Endangered Species Act and report back to me with recommendations for regulatory reform consistent with the need to streamline regulation and reduce the regulatory burdens faced by American individuals and businesses.

Compensatory Mitigation:

The Presidential Memorandum entitled Mitigating Impacts on Natural Resources from Development and Encouraging Related Private Investment (November 3, 2015) directs federal agencies to use compensatory mitigation to offset the impacts of their activities and the projects that they approve. In implementing this Presidential direction, agencies have demanded additional compensation on top of Congressionally-authorized bonus bids, rentals,

permitting fees, cost-recovery fees and royalties that they collect, under the law, from energy producers, driving up the costs of energy production and raising energy prices for the American public.

Consistent with principles of responsible public stewardship entrusted to this office, with due consideration of the critical importance of energy security, job creation, and conservation stewardship, I hereby withdraw, revoke, and rescind the Presidential Memorandum dated November 3, 2015, "Mitigating Impacts on Natural Resources from Development and Encouraging Related Private Investment."

National Monuments:

Past Presidents have created 125 National Monuments to protect areas of cultural or historical importance. These National Monuments often protect sensitive areas of significance. However, increasingly, Presidents have used this authority to block activities important for American energy and American jobs. In order to ensure that these National Monument Designations are consistent with Congressional intent and the views of the states, it is important that the Secretary of the Interior consult with the Secretary of Commerce, the Secretary of Defense, the Secretary of Homeland Security, and the Governors of any states, Indian lands, and territories that have National Monument Designations in order to ensure that National Monument designations and boundaries are consistent with all of our national priorities being taken into account.

In order to ensure that these National Monument Designations are consistent with Congressional intent and the views of the states, territories, and tribal nations, I request the Secretary of the Interior to examine each of the National Monument Designations and determine if they are confined to the smallest area compatible with proper care and management of the objects protected under each proclamation and shall recommend a collaborative process to ensure stakeholder input for future National Monument Designations. In conducting this review, the Secretary of the Interior shall consult with the Secretary of Commerce, the Secretary of Defense, the Secretary of Homeland Security, and the Governors of any states, territories, and Indian Nations that have National Monument Designations and report back to the President with recommended changes for National Monument Designations. These recommendations should include any maps with proposed changes.

Stream Protection Rule:

The Department of the Interior's misleadingly titled "Stream Protection Rule" negatively affects American energy security and American jobs. The rule has little to do with protecting streams; instead it vastly increases the power of the federal bureaucracy at the expense of state regulators who have ably served as the front-line environmental regulators for over 30 years.

Accordingly, I request the Secretary of the Interior to work together with the Administrator of the Environmental Protection Agency and take all steps necessary to effectuate the lawful withdrawal and rescission of the Final Rule, "Stream Protection Rule," published at 81 Federal Register 93066 (December 20, 2016), and all other rules and guidance published pursuant thereto.

Federal Coal Moratorium:

Signed on January 15, 2016, Secretarial Order 3338 ("Discretionary Programmatic Environmental Impact Statement (PEIS) to Modernize the Federal Coal Program") directs the Bureau of Land Management to analyze and "consider potential leasing and management reforms to the current Federal coal program." During the comprehensive review, the Department ceased all coal leasing on federal lands despite its ability to conduct leasing under the current PEIS until such time as the revised PEIS is completed.

Accordingly, I request the Secretary of the Interior to issue a Secretarial Order withdrawing Secretarial Order 3338 and halting all activities associated with the PEIS.

National Petroleum Reserve – Alaska:

The National Petroleum Reserve – Alaska is the largest block of federally-managed land in the United States and contains approximately 895 million barrels of oil and 52.8 trillion cubic feet of natural gas. In 2012, 11 million of the Reserve's 22.8 million acres in 2012 were set aside, potentially, precluding development of up to 350 million barrels of oil and 45 trillion cubic feet of natural gas.

Accordingly, I request the Secretary of the Interior to immediately initiate the development of a revised Integrated Activity Plan for the National Petroleum Reserve – Alaska.

DRAFT

Onshore Leasing Program:

Multiple onshore oil, gas, and mineral lease sales have been cancelled with little or no warning. Quarterly onshore lease sales have not been conducted as required under current law. American energy security and America jobs have suffered significantly as a result.

Accordingly, I request that the Secretary of the Interior immediately reinitiate the quarterly lease sales program, provide increased regulatory certainty for the onshore lease sales program, and identify additional steps to enhance the exploration, production, and development of onshore oil, gas, and mineral leasing.

General Provisions:

This Presidential Memorandum is not intended to, and does not, create any right, benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

DONALD J. TRUMP

EXECUTIVE ORDER

Restoring the Rule of Law, Federalism, and Economic Growth by Rescinding the "2015 Ozone NAAQS" Rule

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in recognition of Congress's power to determine the scope of federal regulatory power over air quality, subject in turn to the limits imposed on Congress by the Constitution, it is hereby ordered as follows:

Section 1. *Policy.*

It is in the national interest to ensure that the States and the U.S. Environmental Protection Agency (EPA), in partnership, restore and maintain air quality, while at the same time promoting economic growth and minimizing regulatory uncertainty.

It is also recognized States require sufficient time to implement National Ambient Air Quality Standards (NAAQS) and that revision of NAAQS is proper only where the effectiveness of existing NAAQS compliance is known and where EPA uses all new data that can inform establishing a NAAQS.

It is in the national interest to base regulations on information of high quality and certainty, and to limit regulation implementation where uncertainties overwhelm the ability of the executive to determine whether the proposed regulations have a net beneficial effect on the nation.

Is in the national interest to rigorously apply EPA and OMB Guidelines for Ensuring and maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies.

It is not possible to establish a zero-risk natural environment and it is not in the national interest to promulgate regulations that would require reduction of chemicals found in ambient air to levels below that found in nature at normal, unpolluted background concentrations.

Section 2. *Findings*

EPA reduced the Ozone NAAQS from 75 parts per billion to 70 using selected, questionable studies and ignored contradictory studies. For many parts of the country 70 parts per billion is at or near the natural background level of ozone. It is difficult, and perhaps, impossible to sort out background levels from manmade portions of ambient ozone levels. The EPA estimated background levels using modeling that the Agency qualified as limited in accuracy. EPA also rejected establishing background levels on measured results from monitors in remote locations, a reasonable alternative that yields higher background levels than modeling. Even using the lower background estimates from modeling, background levels exceed 80% of the measured ambient

levels in some locations. EPA also departed from its normal regulatory practices, by continuing to use the three-year average of the fourth highest day measurement, or 99th percentile, while the next most stringent NAAQS uses the seventh highest day, or the 98th percentile.

Section 3. *Rescission of the 2015 Ozone NAAQS*

(a) The Administrator of the U.S. Environmental Protection Agency shall immediately take all steps necessary to effectuate the lawful withdrawal and rescission of the 2015 Ozone NAAQS rule published at 80 Federal Register 65292 (October 26, 2015), and all other rules and guidance published pursuant thereto, including the October 1, 2015, Directives "Implementing the 2015 Ozone National Ambient Air Quality Standards".

(b) The Administrator shall also consider petitions filed to reconsider the rule listed in subparagraph (a), and any other rules and guidance published pursuant thereto; and, where appropriate, grant such petitions where the effect of such grants would effectuate the purposes of this Executive Order.

Sec. 4. *General Provisions.*

(a) Nothing in this order shall be construed to impair or otherwise affect (i) authority granted by law to a department or agency, or the head thereof; or (ii) functions of the Director of the Office of Management and Budget relating to budget, administrative, or legislative proposals.

(b) This order shall be implemented with applicable law and subject to the availability of appropriations.

(c) This order is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

THE WHITE HOUSE,
January 20, 2017

EXECUTIVE ORDER

Restoring the Rule of Law, Federalism, and Economic Growth by Revising and Reconsidering Elements of the Regional Haze Rules

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in recognition of Congress's power to determine the scope of federal regulatory power over air quality, subject in turn to the limits imposed on Congress by the Constitution, it is hereby ordered as follows:

Section 1. *Policy.*

It is in the national interest to ensure that the States and the U.S. Environmental Protection Agency (EPA), in partnership, restore and maintain air quality, while at the same time promoting economic growth and minimizing regulatory uncertainty.

States have a strong economic and social interest in ensuring local environmental quality as well as bearing the responsibility for ensuring local economic and energy needs are met, and stand in the best position to harmonize the two. Federal implementation of National Ambient Air Quality Standards (NAAQS) must accede to States' reasoned approaches to implementation of the national air quality requirements.

States require sufficient time to implement National Ambient Air Quality Standards (NAAQS).

It is in the national interest to rigorously apply EPA and OMB "Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies" when determining what data, predictions, projections and similar information upon which to rely when implementing regulations.

It is not possible nor desirable to attempt to establish a zero-risk, residuals-free environment and it is not in the national interest to promulgate regulations that would require reduction of air-borne residuals found in ambient air to levels below that found in nature as a result of common natural events.

Section 2. *Findings*

In several cases under the Regional Haze program, EPA has unfairly and unlawfully usurped states' authority to regulate emissions, and done so in a manner that threatens local economic activity, including closure of essential electricity generating capacity. In Texas, alone, EPA's actions require $2 billion in retrofits at existing power plants, a matter now challenged at law. On December 14, 2016, EPA established new regulations substantially revising the existing

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Regional Haze program and has signed a final rule. As of December 31, 2016, the rule was not published in the Federal Register and will not be effective until 30 days after the date of Federal Register publication.

Issued in December and not yet published in the Federal Register, the new final rule would not have an effective date prior to January 20th. As such, the regulation could be suspended and reviewed as part of a new Administration's OMB clawback of all final regulations not yet effective as of Inauguration Day.

Section 3. *Rescission of the "Protection of Visibility: Amendments to Requirements for State Plans" Final Rule*

(a) If the final rule has not been published in the Federal Register prior to January 20, 2017, the rule shall be withdrawn and the Administrator shall reconsider and revise the rule as appropriate in light of the policies listed in Section 1 above.

(b) In the event the final rule is published in the Federal Register prior to January 20, 2017, the Administrator of the U.S. Environmental Protection Agency shall immediately publish a notice suspending implementation of the final rule for no less than 90 days after publication in the Federal Register.

(c) If the final rule is published in the Federal Register prior to January 20, 2017, the Administrator shall consider petitions filed to reconsider the rule, and any other rules and guidance related to the rule; and, where appropriate, grant such petitions where the effect of such grants would effectuate the purposes and policies of this Executive Order.

(d) With respect to litigation before the Federal courts related to the final rule and other "Protection of Visibility" rules, the Administrator shall promptly direct the U.S. Department of Justice to seek remand of such final rules by judicial orders holding all litigation concerning the final rules in abeyance until such time as the Administrator takes final action to rescind or revise the rules. The Administrator shall immediately cease all efforts related to implementation of the "Protection of Visibility: Amendments to Requirements for State Plans" rule and any other related rules being challenged at law, including, without limitation, immediate cessation of expenditures related to implementation of the final rule except as directly required by applicable appropriations.

Sec. 4. *General Provisions.*

(a) Nothing in this order shall be construed to impair or otherwise affect (i) authority granted by law to a department or agency, or the head thereof; or (ii) functions of the Director of the

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Office of Management and Budget relating to budget, administrative, or legislative proposals.

(b) This order shall be implemented with applicable law and subject to the availability of appropriations.

(c) This order is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

THE WHITE HOUSE,
January 20, 2017

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MEMORANDUM FOR THE ADMINISTRATOR OF THE ENVIRONMENTAL PROTECTION AGENCY

SUBJECT: Renewable Fuel Standard

The Renewable Fuel Standard (RFS) was created in 2005 and expanded by the Energy Independence and Security Act of 2007 (EISA). The program mandates that transportation fuels sold in the U.S. contain an increasing volume of renewable fuels including conventional ethanol, advanced biofuels, cellulosic ethanol and biodiesel – each of which have its own target volumes set forth in statute. EPA administers the RFS program and sets the annual volumetric requirements for each of the four biofuels categories through a formal rulemaking process.

Compliance issues with the RFS program have arisen from the fact that volumetric requirements set forth in EISA were based on projections of what U.S. gasoline consumption would be – projections which have been proven to be highly inaccurate because they did not take into account decreasing gasoline demand brought on by the slumping U.S. economy and increased fuel efficiency standards implemented by the Obama Administration. This is important because many auto engine warranties are voided if drivers use gasoline containing more than 10% ethanol and gasoline station pumps and underground storage tanks are only certified for gasoline containing 10% ethanol or less. This confluence is called the E-10 Blendwall. Compliance issues have also arisen from the fact that Congress dramatically overestimated the volume of advanced biofuels and cellulosic ethanol that would be or could be produced by the renewable fuels industry. At present, these two fuels are not economically competitive and can only be produced at a significant economic inefficiency that redounds on marketplace participants.

Concerns have also been raised regarding the point of obligation for the program. Several refiners have filed lawsuits against EPA and also petitioned the agency to change its regulations which place the point of obligation for compliance with the RFS on refiners, blenders and importers of gasoline and diesel. In November 2016, EPA published a proposed denial of the petitions and is taking public comments on the issue until February 22, 2017.

Accordingly, I am requesting the Administrator of the Environmental Protection Agency to conduct a programmatic review of the Renewable Fuel Program and report back to me with recommendations for the long-term viability of the program. In conducting this review, the Administrator shall consider whether any changes to the program are necessary. If the Administrator determines that any such changes are necessary, the recommendations shall include proposed regulatory or legislative revisions to the program

Nothing in this memorandum shall be construed to require the disclosure of classified, proprietary, law enforcement sensitive, or other information protected under governing law. This memorandum shall be implemented consistent with applicable law and subject to the availability of appropriations. This memorandum is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

Executive Order – Ensuring Scientific Rigor in Agency Decisions

EXECUTIVE ORDER

Ensuring Scientific Rigor in Agency Decisions

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in order to establish consistent policies and procedures governing transparency, accountability and scientific rigor in agency decision-making throughout the Federal Government, it is hereby ordered as follows:

Section 1. *Definitions.*

For purposes of this order:

(a) "agency" shall have the meaning given in section 551(1) of title 5, United States Code.

(b) "Comment Period" means any opportunity provided by law or agency discretion for the public or any other agency to provide comment or information to an agency on any Regulatory Proposal or Regulatory Decision.

(c) "Regulatory Decision" means any decision by an agency of the United States that directly or indirectly establishes rules, standards, guidelines or other norms applicable to any member of the public or any agency.

(d) "Regulatory Proposal" means any proposed, tentative or draft Regulatory Decision that an agency makes available to a Comment Period.

Sec. 2. *Mandatory Measures to Provide Transparency, Accountability, and Scientific Rigor in Agency Decision-making.*

(a) All Regulatory Proposals and Regulatory Decisions by an agency shall cite the specific page and, where possible, the paragraph of any document containing data or information upon which the agency is relying, explain how the cited data or information supports the proposal or decision, and list any documents reviewed by the agency in connection with the proposal or decision and upon which the agency is not relying. No agency may base any Regulatory Proposal or Regulatory Decision on any data or information contained in a personal communication that is not in writing, unless the Secretary of the department in which the agency is located, or an equivalent agency head, certifies in writing the reasons the agency was required to use data or information that is not in writing, and such certificate is posted on the agency's Web site or another widely available government Web site.

(b) Each regulatory agency shall rigorously apply OMB "Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by

Federal Agencies."

(c) An agency shall post on its Web site during any Comment Period on any Regulatory Proposal by the agency the full text of every document upon which the agency relies in making the Regulatory Proposal.

(d) After the close of any Comment Period on a Regulatory Proposal, an agency shall post on its Web site as soon as practicable the full text of any newly obtained document , not posted under subsection (b) of this section, upon which the agency expects to rely in a final decision, stating when and how the document came to the agency's attention, and providing an agency e-mail address to which comments regarding the document from the public or other agencies can be transmitted for a period of not less than 14 days.

(e) An agency shall request supporting original data from the author of any document upon which the agency relies in any Regulatory Proposal or Regulatory Decision and shall post any such data on its Web site in accordance with subsections (b) and (c) of this section; if the author refuses to provide the supporting data, the agency must post or note the refusal on its Web site and explain in any final decision why it chose to rely upon the document despite the refusal. An agency shall explain in any Regulatory Proposal or Regulatory Decision what efforts the agency made to verify the accuracy of all data or information in any document upon which the agency relies.

(f) An agency shall post on its Web site all comments on a Regulatory Proposal received from any member of the public or any other agency at any time before the agency makes a final decision on the proposal.

(g) An agency shall include in all Regulatory Proposals and Regulatory Decisions the name or title and a brief statement of the professional background of all agency professional staff or contractors who worked on, contributed to, or reviewed the proposal or decision, a statement of the number of hours each such person devoted to the proposal or decision , a description of what tasks each such person performed on the proposal or decision, including identifying by name or title the persons with principal drafting responsibilities for sections of the proposal or decision.

Sec. 3. *Oversight of Agency Compliance.*

The Director of the Office of Management and Budget shall oversee agency compliance with this order, and shall deliver to the President annually beginning December 31, 2013 a report evaluating such compliance by each agency.

Sec. 4. *A Scientific Integrity Policy*

(a) The Director of the White House Office of Science and Technology Policy (OSTP) shall issue a new scientific integrity policy for federal agencies within 60 days that shall include the following elements:

- Reiterate the six principles identified in President Obama's March 9, 2009, Memorandum on Scientific Integrity;
- Ensure agency compliance with all relevant laws (IQA, DAA, and FOIA);
- Ensure that all major agency actions rely solely on the best available science that is publicly available and reproducible and which meets the OMB "Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies";
- Prohibit any government scientist from signing a nondisclosure agreement or otherwise take actions to intentionally avoid FOIA requests, even with international partners (unless a matter of strict national security);
- Establish more transparent procedures for what is a "highly influential scientific" document as defined by the Information Quality Act;
- Require federal agencies to update/issue internal scientific integrity policy within 60 days of the issuance of the new OSTP policy and submit to OSTP for review. The policy would go into effect on the day in which OSTP approves it.

(b) The Director of OSTP to review all federal scientific assessment programs to determine whether they are necessary/redundant, and in appropriate cases, recommend their elimination by Congress, this review to be completed within 120 days.

(c) With respect to the programs that are not eliminated under the preceding subparagraph (b), OMB (OIRA) shall have authority to review the assessments, in order to ensure compliance with the December 16, 2004, OMB Memorandum entitled "Final Information Quality Bulletin for Peer Review," and OMB shall return a rule for further revision in every case the Agency has not fully complied with either IQA guidance or the Peer Review Bulletin.

Sec. 4. *General Provisions.*

(a) Nothing in this order shall be construed to impair or otherwise affect (i) authority granted by law to a department or agency, or the head thereof; or (ii) functions of the Director of the Office of Management and Budget relating to budget, administrative, or legislative proposals.

(b) This order shall be implemented consistent with applicable law and subject to the availability of appropriations.

(c) This order is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

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THE WHITE HOUSE,
January 20, 2017

EXECUTIVE ORDER

Restoring the Rule of Law, Federalism, and Economic Growth
by Rescinding the "Waters of the United States" Rule

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in recognition of Congress's power to determine the scope of federal regulatory power over navigable waters, subject in tum to the limits imposed on Congress by the Constitution, it is hereby ordered as follows:

Section 1. *Policy.*

It is in the national interest to ensure that the States and EPA, in partnership, restore and maintain the chemical, physical and biological integrity of the nation's navigable waters, while at the same time promoting economic growth and minimizing regulatory uncertainty.

Sec. 2. *Rescission of the Waters of the United States Rule.*

(a) The Administrator of the Environmental Protection Agency (EPA) and the Commanding General and Chief of Engineers of the U.S. Army Corps of Engineers (USACE) shall immediately take all steps necessary to effectuate the lawful withdrawal and rescission of the Final Rule, "Clean Water Rule: Definition of 'Waters of the United States,'" published at 80 Federal Register 37054 (June 29, 2015), and all other rules and guidance published pursuant thereto.

(b) The Administrator of EPA, the Commanding General and Chief of Engineers of the USACE, and heads of all executive agencies shall promptly move to rescind any orders, rules, regulations, guidelines, or policies implementing or enforcing the rule listed in subparagraph (a).

(c) The Administrator of the EPA shall also consider petitions filed with the Agency to reconsider the rule listed in subparagraph (a) and, where appropriate, grant such petitions where the effect of such grants would effectuate the purposes of this Executive Order.

(d) With respect to litigation before the Federal courts related to rules listed in subparagraph (a), the Administrator shall take all available measures to effectuate this Order, including by promptly directing the U.S. Department of Justice to seek remand of the final rule listed in subparagraph (a) by judicial orders holding all litigation concerning the final rules listed in subparagraph (a) in abeyance until such time as the Administrator takes final action to rescind the final rule listed in subparagraph (a). The Administrator shall immediately cease all efforts related to implementation of the final rule listed in subparagraph (a), including without limitation by immediately ceasing any expenditures related to implementation of the final rule listed in subparagraph (a) except as directly required by applicable appropriations.

Sec. 3. Appropriate Exercise of Enforcement Discretion.

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Until the definition of "Waters of the United States" is revised pursuant to this order, the EPA, the USACE, and all executive agencies shall construe "navigable waters," as defined in 33 U.S.C. 1362(7), in a manner consistent the opinion of Justice Scalia in *Rapanos v. United States,* 547 U.S. 715 (2006).[1]

Sec. 4. *General Provisions.*

(a) Nothing in this order shall be construed to impair or otherwise affect (i) authority granted by law to a department or agency, or the head thereof; or (ii) functions of the Director of the Office of Management and Budget relating to budget, administrative, or legislative proposals.

(b) This order shall be implemented with applicable law and subject to the availability of appropriations.

(c) This order is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States , its departments, agencies, or entities, its officers, employees, or agents, or any other person.

THE WHITE HOUSE,
January 20, 2017

[1] "[T]he phrase 'the waters of the United States' includes only those relatively permanent, standing or continuously flowing bodies of water 'forming geographic features' that are described in ordinary parlance as 'streams[,] … oceans, rivers, [and] lakes.'"; and, "wetlands with a continuous surface connection to bodies that are 'waters of the United States' in their own right, so that there is no clear demarcation between 'waters' and wetlands, are 'adjacent to' such waters and covered by the Act."

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Check WOTUS

EXPLANATORY STATEMENT

American landowners and companies current!y spend $1.7 billion every year on wetlands permits-approvals from federal regulators to use lands near what the federal government defines as navigable waters. That figure comes from comments filed by the U.S. Chamber of Commerce and nearly 400 other organizations opposing efforts by the Environmental Protection Agency and Army Corps of Engineers to expand federal regulators' authority even further.1

The agencies rejected their pleas, and finalized the "Waters of the United States Rule." It purports to interpret the Clean Water Act, which grants the federal agencies regulatory power over "navigable waters," which the Act defines in tum as "the waters of the United States" (33
U.S.C. § 1362(7)). But the EPA's and Army Corps's rule goes much further than actually navigable waters, like rivers or streams, or even lands near rivers and streams that are wet year-round. Instead, the agencies' rule purports to reach many more lands that have what the agencies claim to be a "significant nexus" to actually navigable waters-to bedetermined on a case-by- case basis casting an immense cloud of regulatory uncertainty over families, farms, and businesses that want simply to put their own land to good use.

The "WOTUS" Rule has been universally criticized by chambers of commerce and other organizations opposed to national control ofland management. Indeed, the U.S. Chamber of Commerce has denounced the rule for putting the EPA "effectively in charge of zoning the entire country."2

The National Association of Manufacturers says that the EPA's and Army Corps's rule "exerts power over a staggering range of man-made and isolated features - even if they are usually dry or too small to appear on a map. The definitions are complex and vague, and often require case-by-case determinations by the agencies." 3

And the National Association of Homebuilders sums up the rule's disastrous impact on everyday lives: "While many wetlands and streams are an important part of the ecosystem and should be protected, the new definition represents federal overreach of the worst kind: more permits, more regulation and more costs without a corresponding environmental benefit. The new 'waters of the U.S.' definition means, for example, that a builder in Arizona would have to get a pennit for an activity in a dry desert wash that could be 30 miles from the nearest river. Such intrusive federal encroachment is bad governance and will inevitably lead to bureaucratic delays, increased project costs and mitigation fees, and ultimately, decreased housing affordability."4

Simply put, the Waters of the United States Rule runs roughshod over both federalism and the limits that Congress imposed upon these federal agencies. It should be rescinded through

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1 htt ps://www. usc hamber.com/comment/ m ult i-orga niza tion-comme nts-epa-a ncl- usace-p ropose cl-r ule-d efinit ion -wa ters-t he- unit ed-s tates

2 https://www.u schamber.com/a bove-t he-fold/ full-s trea m-a head-w h Y-e pa -s - wa tel'- rule-goes-too-far

3 http://www.na m.org/I ss ues/Wa ter-Regula tion s/ - stha h.oRBEIY39.dpuf

4 http://www.na hb.or g/cn/resea rch/nahb-prior it ies/we tlancls .a s px

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(') notice-and-comment rulemaking, beginning with an executive order directing the agencies to
, repeal the rule.

And while that process is pending, the President should direct the agencies to exercise their enforcement discretion very carefully, by honoring the bright line drawn by Justice Scalia in his opinion for the Court's four-justice plurality in *Rapanos v. United States* (2006). "Navigable waters" should include only waters that are *navigable in fact-only* "continuous flow[s] of water in a permanent channel," and not merely "intermittent flows," let alone ditches or drains that are only rarely damp.

* * *

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NEXT STEPS: LITIGATION

Like the Clean Power Plan, the "Waters of the United States" rule promulgated by the EPA and Army Corps already is the subject of major litigation. A federal district court issued a preliminary injunction prohibiting the agencies from enforcing it while appeals are pending. More importantly, a similar prohibition - a "stay" pending appeal- has been issued by the U.S. Court of Appeals for the Sixth Circuit, the court that will hear all cases challenging the merits of the rule.

Under Sixth Circuit's briefing schedule (dated June 14, 2016, in case nos. 15-3751 *et al.),* briefing in this case will not conclude until after the inauguration, on Feb. 17, 2017. Oral argument will then follow, meaning that a decision will not be reached until well into 2017- and the stay-pending-appeal will prevent enforcement of the rule until that time .

Thus, as with the Clean Power Plan , the court's stay-pending-appeal is a gift, because it gives the new Administration space to formulate its own policy free of any obligation to continue to implement the Obama Administration's policy.

But to leverage the court' s temporary relief for as long as possible, the new Administration must take immediate steps to freeze the litigation itself in place: for as long as the litigation is frozen, the Court's stay-pendin g-appeal order remains locked in place, too .

This executive order contains express language ordering the Justice Department to file a motion in the Sixth Circuit requesting that the litigation be held in abeyance- see Section 2(c). The parties challenging the rule would almost certainly join that motion, greatly increasing the likelihood that the court will grant the motion.

But even if that litigation-management language is ultimately removed from the executive order itself, it is incumbent upon the new Administration, through the Justice Department representing the EPA and USACE, to immediately take affirmative steps to hold the current litigation in abeyance , allowing the Sixth Circuit's stay to remain in effect indefinitely.

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To: Russ Hendricks[rhendricks@idahofb.org]
From: Bangerter, Layne
Sent: Tue 3/28/2017 8:15:39 PM
Subject: FW: Clean Power Plan 3/28/17

FYI: Layne

Below: New York Times, AP, Reuters, Bloomberg, Politico, The Hill, E&E News (2), Huffington Post, USA Today, CNN, Mashable, Gizmodo, Daily Caller, BNA, Wall Street Journal, BBC, Reuters, Politico (2), E&E News (3), CNN, Huffington Post, Washington Times (3/27), Washington Post (3/27), The Hill (2) (3/27), InsideEPA (3/27), Washington Examiner (3/27), Mother Jones (3/27)

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New York Times

https://www.nytimes.com/2017/03/28/climate/trump-executive-order-climate-change.html

Trump Signs Executive Order Unwinding Obama Climate Policies

By Coral Davenport 3/28/17

WASHINGTON — President Trump signed on Tuesday a much-anticipated executive order intended to roll back most of President Barack Obama's climate-change legacy, celebrating the move as a way to promote energy independence and to restore thousands of lost coal industry jobs.

Flanked by coal miners at a ceremony at the Environmental Protection Agency, Mr. Trump signed a short document titled the "Energy Independence" executive order, directing the agency to start the legal process of withdrawing and rewriting the Clean Power Plan, the centerpiece of Mr. Obama's policies to fight global warming.

The order also takes aim at a suite of narrower but significant Obama-era climate and environmental policies, including lifting a short-term ban on new coal mining on public lands.

The executive order does not address the United States' participation in the 2015 Paris Agreement, the landmark accord that committed nearly every country to take steps to reduce climate-altering pollution. But experts note that if the Trump program is enacted, it will all but ensure that the United States cannot meet its clean air commitments under the accord.

Mr. Trump advertised the moves as a way to decrease the nation's dependence on imported fuels and revive the flagging coal industry.

This action by Trump places the U.S. completely out of step with most of the rest of the world in regard to climate change.

Trump's the president and we're not. He issued the order simply because President Obama promoted it. As Trump is a Republican, if President...

This country needs to develop a coal-powered pickup truck. It would be a win-win-win for everyone involved. Pickup trucks are very popular...

But energy economists say the order falls short of both of those goals — in part because the United States already largely relies on domestic sources for the coal and natural gas that fires most of the nation's power plants.

"We don't import coal," said Robert N. Stavins, an energy economist at Harvard University. "So in terms of the Clean Power Plan, this has nothing to do with so-called energy independence whatsoever."

Scott Pruitt, the E.P.A. administrator, said in an interview on ABC News on Sunday that the order will help the United States "be both pro-jobs and pro-environment."

But coal miners should not assume their jobs will return if Trump's regulations take effect.

The new order would mean that older coal plants that had been marked for closing would probably stay open for a few years longer, extending the demand for coal, said Robert W. Godby, an energy economist at the University of Wyoming.

But even so, "the mines that are staying open are using more mechanization," he said.

"They're not hiring people," he continued.

"So even if we saw an increase in coal production, we could see a decrease in coal jobs," he added.

Legal experts say it could take years for the Trump administration to unwind the Clean Power Plan, which has not yet been carried out because it has been temporarily frozen by a Supreme Court order. Those regulations sought to cut planet-warming carbon dioxide pollution from coal-fired power plants. If enacted, they would have shut down hundreds of those plants, frozen construction of future plants and replaced them with wind and solar farms and other renewable energy sources.

Throughout his campaign, Mr. Trump highlighted his support of coal miners, holding multiple rallies in coal country and vowing to restore lost jobs to the flagging industry. At a rally last week in Kentucky, Mr. Trump vowed that his executive order would "save our wonderful coal miners from continuing to be put out of work."

While coal mining jobs have dropped in the United States, they do not represent a significant portion of the American economy. Coal companies employed about 65,971 miners in 2015, down from 87,755 in 2008, according to Energy Department statistics.

And though the percentage of coal mining jobs dropped sharply, economists said that was not

driven by the Clean Power Plan. Rather, they blamed two key forces: an increase in the production of natural gas, which is a cheaper, cleaner-burning alternative to coal, and an increase in automation, which allowed coal companies to produce more fuel with fewer employees. The rollback of Mr. Obama's regulations will not change either of those forces, economists say.

"The problem with coal jobs has not been CO_2 regulations, so this will probably not bring back coal jobs," Mr. Godby said. "The problem has been that there has not been market demand for coal."

The coal industry nonetheless cheered the move.

"These actions are vital to the American coal industry, to our survival, and to getting some of our coal families back to work," said Robert E. Murray, the chief executive of Murray Energy, one of the nation's largest coal mining companies.

But even Mr. Murray conceded that he did not expect Mr. Trump's order to return coal mining numbers to their former strength. "I really don't know how far the coal industry can be brought back," he said.

Mr. Trump's directive also eliminates about a half-dozen of Mr. Obama's smaller executive orders and memorandums related to combating climate change.

For example, the order would require White House economists to recalculate a budgeting metric known as the social cost of carbon that, under the Obama administration, limited pollution by arguing that global warming outweighed economic benefits for industries. It would also eliminate a requirement that federal agencies consider the impact on climate change when analyzing all future environmental permits.

Combined, the measures are likely to ensure the United States' emissions of planet-warming pollution remain too high to meet the terms of the Paris climate accord.

The aim of the Paris deal is to reduce emissions enough to stave off a warming of the planet by more than 3.6 degrees Fahrenheit, the level at which, experts say, the Earth will be irrevocably locked into a future of extreme droughts, flooding and shortages of food and water.

But analysts say Mr. Trump's order signals that the United States will not meet its pledges under the Paris deal to cut its emissions about 26 percent from 2005 levels by 2025.

"Meeting the U.S. terms of the Paris Agreement would require full enforcement of the current regulations, plus additional regulations," said Michael Oppenheimer, a climate scientist at Princeton University. "It takes a comprehensive effort involving every country doing what they committed to and more."

He said Mr. Trump's order "sends a signal to other countries that they might not have to meet their commitments — which would mean that the world would fail to stay out of the climate danger zone."

AP

http://hosted.ap.org/dynamic/stories/U/US_TRUMP_CLIMATE_PLAN?SITE=AP&SECTION=HOME&TEMI
03-28-08-51-48

Trump puts anti-global warming projects on chopping block

By Matthew Daly and Jill Colvin 3/28/17 2:58PM

WASHINGTON (AP) -- Declaring "the start of a new era" in energy production, President Donald Trump signed an executive order Tuesday that he said would revive the coal industry and create jobs.

The move makes good on his campaign pledge to unravel former President Barack Obama's plan to curb global warming. The order seeks to suspend, rescind or flag for review more than a half-dozen measures in an effort to boost domestic energy production in the form of fossil fuels.

Environmental activists, including former Vice President Al Gore, denounced the plan. But Trump said the effort would allow workers to "succeed on a level playing field for the first time in a long time."

"That is what this is all about: bringing back our jobs, bringing back our dreams and making America wealthy again," Trump said, during a ceremony at the Environmental Protection Agency headquarters, attended by a number of coal miners.

The order initiates a review of the Clean Power Plan, which restricts greenhouse gas emissions at coal-fired power plants. The regulation, which was the former president's signature effort to curb carbon emissions, has been the subject of long-running legal challenges by Republican-led states and those who profit from burning oil, coal and gas.

But just as Obama's climate efforts were often stymied by legal challenges, environmental groups are promising to fight Trump's pro-fossil fuel agenda in court.

Trump has called global warming a "hoax" invented by the Chinese, and has repeatedly criticized the power-plant rule as an attack on American workers and the struggling U.S. coal industry.

In addition to pulling back from the Clean Power Plan, the administration will also lift a 14-month-old moratorium on new coal leases on federal lands.

The Obama administration had imposed a three-year moratorium on new federal coal leases in January 2016, arguing that the $1 billion-a-year program must be modernized to ensure a fair financial return to taxpayers and address climate change.

Trump accused his predecessor of waging a "war on coal" and boasted in a speech to Congress that he has made "a historic effort to massively reduce job-crushing regulations," including some that threaten "the future and livelihoods of our great coal miners."

The order will also chip away at other regulations, including scrapping language on the "social cost" of greenhouse gases. It will initiate a review of efforts to reduce the emission of methane in oil and natural gas production as well as a Bureau of Land Management hydraulic fracturing rule, to determine whether those reflect the president's policy priorities.

It will also rescind Obama-era executive orders and memoranda, including one that addressed climate change and national security and one that sought to prepare the country for the impacts of climate change.

The administration is still in discussion about whether it intends to withdraw from the Paris Agreement on climate change.

Trump's order could make it more difficult, though not impossible, for the U.S. to achieve its carbon reduction goals. The president's promises to boost coal jobs run counter to market forces, such as U.S. utilities converting coal-fired power plants to cheaper, cleaner-burning natural gas.

Trump's Environmental Protection Agency chief, Scott Pruitt, alarmed environmental groups and scientists earlier this month when he said he does not believe carbon dioxide is a primary contributor to global warming. The statement is at odds with mainstream scientific consensus and Pruitt's own agency.

The overwhelming majority of peer-reviewed studies and climate scientists agree the planet is warming, mostly due to man-made sources, including carbon dioxide, methane, halocarbons and nitrogen oxide.

Opponents say Obama's effort would have killed coal-mining jobs and driven up electricity costs. The Obama administration, some Democratic-led states and environmental groups counter that it would spur thousands of clean-energy jobs and help the U.S. meet ambitious goals to reduce carbon pollution set by the international agreement signed in Paris.

Trump's order on coal-fired power plants follows an executive order he signed last month mandating a review of an Obama-era rule aimed at protecting small streams and wetlands from development and pollution. The order instructs the EPA and Army Corps of Engineers to review a rule that redefined "waters of the United States" protected under the Clean Water Act to include smaller creeks and wetlands.

While Republicans have blamed Obama-era environmental regulations for the loss of coal jobs, federal data shows that U.S. mines have been shedding jobs for decades under presidents from both parties as a result of increasing automation and competition from natural gas, which has become more abundant through hydraulic fracturing. Another factor is the plummeting cost of solar panels and wind turbines, which now can produce emissions-free electricity cheaper than burning coal.

According to an Energy Department analysis released in January, coal mining now accounts for fewer than 75,000 U.S. jobs. By contrast, renewable energy - including wind, solar and biofuels - now accounts for more than 650,000 U.S. jobs.

The Trump administration's plans drew praise from business groups and condemnation from environmental groups.

U.S. Chamber of Commerce President Thomas J. Donohue praised the president for taking "bold steps to make regulatory relief and energy security a top priority."

"These executive actions are a welcome departure from the previous administration's strategy of making energy more expensive through costly, job-killing regulations that choked our economy," he said.

Former Vice President Al Gore blasted the order as "a misguided step away from a sustainable, carbon-free future for ourselves and generations to come."

"It is essential, not only to our planet, but also to our economic future, that the United States continues to serve as a global leader in solving the climate crisis by transitioning to clean energy, a transition that will continue to gain speed due to the increasing competiveness of solar and wind," he said in a statement.

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Reuters

http://www.reuters.com/article/us-usa-trump-energy-idUSKBN16Z1L6

Trump signs order sweeping away Obama-era climate policies

By Valerie Volcovici and Jeff Mason 3/28/17, 2:48PM

U.S. President Donald Trump signed an executive order on Tuesday to undo a slew of Obama-era climate change regulations that his administration says is hobbling oil drillers and coal miners, a move environmental groups have vowed to take to court.

The decree's main target is former President Barack Obama's Clean Power Plan that required states to slash carbon emissions from power plants - a critical element in helping the United States meet its commitments to a global climate change accord reached by nearly 200 countries in Paris in 2015.

The so-called "Energy Independence" order also reverses a ban on coal leasing on federal lands, undoes rules to curb methane emissions from oil and gas production, and reduces the weight of climate change and carbon emissions in policy and infrastructure permitting decisions.

"I am taking historic steps to lift restrictions on American energy, to reverse government intrusion, and to cancel job-killing regulations," Trump said at the Environmental Protection Agency headquarters, speaking on a stage lined with coal miners.

The wide-ranging order is the boldest yet in Trump's broader push to cut environmental regulation to revive the drilling and mining industries, a promise he made repeatedly during the presidential campaign. But energy analysts and executives have questioned whether the moves will have a big effect on their industries, and environmentalists have called them reckless.

"I cannot tell you how many jobs the executive order is going to create but I can tell you that it provides confidence in this administration's commitment to the coal industry," Kentucky Coal Association president Tyler White told Reuters.

Trump signed the order with EPA Administrator Scott Pruitt, Interior Secretary Ryan Zinke, Energy Secretary Rick Perry and Vice President Mike Pence by his side.

U.S. presidents have aimed to reduce U.S. dependence on foreign oil since the Arab oil embargo of the 1970s, which triggered soaring prices. But the United States still imports about 7.9 million barrels of crude oil a day, almost enough meet total oil demand in Japan and India combined.

While Trump's administration has said reducing environmental regulation will create jobs, some green groups have countered that rules supporting clean energy have done the same.

The number of jobs in the U.S. wind power industry rose 32 percent last year while solar power jobs rose by 25 percent, according to a Department of Energy study.

'ASSAULT ON AMERICAN VALUES'

Environmental groups hurled scorn on Trump's order, arguing it is dangerous and goes against the broader global trend toward cleaner energy technologies.

"These actions are an assault on American values and they endanger the health, safety and prosperity of every American," said billionaire environmental activist Tom Steyer, the head of activist group NextGen Climate.

Green group Earthjustice was one of many organizations that said it will fight the order both in and out of court. "This order ignores the law and scientific reality," said its president, Trip Van Noppen.

An overwhelming majority of scientists believe that human use of oil and coal for energy is a main driver of climate change, causing a damaging rise in sea levels, droughts, and more frequent violent storms.

But Trump and several members of his administration have doubts about climate change, and Trump promised during his campaign to pull the United States out of the Paris climate accord, arguing it would hurt U.S. business.

Since being elected Trump has been mum on the Paris deal and the executive order does not address it.

Christiana Figueres, former executive secretary of the United Nations Framework Convention on Climate Change who helped broker the Paris accord, lamented Trump's order.

"Trying to make fossil fuels remain competitive in the face of a booming clean renewable power sector, with the clean air and plentiful jobs it continues to generate, is going against the flow of economics," she said.

The order will direct the EPA to start a formal "review" process to undo the Clean Power Plan, which was introduced by Obama in 2014 but was never implemented in part because of legal challenges brought by Republican-controlled states.

The Clean Power Plan required states to collectively cut carbon emissions from power plants by 32 percent below 2005 levels by 2030.

Some 85 percent of U.S. states are on track to meet the targets despite the fact the rule has not been implemented, according to Bill Becker, director of the National Association of Clean Air Agencies, a group of state and local air pollution control agencies.

Trump's order also lifts the Interior Department's Bureau of Land Management's temporary ban on coal leasing on federal property put in place by Obama in 2016 as part of a review to study the program's impact on climate change and ensure royalty revenues were fair to taxpayers.

It also asks federal agencies to discount the cost of carbon in policy decisions and the weight of climate change considerations in infrastructure permitting, and reverses rules limiting methane leakage from oil and gas facilities.

Bloomberg

https://www.bloomberg.com/politics/articles/2017-03-28/trump-to-cancel-obama-s-policies-aimed-at-paris-climate-pledge

Trump Sweeps Away Climate Rules Vowing 'New Energy Revolution'

By Jennifer A Dlouhy 3/28/17 2:58PM

President Donald Trump moved aggressively to undo his predecessor's carbon-cutting commitments, promising "a new energy revolution" that would unleash America's abundant fossil-fuel resources.

Flanked by coal miners, Trump signed an executive order Tuesday that begins unraveling a raft of rules and directives to combat climate change, which President Barack Obama wove into the fabric of the federal government as he made addressing the issue a centerpiece of his second term.

"My administration is putting an end to the war on coal," Trump said, highlighting the coming rollback of Obama's Clean Power Plan, a rule that discouraged utilities from using the fossil fuel to generate electricity. "Perhaps no single regulation threatens our miners, energy workers and companies more than this crushing attack on American industry."

Trump, who once called climate change a hoax, has vowed to reorient the federal government so that U.S. oil and coal producers thrive, while manufacturers aren't burdened by "job-killing" restrictions -- a commitment he reiterated Tuesday at the Environmental Protection Agency. The U.S. is "ending the theft of American prosperity," he said.

He stopped short of withdrawing the U.S. from the landmark Paris accord on climate change negotiated by his predecessor. Aides say that is still being discussed, even as the steps he took would make it hard for the nation to keep its commitment.

Some changes will happen immediately, such as the repeal of a 2016 policy that encouraged federal regulators to consider climate change in environmental reviews as well as directives from Obama that compelled government agencies and the military to factor the phenomenon into their planning. The Interior Department also will swiftly rescind a moratorium on the sale of new rights to extract coal on federal land.

And the Trump administration also is tossing an Obama-era "social cost of carbon" metric that estimated the potential economic damage from climate change and was used to justify a slew of environmental actions, from efficiency standards for microwave ovens to the revamp of government buildings. Instead, the government will return to an earlier 2003 approach for estimating the potential costs of any regulations governing greenhouse gas emissions.

Other policy pivots will take years of work, such as reversing the Clean Power Plan that forced states to cut greenhouse gas emissions from electricity. An Interior Department rule setting requirements for hydraulic fracturing on federal land will be rescinded. And a pair of regulations governing potent methane emissions from oil and gas wells also will be reviewed at the Environmental Protection Agency and the Interior Department -- with possible changes or a reversal years away.

Most -- if not all -- of the changes will face legal challenges from the same environmentalists who already are fighting to defend Obama's Clean Power Plan in federal court.

"In taking a sledgehammer to U.S. climate action, the administration will push the country backward, making it harder and more expensive to reduce emissions," Andrew Steer, president of the World Resources Institute, said in an emailed statement. "Climate science is clear and unwavering: mounting greenhouse gas emissions are warming our planet, putting people and business in harm's way."

Agencies will have to justify their regulatory reversals and submit the proposed changes to public comment. And saying climate change isn't real won't cut it, said Gina McCarthy, the former EPA administrator who drove many of the mandates now on the chopping block.

"They are going to have to figure out a lot better argument than that," McCarthy said in a phone interview.

Unwinding some mandates will be tougher than others, notes Victor Flatt, co-director of the Center for Climate, Energy, Environment and Economics at the University of North Carolina School of Law.

"According to the Supreme Court, all actions by federal agencies, including rulemakings, must be made on the basis of evidence, and may not be arbitrary and capricious or an abuse of discretion," Flatt said by email.

"Having established a deep base of evidence in support of these rules, the EPA can't simply say it changed its mind. It'll need new evidence, new analysis, new public comments, a new cost-benefit analysis, and in all likelihood, new litigation."

Trump's order was cheered by some conservatives who have been pushing the president to go even further in stripping climate regulations from the rulebooks, including by undoing the EPA's landmark declaration that greenhouse gas emissions jeopardize the public health and welfare. That 2009 endangerment finding served as the underpinning for later EPA carbon rules.

Myron Ebell, director of the Competitive Enterprise Institute's Center for Energy and Environment, cast Trump's executive order as a good start.

"It takes the necessary first steps in undoing President Obama's energy-rationing agenda," Ebell said by email. "Of course, there is more work to be done down the road, most importantly withdrawing from the Paris climate treaty and reopening the endangerment finding."

The Trump administration hasn't said if the U.S. will remain a part of that 2015 Paris climate accord -- despite the president's campaign pledges to rip up the deal that set broad, non-binding carbon-cutting targets for the U.S. and nearly 200 other countries.

Secretary Tillerson

Secretary of State Rex Tillerson has advocated the U.S. keep its seat at the table by sticking with the plan. Even without formally pulling out of the Paris pact, the U.S. is abandoning its pledge to pay $3 billion into a United Nations fund to help countries on the front lines of climate change.

Trump's actions are politically significant, following months of promises to reverse the fortunes of struggling coal miners -- campaign vows that helped propel him to victory in industrial strongholds like West Virginia and Pennsylvania. Although the changes he is setting in motion will make it cheaper to extract coal and use it to generate electricity, they are unlikely to dramatically boost domestic demand for coal, which faces stiff competition from cheap natural gas and is affected by other pollution regulations untouched by Trump's order.

And mining jobs have been in decline for decades as automated equipment increasingly unearths coal, doing the work that once required pick axes and mules.

Even before the Obama administration imposed the coal-leasing moratorium in January 2016, coal producers had little interest in adding new federal reserves to their portfolios, amid slumping domestic demand. Existing federal leases contain at least 20 years' worth of coal, according to Interior Department estimates.

It was not immediately clear Monday whether Trump's Interior Department would continue a broad review of the federal coal leasing program even as it restarts sales; that analysis is already about a third complete, with regulators unveiling a broad blueprint of possible changes earlier this year.

Sierra Club Executive Director Michael Brune called Trump's order "the single biggest attack on climate action in U.S. history" and said it was a misguided attempt to help workers displaced by the global shift to cleaner energy sources.

"The best way to protect workers and the environment is to invest in growing the clean energy economy that is already outpacing fossil fuels and ensuring no one is left behind," Brune said in an emailed statement. "At a time when we can declare independence from dirty fuels by

embracing clean energy, this action could only deepen our dependence on fuels that pollute our air, water and climate while making our kids sicker."

Legal Limbo

The EPA's Clean Power Plan was already in legal limbo, having been put on hold by the Supreme Court in February 2016, while lower court proceedings were underway. The U.S. Court of Appeals heard arguments on the challenge last September but has not ruled on the case that the Trump administration will now seek to put on hold. Environmental groups and states that support the rule and are defending it in court have vowed to fight to keep those proceedings going.

Janet McCabe, the former head of the EPA Office of Air and Radiation that helped develop the Clean Power Plan, defended the measure as a "solid, reasonable and flexible rule based on years of research and outreach that follows" an ongoing market transition toward cleaner energy. "EPA has an obligation to address carbon pollution," she said in an emailed statement. "Congress put the Clean Air Act in place to protect Americans from air pollution, and there is no doubt greenhouse gases are air pollution; the science makes that crystal clear."

Critics of the initiative said the EPA went beyond its authority under the Clean Air Act by imposing broad statewide emissions targets, rather than specific mandates for individual power plants.

"The Clean Power plan was an unprecedented power grab by the previous administration that was built on a shaky legal foundation," said Thomas Pyle, head of the American Energy Alliance, a fossil fuel-oriented free market advocacy group. "This executive order won't get rid of the regulation overnight, but it's an important first step that reaffirms President Trump's commitment to protecting American families from higher energy costs."

Politico

http://www.politico.com/story/2017/03/donald-trump-climate-change-executive-order-236597

Trump signs order to unwind Obama's climate actions

By Politico Staff 3/28/17, 2:33PM

President Donald Trump on Tuesday signed an executive order that represents his biggest effort yet to erase former President Barack Obama's legacy on climate change.

The order directs EPA to begin rolling back the Clean Power Plan, the landmark 2015 rule requiring existing power plants to curb their greenhouse gas emissions.

Also on the chopping block are a year-old coal leasing moratorium, regulations on methane emissions and fracking, White House guidance on incorporating climate change into federal projects and the "social cost of carbon," a dollar amount of damage estimated for carbon dioxide emissions.

The Hill

http://thehill.com/policy/energy-environment/326124-trump-signs-order-to-roll-back-obamas-climate-moves

Trump signs order to roll Obama's climate moves

By Timothy Cama 3/28/17, 2:28PM

President Trump on Tuesday signed a wide-ranging executive order to start the process of rolling back former President Obama's aggressive climate change agenda, promising that the measure would create jobs in the fossil fuel industry.

Trump signed the order in a ceremony at the headquarters of the Environmental Protection Agency (EPA), the agency responsible for many of the major policies being targeted.

He was flanked by coal miners — whom EPA Administrator Scott Pruitt joked "might never have been to the EPA before" — as well as cabinet officials and Vice President Mike Pence, who celebrated the executive order as a repudiation of the Obama administration's climate agenda.

"My administration is putting an end to the war on coal," Trump said, using a term coined by the industry and its supporters to describe government regulations.

"I am taking an historic step to lift the restrictions on American energy, to reverse government intrusion and to cancel job-killing regulations."

The administration is pitching the order primarily as a move to increase the nation's energy independence, with the added effect of increasing jobs in affected sectors and related industries.

Trump said the order fulfills a promise made to coal miners during his presidential campaign. He recounted a trip to West Virginia when he met with miners who told him they wanted to continue working in the industry despite a downturn in employment.

"I said, if that's what you want to do, that's what you're doing to do," Trump said.

"The miners told me about the attacks on their jobs and their livelihoods. ... I made them this promise: we will put our miners back to work."

Experts and environmental groups challenge the assertion that rolling back Obama's policies would benefit energy independence or jobs.

"Right now, clean energy jobs already overwhelm dirty fuels in nearly every state across America, and that growth is only going to continue as clean energy keeps getting more affordable and accessible by the day," Sierra Club Executive Director Michael Brune said in a statement.

"These facts make it clear that Donald Trump is attacking clean energy jobs purely in order to boost the profits of fossil fuel billionaires."

The most significant piece of the order instructs the EPA to formally consider repealing the Clean Power Plan. It was the central piece of Obama's second-term climate agenda, setting a 32 percent cut in the power sector's carbon dioxide emissions by 2030.

Federal regulators are also asked under the order to consider repealing the EPA's carbon limits for newly built power plants and methane emissions standards for oil and natural gas drilling from the EPA and the Interior Department.

It also has some immediate effects. The order stops Interior's moratorium on new coal-mining leases on federal land, something Obama instituted to study how to charge coal companies for the climate impacts of the fuel they mine on federal property.

It also stops policies asking federal agencies to consider climate change in environmental reviews, a government-wide accounting method for climate change regulations called the "social cost of carbon" and Obama executive orders on climate, like one asking that infrastructure be built to withstand a future climate affected by global warming.

Fossil fuel industries stand to benefit from the order, and many voiced their support for the measure this week.

Oil and natural gas groups, for instance, have fought back against the methane rules in court and in Congress.

But Trump and his administration have had a special affinity for the coal industry. The sector is suffering through an economic downturn due in large part to declining demand for its product, which is increasingly being replaced by cheaper and more plentiful natural gas.

Trump framed his order Tuesday as a measure to help put coal miners back to work, a promise repeated this week by administration officials like Pruitt and Interior Secretary Ryan Zinke.

"You know what this says?" Trump asked a miner before he signed the order on Tuesday. "You're going back to work."

E&E News

http://www.eenews.net/greenwire/2017/03/28/stories/1060052208

White House outlines more cuts for energy, environment

By George Cahlink 3/28/17

The White House is asking Congress to slash billions of dollars from energy and environmental programs for the last six months of fiscal 2017, beyond the already deep cuts it previously proposed for next year.

According to budget documents obtained by E&E News, the Trump administration is proposing that $1.75 billion be cut from the Energy and Water Development appropriations bill and $714 million be carved from the Interior and Environment spending measure.

Specifically, the administration would cut the Department of Energy by $1.43 billion, U.S. EPA by $247 million, the Interior Department by $371 million and the National Oceanic and Atmospheric Administration by $300 million.

The administration sent the proposals to Capitol Hill on Friday as lawmakers and the White House prepare for grinding talks over spending for the last half of fiscal 2017. A stopgap funding measure, known as a continuing resolution, expires April 28, and Congress will need to put a new spending plan in place by then or face a politically treacherous government shutdown.

The White House earlier this month said it wanted $18 billion in domestic spending cuts for fiscal 2017 to help fund a $33 billion hike in supplemental defense spending for the final six months of the year. Documents circulated this week mark the first time the administration has

offered details on where those supplemental cuts would be taken, the bulk of them — about $7.25 billion — coming from the Labor, Health and Human Services, and Education spending bill.

Lawmakers are unlikely to welcome the domestic cuts that many in both parties have said are not the way to pay for Pentagon increases. Several appropriators said they would prefer the defense hike be counted as emergency spending so it would not require offsetting cuts.

House Minority Whip Steny Hoyer (D-Md.) told reporters today that proposing additional cuts to energy and environmental programs across government is a "non-starter" for the supplemental spending measure. He said Congress should stick to the two-year budget agreement passed in 2015 that sets spending caps for fiscal 2016 and 2017.

"The 'art of the deal' is keeping the deal," he said.

A Senate appropriations aide stressed the reductions were not being floated by Senate Republicans.

The proposed cuts to energy and environmental programs target efforts that President Trump has already said would be or are expected to be cut in fiscal 2018. The full budget proposal for next year is due in May.

Chopping block

Under the proposal for the rest of fiscal 2017, DOE's renewable energy and energy efficiency efforts would face the budget ax.

The administration wants to cut about 25 percent ($516 million) from the $2 billion energy efficiency and renewable energy program by decreasing grants and rescinding unobligated spending. The Advanced Research Projects Agency-Energy budget, where the department has focused on commercializing clean energy technologies, would be reduced by more than 50 percent ($150 million) from $290 million.

Fossil fuel research programs would also take a more than 50 percent hit ($341 million) from current spending of $631 million for the rest of the year. The savings would come largely by cutting research grants.

At EPA, state environmental grant programs would be cut by about 10 percent ($115 million) from $1.079 billion. The White House notes that the reduction would help the agency ease into far larger reductions of about 44 percent for those grant programs it is seeking for fiscal 2018.

Also marked for cuts would be EPA research and development programs by about 10 percent ($48 million) from $483 million. Documents say the money would come out of climate research programs and grants.

At Interior, the single largest savings would come from tapping $230 million in proceeds in the department's Southern Nevada Public Land Management account, which collects fees from public lands sales around Las Vegas. Other reductions would hit the Abandoned Mine Land Reclamation Program ($90 million) and the payment-in-lieu-of-taxes program ($51 million).

For the National Oceanic and Atmospheric Administration, the proposal would cut funding for the National Sea Grant College Program by $30 million, from its current budget of $73 million. The administration wants to completely eliminate it in fiscal 2018. The program supports research at 33 universities and is popular among both Republicans and Democrats, but the administration calls it a "lower priority research grant program that primarily benefits industry and state and local stakeholders."

Trump is also asking Congress to eliminate funding for the Pacific Coastal Salmon Recovery Fund, noting that it has collected $1 billion since 2000. NOAA has repeatedly — and unsuccessfully — tried to decrease the program's funding. Congress reliably funds it anyway, at $65 million annually.

The Trump administration's proposed cuts would represent a double hit for the agencies.

The reductions would come from current, fiscal 2017 spending, which is mostly based on fiscal 2016 levels since the government has been operating under a CR. In many cases, the current spending is lower than what agencies had sought in their fiscal 2017 budget requests.

E&E News

http://www.eenews.net/greenwire/2017/03/28/stories/1060052207

Greens search for silver linings in executive action

By Hannah Hess 3/28/17

On an otherwise dismal day for environmentalists, supporters of climate action see some silver linings for the power sector.

The centerpiece of President Trump's new energy directive, ordering U.S. EPA to review the Clean Power Plan, does not undo the Obama administration's groundwork in the effort to cut greenhouse gas emissions.

The unprecedented amount of planning, analysis and engagement that the agency conducted ahead of its rules on new and existing power plants provide a path forward for utilities and regional authorities to advance the dialogue on climate issues.

Increased energy efficiency, more renewable energy and conversations among stakeholders about how to rein in emissions can still happen — and may even be easier with the Clean Power Plan gone, said Vicki Arroyo, executive director of the Georgetown Climate Center.

"Not that I want to laud the demise of the Clean Power Plan after so many have done so much to try to bring it about, but I do think that, at least in a handful of states, it might be a bit easier for people to have these conversations without some of the partisanship and polarization we saw around the Clean Power Plan," Arroyo said at a recent forum on climate action.

Bill Becker, executive director of the National Association of Clean Air Agencies, noted that 75 percent of the states are already meeting their 2022 interim greenhouse gas targets under the Clean Power Plan, 20 percent of the states are meeting their 2030 final targets, and 85 percent of the states are on track to meet their final 2030 targets.

"The CPP lays the groundwork for ... integration of state air quality, energy and utility planning, and expanded dialogue among states and between regions of the country," Becker said today. "If the Trump executive order prevails, the CPP will, nonetheless, leave a legacy in the form of a substantial impact on states' actions to address the challenges of climate change."

Sizing up coal's role

Ahead of Trump's trip to U.S. EPA headquarters this afternoon, mining officials and oil and gas

industry groups welcomed his plan to wipe out many of the Obama administration's executive orders dealing with climate change and its coal-leasing moratorium on public lands (*Greenwire*, March 27).

Hal Quinn, the National Mining Association's president and CEO, praised the action and called the Clean Power Plan "an unlawful attempt to radically transform the nation's power grid, destroying valuable energy assets and leaving our economy more vulnerable to rising power prices — all for no discernible environmental benefit."

Senate Majority Leader Mitch McConnell (R-Ky.) said Trump's action would be good news for coal communities, calling it a "victory" for middle-class families and "another important step away from the overregulation of the Obama years." McConnell also urged EPA to work with stakeholders.

American Petroleum Institute President and CEO Jack Gerard also called the executive order an "important step." Gerard said API anticipates working with the administration and Congress on "forward-looking energy policies" that help maintain U.S. leadership in the production and refining of oil and natural gas and the reduction of carbon emissions.

Scott Segal, an industry lawyer at Bracewell LLP, said the executive order "can remove the shadow of a regulatory straitjacket" and replace it with market principles that would perhaps help the coal industry.

"If going-forward policy makes more accurate technological assumptions, removes clear obstacles like leasing moratoriums, and seizes the opportunity to clarify Clean Air Act applicability to efficiency improvement, coal can be advantaged by the executive order and subsequent actions," Segal said in an email.

First move of 'long chess game'

Richard Revesz, director of the Institute for Policy Integrity at the New York University School of Law, argued that the executive order has no legal significance at all when it comes to the Clean Power Plan, due to the drawn-out nature of the rulemaking process.

"This is the first move of a long chess game that will take years to unfold, and future moves will be far more challenging," Revesz said.

EPA will need to initiate a notice-and-comment rulemaking process that has many significant built-in hurdles, and when the agency promulgates its final rule, it will need to respond to potentially millions of comments.

"Then, the litigation will start, first in the D.C. Circuit and then, perhaps, in the Supreme Court. This issue might not be resolved before the 2020 election, so the fate of the Clean Power Plan might ultimately be determined by the winner of that election," Revesz said.

Environmentalists have planned an "emergency rally" this evening at Lafayette Square in front of the White House to advocate for the Clean Power Plan. Mustafa Ali, who recently left his post as EPA's assistant associate administrator for environmental justice to join the Hip Hop Caucus, will attend, along with NextGen Climate President Tom Steyer.

Another silver lining for climate action: The order is mum on whether the United States should withdraw from the Paris Agreement, under which it has pledged to cut its greenhouse gas emissions between 26 and 28 percent by 2025 compared to 2005 levels. Trump advisers are still divided on whether to withdraw (*see related story*).

"You can't just stay in the Paris Agreement, then do nothing — it requires some action," said Jon Sohn, an attorney with multinational law firm Dentons. "This would have been the ideal moment to include something about Paris, and they didn't."

By staying in the agreement, the United States would still be required to submit future targets for cutting greenhouse gas emissions and contribute to international climate finance, Sohn said.

Countries agreed at Paris to come back in 2018 to take stock of initial progress toward their collective goal and to inform new or updated targets that would be put forward by 2020. After 2020, this will be followed by "global stocktakes" every five years starting in 2023, Sohn said.

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Huffington Post

http://www.huffingtonpost.com/entry/trump-climate-order_us_559aab91e4b0c706985a42be

Donald Trump's Disastrous Plan To Derail U.S. Climate Action

By Alissa Scheller and Alexander Kaufman 3/28/17, 2:35PM

President Donald Trump signed a sweeping executive order on Tuesday aimed at reversing much of former President Barack Obama's efforts to shrink the United States' carbon footprint.

The long-awaited order instructs the Environmental Protection Agency to review the Clean Power Plan, the Obama administration's signature policy for slashing greenhouse gas emissions from the utility sector, by far the country's biggest emitter. This review marks the first step toward scrapping the regulation.

"Perhaps no single regulation threatens our miners, energy workers and companies more than this crushing attack on American industry," Trump said at the 2 p.m. signing at the EPA. "**We're ending the theft of American prosperity and rebuilding our beloved country."**

Trump's order also directs the Department of the Interior to lift a temporary ban, put in place last year, on coal leasing on federal lands. In addition, it eliminates federal guidance instructing agencies to factor climate change into policymaking and disbands a team tasked with calculating the "social cost of carbon."

By undoing the Clean Power Plan, the Trump administration is putting projected carbon emissions back on an upward trajectory. It is also abandoning any hope of meeting the U.S. emissions reduction targets set out in 2015 in the 195-country Paris Agreement, the first global climate pact to include China and the U.S., the world's top polluters.

China ratified the Paris climate deal in September. In January, Chinese President Xi Jinping urged the U.S. not to withdraw from the agreement. Trump's executive order does not contain language critical of the Paris accord, reflecting pressure from Trump's few advisers who don't take a hard-line stance against climate science.

To be sure, the Trump administration can't just get rid of the Clean Power Plan outright. In his previous role as Oklahoma's attorney general, EPA chief Scott Pruitt sued the Obama administration to block the plan, claiming the rule overstepped the EPA's legal mandate.

In a victory for Pruitt and other Republican state attorneys general, the Supreme Court issued a stay on implementing the plan in February 2016. But the high court's 2007 ruling in Massachusetts v. EPA, which categorized greenhouse gases as a pollutant, legally compels the federal environmental agency to police emissions.

“It looks like there’s going to be a reopening of the whole question of the best way, the legal way, to get at the largest source of greenhouse gas pollution in our country, which is the fossil fuel-fired power plants,” Frank Rambo, head of clean energy and air pollution at the nonprofit Southern Environmental Law Center, told The Huffington Post in an interview ahead of the order’s release.

Environmentalists are likely to sue to protect the Clean Power Plan, forcing the White House to prove in court that the regulation meets the legal standard of “arbitrary and capricious.” To successfully employ this standard to overturn a previous court ruling, White House attorneys would have to debunk the overwhelming scientific consensus that global warming is man-made.

The biggest problem with dismantling the Clean Power Plan is that the plan itself represents only a preliminary step toward reaching emissions reduction goals. Even if the plan were to be perfectly implemented, the U.S. would still be progressing only halfway toward achieving its emissions goals for 2025. Trump may fail to completely undo the plan, but his administration seems unlikely to enact other policies to reduce emissions.

Trump pledged to boost the U.S. economy by gutting environmental regulations he blames for holding back businesses. Earlier this month, he proposed slashing the EPA budget by nearly one-third, eliminating popular programs like Energy Star and hampering the agency’s enforcement division. The EPA already rescinded a rule this month requiring oil and gas drillers to report leaks of methane, a greenhouse gas 40 times more potent than carbon dioxide.

Kneecapping U.S. participation in the Paris Agreement could jeopardize the future of the deal itself. The accord, signed in December 2015, set out global emissions targets far below what’s required to prevent world temperatures from surpassing the 3.6-degree Fahrenheit increase that scientists say will irreversibly damage human civilization.

The language of the Paris deal urges the United Nations to reconvene every five years to set new, more stringent goals. If a country as wealthy and powerful as the U.S. fails to meet its baseline commitments, it’s unlikely that poor, developing countries that depend on fossil fuels to grow their economies will make ambitious emissions cuts themselves.

The failure of previous global deals, such as the 1992 Kyoto Protocol, hinged in large part on the U.S.’s refusal to implement emission cuts. And already, Trump has proposed curtailing payments to the U.N.-administered Green Climate Fund, which helps poorer countries build renewable energy infrastructure and prepare for the effects of climate change.

“The world is safer when America is strong,” Interior Secretary Ryan Zinke said in a speech before Trump. “Our strength relies on energy.”

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USA Today

http://www.usatoday.com/story/news/politics/2017/03/28/energy-independence-not-climate-change-becomes-priority-under-trump-order/99725640/

Energy independence, not climate change, becomes priority under Trump order

By Gregory Korte 3/28/17, 2:20PM

WASHINGTON — President Trump's executive order on American energy independence is a sweeping repudiation of Obama-era environmental initiatives, substituting a strategy of combating climate change through international cooperation for an America-first energy policy.

Trump proclaimed the order as "the start of a new era of American energy production" that would "restore economic freedom and allow our workers to thrive compete and succeed on a level playing field for the first time in a long time."

Trump spoke at a signing ceremony at the Environmental Protection Agency Tuesday on a stage with a dozen coal miners.

Trump's order attempts to roll back Obama-era policies on power plant emissions limits, coal mining on federal lands, and regulations on fracking and methane. Because most of those rules were finalized under Obama, the Trump would have to start from the beginning on a rulemaking process to dismantle those regulations.

Even further, the order also takes aim at the entire framework of climate change action under the previous administration. Under Obama, federal agencies were required to plan for and mitigate the future effects of climate change, treat it as a national security issue, and attempt to reduce their own greenhouse gas emissions by 40%. All of those policies are rescinded by Trump's order.

Environmental activists deplored the order. Annie Leonard of Greenpeace USA said it showed Trump is "just a fossil fuel industry stooge with a presidential pen."

But she also cast the executive order as a temporary setback. "Thankfully, for all his bluster, the best Trump can do is delay America’s inevitable transition to clean energy, but he can’t stop it," she said.

White House officials said Trump's action "will look back and it will look forward," providing

the framework for a new Trump-era energy framework that will emphasize more production and more jobs.

And despite relaxing environmental standards, the White House argues that its energy policies can be good for the environement in the long term. "The president strongly believes that protecting the environment and promoting our economy are not mutually exclusive goals," press secretary Sean Spicer said Tuesday. "This executive order will help to ensure that we have clean air and clean water without sacrificing economic growth and job creation."

The order will ask all federal agencies to identify obstacles to domestic energy production, with a report back to the White House for future action. And Trump said the order is "returning power to the states, where that power belongs."

The order makes good on Trump's promise to end what he called a "war on coal," and to bring back coal jobs. "I made them this promise. We will put our miners back to work," Trump said Tuesday.

"The war on coal is over," said Vice President Mike Pence at an executive order signing ceremony Tuesday, flanked by Secretary of Energy Rick Perry, Interior Secretary Ryan Zinke and EPA Administrator Scott Pruitt.

Former vice president Al Gore called the order "a misguided step away from a sustainable, carbon-free future for ourselves and generations to come."

"No one man or group can stop the encouraging and escalating momentum we are experiencing in the fight to protect our planet," Gore said.

CNN

http://www.cnn.com/2017/03/27/politics/trump-climate-change-executive-order/

Trump dramatically changes US approach to climate change

By Dan Merica 3/28/17

Washington (CNN)President Donald Trump signed a sweeping executive order Tuesday at the Environmental Protection Agency, which officials said looks to curb the federal government's enforcement of climate regulations by putting American jobs above addressing climate change.

The order represents a clear difference between how Trump and former President Barack Obama view the role the United States plays in combating climate change, and dramatically alters the government's approach to rising sea levels and temperatures -- two impacts of climate change.

Trump said during the signing that the order will "eliminate federal overreach" and "start a new era of production and job creation."

"My action today is latest in steps to grow American jobs," Trump added, saying his order is "ending the theft of prosperity."

A White House official briefed on the plan said Monday the administration believes the government can both "serve the environment and increase energy independence at the same time" by urging the EPA for focus on what the administration believes is its core mission: Clean air and clean water.

More important than regulating climate change, the official said, is protecting American jobs.

"It is an issue that deserves attention," the official said of climate change. "But I think the President has been very clear that he is not going to pursue climate change policies that put the US economy at risk. It is very simple."

Tuesday's order initiates a review of the Clean Power Plan, rescinds the moratorium on coal mining on US federal lands and urges federal agencies to "identify all regulations, all rules, all policies ... that serve as obstacles and impediments to American energy independence," the official said.

Specifically, the order rescinds at least six Obama-era executive orders aimed at curbing climate change and regulating carbon emissions, including Obama's November 2013 executive order instructing the federal government to prepare for the impact of climate change and the September 2016 presidential memorandum that outlined the "growing threat to national security" that climate change poses.

"The previous administration devalued workers by their policies," the official said. "We are saying we can do both. We can protect the environment and provide people with work."

The White House official went on to argue that the best way to protect the environment is to have a strong economy, noting that countries like India and China do less to protect the environment.

"To the extent that the economy is strong and growing and you have prosperity, that is the best way to protect the environment," the official said.

The executive order also represents the greatest fears climate change advocates had when Trump was elected in November 2016.

"These actions are an assault on American values and they endanger the health, safety and prosperity of every American," Tom Steyer, the president of NexGen Climate, said in a statement. "Trump is deliberately destroying programs that create jobs and safeguards that protect our air and water, all for the sake of allowing corporate polluters to profit at our expense."

Andrew Steer, CEO of the World Resources Institute, said that the executive order shows Trump is "failing a test of leadership to protect Americans' health, the environment and economy."

Some environmental advocates have already said they plan to take legal action against the Trump administration.

But as much as Democrats and climate advocates will decry it, Trump's executive order follows the President's past comments about climate change. Though Trump told The New York Times during the election that he has an "open mind" about confronting climate change, he also once called it a hoax.

"The concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive," Trump tweeted in November 2012.

"I will also cancel all wasteful climate change spending from Obama/Clinton," Trump said in October 2016.

On Tuesday, ahead of the signing, White House press secretary Sean Spicer declined to say whether Trump still believes climate change is a hoax.

"He does not believe ... that there is a binary choice between job creation, economic growth and caring about the environment," Spicer said. "That's what we should be focusing on."

The changes, the official said, do not mean the Trump administration will not look to protect the environment any longer, the official said, but when pressed about the human impact on climate change and Trump's beliefs, the official was reluctant to say whether all government officials in the Trump White House believe humans cause climate change.

"I think there are plenty of rules on the books already. We will continue to enforce that provide for clean air and clean water. And that is what we are going to do," the official said. "The President has been very clear that he wants the EPA to stick to that basic core mission that Congress set out for it."

The changes also reflect the view of EPA Administrator Scott Pruitt, who routinely sued the organization he now leads during his time as the Attorney General of Oklahoma. In an interview with CNBC earlier this month, Pruitt argued incorrectly that carbon dioxide isn't the "primary contributor" to climate change, a comment that goes against most scientific research.

This executive order is also an attempt by the Trump administration to make good on its promise to bring more coal jobs back. The official said that Obama's regulations "were not helpful" to the coal industry and these reversals are the President honoring "a pledge he made to the coal industry."

"We are going to put our coal miners back to work," Trump said at a March 2017 event in Kentucky. "They have not been treated well, but they're going to be treated well now."

He added: "The miners are coming back."

On Tuesday at the EPA, Trump welcomed a group of miners that attended the signing and said the order was "putting an end to the war on coal."

It is unclear whether Trump's order will actually bring back coal jobs, in part, because of market forces like the rise of clean energy that are already putting pressure on the coal industry.

Robert Murray, the CEO of Murray Energy, told CNN in January that coal employment "can't be brought back to where it was before the election of Barack Obama" because of market pressure.

Mashable

http://mashable.com/2017/03/28/trump-climate-change-rollback-order-from-epa/#j6w_RvcwPiqN

In ultimate insult, Trump to roll back EPA's climate policies from within the EPA

By Maria Gallucci 3/28/17

President Donald Trump took his first swing at the Environmental Protection Agency (EPA) when he tapped the agency's biggest opponent — a man who denies climate science — to run the show. His second hit came earlier this month when Trump proposed shrinking the EPA's budget by 31 percent.

Trump will land his third big blow on Tuesday afternoon, when he is expected to issue a sweeping executive order that will begin unraveling the Obama administration's key efforts to address climate change, including the EPA's Clean Power Plan.

Adding insult to injury, he's expected to sign the order from within the very walls of the EPA's headquarters — a move that prompted plenty of bitter eye-rolling on Twitter.

The Trump administration says the order will simply prioritize the EPA's focus on clean air and water while winding down "job-killing" policies designed to reduce emissions contributing to global warming.

A White House official briefed on the plan told CNN that Trump officials believe the government can "serve the environment and increase energy independence at the same time." Trump's supporters have said the coming changes will finally lift EPA's "strangling effect" on the economy.

But many climate and environmental experts have staunchly opposed the Trump administration's regressive vision for the 47-year-old agency. The EPA is, by definition, supposed to protect Americans from environmental harm, including the effects of human-driven climate change such as rising sea levels, more intense droughts, extreme weather events and more.

Current and former EPA employees have turned out by the hundreds to oppose Trump's attempted rollback of Obama-era policies to cut emissions from power plants, automobiles and oil and gas well sites.

The EPA's new boss, Scott Pruitt, is one of the nation's biggest champions of such reversals. As Oklahoma attorney general, he led a Republican legal battle against the Clean Power Plan, which requires states to reduce carbon emissions from power plants.

Like Trump, Pruitt has also questioned the mainstream scientific consensus that the planet is warming and that human activity is primarily to blame.

While some climate rollbacks can be changed with the stroke of a pen, others could take years to complete. The Clean Power Plan, for instance, requires at least a year of bureaucratic work to unravel, and lawsuits from environmental groups could delay the process even longer.

Still, at Trump's signing ceremony, smiles and prolonged handshakes are sure to fill the room. But down the halls of the EPA, and in many homes and offices across the U.S., the mood will grow resoundingly sour.

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Gizmodo

http://gizmodo.com/trumps-drastic-move-to-dismantle-the-clean-power-plan-w-1793709534

Trump's Drastic Move to Dismantle the Clean Power Plan Won't Bring Coal Back

By Sidney Fussell 3/28/17, 11:50AM

On Tuesday, President Trump is expected to begin the process of dismantling Obama's environmental legacy, including his signature climate action policy, the Clean Power Plan. According to Reuters, Trump will sign an executive order compelling the Environmental Protection Agency to review and rewrite the plan, which calls on states to reduce carbon emissions from power plants, with an overall goal of shaving 32 percent off the power sector's greenhouse gas footprint by 2030. As Trump and EPA head Scott Pruitt see it, regulations like this need to be dismantled to end the EPA's "job killing war on coal." Other experts say a roll back of the CPP is in the fossil fuel industry's best interest, but can't revitalize Big Coal.

It's important to recognize that Trump can't unilaterally sweep away the CPP with a single executive order. All he can do is give the EPA the green light to review and rewrite the plan under Pruitt. (As Oklahoma Attorney General, Pruitt sued to block implementation of the CPP, and later, he dismissed calls from Democrats to recuse himself from the rewriting process.) Any real changes to the CPP will require years of public hearings and, undoubtedly, lawsuits from environmental agencies arguing that a coal-friendlier version of the policy doesn't go far enough in protecting us from climate pollution. In the meantime, however, Pruitt can send the message to the fossil fuel industry that the EPA, under his leadership, will be lax in enforcing regulations. The message to the rest of the world is that the America doesn't give a shit about tackling climate change.

"I think that message has already been sent," Janet McCabe, the former head of the EPA's Office of Air and Radiation, and one of the architects of the Clean Power Plan, told Gizmodo.

When crafting the CPP, McCabe told Gizmodo, the EPA's plan was to allow states to set emissions targets in line with a nationwide energy transition away from coal, and towards natural gas and green energy. Coal usage has been dropping for decades as the US invests in fracking and green energy, with solar in particular growing in prominence as prices have fallen. The regulatory impact of the CPP adds to the market forces crippling coal, but it isn't the root cause of coal's demise.

This makes it difficult to quantify what *exactly* is being caused by the CPP in terms of jobs losses, versus what's happening naturally. Or as McCabe put it, "How do you tease out the effects of the Clean Power Plan in comparison to how the market is going anyway?"

The upside of accelerating the transition away from coal, McCabe said, was the opportunities afforded to the green energy sector, which has taken off explosively in recent years, both in the United States and internationally. Green energy is expected to continue to grow as new technology makes solar panels and wind turbines more cost-effective, and as production of these technologies reaches economies of scale. Last year, renewable energy accounted for more than half of all new power-generating capacity worldwide, with roughly half a million solar panels installed around the planet each day. A person interested in bringing back American jobs might call such an industry a good investment.

"When you look at the impacts of regulation, you look not just at job losses but also potential job gains," McCabe said.

Jobs aside, the CPP is essential to upholding our commitment to the Paris Climate Agreement, an agreement between 141 countries to zero out carbon emissions this century in order to limit global warming to 2 degrees Celsius and prevent some of the more catastrophic impacts scientists are predicting. Dismantling the CPP essentially walks back our commitment not just to Paris specifically, but to international climate action. Pruitt called the agreement a "bad deal" but there's no official word on whether the US will try to withdraw, a process that would take several years.

Tellingly, several of the states that sued to block the Clean Power Plan's implementation—arguing that the rules were too stringent—are nonetheless still meeting their emissions reduction goals, because they've increased their reliance on natural gas and green energy. Even if the CPP is weakened, the market forces driving that energy transition will still exist. Gas will still be cheaper and cleaner than coal. Green energy will still, eventually, be cheaper and cleaner than coal. And a lot of coal miners will still be out of a job.

Daily Caller

http://dailycaller.com/2017/03/28/industry-eagerly-anticipating-trump-order-trashing-obamas-green-legacy/

Industry 'Eagerly Anticipating' Trump Order Trashing Obama's Green Legacy

By Andrew Follett 3/28/17, 1:03PM

The largest U.S. business lobby is excited President Donald Trump will sign an executive order to repeal much of Obama's environmental legacy.

"This is something we are eagerly anticipating," Christopher Guith, vice president for energy at the U.S. Chamber of Commerce, told The Daily Caller News Foundation. "It addresses many overreaches of the previous administration. It starts the process by which agencies can create sane and sound regulations."

Trump's order will get the Environmental Protection Agency (EPA) to revisit Obama's Clean Power Plan, alter the previous administration's environmental permitting process, and rework the government's "social cost of carbon." Rolling back these rules and regulations should get the U.S. closer to energy independence and spur job growth.

"The order give EPA premise to revisit the Clean Power Plan [CPP] which was unworkable," Guith said "This isn't about crippling the CPP, it is about making a system which actually work. This will ultimately bring about more carbon dioxide emissions reduction than Obama's plan would and will do it without the economic devastation."

If implemented, CPP would have cost a staggering $41 billion annually, which equates to about $10.74 a month for each American. Less than 39 percent of Americans would be willing to spend that level of extra cash to fight global warming, according to a poll. The Clean Power Plan would have only adverted 0.019° Celsius of warming by the year 2100, an amount so small it can't be detected, according to analysis by the libertarian Cato Institute using models created by the Environmental Protection Agency.

Trump's executive order will also change how the federal government interprets the National Environmental Policy Act (NEPA) will make it easier for companies, individuals and government entitites to get environmental permits. President Obama changed the way the government interpreted the act in a way which made permitting very difficult

"The guidance that the Obama administration put out without going through any sort of rulemaking will also be addressed," Guith told TheDCNF. "This was a godsend for

environmental lawyers as they could sue the federal government for any previous projected which addressed greenhouse gases. Rolling back the unilateral action on NEPA permitting reviews by the Obama administration will change that."

The other major impact of Trump's order is to shift the way government agencies measure carbon dioxide (CO2) emissions.

"When the Obama administration was trying to justify regulations that would cost the economy tens of billions of dollars they created this process called the Social Cost of Carbon," Guith concluded. "The Trump administration has said that this isn't how we do cost benefit analysis. We don't just invent them This was used to justify regulations which cost tens of billions of dollars and claim they were saving money."

EPA previously used the Social Cost of Carbon to claim CPP created billions of dollars in economic benefits from reducing carbon dioxide emissions, allowing the agency to significantly overstate the benefits of the regulation.

Free market groups were also pleased by the executive order, as it will significantly reduce regulation.

"President Trump's Executive Order on withdrawing much of President Obama's climate and energy-rationing agenda is welcome news for the American people," Myron Ebell, director of energy and environment at the libertarian Competitive Enterprise Institute and Trump's former EPA transition head, said in a press statement. "These rules, which are clearly illegal, would raise electric rates for consumers significantly and do immense economic damage to the heartland states where U. S. manufacturing is now concentrated."

BNA

http://esweb.bna.com/eslw/1245/split_display.adp?fedfid=108093090&vname=dennotallissues&wsn=49956600

Trump Said to Issue Far-Reaching Reversal of Obama Climate Push

By Jennifer A Dlouhy 3/28/17

President Donald Trump is set to sign a sweeping executive order March 28 aimed at promoting

domestic oil, coal and natural gas by reversing much of his predecessor's efforts to address climate change.

The document lays out a broad blueprint for the Trump administration to dismantle the architecture that former President Barack Obama built to combat the phenomenon, according to details shared with Bloomberg News. Some of the changes will happen immediately, while others will take years to complete.

The order will compel federal agencies to quickly identify any actions that could burden the production or use of domestic energy resources, including nuclear power, and then work to suspend, revise or rescind the policies unless they are legally mandated, are necessary for the public interest or promote development.

It also will toss out two Obama-era directives that gave climate change a prominent role in federal rule making. One advised government agencies to factor climate change into environmental reviews, such as those governing where oil drilling could take place. The other, called the “social cost of carbon,” is a metric reflecting the potential economic damage from climate change that the Obama administration used to justify a suite of regulations.

Pro-Growth

“This is about making sure that we have a pro-growth and pro-environment approach to how we do regulation in this country,” Scott Pruitt, head of the Environmental Protection Agency, said on ABC's “This Week” program March 26.

Trump, who has called climate change a hoax, has vowed to reorient the government so that U.S. oil and coal producers thrive and steel and auto manufacturers don't face “job-killing restrictions.” The coming order underscores Trump's commitment to make good on his campaign promises, which helped propel him to victory in industrial strongholds such as West Virginia and Pennsylvania.

The details shared with Bloomberg News reflected the latest draft of the White House order and

could change before the announcement, which Pruitt said would happen March 28.

While the order will make clear that the target of the planned regulatory rollback should be policies curbing the production of oil, natural gas, coal and nuclear energy, it also will say the U.S. is well served when affordable, reliable and clean electricity is produced from an array of sources, including solar, wind and hydropower.

The order also is set to include a targeted assault on a handful of specific Obama-era regulations. It will require the Interior Department to lift a moratorium on the sale of new coal leases on federal land and compel the EPA to review, and, “if appropriate,” begin proceedings to suspend, revise or rescind regulations designed to reduce greenhouse gas emissions from power plants.

Clean Power Plan

Obama's Clean Power Plan was designed to cut carbon dioxide emissions from electricity by 32 percent by 2030 compared to 2005 levels. The initiative has been in legal limbo since the Supreme Court stayed it while it was reviewed by a federal appeals court. The Trump administration now is expected ask that court to put the matter on hold to allow it time to revise or undo the measure—an action environmentalists have vowed to challenge.

Other policies in the crosshairs: an EPA rule setting requirements for greenhouse gas emissions for construction of new power plants and an Interior Department regulation setting mandates on hydraulic fracturing of oil and gas wells on federal lands. The Interior Department's Bureau of Land Management said earlier this month that it will begin the process to rescind the regulation, which requires companies to disclose the chemicals they pump underground and to seal off wastewater in storage tanks.

Revoking Directives

Trump's executive order also is set to revoke six specific directives from his predecessor, including Obama's broad strategy for paring emissions of methane released from oil and gas operations. Other Obama directives targeted for repeal include one on climate change and

national security, as well as a pair of directives from June 2013 that laid out his climate plans.

The Obama administration wove climate considerations into decisions across the federal bureaucracy, from efficiency standards for microwave ovens to the refurbishing of government buildings.

Coal Market

The changes may have little immediate impact on the market for coal, which is facing stiff competition from cheaper natural gas and renewable energy, analysts said.

Even before the Obama administration imposed the coal-leasing moratorium in January 2016, producers had little interest in adding new federal reserves to their portfolios amid slumping domestic demand. The U.S. government has sold just one coal leases since October 2012, though earlier this month it approved a transaction originally sought in 2005. Existing federal leases contain at least 20 years' worth of coal, according to Interior Department estimates.

Even without the EPA's Clean Power Plan in force because of the Supreme Court stay, using coal to generate electricity has been in decline as a result of previous pollution regulations and competition from low-cost natural gas, solar and wind.

Coal's Decline

The removal of the Clean Power Plan could halt coal's decline as a source of electricity during the next two decades, according to projections from the Energy Information Administration. More coal use would mean less natural gas use, EIA said.

Trump's action sets in motion at least a year of bureaucratic work at the EPA to formally dismantle the Clean Power Plan. And whatever happens will inevitably be challenged in court by those same environmental groups.

By contrast, the Interior Department can undo the coal leasing moratorium with the stroke of a pen, the same way it was imposed a year ago, under an administrative order issued by former Interior Secretary Sally Jewell.

Trump's targets also would reduce the role of climate change in government decision-making. For instance, the social cost of carbon metric served as the linchpin for many Obama administration environmental rules. Critics say the number—now nearly $40 for every metric ton of carbon dioxide emitted into the atmosphere—gives artificial precision to uncertain conditions nearly 300 years in the future.

According to shared details of the executive order, the Trump administration will disband the working group that created the social cost of carbon and return to an earlier 2003 approach for calculating the costs and benefits of proposed regulations.

Wall Street Journal

https://www.wsj.com/articles/despite-trump-move-utilities-shift-from-coal-is-set-to-continue-1490693406

Despite Trump Move on Climate Change, Utilities Shift From Coal Is Set to Continue

By Cassandra Sweet 3/28/17, 10:08AM

The Trump administration's expected move to roll back President Obama's signature climate-change policy may extend the life of some aging coal-fired power plants, but companies and energy experts say it is unlikely to reverse the U.S. utility industry's shift to natural gas, solar and wind as leading sources of electricity.

President Donald Trump is expected Tuesday to sign an executive order that would begin to reverse the Clean Power Plan, which would have required utilities to reduce power-plant carbon-dioxide emissions to 32% below 2005 levels by 2030. The order also rolls back guidance from the Council on Environmental Quality on climate change and rescinds a temporary ban on new coal leases on federal lands, a senior White House official said Monday night.

While the action may give a reprieve to some coal-fired plants facing extinction, large utilities say they will continue long-term investments to generate more power from gas, wind and solar, which are being driven by economic as well as regulatory forces. The White House official said Monday that the order is part of the president's promise to restore the coal sector, but the official acknowledged that merely repealing the regulations wouldn't bring back jobs.

Cheap U.S. natural gas unlocked by hydraulic fracturing and horizontal drilling has prompted many companies to scrap older coal plants in favor of gas-fired plants, which require fewer workers to operate. Companies are also taking advantage of tax credits for renewable power to build out solar and wind farms, which are becoming more cost-competitive with fossil-fuel generation thanks to economies of scale and advances in technology.

Duke Energy Corp. says it plans to invest $11 billion in natural gas and renewable power generation over the next 10 years, as the company aims by 2026 to cut its greenhouse-gas emissions by 35% from 2005 levels.

That represents a long-term company strategy and isn't likely to change, Duke Chief Executive Lynn Good said in a February interview. The utility's power generating mix is now 34% coal and 28% natural gas, compared with 61% coal and 5% gas in 2005. By 2026, it estimates gas will be the dominant fuel, followed by coal, nuclear and renewable power.

"Because of the competitive price of natural gas and the declining price of renewables, continuing to drive carbon out makes sense for us," said Ms. Good. "Administrations will change during the life of our business and our assets, and we'll continue to move forward in a way that makes sense for our investors and our customers."

Southern Co. plans to invest at least $1 billion a year over the next five years in new wind farms. It now uses natural gas to generate 47% of its power, with coal providing 31%, nuclear 15%, and hydropower, wind, solar and other renewable sources 7%.

"Going forward, we anticipate an increase in renewable generation capacity and declining utilization of coal," said Terrell McCollum, a spokesman for the Atlanta-based utility.

U.S. utilities generated more electricity from natural gas than from coal last year. Power from coal plants fell to 3.4 million megawatt-hours a day in 2016 to supply 30% of U.S. generation,

down from 33% in 2015, according to the U.S. Energy Department. Natural-gas plants supplied 3.8 million megawatt-hours daily, or 34% of total power supplies this past year, up from 33% the previous year.

Hydropower and other renewables generated 1.7 million megawatt-hours daily, or about 15% this past year, up from 13% in 2015. Nuclear plants contributed 20%, and petroleum and other sources produced the rest.

Without the Clean Power Plan, however, the Energy Department expects coal-fired generation from existing plants to rise and natural gas-fired generation to fall by 2020, followed by another reversal after 2030 when it anticipates gas will exceed coal again.

The extent of a coal recovery will depend largely on the price utilities pay for gas, which averaged about $3 a million British thermal units last year. The department predicts it will rise to more than $4.50 in 2020, and $5 in 2029.

Many energy companies face state requirements to increase renewable power generation and are coming under pressure from large investors such as pension funds and university endowments to clean up their operations.

More pension funds, university endowments and other funds are divesting from companies that burn coal over concerns about the environment, said Fiona Reynolds, managing director at Principles for Responsible Investment, a London-based nonprofit that helps funds figure out how to cut the carbon footprint of their investments. “Investors want to see companies that are moving away from coal, to other energies,” she said.

Nearly 700 institutions worth more than $5 trillion have pledged to divest from fossil fuel companies, according to a December report by consulting firm Arabella Advisors.

Still, some coal plants that are economical to run, particularly those owned by rural electric cooperatives in states where coal is plentiful, are likely to enjoy longer lives without the carbon rule.

Basin Electric Power Cooperative, based in Bismarck, N.D., was among the power generators that fought the Clean Power Plan in court. It was concerned it would be forced to shut down coal plants it is still paying off, and replace them with new gas plants and wind farms, at a cost of $5 billion.

“We’re building natural gas and wind, but that doesn’t mean we would take a perfectly functioning coal facility and not consider that a valuable resource as well,” said Mike Eggl, a spokesman for Basin Electric.

BBC

http://www.bbc.com/news/science-environment-39419074

Trump to make major change to US climate change narrative

By Matt McGrath 3/28/17

"This is, I think, one of the most historic attacks on climate and environmental action that the US has ever seen," said Liz Perera from the Sierra Club.

Her words are certain to cheer Trump supporters everywhere.

Green "job-killing" regulations limiting energy production have long been a red rag for Donald Trump, as candidate and President.

His **expected new energy independence executive order** seeks to radically change the US narrative on climate change, its causes and its importance. The best way of fighting global warming according to the new outline is to create prosperity. Environmental regulation should be about air and water. CO2, in this light, is your friend.

Supporters believe that cutting back Obama climate regulations will create thousands of jobs in the newly liberated oil and gas industries.

His opponents agree the new order will be a job creator - but they'll be jobs for lawyers, not in the coal fields.

Front and centre is practical action on the **Clean Power Plan** (CPP), the Obama project to cut fossil fuels from electricity production. Although it has long **been tied up in the courts**, the CPP will be left to fester there while the new administration comes up with a much weaker replacement.

"Undoing the rule will not be straightforward," said Prof Bruce Huber, from the Notre Dame law school.

"For the Environmental Protection Agency (EPA) to reverse course, it will have to propose a new rule, with all the lengthy procedures that entails. When President George W Bush tried to reverse course on some of President Clinton's signature environmental regulations, those efforts took years and were not entirely successful."

In terms of coal, the new executive order will allow the Department of the Interior to lift a moratorium on the sale of new coal leases on federal lands. However, boosting coal as a source of energy, and jobs, will be very difficult.

Many coal plants **have shut down** not because of Obama's carbon restrictions but because of mercury pollution associated with burning the fuel. Thanks to fracking, cheap natural gas has soared as a source of power generation, and renewables are taking an every bigger share.

Former State department climate adviser Andrew Light now works for the World Resources Institute. Both of his grandfathers were coal miners.

"They were paid by the tonne for the coal they pulled out of the ground, but those jobs are gone, and technology has moved beyond that and I hope it's the case that voters in the coal states will recognise that their jobs aren't magically coming back because of this executive order," he told BBC News.

President Obama sought to put consideration of climate change at the heart of all government policy - but by revising the **social cost of carbon measure** and encouraging an immediate government review of all rules that inhibit energy production, President Trump is signalling a change in the widely held philosophy that CO2 is the enemy, the main driver of climate change.

While rolling back Obama era ideas like the role of climate change in national security, or how climate change should be considered in relation to the **National Environmental Policy Act**, the Trump plan does not directly attack the key finding on which much of America's carbon restrictions are based.

Back in 2007, the US Supreme Court **ruled** that carbon dioxide gas was a pollutant under the Clean Air Act.

In response, the EPA ruled in 2009 that CO2 and other gases were responsible for contributing to climate change which results in a threat to the public health and welfare of current and future generations.

This "endangerment finding" compels the federal government to regulate emissions of CO2. And according to some environmentalists, this finding is the solid rock that Trump's plans will be dashed against.

"The law of the land is that CO2 endangers my public health and welfare," said Liz Perera from the Sierra Club.

"So they have to regulate it. What they are doing now is saying that all the Obama regulations were wrong but that means they are going to have to put something forward in their place and by the law it has to be adequate or we can sue them every step of the way."

Other experts believe that the ultimate goal of this executive order will be to overturn the Supreme Court ruling on CO2 as a pollutant.

They believe that the **declaration** of EPA administrator Scott Pruitt that CO2 was not a "primary contributor" to climate change is instructive of the direction of travel.

"It is fundamental," said Andrew Light. "I believe that Scott Pruitt wants to go after the endangerment finding. Their argument is that climate change exists, but it is not the case that humans are causing it.

"It is the endangerment finding that draws that tight connection between the fact that humans are making it and the fact that global warming is happening. Once you destabilise that point then you can go for the endangerment finding. That would be the biggest win they could get."

But Liz Perera, for one, believes that won't happen.

"We have the economics on our side, we have the market on our side, we have the public on our side, and we have the law on our side - that this is endangering public health and welfare. They can't change any of those things."

But in many ways, extended court battles are exactly what President Trump and the fossil fuel lobby are looking for.

"Delay is what they want," one green source told me. "Delay is winning."

Reuters

http://www.reuters.com/article/us-usa-trump-energy-idUSKBN16Z1L6

Trump to sign order sweeping away Obama-era climate policies

By Valerie Volcovici and Timothy Gardner 3/28/17 8:58 AM

U.S. President Donald Trump will sign an executive order on Tuesday to undo a slew of Obama-era climate change regulations, a move meant to bolster domestic energy production and create jobs, but environmentalists say the order is dangerous and vow to challenge it in court.

The decree's main target is former President Barack Obama's Clean Power Plan, requiring states to slash carbon emissions from power plants - a critical element in helping the United States meet its commitments to a global climate change accord reached by nearly 200 countries in Paris in December 2015.

The order will also rescind a ban on coal leasing on federal lands, reverse rules to curb methane emissions from oil and gas production, and reduce the weight of climate change in federal assessments of new regulations.

Trump has long telegraphed the moves, and claimed that undoing green regulation will trigger a new boom in oil, gas, and coal production and create thousands of jobs, all without harming U.S. air and water quality.

"We're going to go in a different direction," a senior White House official told reporters ahead of Tuesday's order. "The previous administration devalued workers with their policies. We can protect the environment while providing people with work."

Energy analysts and executives have questioned whether the moves will have a big effect on their industries, and environmentalists have called them reckless.

"I cannot tell you how many jobs the executive order is going to create but I can tell you that it provides confidence in this administration's commitment to the coal industry," Kentucky Coal Association president Tyler White told Reuters.

Trump will sign the order at the Environmental Protection Agency with Administrator Scott Pruitt, Interior Secretary Ryan Zinke and Energy Secretary Rick Perry on Tuesday afternoon.

The wide-ranging order is the boldest yet in Trump's broader push to cut environmental regulation to revive the drilling and mining industries, a promise he made repeatedly during the presidential campaign.

'ASSAULT ON AMERICAN VALUES'

Environmental groups hurled scorn on Trump's order.

"These actions are an assault on American values and they endanger the health, safety and prosperity of every American," said billionaire environmental activist Tom Steyer, the head of activist group NextGen Climate.

Green group Earthjustice was one of many organizations that said it will fight the order both in and out of court. "This order ignores the law and scientific reality," said its president, Trip Van Noppen.

An overwhelming majority of scientists believe that human use of oil and coal for energy is a main driver of climate change, causing a damaging rise in sea levels, droughts, and more frequent violent storms.

Trump and several members of his administration, however, have doubts about climate change, and Trump promised during his campaign to pull the United States out of the Paris climate accord, arguing it would hurt U.S. business.

Since being elected Trump has been mum on the Paris deal and the executive order does not address it.

Christiana Figueres, former executive secretary of the United Nations Framework Convention on Climate Change who helped broker the Paris accord, lamented Trump's order.

"The action by the U.S. to undo important domestic carbon reduction regulation in the face of the enormous momentum building globally toward a low carbon economy risks putting the country on a back-foot at a time when most Americans are looking to lead," she said in a statement.

"Trying to make fossil fuels remain competitive in the face of a booming clean renewable power sector, with the clean air and plentiful jobs it continues to generate, is going against the flow of

economics," she said.

The order will direct the EPA to start a formal "review" process to undo the Clean Power Plan, which was introduced by Obama in 2014 but was never implemented in part because of legal challenges brought by Republican-controlled states.

The Clean Power Plan required states to collectively cut carbon emissions from power plants by 32 percent below 2005 levels by 2030.

Trump's order lifts the Interior Department's Bureau of Land Management's temporary ban on coal leasing on federal property put in place by Obama in 2016 as part of a review to study the program's impact on climate change and ensure royalty revenues were fair to taxpayers.

It also asks federal agencies to discount the cost of carbon in policy decisions and the weight of climate change considerations in infrastructure permitting, and reverses rules limiting methane leakage from oil and gas facilities.

Politico

http://www.politico.com/story/2017/03/donald-trump-obama-climate-change-policies-236570

Trump takes biggest swing yet at Obama climate legacy

By Alex Guillen 3/28/17, 7:01AM

President Donald Trump will direct the federal government on Tuesday to begin dismantling his predecessor's most significant climate change policies, with a sweeping directive telling agencies to stop trying to reduce the carbon pollution of electric utilities, oil and gas drillers and coal miners.

The executive order Trump will sign represents his biggest blow yet to former President Barack Obama's climate legacy. But it does not go as far as some conservatives would like to dismantle the EPA's authority to regulate greenhouse gases, nor will it begin to separate the U.S. from a landmark international climate accord — two areas of intense disagreement within the administration.

Democrats argue that Trump is ignoring the risks of climate change for the sake of rewarding supporters in the fossil fuel industry.

“My hope is that we’re at peak climate science denial in the Republican Party," Sen. Chris Murphy (D-Conn.) told POLITICO Monday. "They’re going to extraordinary lengths to deny this meteor that is global warming is catapulting toward the Earth. I’m scared stiff. My kids won’t be able to solve this problem if we don’t tackle it right now because it will be too late in 20 years."

After last week’s embarrassing failure of Trump’s attempt to repeal and replace Obama’s health care law, the energy executive order offers the president a chance to refocus on another key campaign-trail promise: unleashing the American energy industry. The order comes on the heels of Trump’s move to ease Obama’s ambitious vehicle fuel efficiency requirements and his order to reverse EPA’s controversial Waters of the U.S. rule. The president has also recently signed legislation undoing Obama-era rules on Appalachian coal mining and energy companies’ payments to foreign governments.

Trump plans to order the EPA to rewrite tough rules that make it virtually impossible to build a new coal-fired power plant, and he will tell the Interior Department to end Obama’s moratorium on new coal mines on federal lands, among other steps, White House officials said.

Additionally, the president’s “energy independence” executive order also will repeal several Obama-era environmental directives aimed at reducing the federal government’s own carbon footprint, and it will direct agencies to ferret out any additional policies that “result in impediments” to U.S. energy production, a likely reference to restrictions on fracking and offshore drilling. The president also will tell federal regulators to stop using the “social cost of carbon,” which attempts to quantify the effects of climate change, in economic analyses of future rules.

“There is every reason to believe that the federal government will no longer seek to punish American consumers and businesses for using the energy resources that fuel our economy," U.S. Chamber of Commerce President and CEO Thomas J. Donohue said in a statement welcoming the order.

But Trump is not expected to tell EPA to reconsider the underlying policy that lets it regulate carbon emissions — the 2009 “endangerment finding” in which it declared that greenhouse gas pollution threatens human health and welfare. Nor will he address whether the U.S. will stay in the 2015 Paris climate accord.

“We’re happy with it so far and we look forward to the right decisions on Paris and endangerment, but I think those are still to be made and they’re a ways down the road,” said Myron Ebell, director of the Center for Energy and Environment at the Competitive Enterprise Institute and the former leader of Trump’s EPA transition team.

EPA Administrator Scott Pruitt went on national TV earlier this month to declare that carbon dioxide is not “a primary contributor to the global warming that we see,” a statement that is at odds with the conclusions of the vast majority of climate scientists, including those at his own agency. But Pruitt has not followed up on that statement with any effort to reverse the Obama-era endangerment finding — a factor that sources say contributed to last week’s abrupt departure of a Trump appointee from the agency.

On Monday, a writer for Breitbart.com, the site previously run by White House strategist Steve Bannon, suggested that a failure to revoke the endangerment finding would be grounds for Pruitt to resign.

"If Scott Pruitt is not up to that task, then maybe it’s about time he did the decent thing and handed over the reins to someone who is," wrote James Delingpole, a prominent climate skeptic.

The White House did not rule out later revisiting the endangerment finding, which Trump promised on the campaign trail to review. But environmentalists hope the administration decides that would be too much trouble, given that the policy already survived judicial scrutiny, and that courts are unlikely to support revoking it given the overwhelming scientific data on climate change.

Trump has not nominated anyone to fill key leadership positions below Pruitt and Interior Secretary Ryan Zinke, leaving open the question of how quickly his order will yield any concrete results.

“It’s going to be harder if you don’t have those positions filled,” said David Doniger, director of the climate and clean air program at the Natural Resources Defense Council. “Unless, actually,

their intention is never to fill them and work through political operatives who are not accountable."

Trump's advisers are split over whether to withdraw from the Paris climate deal, which Obama joined with a pledge to reduce U.S. emissions at least 26 percent from 2005 levels by 2025. The U.S. would face no penalty for missing that target, but many conservatives nonetheless say Trump should abandon the agreement altogether, as he pledged to do during the campaign.

But more moderate advisers, including Trump's daughter Ivanka and his son-in-law Jared Kushner, fear that pulling out would damage relations with key U.S. allies. Administration officials are now considering a middle-ground approach: Stay in the deal in exchange for more international support for technologies to reduce emissions from fossil fuels.

The order was also silent on a carbon tax, another issue that has become a flashpoint in disputes between moderates and hardliners in the White House.

Despite the lofty rhetoric coming out of the White House, Tuesday's order will have relatively little immediate effect.

It will take EPA years to rewrite its Clean Power Plan and accompanying rules on future power plants — both of which courts already had frozen while lawsuits play out.

The Trump administration plans to ask federal courts to suspend lawsuits over the EPA climate regulations and send the rules back to the agency to be rewritten or withdrawn. But the D.C. Circuit Court of Appeals, which heard arguments on the Clean Power Plan six months ago, does not have to go along. The appeals court judges could rule any day on the Clean Power Plan, and a separate D.C. Circuit panel has scheduled oral arguments on the future plant rule for April 17.

If EPA will not defend the regulation, environmentalists and states like California and New York have indicated they will step up and do so. And the ultimate fate of EPA's climate authority likely will eventually be decided by the Supreme Court, which ruled in 2007 that the agency had to regulate greenhouse gases if they endanger public health — but did not say how.

Trump's plans for the social cost of carbon are less clear.

The Obama administration estimated of that each ton of carbon dioxide imposes $36 in costs to society to evaluate its climate rules. But Republicans and fossil energy supporters argued it arrived at that figure by counting global benefits while specifying only domestic costs — and they complain the metric was not subjected to a traditional notice-and-comment period before it was employed.

Critics also said the Obama administration used the social cost of carbon to impose stricter rules at EPA, the Energy Department and elsewhere that would be too costly to justify otherwise. Many environmentalists, meanwhile, complained that the amount was too low.

Whether Trump significantly lowers the cost of carbon or abolishes it altogether, the change could have a serious impact on energy regulations that will play out over a period of years. And it remains unclear how the courts might react. Federal judges have upheld agencies' use of the metric before, but some may be inclined to give deference to the Trump administration over what amounts to a highly technical calculation.

Meanwhile, Trump's order will also lead to the resumption of federal coal leasing. But major coal companies are hardly champing at the bit to sign new leases on federal land, although the Bureau of Land Management could make new tracts available relatively quickly. For example, a spokesman for Peabody Energy, which mines more U.S. coal than anyone else, told Bloomberg that the company will not need a new lease in Wyoming's Powder River Basin for "approximately a decade."

The Obama administration imposed a moratorium in February 2016 as part of a three-year review of the federal coal program. That followed reports from the Government Accountability Office, Interior's inspector general and a coalition of environmentalists and government spending watchdogs that concluded Interior was undervaluing coal on public lands.

Zinke hinted earlier this month that he will continue the underlying review, despite lifting the

moratorium, to ensure taxpayers get the full value of coal being sold off of federal lands.

It's not clear that the moratorium cost any jobs, particularly since most coal mining is happening on private rather than public lands. The National Mining Association has not calculated the costs of the moratorium so far, but the group noted that coal mines on federal lands employ 14,000 miners.

Politico Pro

https://www.politicopro.com/tipsheets/morning-energy/2017/03/energy-executive-order-arrives-but-wont-go-far-enough-for-some-022057

Energy executive order arrives but won't go far enough for some

By Anthony Adragna 3/28/17, 5:41AM

TODAY'S THE DAY! President Donald Trump will travel to EPA headquarters today at 2 p.m. to sign a sweeping directive that will begin dismantling his predecessor's most significant climate change policies, Pro's Alex Guillén reports. White House officials said the executive order will ask EPA to rewrite its Clean Power Plan and an accompanying rule on future power plants, repeal several Obama-era environmental directives aimed at reducing the federal government's own carbon footprint, request the Interior Department end Obama's moratorium on new coal mines on federal lands and tell federal regulators to stop using the "social cost of carbon," which attempts to quantify the effects of climate change, in economic analyses of future rules, among other provisions.

Far enough? While the order takes a sledgehammer to Obama-era efforts to embed climate change considerations into all components of federal decision-making, it does not go as far as some conservatives would like. Trump will not tell EPA to reconsider its "endangerment finding," the underlying policy that lets it regulate carbon emissions, nor will he pull the U.S. from the international Paris climate deal. A columnist for Breitbart, the website previously run by Trump's chief strategist Steve Bannon, even suggested EPA Administrator Scott Pruitt should consider resigning because he is "more interested in building his political career than he is taking on the Green Blob."

Pro's Andrew Restuccia and Alex Guillén have a deeper look at the conflicts. Pruitt successfully

argued in closed-door meetings against using the executive order to try to overturn the endangerment finding, saying the legal hurdles were too great. Hardliners now hope the White House, perhaps Bannon, will intervene in the matter. But the endangerment finding is not the only source of unrest within EPA — Pruitt is irked by the White House's slow pace in nominating deputies, while others are expressing frustration at the presence of former Washington State Sen. Don Benton, who is expected to leave the agency soon.

EPA Spokesman John Konkus did not directly address Pruitt's role in discussions over the endangerment finding in a statement to ME Monday night: "The Executive Order focuses on the Clean Power Plan, and Administrator Pruitt is excited that the President is taking action on jobs, our economy, and the regulations that fail to put Americans first. This executive order is a victory for American jobs, and we think that speaks for itself."

A couple of important cautions: Neither Pruitt nor Interior Secretary Ryan Zinke have any reinforcements nominated below them to help implement the order, leaving open the question of how quickly Trump's order will yield any concrete results. And despite the lofty rhetoric coming out of the White House, Tuesday's order will have relatively little immediate effect. Some efforts, like rewriting the Clean Power Plan and other regulations, will take years to complete and face vigorous legal challenges from environmental advocates and blue states all along the way.

Not lying down: But green groups aren't waiting to mount their resistance to the administration's action. Activists are looking to protest outside Trump's speech at EPA and the Sierra Club, Mom's Clean Air Force and People's Climate Movement will host what they're calling an "emergency" White House rally tonight at 5 p.m. to fight rolling back the Clean Power Plan. "Trump can't reverse our clean energy and climate progress with the stroke of a pen, and we'll fight Trump in the courts, in the streets, and at the state and local level across America to protect the health of every community," Sierra Club Executive Director Michael Brune said in a statement. And five Senate Environment and Public Works Committee Democrats will hold their own press availability at 2 p.m. to respond to the executive order.

TRUMP TEAM RECOMMENDS DEEP DOE, EPA CUTS: A budget breakdown obtained by POLITICO recommends deep cuts for key EPA and Energy Department programs during the rest of fiscal year 2017, Pro's Alex Guillén and Helena Bottemiller Evich report.

DOE would take a $1.4 billion cut overall, including a 25 percent cut to the Office of Energy

Efficiency and Renewable Energy.

EPA would lose $247 million, including a $48 million cut to the research and development account, largely from scaling back climate research. The document also suggests cutting $115 million from a more than $1 billion grant program to help states run their own environmental offices.

Interior's budget would take a $371 million hit, including $51 million from the Payment in Lieu of Taxes program, which compensates states with abundant federal land. It also proposes ending Rep. Hal Rogers's coal mine reclamation pilot project, saving $90 million, and would cut $372 million from the Low Income Home Energy Assistance Program.

But, but, but: Helena and Sarah Ferris report the request may not find a friendly airing on Capitol Hill. "Lawmakers have indicated they are prepared to reject Trump's calls to gut programs they deem important," they report.

READY TO ROLL: The Dakota Access Pipeline now contains oil ready for shipment, the pipeline operators said. The news marks the latest success for pipelines that President Trump highlighted in executive orders he signed during the first week of his taking office, following Trump's approval of Keystone XL on Friday. DAPL developer Energy Transfer Partners said in a court filing that it is in the last stages of commissioning the 1,200-mile pipeline and preparing it to deliver crude. DAPL opponents earlier this month lost their court fight seeking a block its completion.

HOW TRUMP MAKES POLICY CALLS: Trump is increasingly leaning on business executives to help shape his nascent policy decisions, Pro's Andrew Restuccia reports. The president often asks CEOs during private conversations to list the federal regulations they would most like to eliminate, according to people who have spoken with him. It's a level of access that is especially astonishing to industry and business executives used to being shut out during eight years with Barack Obama in the White House.

The rise of the business community comes as career staff at federal agencies are increasingly being left out of policy discussions: EPA's transportation experts were sidelined during the internal discussion about reopening Obama's fuel economy standards, infuriating staffers who

had worked on the issue for years, according to two people familiar with the issue. And Trump's political appointees did not consult with State Department officials before the president issued a January memo calling for a Keystone approval.

FLINT GETS PIPE PROMISE: Under a settlement filed in federal district court Monday, the state of Michigan and city of Flint for the first time committed legally to replace 18,000 water service lines made of lead and galvanized steel. If approved by the judge, the agreement would end a lawsuit brought by Flint pastors, the Natural Resources Defense Council and the American Civil Liberties Union. The deal would have the state set aside $87 million for the work, in addition to the $100 million in federal funds approved by Congress last year, and commit to monitoring requirements to ensure the water's safety, but it would stop short of the door-to-door bottled water delivery that the plaintiffs sought in the suit.

YOU'RE HIRED: J.P. Freire is expected to join EPA as communications director, two sources with knowledge of the hire tell ME. Freire is currently communications director for Sen. Orrin Hatch. Neither Freire nor EPA responded to requests for comment.

ANOTHER EPA-RELATED BILL HEADED TO HOUSE FLOOR: The House Rules Committee meets today at 3 p.m. to discuss the EPA Science Advisory Board Reform Act (H.R. 1431), likely clearing the measure for floor action later this week. The bill, similar versions of which have cleared the House in prior congresses, would overhaul how members are picked for the agency's independent science advisory board to allow more industry-associated scientists to come aboard.

E&E News

http://www.eenews.net/energywire/2017/03/28/stories/1060052176

It's D-day for climate regs. Bombs fall at 2 p.m.

By Evan Lehmann 3/28/17

President Trump will try to land a knockout blow on his predecessor's sprawling climate agenda by issuing an executive order today targeting at least nine actions that form the foundation of U.S. efforts to cut emissions and prepare for rising perils.

The "energy independence" order, to be signed at 2 p.m. today, underscores Trump's belief that the seriousness of climate change was overblown by the past administration and deserves to be

set aside in order to revive a struggling coal industry and encourage an unbridled boom in the production of oil and gas.

A senior White House official, when asked yesterday if the president agrees with scientists who say that people are largely responsible for rising temperatures, told reporters, "Yeah, sure."

But the administration appears deeply skeptical about the extent of potential damage that climate change might cause, and the order to be signed today would leave the administration seemingly free of any policy to address the risks — both environmental and economic — that scientists have warned about for years.

"I mean, to the extent that the economy is strong and growing and you have prosperity, that's the best way to protect the environment," the White House official said in a briefing about the order. "But certainly, natural gas is important. Clean coal's important. Nuclear is important. Renewables are important."

Today's executive order sets EPA on the road to rescind the Clean Power Plan, an Obama-era rule to reduce emissions at power plants 32 percent by 2030. The official said rescinding the rule could take up to three years and is bound to face legal challenges.

The order also eliminates Obama-era efforts to improve adaptation, embed climate risks in national security apparatuses, reduce agency emissions, expand the importance of climate impacts in the National Environmental Policy Act and freeze new coal leases on public land. It also begins a review of methane regulations by EPA and the Bureau of Land Management and a rule on hydraulic fracturing by BLM. And it will instruct agencies not to use the social cost of carbon when weighing the costs and benefits of environmental regulation.

The order also promotes fossil fuel production. It requires agencies to identify "all regulations, all rules, all policies [and] guidance documents that serve as obstacles or impediments to domestic energy production," the official said.

Then, in 180 days, the White House will use those agency plans to develop a "blueprint" for energy policy.

Does Trump believe in man-made warming? 'Sure, yeah'

The Clean Power Plan is the cornerstone of the United States' climate policy, and it is a key to meeting the nation's commitment under the global Paris Agreement, under which the United States has pledged to cut emissions 26 to 28 percent by 2025. Whether the United States will remain in the Paris accord is still being discussed in the White House, but the official suggested the nation's commitments stand to be weakened. Paris is not included in the order.

"I mean, we have a different view about how you should address climate policy in the United States, so we're gonna go in a different direction," the official said. "I can't get into what that ultimately means from an emissions standpoint. I have no idea."

The order also instructs the Department of Justice to essentially withdraw its defense of the Clean Power Plan in the U.S. Court of Appeals for the District of Columbia Circuit. Instead, it seeks to freeze the case, which is near completion, before the court issues an opinion expected this spring.

The official disputed the idea that the federal government is required to regulate greenhouse gases under Section 111(d) of the Clean Air Act.

"I'm sure there are plenty of people who disagree on that, but that's not something we're thinking of right now," the official said, adding that the administration is focused on unspooling the "massive" Clean Power Plan and not devising new policies to address emissions.

Environmental groups are already threatening to sue the government if it fails to aggressively cut emissions. They contend that EPA is legally obligated to drive down climate pollutants. The official, meanwhile, described an EPA under Trump that focuses not on climate change but on the agency's "core mission" — conventional air and water pollution.

The official faced a string of questions from reporters about whether the president and his advisers believe that humans are causing climate change.

"I think the president understands there's a disagreement over the policy response, and we're gonna see that in the order tomorrow. We're taking a different path," the official said.

When pressed on whether Trump believes in man-made warming, the official said, "Sure, yeah."

A campaign promise checked off

Another reporter asked if the official believes that sea-level rise could cause economic damage to major cities like Miami, New York and New Orleans, as scientists are warning.

"I'd like to see the research. Sure, that would be good. Show it to me," the official said.

The reporter replied: "So are you saying there's not rising sea levels?"

The official answered: "I didn't say that all. I want to see the study."

The president has sent inconsistent signals about his views of human-caused climate in the past 18 months, saying in December 2015 that it's a "hoax," and a year later that there is some "connectivity" between people's actions and warming.

Today's order ushers a White House that is still reeling from last week's remarkable legislative loss on health care into the embracing arms of the coal industry. Trump vowed last May to revive jobs in the hard-hit towns of Appalachia by erasing the Clean Power Plan.

"We're going to rescind all the job-destroying Obama executive actions," Trump said then. "OK, remember that. We're going to save the coal industry. We're going to save that coal industry,

believe me. We're going to save it."

He promised to revoke the climate rules within 100 days of taking office. It's day 68.

E&E News

http://www.eenews.net/climatewire/2017/03/28/stories/1060052178

Was the climate rule really bad for the economy?

By Emily Holden 3/28/17

As President Trump today pulls the first strings in unraveling President Obama's signature climate change regulation, he will claim he's saving Americans from skyrocketing electricity bills and putting coal miners back to work.

In truth, that's hard to show.

Experts say it's difficult to get more than a rough estimate of how the Clean Power Plan would influence power costs, since natural gas and renewable energy prices play a role, as do state choices about trading systems.

Canceling the first-ever standards to reduce emissions from power plants is also unlikely to revive the dying coal industry, although it may keep some jobs in western U.S. mines from disappearing, according to the U.S. Energy Information Administration.

While economic studies on the rule have varied wildly, the Trump administration is relying on one paid for by the coal lobby and conducted by NERA Economic Consulting. NERA found that the Clean Power Plan could cause double-digit electricity price increases in many states. In a briefing yesterday, the White House cited that finding and argued that it couldn't pursue any policy that "puts the economy at risk."

Supporters of the Clean Power Plan, however, point to studies that show people would save money on electricity under the rule. They believe the Clean Power Plan would spur energy savings and result in lower bills. U.S. EPA and EIA came in somewhere in between, estimating that electricity prices would rise slightly at first but fall later. EPA thought they would be lower than without the rule by 2030.

The huge number of unknowns makes it "very easy for folks to cherry-pick desired results," said Noah Kaufman, a climate economist with the World Resources Institute who worked for the Obama administration. NERA assumed much higher costs for wind and solar power than did groups like MJ Bradley & Associates and Synapse Energy Economics, Kaufman noted in a recent analysis.

Despite the wide range of estimates, Kaufman said he hasn't seen any study that "makes a compelling and independent case to show that the economic effects are anything other than just noise in comparison to the economy as a whole."

Industry groups disagree, and they believe the costs of the rule would be higher than any possible benefits.

A recent study by NERA for the U.S. Chamber of Commerce and the American Council for Capital Formation found that meeting the Paris climate pledge would cost the average American household up to $160 a year and eliminate up to 440,000 jobs by 2025 (*Greenwire*, March 16). Environmental groups attacked those numbers as unreasonable, saying the researchers intentionally picked the most expensive ways to comply. The chamber says it was being realistic about how the United States might regulate different sectors based on legal confines.

As those types of debate rage on, Trump today will claim a victory for cash-strapped Americans and fossil fuel workers. But the actual economic impact of his actions will be hard to decipher.

When ideology mixes with economics

Observers might assume that the true cost of climate action would fall in the middle of the range of estimates. Researchers warn against that.

"Across all the years I've looked at it, it's not necessarily in the middle," said Tom Wilson, a senior program manager at the Electric Power Research Institute who has been studying climate policy analyses since the 1980s and has witnessed the unexpected natural gas boom and rapid declines in renewable power costs.

"The sort of key thing is that all types of strange things can happen," he said.

Wilson in his presentations explains how analysts in the 1980s estimated the level of global carbon emissions for 2000 and nailed it. They got all the inputs wrong, believing before the Chernobyl meltdown that nuclear power would expand quickly and thinking that Africa would use more power than China. But somehow all the figures balanced out.

There is similar uncertainty in the power sector now. Cheap natural gas has pushed coal and zero-carbon nuclear power offline. It's unclear whether people will really want to buy electric vehicles even when they cost the same as traditional ones. They might not like the way the cars accelerate or could cling to range anxiety, Wilson explained.

"Fundamental issues like that would dictate the cost of a climate policy," he said.

Environmental advocates will also note that many studies don't consider the economic benefits of reducing carbon emissions and spurring other countries to do so, as well. They say policymakers should consider lowered public health costs, avoided infrastructure expenses and savings from curbing the intensity of extreme weather events.

While the exact costs of the Clean Power Plan are hard to pin down, soldiers on both sides of the political debate insist they know how the rule would play out. That's an age-old strategy.

When the House passed cap-and-trade legislation in 2009, and the Senate was considering it, some models showed that the legislation would have been economically manageable, recalled Greg Dotson, who worked for former Rep. Henry Waxman (D-Calif.), a co-author of the bill. Dotson cited one government study that found the cap-and-trade plan would have slowed the growth of the gross domestic product, but only by a few months and not for decades.

Dotson said critics misused some modeling to make their arguments that the measure would be bad for the economy. He said models also almost never adequately assessed the cost of failing to address climate change and exaggerated the importance of small effects projected to occur years in the future. For example, during the debate in 2009, opponents posted stickers on gas pumps warning of immediate price spikes that weren't projected to occur until 2030.

"When you start thinking about it in those terms, models show that it's possible to craft climate change policies in which the costs are small but the benefits are huge," he said.

At the time, it was mainly pundits and those in conservative circles citing industry studies against cap and trade. Now, the president is using such assessments to back up his executive actions.

Dotson said that could be helpful, in giving people a chance to do some fact-checking.

"The problem with whisper campaigns that take place by industry outside of Washington, D.C., is sometimes they're quite hard to rebut," Dotson said. "When something comes from the president's mouth or Administrator Pruitt's mouth ... it gives experts something to really focus on."

Public Citizen yesterday was already taking aim at Pruitt's comments on ABC News on Sunday that climate policies cause electricity rates to increase.

'Coal still has a role to play'

Part of why Clean Power Plan assessments are so hard is because EPA would have given states wide latitude in how to meet their goals, including by using carbon trading.

Before the courts stalled the rule, most states were considering carbon trading, which would have lowered costs, according to various studies by regional grid organizations.

To be sure, costs of the rule would vary around the country, likely hitting coal-heavy states that have been slower to transition away from fossil fuels the hardest.

Market realities are hitting states in the West particularly hard as they try to navigate coal plant closures as companies no longer find the fossil fuel cost-competitive.

Scott Segal, an industry lawyer at Bracewell LLP, said that while it's "always difficult for the government to establish a program that can expand or save any specific industry," the government can "remove obstacles."

He argued that while natural gas is cheap and renewable power is growing cheaper, "coal still has a role to play."

No power company in the country is looking to invest in a new coal plant. But Segal said that "market demands and unforeseen circumstances could spell a resurgence for coal," if the government gets the regulatory approach right.

E&E News

http://www.eenews.net/eedaily/2017/03/28/stories/1060052163

Staff awaits trump with trepidation

By Kevin Bogardus 3/28/17

Many U.S. EPA staff members are gritting their teeth for President Trump's visit today.

The president plans to visit the agency's Washington headquarters this afternoon to sign his long-anticipated executive order to boost energy production and target environmental regulations, including the Clean Power Plan.

Trump — who has proposed a massive 31 percent, or $2.6 billion, budget cut for EPA, which could result in 3,200 fewer jobs at the agency — is not a popular figure among its employees.

After his election last year, many EPA workers were upset, worried about the future of their jobs and the agency itself. On the campaign trail, Trump pledged to dismantle EPA. And last week in Kentucky, he said Administrator Scott Pruitt "would turn the EPA from a job killer into a job creator."

Consequently, gallows humor has become prevalent at the agency.

"Coming to EPA? Are you sure he's not going across the street to have lunch at Trump Hotel?" said one career EPA employee when told about Trump's visit to agency headquarters.

Across the street from EPA's William Jefferson Clinton Federal Building is the Trump International Hotel, where the president has already dined a few times since his inauguration.

That career employee predicted Trump would receive a chilly reception from staff, with many staying in their cubicles rather going to the president's signing of the executive order — if they're invited at all.

"There is going to be bewilderment and shock. Not a lot of excitement. Just pissed-off people," said the employee. "We're going to be at our desks. We'll not be going down there."

A presidential visit will also require heightened security. According to an internal email sent to agency employees yesterday and obtained by E&E News, the Secret Service and the Federal Protective Service will implement "multiple security measures" for the building, "and there will

be an increased security presence at the Federal Triangle Complex."

With some entrances closed all day, employees will not be allowed on the first floor of the Clinton East building. The agency's mailroom and print shop will also be closed for the day.

In addition, some EPA employees working in an area facing the courtyard "must close window blinds beginning no later than 10:00 am (and remain closed all day)," said the email.

Security was likely as tight for President Obama's visit to EPA in January 2012. The mood then, however, was celebratory.

Back then, agency employees crowded into the Andrew W. Mellon Auditorium to cheer on the 44th president. Obama thanked workers for their dedication and said environmental protection and economic benefits can go hand in hand.

"I do not buy the notion that we have to make a choice between having clean air and clean water and growing this economy in a robust way," Obama said. "I think that is a false debate" (*E&E News PM*, Jan. 10, 2012).

Pruitt has offered similar sentiments as EPA chief. Nevertheless, it hasn't done much to improve relations between the administration's leadership and the agency's workers.

"Oh, God," said one former EPA official when told about Trump's visit. "There will be certainly a different dynamic than when Obama visited."

The ex-official added, "There is probably no agency and political leader that feel this hostile toward each other, including the CIA."

Trump of course visited the intelligence agency the day after his inauguration. Speaking about his inaugural crowd size and election victory before the CIA's Memorial Wall, Trump sparked criticism for his campaignlike speech.

The president's visit to EPA could lead to similar reviews. Asked if Trump's stopping by EPA headquarters to sign an order to roll back agency rules was a poke in the eye to employees, one union leader said it was.

"It definitely is. Otherwise, he would do this from the comfort of the White House," said John O'Grady, president of American Federation of Government Employees Council 238, which represents thousands of EPA employees. "I'm speechless. This is like someone's worst nightmare."

CNN

http://www.cnn.com/2017/03/27/politics/trump-climate-change-executive-order/

In executive order, Trump to dramatically change US approach to climate change

By Dan Mercia 3/28/17 7:38 AM

Washington (CNN) President Donald Trump will sign a sweeping executive order Tuesday at the Environmental Protection Agency, which looks to curb the federal government's enforcement of climate regulations by putting American jobs above addressing climate change.

The order represents a clear difference between how Trump and former President Barack Obama view the role the United States plays in combating climate change, and dramatically alters the government's approach to rising sea levels and temperatures -- two impacts of climate change.

A White House official briefed on the plan said Monday the administration believes the government can both "serve the environment and increase energy independence at the same time" by urging the EPA for focus on what the administration believes is its core mission: Clean air and clean water.

More important than regulating climate change, the official said, is protecting American jobs.

"It is an issue that deserves attention," the official said of climate change. "But I think the President has been very clear that he is not going to pursue climate change policies that put the US economy at risk. It is very simple."

Tuesday's order will initiate a review of the Clean Power Plan initiative, rescind the moratorium on coal mining on US federal lands and urge federal agencies to "identify all regulations, all rules, all policies ... that serve as obstacles and impediments to American energy independence," the official said.

Specifically, the order will rescind at least six Obama-era executive orders aimed at curbing climate change and regulating carbon emissions, including Obama's November 2013 executive order instructing the federal government to prepare for the impact of climate change and the September 2016 presidential memorandum that outlined the "growing threat to national security" that climate change poses.

"The previous administration devalued workers by their policies," the official said. "We are saying we can do both. We can protect the environment and provide people with work."

The White House official went on to argue that the best way to protect the environment is to have a strong economy, noting that countries like India and China do less to protect the environment.

"To the extent that the economy is strong and growing and you have prosperity, that is the best way to protect the environment," the official said.

The executive order also represents the greatest fears climate change advocates had when Trump

was elected in November 2016.

"These actions are an assault on American values and they endanger the health, safety and prosperity of every American," Tom Steyer, the president of NexGen Climate, said in a statement. "Trump is deliberately destroying programs that create jobs and safeguards that protect our air and water, all for the sake of allowing corporate polluters to profit at our expense."

Andrew Steer, CEO of the World Resources Institute, said that the executive order shows Trump is "failing a test of leadership to protect Americans' health, the environment and economy."

But as much as Democrats and climate advocates will decry it, Trump's executive order follows the President's past comments about climate change. Though Trump told The New York Times during the election that he has an "open mind" about confronting climate change, he also once called it a hoax.

"The concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive," Trump tweeted in November 2012.

"I will also cancel all wasteful climate change spending from Obama/Clinton," Trump said in October 2016.

The changes, the official said, do not mean the Trump administration will not look to protect the environment any longer, the official said, but when pressed about the human impact on climate change and Trump's beliefs, the official was reluctant to say whether all government officials in the Trump White House believe humans cause climate change.

"I think there are plenty of rules on the books already. We will continue to enforce that provide for clean air and clean water. And that is what we are going to do," the official said. "The President has been very clear that he wants the EPA to stick to that basic core mission that Congress set out for it."

The changes also reflect the view of EPA Administrator Scott Pruitt, who routinely sued the organization he now leads during his time as the Attorney General of Oklahoma. In an interview with CNBC earlier this month, Pruitt argued incorrectly that carbon dioxide isn't the "primary contributor" to climate change, a comment that goes against most scientific research.

This executive order is also an attempt by the Trump administration to make good on its promise to bring more coal jobs back. The official said that Obama's regulations "were not helpful" to the coal industry and these reversals are the President honoring "a pledge he made to the coal industry."

"We are going to put our coal miners back to work," Trump said at a March 2017 event in Kentucky. "They have not been treated well, but they're going to be treated well now."

He added: "The miners are coming back."

Huffington Post

http://www.huffingtonpost.com/entry/trump-climate-executive-order-environmentalists_us_58d9ec2ae4b018c4606ae900

Environmentalists Vow To Fight Donald Trump's 'Dangerous,' 'Embarrassing' Climate Rollback

By Nick Visser 3/28/17, 5:47AM

Environmentalists and former White House officials on Monday slammed President Donald Trump's impending executive order that would undue much of the work his predecessor has done to combat climate change.

Trump was due to sign the Energy Independence Executive Order on Tuesday, which will target former President Barack Obama's signature Clean Power Plan and open up federal land to coal development. But environmentalists are not giving up without a fight and plan to protest the wide-ranging order that has been met with fierce criticism.

Gina McCarthy, a former administrator of the Environmental Protection Agency, called it a "dangerous," order that flies "in the face of EPA's mission."

"They want us to travel back to when smokestacks damaged our health and polluted our air, instead of taking every opportunity to support clean jobs of the future," McCarthy said in a statement. "This is not just dangerous; it's embarrassing to us and our businesses on a global scale to be dismissing opportunities for new technologies, economic growth, and US leadership."

EPA Administrator Scott Pruitt, a noted climate change denier, said Tuesday's order would "address the past administration's effort to kill jobs throughout the country" — a statement that couldn't be more different from the agency's stance just three months ago.

Janet McCabe, the former head of the EPA's Office of Air and Radiation, said the agency "has an obligation to address carbon pollution" and challenged Pruitt's recent assertion that carbon emissions were not the cause of climate change.

"Congress put the Clean Air Act in place to protect Americans from air pollution, and there is no doubt greenhouse gases are air pollution — the science makes that crystal clear and the Supreme Court has confirmed it as a matter of law," she said in a statement.

Environmentalists vowed to fight the effects of the rollback and planned a protest in Washington, D.C., for Tuesday evening.

"Trump's attack ignores reality — not just the reality of the climate crisis, but the reality that the clean energy economy is rapidly growing in both red and blue states, creating jobs and safeguarding our air and water," Sierra Club executive director Michael Brune said in a statement. "Trump can't reverse our clean energy and climate progress with the stroke of a pen, and we'll fight Trump in the courts, in the streets, and at the state and local level across America to protect the health of every community."

World Resources Institute president Andrew Steer said the Trump administration was "taking a sledgehammer to U.S. climate action," and with the signing of a pen, the president will "push the country backward."

"Make no mistake: This Executive Order will undermine people's health and the U.S. economy. It hands moral authority and global leadership over to others, leaving America behind," Steer said in a statement.

Economists and energy executives have already casts doubts on the aim of the executive order and Trump's plans to restore thousands of coal mining jobs.

"I really don't know how far the coal industry can be brought back," Robert Murray, the head of one of the countries largest coal mining companies, told The New York Times.

Washington Times

http://www.washingtontimes.com/news/2017/mar/27/paris-climate-treaty-faces-us-exit-after-donald-tr/

Trump's executive action on Clean Power Plan signals U.S. exit from Paris climate treaty

By Ben Wolfgang 3/27/17

President Trump's executive action Tuesday to begin unraveling the Clean Power Plan may also signal America's de facto exit from the landmark Paris climate treaty — former President Barack Obama's signature environmental achievement.

The Clean Power Plan, the first set of national limits on greenhouse gas pollution from power plants, is crucial to the U.S. meeting President Obama's pledge to cut emissions by at least 26 percent by 2025.

While Mr. Trump has yet to formally pull out of the Paris deal — a nonbinding agreement with no enforcement mechanisms other than public shaming — his move Tuesday essentially guarantees the U.S. won't meet the ambitious target.

"It was extraordinarily unlikely we would've met President Obama's Paris pledge under the best of circumstances. But clearly, if the Trump administration goes through with what's on the table so far, it will be impossible to meet the pledge," said Stephen Eule, vice president for climate and technology at the U.S. Chamber of Commerce's Institute for 21st Century Energy.

The Clean Power Plan, which was stayed by the Supreme Court last year and has not gone into full effect, calls for a 30 percent reduction in carbon emissions from the power sector by 2030, and would greatly shrink coal's share of electricity generation in the process.

That reduction is central to meeting the broader Paris goal, as are other regulations now under review, including fuel economy standards for automobiles.

Within the administration, there's an ongoing debate over whether to stay in the Paris deal or formally withdraw. The agreement itself remains highly controversial, not only because of the onerous measures the U.S. would have to put in place to meet its targets but also because it gives China, the world's biggest polluter, a free pass for the next 13 years.

Under Paris, China has to do virtually nothing until 2030, when the country says its greenhouse gas emissions will peak and then slowly begin dropping each year thereafter.

India, another major polluter, also faces no targets for more than a decade.

There's no indication that a decision on the Paris deal is on the immediate horizon, but top officials within the administration increasingly are speaking out. Even without technically disavowing the deal, it's becoming clear the White House has no intention whatsoever of honoring Mr. Obama's commitment.

"What was wrong with Paris was not just that it … failed to be treated as a treaty, but China and India, the largest producers of CO2 internationally, got away scot-free. They didn't have to take steps until 2030," Environmental Protection Administrator Scott Pruitt told ABC News over the

weekend.

“So we’ve penalized ourselves through lost jobs, while China and India didn’t take steps to address the issue internationally. So Paris was just a bad deal, in my estimation,” he said.

A senior White House official on Monday evening said it’s “still under discussion” whether to leave formally the Paris agreement, and wouldn’t elaborate on how the administration could possibly meet its commitment while eliminating rules to cut emissions.

In addition to the Clean Power Plan, the official also confirmed that Tuesday’s executive order will eliminate Obama administration estimates on the “social cost of carbon,” will end a federal moratorium on new coal leases and will take other steps to reduce regulations and promote American energy independence.

The order, however, is by no means the final word on the Clean Power Plan.

The EPA still must hold public hearings, accept public comments, consult with stakeholders and likely face numerous lawsuits in its effort to eliminate the Clean Power Plan altogether.

Specialists have said it will take at least one year, possibly longer, to remove it from the books completely.

Exiting the Paris deal is a different story. Because the agreement was never submitted to the Senate to be approved as a formal treaty, there’s nothing stopping the administration from quickly ending U.S. participation.

Supporters of the Paris deal say the White House is sending the wrong signal to the rest of the world by approving new fossil fuel projects like the Keystone XL oil pipeline while backing down on emissions-reduction goals.

“The Trump administration says ‘yes’ to sending the dirtiest Canadian oil to Latin America and China after it crosses the American plains, but ‘no’ to providing American leadership as China and Latin America make historic commitments to the global agreement on climate change,” Sen. Edward J. Markey, Massachusetts Democrat, said Monday.

Indeed, there would seem to be little reason for the rest of the world to accept U.S. leadership on climate issues if the administration abandons Paris.

“We lose any ability, any moral authority, to say to any other country, ‘You have to clean up your act,’” said Christine Todd Whitman, the former Republican governor of New Jersey and EPA administrator during the George W. Bush administration.

But some analysts say the U.S. can retain a global voice on emissions even while undoing regulations, like the Clean Power Plan, that would hamper economic growth at home.

“It would be possible … to keep our seat at the table while still making fundamental changes to

our domestic regulations. This position is all the more reasonable in light of the fact that market forces are already advancing the ball toward reasonable greenhouse gas goals," said Scott Segal, a partner at Washington's Bracewell law firm who specializes in energy and environmental issues.

Washington Post

https://www.washingtonpost.com/national/health-science/trump-moves-decisively-to-wipe-out-obamas-climate-change-record/2017/03/27/411043d4-132c-11e7-9e4f-09aa75d3ec57_story.html?utm_term=.c54766528a9c

Trump moves decisively to wipe out Obama's climate change record

By Juliet Ellperin and Brady Dennis 3/27/17, 11:01PM

President Trump will take the most significant step yet in obliterating his predecessor's environmental record Tuesday, instructing federal regulators to rewrite key rules curbing U.S. carbon emissions.

The sweeping executive order also seeks to lift a moratorium on federal coal leasing and remove the requirement that federal officials consider the impact of climate change when making decisions.

The order sends an unmistakable signal that just as President Barack Obama sought to weave climate considerations into every aspect of the federal government, Trump is hoping to rip that approach out by its roots.

"This policy is in keeping with President Trump's desire to make the United States energy independent," said a senior administration official who briefed reporters on the directive Monday evening and asked for anonymity to speak in advance of the announcement. "When it comes to climate change, we want to take our course and do it in our own form and fashion."

Some of the measures could take years to implement and are unlikely to alter broader economic trends that are shifting the nation's electricity mix from coal-fired generation to natural gas and renewables. The order is silent on whether the United States should withdraw from the 2015 Paris climate agreement, under which it has pledged to cut its greenhouse gas emissions between 26 and 28 percent by 2025 compared to 2005 levels, because the administration remains divided on that question.

The order comes after several moves by Trump to roll back Obama-era restrictions on mining, drilling and coal- and gas-burning operations. In his first two months as president, Trump has nullified a regulation barring surface-mining companies from polluting waterways and set aside a new accounting system that would have compelled coal companies and other energy firms to pay more in federal royalties.

The administration also has announced it will reconsider stricter fuel-efficiency standards for cars and light trucks and has approved two major oil pipelines, Dakota Access and Keystone XL, that Obama had halted.

Accelerating fossil-fuel production on federal lands and sidelining climate considerations could lead to higher emissions of the greenhouse gases driving climate change and complicate a global effort to curb the world's carbon output. But Trump has repeatedly questioned whether climate change is underway and emphasized that he is determined to deliver for the voters in coal country who helped him win the Oval Office.

"He's made a pledge to the coal industry and he's going to do whatever he can to help those workers," the senior administration official said.

U.S. coal jobs, which number about 75,000, have been declining for decades. The official did not predict how many jobs might be spurred by this shift in policy.

Legal fight possible

The centerpiece of the new presidential directive, telling the Environmental Protection Agency to begin rewriting the 2015 regulation that limits greenhouse-gas emissions from existing power plants, will trigger a laborious rulemaking process and a possible legal fight.

The agency must first get permission from the U.S. Court of Appeals for the D.C. Circuit, where

the rule is tied up in litigation, to revisit the matter. Then, agency officials will have to justify reaching the opposite conclusion of the Obama EPA, which argued it was technically feasible and legally warranted to reduce carbon pollution by about one-third by 2030, compared with 2005 levels.

"So, for the president, even if he would like to revoke the Clean Power Plan, he doesn't have legal authority to do that," said Jeffrey Holmstead, a partner at the Bracewell law firm who opposes the Obama-era rule. Holmstead, who headed the EPA's air and radiation office under President George W. Bush, said he thinks the agency can justify reversing the regulation. But "they have to justify why they have changed," he added.

While environmental groups decried Trump's move, mining officials welcomed it as an important course correction in federal energy policy.

"This rule was an unlawful attempt to radically transform the nation's power grid, destroying valuable energy assets and leaving our economy more vulnerable to rising power prices — all for an insignificant environmental benefit," said Hal Quinn, president and chief executive of the National Mining Association.

Environmentalists vowed to fight the executive order in court and press ahead with their goals on the state level.

David Doniger, director of the Natural Resources Defense Council's climate and clean-air program, said unwinding the Clean Power Plan will not happen quickly, no matter what the president wants. "Tearing the rules down require going through the same process it took to build them up," Doniger said. "We will make them face the music at every step."

Christopher Field, a professor at Stanford University's Wood Institute for the Environment, said in an email that the directive carries long-term risks, rather than immediate ones. "Some are risks from eroding the position of U.S. companies in the clean energy sector," Field said. "Others are from the loss of irreplaceable natural heritage that is put in jeopardy by ill-conceived policies."

The president will also instruct the Interior Department to rewrite a 2015 rule, currently stayed in court, that imposes restrictions on hydraulic fracturing on federal and tribal lands. The directive will also make it easier to flare methane in oil and gas operations on federal land, by triggering the review of a rule the Interior Department finalized in November.

More immediate actions

Other aspects of the executive order can take effect immediately, though it is unclear how quickly they will translate into greater coal extraction. One section overturns a 2016 White House directive to consider climate change when agencies conduct reviews under the National Environmental Policy Act, a sweeping law that informed any federal decisions that have a significant environmental impact.

Another provision instructs Interior's Bureau of Land Management to lift a freeze on federal coal leasing. That moratorium has been in effect since December 2015.

Tom Sanzillo, director of finance for the Institute for Energy Economics and Financial Analysis, said in an interview that the move "becomes a largely politically symbolic measure for right now" because other, lower-carbon sources of energy are out-competing coal. He noted that U.S. coal consumption has declined 27 percent since 2005, from 1.02 billion tons to 739 million tons in 2016, its lowest level in nearly four decades.

"They're not going to reverse the fundamental economic law here," Sanzillo said. "There's no market signal that's telling them they should be mining more coal."

Still, regulatory relief could make some coal firms, nearly 50 of which have filed for bankruptcy since 2012, somewhat more economically viable. Some of the sector's biggest companies — including Arch Coal, Peabody Energy and Alpha Natural Resources — are just now emerging from bankruptcy protection.

Ethan Zindler, head of U.S. research at Bloomberg New Energy Finance, said in an email that solar and wind are competitive with coal in some parts of the country and that natural gas ranks

as the lowest-cost source of electricity generation overall. The sector that could suffer the greatest hit from the elimination of the Clean Power Plan is nuclear energy, which provides about a fifth of U.S. businesses' and households' power.

"Many of the 100 or so U.S. plants are aging, and approximately a third are economically uncompetitive today," Zindler said. Without stricter federal emissions limits, he added, "there may be little to stop the retirement of these plants in coming years and their replacement with a combination of gas, wind and solar."

Separately, Trump has instructed federal officials to abandon the practice of factoring in the impact of climate change — what is dubbed "the social cost of carbon" — in their policymaking decisions. That calculus, which is currently set at $36 per ton of carbon dioxide, aims to capture the negative consequences of allowing greenhouse-gas emissions to continue to rise. But some conservatives have criticized it as too sweeping.

Federal officials will return to the traditional cost-benefit analysis the George W. Bush administration adopted nearly 15 years ago, which has a much lower cost associated with carbon emissions.

As Trump seeks to scale back federal limits on greenhouse gas emissions, states and cities are likely to take on a larger role in charting the course forward.

An analysis by the Rhodium Group, an economic consulting firm, found that Trump's forthcoming executive order would slow the country's shift away from carbon-emitting sources of energy. It found after Trump's action, the United States would be 14 percent below its 2005 emissions levels by 2025, compared to 21 percent below that mark had current Obama-era policies remained in place.

Tim Profeta, who directs Duke University's Nicholas Institute for Environmental Policy Solutions, said regulators from more than half-dozen states in the Southeast are now talking about how to chart their own path forward. Having met for nearly three years, the group stopped discussing how to comply with the Clean Power Plan after November's election, but it is still talking.

"We are now talking about the evolution of the power sector in an environment of uncertainty," Profeta said in an interview. "We're seeing the beginning of states taking control of their

destiny."

The Hill

http://thehill.com/policy/energy-environment/325977-what-to-watch-for-in-trumps-climate-change-order

What to watch for in Trump's climate change order

By Devin Henry and Timothy Cama 3/27/17, 4:01PM

President Trump will sign an executive order on climate change Wednesday, opening a new front in his battle against former President Obama's environmental legacy.

The action will address Trump's campaign promises and is expected to knock out the Obama administration's landmark climate rule, among other things.

Here are five things to watch when Trump releases the long-awaited executive order on Tuesday.

How far does he go?

The order is expected to be a broad assault on key aspects of Obama's climate change policies.

Trump is expected to order the Environmental Protection Agency (EPA) to formally consider repealing its Clean Power Plan, a rule created to cut power sector emissions. He is also likely to lift a moratorium on new coal mining leases on public land.

Sources told The Hill last week that the order would also target oil and gas drilling rules and the climate change metrics that Obama built into government environmental assessments and regulations, among other things.

Trump will also direct agencies to begin considering actions they can take to encourage energy production, according to Bloomberg.

Some parts of the order will take effect immediately, while others will take time. Trump can't immediately scrap the Clean Power Plan, for instance, as the EPA will have to conduct a formal rulemaking process that could take up to a year.

What will the battle lines be?

Don't expect environmentalists to immediately challenge Trump's action in court.

Lawsuits against the order are certain, but environmental advocates can't file them until the EPA proceeds through the regulatory process.

Much of the coming legal battle is likely to center on the Clean Power Plan. The rule is already at the center of a major lawsuit, with fossil fuel companies, industry groups and coal-friendly Republican states suing to undo the regulation.

That litigation will likely freeze after Trump signs the executive order but will restart again as the process moves forward.

Environmentalists are also likely to fight the cancellation of the coal moratorium, a policy Obama's Interior Department implemented in part to address complaints that the government was not doing enough to account for the climate impact of the fuel's use.

Will the Paris climate pact be mentioned?

The president's order is expected to tread lightly on one major piece of Obama's climate agenda: the Paris agreement.

The non-binding pact was negotiated in 2015 by nearly 200 countries, through the United Nations, with significant leadership from Obama. Each country pledged its own greenhouse gas emissions limits; Obama promised a 26 percent to 28 percent cut in the United States' emissions by 2025.

While Trump promised to "cancel" the accord during last year's campaign, he's been under pressure from some in his administration. In particular, his daughter Ivanka and her husband Jared Kushner — one of Trump's closest advisers — support the accord and convinced Trump to strike language from the order that would have been critical of it, according to The Wall Street Journal.

But while the United States might stay in the pact, Trump's executive order striking climate policies could make it difficult to meet the 2025 goal.

Trump may instead seek to reduce the United States' commitments under the agreement, something that has the support of Trump allies in Congress like Rep. Kevin Cramer (R-N.D.).

Will the order help jobs?

Trump and the White House have touted the order as being designed to help produce jobs in the energy industry.

"We can be both pro-jobs and pro-environment," EPA Administrator Scott Pruitt said Sunday on "This Week with George Stephanopoulos."

"The executive order will address the past administration's efforts to kill jobs across this country

through the Clean Power Plan."

But there are indications the order won't pack quite the punch the White House is promising.

Undoing the power plant rules, for instance, is designed to help coal workers. But the industry's decline is much more closely tied to market forces like cheap, prevalent natural gas than federal regulations, something that even the coal industry acknowledges.

"I suggested that he temper his expectations," coal executive Bob Murray told The Guardian on Monday. "Those are my exact words. He can't bring them back."

The White House insists its new action will have an impact.

Asked if the order will bring back coal jobs, Pruitt said Sunday, "I think absolutely it will. It will bring back manufacturing jobs across the country, coal jobs across the country."

How will the White House unveil the order?

Trump is aiming to unveil the order with his traditional showman's touch.

The White House says Trump will go to EPA headquarters in downtown Washington, D.C., to sign the directive.

In addition to Pruitt, the administration may bring in coal miners to celebrate the signing, as Trump did when he signed legislation to undo the Interior Department's rule to protect streams from mining pollution.

Members of Congress, who have long looked to halt Obama's climate actions, are likely to look on as well.

The order could represent a major turning point in American energy policy, fulfilling several of the president's campaign promises.

The Hill

http://thehill.com/policy/energy-environment/326047-trump-to-undo-obamas-climate-change-agenda

Trump to undo Obama's climate change agenda

By Devin Henry 3/27/17, 11:00AM

President Trump will use an executive order on Tuesday to dismantle to the Obama administration's climate change agenda.

The order will compel the Environmental Protection Agency (EPA) to review the Obama administration's chief climate rule for power plant emissions, the 2015 Clean Power Plan, a White House official said on Monday night. The White House opposes that rule, signaling its eventual termination.

The action will order several other federal agencies to undo the previous administration's climate change work: it will tell the Interior Department to end a moratorium on new coal leasing on federal land, the official said, and the Obama administration's assault on methane emissions — outlined in early 2014 and overseen by Interior and EPA — will be ended, as well.

A major hydraulic fracturing regulation from the Bureau of Land Management will be reviewed under the order. It will also end President Obama's climate action plan, the main 2013 directive outlining the federal government's response to climate change.

Trump's Tuesday order will represent a reset of the federal government's policies on climate change. It will not address several major environmental rules issued during Obama term, including an update on ozone pollution or mercury standards at power plants. But efforts initiated by Obama — who made addressing climate change a key goal of his second term — will disappear.

"There are plenty of rules on the books already, that we will continue to enforce, that provide for clean air and clean water and that's what we're going to do," the White House official told reporters on Monday night.

"I think the president has been clear he wants the EPA to stick to that basic core mission that Congress laid out for it."

One thing the order will not address is the United States's involvement in the Paris climate deal, a global pact to cut greenhouse gases. Obama was a driving force behind that agreement, pledging a 26 percent to 28 percent reduction in U.S. emissions by 2025.

But the official said the administration has a "different view about how you should to address climate policies as the United States and we're going to go in a different direction."

Trump doubts the broad scientific consensus — affirmed by the vast majority of climate scientists — that human activity contributes to and has exacerbated a warming trend around the globe.

He has stacked his administration with officials who agree with his views. EPA Administrator Scott Pruitt, for example, said earlier this month that he does not believe carbon dioxide is a "primary contributor" to global warming, a conclusion at odds with the scientific research of his own agency.

Trump's order will not nix the Obama administration's 2009 finding that carbon dioxide is a threat to the United States, a formal conclusion that underpins federal rules on the matter.

"But the administration will interpret it differently than Obama did. That "endangerment finding," Trump's administration argues, relates only to carbon emissions from cars, not carbon emissions as a whole, and therefore does not apply to the power plant rules Obama issued.

The official said climate change is an "issue that deserves attention," but there is no indication from the contents of the order that Trump will focus on it.

Instead, the White House is framing the order as one to help the U.S. economy -- something Republicans, Trump and others in his administration have said is threatened by climate regulations.

"Energy independence: that's the goal," the official said. "The president understands there's a disagreement over the policy response and you'll see that in the order tomorrow. We're taking a different path."

Environmentalists have promised a strong response.

Groups have planned a protest on Tuesday night, an early sign that they will fight back against the changes.

"On the heels of the three hottest years on record, President Trump is reversing the biggest steps our country has taken to fighting climate change, League of Conservation Voters President Gene Karpinski said.

"Donald Trump may care more about corporate interests, but the people of this country care about a safe, clean and healthy environment and they will not let him get away with destroying it."

Environmental lawyers have said they will pore over the regulatory review process in order to sue against it in the end.

"This order ignores the law and scientific reality," Trip Van Noppen, the president of the environmental law group Earthjustice, said in a statement.

"Dirty coal power is never coming back because it can't compete with clean energy and denial won't make climate change go away. Earthjustice will continue to defend clean air and progress on climate in court and out, and we will never back down from protecting our public lands."

The White House said it was preparing for a lengthy fight over the contents of the order.

"I bet a good deal that there will be litigation once the final review is undertaken," the official

said. “It’s going to take a while.”

The action will rescind several other Obama directives issued by his administration.

An order asking federal agencies to consider climate impacts in normal environmental reviews will come off the books, and the administration will reconsider the “social cost of carbon” metric designed to assess the climate implications of government actions.

Other Obama policies — including those focusing on climate change adaptation and its impact on national security — will also come off the books.

The order will have federal agencies identify plans for expanding American energy production, something that will serve as a “blueprint” for the Trump administration’s energy agenda.

The fossil fuel industry stands to benefit from the action. The coal sector, for instance, has lambasted the Clean Power Plan as a regulation designed to damage the industry, which produces a high-polluting fuel.

Oil and natural gas companies oppose the methane regulations as burdensome and duplicative, and they have fought them in court and in Congress.

But the order will not be a silver bullet, something even coal executive Bob Murray acknowledged this week.

“I suggested that he temper his expectations,” Murray told The Guardian, noting market forces that have hurt his sector. “Those are my exact words. He can’t bring [jobs] back.”

InsideEPA

https://insideepa.com/daily-news/trump-order-requires-agencies-id-rules-stymie-energy-production

Trump Order Requires Agencies To ID Rules That Stymie Energy Production

By Abby Smith 3/27/17

President Donald Trump will sign a long-awaited executive order March 28 that a senior White House official says will begin to lay out a framework for the administration's energy and environment policy -- one that will prioritize energy production and eliminate climate or environmental policies that “put the U.S. economy at risk.”

The forthcoming order “will look back and look forward,” the official told reporters in

previewing the order late March 27. The order, known as the "Energy Independence" executive order, will direct federal agencies to identify "all regulations, guidance and documents that serve as obstacles or impediments to U.S. energy production," the official said.

Agencies will be expected to come up with energy independence plans, which the White House will then review. "Those plans will serve as a blueprint for the administration going forward on energy policies," the official said.

Regarding climate change, the White House official suggested several Obama-era policies "don't reflect" Trump's agenda, and therefore will be immediately pulled back or subject to review.

The official indicated the administration wants to "take our own course and do" climate policy "in our own form and fashion."

Specifically, the order will target a wide range of Obama administration climate policies, largely mirroring what appeared in a draft summary of the order obtained by *InsideEPA/climate* and other news outlets.

The order will "initiate the review" of several regulations, including EPA's existing power plant greenhouse gas rule known as the Clean Power Plan and the companion rule for new sources. Both rules are currently subject to pending legal challenges in the U.S. Court of Appeals for the District of Columbia Circuit.

The document could also order the Department of Justice to ask the D.C. Circuit to hold litigation on the power plant rules in abeyance or remand the rules to the agency while administrative proceedings to rewrite them are underway.

The White House official said there is no timeframe associated with the review of the Clean Power Plan and other rules, but EPA Administrator Scott Pruitt "is ready to hit the ground running on it." The source also noted that the administration will have to go through the rulemaking process if it intends to rescind or revise the regulations and acknowledged there will likely be litigation over the end result.

Whether the process takes one, two or three years, "I don't know. It's going to take some time,"

the official said.

In addition, the White House official listed several other Obama-era policies that will undergo review -- including EPA's rule regulating emissions of the potent GHG methane from new oil and gas sources, as well as the Bureau of Land Management's (BLM) methane venting and flaring rule and its rule regulating hydraulic fracturing on public lands.

“All will be reviewed” based on “whether those reflect the policy priority at the beginning of the order,” the official said, though the source did not specify what that priority would be beyond a focus on energy independence and “getting EPA back to its core mission.”

NEPA Reviews

According to the White House official, the order will also rescind Obama White House Council on Environmental Quality guidance for how to account for climate impacts in National Environmental Policy Act (NEPA) reviews. “That guidance was widely opposed by a number of different industries,” the official said, adding that the administration believes it goes “way beyond what NEPA requires.”

The order will also target the Obama administration's social cost of carbon metric, and the related social cost of methane and social cost of nitrous oxide -- default values that agencies use to measure the benefits of rules that limit GHGs.

“The prior administration put out its own estimates, not in a very transparent fashion,” the official said, adding the Trump administration believes the metrics violate “longstanding” Office of Management & Budget policy. Those metrics “will no longer stand,” the source said.

In addition, the White House official said the order will target about six climate change-related executive orders and presidential memorandum from former President Barack Obama, including four orders related to climate adaptation and resilience, the 2013 memo putting forth the Climate Action Plan and a 2014 memo outlining a strategy to cut methane.

The order will also rescind the Department of Interior's moratorium on new coal leasing on federal lands.

The White House official said the order will not address how the Trump administration will proceed with the Paris Agreement, which the source said is “still under discussion."

It will also not address EPA's 2009 GHG endangerment finding, which underpins the agency's climate regulations and which many conservative groups have urged the Trump EPA to review. Just last month, the free-market Competitive Enterprise Institute asked EPA to review the GHG risk finding in a petition obtained by *Inside EPA*.

“Certainly if you look at the previous administration's” Paris Agreement pledge, “we have a different view about how you would address climate policy in the U.S.,” the White House official said, adding that the Trump administration intends to go in a “different direction” but the emissions impact of that pathway is unclear.

The White House official emphasized that Trump “made a pledge” to help the coal industry. While it is true that such things like the low cost of natural gas and other market forces affect coal's success, “certainly government policy has a role, and to the extent he can have a beneficial effect, he's going to take it.”

In addition, the White House official indicated the executive order would “lay out very clearly” how the Trump administration intends to approach climate policy. The source suggested the administration believes the most important factor is to “make sure you have a strong economy,” noting that the United States has a “cleaner, healthier environment” than large developing countries like China.

The official also noted that the Trump administration will continue to enforce clean air laws that are “on the books” but will review “policies like the Clean Power Plan that we believe don't provide environmental protection.” The source added that “whether it's clean coal, nuclear power, renewables . . . allowing all those to flourish is a good way to address the issue.” -- *Abby Smith* (asmith@iwpnews.com)

Washington Examiner

http://www.washingtonexaminer.com/trumps-newest-order-looks-to-block-obamas-climate-legacy/article/2618606

Trump's newest order looks to block Obama's climate legacy

By John Siciliano 3/27/17 11:00 PM

President Trump will sign an executive order Tuesday to roll back the centerpiece of the Obama administration's climate change agenda, the Clean Power Plan, and cancel what Trump says are unnecessary rules on coal, oil and natural gas production that are harming economic growth.

The executive order is seen as central in meeting the president's campaign promises to help coal country rebound from the tens of thousands of job losses that the industry blames, in part, on restrictive environmental regulations.

A senior administration official told reporters on a call Monday that the order has the "twin goals" of both moving forward while also looking backward.

It "looks forward" by setting the stage for the "beginning strategy" in devising an energy policy framework for the nation, said the senior official. And it looks backward by eliminating regulations from the previous administration that hinder growth and energy production.

It will call on all agencies to conduct a comprehensive review of all rules to determine those that inhibit energy production, and report back to the White House in 180 days.

After that, the White House will sit down with the agencies to develop an energy "blueprint," the official told reporters.

The order will also direct the Environmental Protection Agency to review and, if necessary, redo climate regulations for existing fossil fuel power plants, called the Clean Power Plan, with the end goal of redacting the regulation. And, it will roll back climate regulations on new power plants, known as the New Source rule, which is called a "defacto ban" on building new coal-fired power plants in the country.

The clean coal technology required to meet the rule is cost prohibitive and not yet even commercially viable.

The rule directs the Justice Department to ask the D.C. Circuit Court of Appeals to hold in abeyance current lawsuits opposing the regulations. Nearly 30 states and hundred of groups, firms and companies are suing the agency over the power plant rules.

Rolling back the regulations would help keep coal power plants from prematurely closing down over the next decade. The review that EPA must do to comply with the Administrative

Procedures Act could take years, as the official expects the review will be challenged in court.

In other areas, the rule takes aim at Obama-era regulations opposed by industry groups that are meant to control methane emissions from fracking wells.

Both the EPA and the Interior Department have regulations for essentially doing the same thing, limiting emissions of methane, which is a potent greenhouse gas that many scientists blame for causing manmade global warming through the burning of fossil fuels.

The methane regulations are part of President Barack Obama's broad climate agenda issued in 2013, called the Climate Action Plan. But the rule rescinds all six executive orders that make up the Climate Action Plan.

The order has faced weeks of delays because of complex legal questions regarding the Clean Power Plan and EPA climate rules, which are currently under review by the D.C. Circuit Court of Appeals.

The order is "legally complex," and the White House was being "very careful" due to the ongoing litigation, the official said.

He said EPA Administrator Scott Pruitt is "ready to hit the ground running" in conducting the climate rule at the agency. But he said it seems clear there will be litigation, which could take years to resolve.

Big environmental groups like the Natural Resources Defense Council and Sierra Club will likely initiate opposition in the courts to the executive order and its actions.

NRDC President Rhea Suh began ramping up support for her group's legal response to Trump's assault on EPA in November. Her group is already suing against Trump's approval of the Keystone XL pipeline on Friday.

Meanwhile, Sen. Ed Markey, D-Mass., an ardent supporter of steps to control climate change, plans to introduce legislation in direct response to Trump's executive orders on Keystone XL and the Clean Power Plan.

"President Trump didn't issue an executive order today, he issued a declaration of war on American leadership on climate change and our clean energy future," said Markey.

Markey said Monday that he plans to introduce a slew of bills, including one to transition to 100 percent clean and renewable energy by 2050, another to reform the federal coal leasing program, and a third to "block export of Keystone XL oil and refined product," while opening up offshore wind energy on the nation's coasts.

Mother Jones

http://www.motherjones.com/environment/2017/03/trump-executive-order-climate

Trump Just Released His Plan to Gut Obama's Climate Policies. It's Worse Than You Thought.

By Rebecca Leber 3/27/17 11:00 PM

President Donald Trump will issue his long-promised executive order rolling back federal government efforts to fight climate change Tuesday.

The wide-ranging order, which will be accompanied by other environmental directives, targets Obama-era policies across the government, including in the Environmental Protection Agency, the Department of Interior, and the Department of Defense. It directs the EPA to revisit the Clean Power Plan, which limits carbon pollution from power plants and was considered the center-piece of former President Barack Obama's climate policy. Additionally, Trump is asking the Justice Department to stop defending the plan in court.

The president will instruct agencies to rescind a moratorium on coal leasing on public lands; rewrite limits on methane emissions from the oil and gas industry; and ignore the EPA's current calculation on the costs of carbon pollution. There are also broad directives reversing an Obama initiative requiring that federal departments consider climate mitigation strategy and the national security risks of global warming.

One of Trump's more notable "Day One" promises is missing, however: The United States will remain in the landmark Paris climate accord for the time being—despite Trump's pledge to "cancel" it.

Still, environmentalists are furious. "This is not just dangerous; it's embarrassing to us and our businesses on a global scale to be dismissing opportunities for new technologies, economic growth, and US leadership," Obama EPA Administrator Gina McCarthy said in a statement.

Sen. Edward Markey (D-Mass.) called Trump's actions "a declaration of war on American leadership on climate change and our clean energy future" in his own statement.

Indeed, Tuesday's actions are just the start of a long fight over the federal government's role in confronting climate change. Undoing the regulations already on the books, from the Clean Power Plan to the methane rule, could take several years. And Trump will face fierce resistance throughout the protracted fight. Green groups are already threatening legal action.

EPA Administrator Scott Pruitt, White House Press Secretary Sean Spicer, and Trump himself have all stuck to a similar script while previewing the order. They insist it will create jobs and help the United States achieve energy independence (although the US wasn't "energy independent" before the Obama rules existed). At a recent Kentucky rally, Trump claimed the executive order would "save our coal industry." (It won't.)

On a press call Monday night, a senior White House official also stuck to that script. That is, until reporters asked him whether administration staffers who worked on the order accepted the science behind global warming and sea level rise—and the research showing that climate change makes extreme weather worse.

"I would like to see" that research, said the official, who spoke on background to reporters. "Send it to me."

Asked whether the president and his staff all believe in manmade climate change, the official stumbled, "Um…again I think it's not a controversial statement. The key question is the extent over what frame of time." Asked whether the official personally believed climate change is manmade, he said, "Yeah, sure I do. That doesn't say much does it?"

It actually says a lot. Trump and Pruitt have both at times dismissed climate science—Trump infamously called it a Chinese hoax. Environmental lawyers think these pronouncements could strengthen their lawsuits. "It is possible that statements of that sort will come back to haunt them," Richard Revesz, a New York University environmental law professor, said. "It would suggest they prejudge the science before consulting with scientists. There is a pretty high burden for departing from an existing rule."

Here's the rundown of some of what Trump's executive actions will do:

Gutting the Clean Power Plan

The Clean Power Plan was the Obama EPA's strategy for reducing carbon pollution from existing power plants 32 percent by 2030. Under this rule, states would have to submit plans to achieve customized emissions targets using a mix of renewables, natural gas, and energy efficiency. The Supreme Court put the rule on hold last year as attempts to block it wind their way through the court system, so the EPA's work on the program has ground to a halt.

Trump's order directs the EPA to revise the plan and review what it thinks is required under the Clean Air Act, which forms the basis for the power plant regulations. The moves will require an extensive public notice and comment period to justify any changes, and the administration has yet to make a timetable public.

Trump is instructing the EPA to revise the rule (and weaken it substantially)—rather than rescind it entirely—presumably because the Supreme Court told the agency in 2007 it must regulate carbon pollution if it finds carbon to be a threat to human health. The agency issued this so-called "endangerment finding" in 2009, and it was upheld in a 2012 appeals court case. As long as the EPA's finding that climate change poses a health danger remains in effect, the EPA is legally required to issue regulations based on the "best available science." While revoking the endangerment finding has long been a goal of some on the right, it would be a difficult feat that would likely involve convincing the courts that climate change is, as Trump contends, a hoax.

Adding more complication still, the DC federal court of appeals has yet to issue its opinion on the legality of the Clean Power Plan, after hearing the case on an expedited schedule last fall. As

expected, Trump is now asking the Department of Justice to withdraw its defense of the plan.

Ignoring the Cost of Carbon

In 2007, a federal appellate court ruled that when performing a cost-benefit analysis on its fuel efficiency standards, the Bush administration had to account for the costs that carbon emissions inflict on society by contributing global warming and other problems. The court recognized that "while the record shows that there is a range of values [for the social cost of carbon], the value of carbon emissions reduction is certainly not zero."

Of course, translating the impacts of carbon emissions and climate change into an economic "cost" that can be measured in dollars is a complicated undertaking. Obama's EPA ultimately worked out a formula for tabulating these costs and used it as a basis for its climate regulations.

Trump's order directs the EPA to ignore this calculation.

Ending the Moratorium on Coal Leases on Public land

In January 2016, Obama ordered a moratorium on new coal leases on public lands until Interior could update its badly outdated leasing program. Trump is now directing the department to reverse that moratorium. Unlike the Clean Power Plan, which was a formal rule that can only be undone through a drawn-out process, Interior can act on this directive immediately.

When that happens, environmental groups are ready to fight back. Earthjustice expects this to be the first in a long series of legal battles over Tuesday's order. The group says it plans to file a lawsuit within hours of the agency's action.

"We expect to challenge any action that allows coal leasing to resume before [an] environmental review is completed that evaluates whether the federal coal leasing program should be reformed (or scrapped altogether) in light of its significant climate impacts and failure to generate a fair return for US taxpayers," Earthjustice attorney Jenny Harbine said.

Rolling Back Methane Restrictions

The Obama administration finalized a series of regulations toward the end of his presidency limiting methane emissions. Among them was an Interior rule limiting excessive flaring and venting from oil and gas operations on public lands. Like the Clean Power Plan, this change will have to go through a formal rulemaking process in order for Trump to undo it. Trump will also rescind Obama's broad strategy, released in 2014, for reducing methane emissions.

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To: Hanson, Andrew[Hanson.Andrew@epa.gov]
From: Bangerter, Layne
Sent: Wed 5/24/2017 8:49:14 PM
Subject: Fwd: E&E News: Path on Clean Power Plan 'yet to be determined' — Pruitt, 5/24/17

Good stuff.

Sent from my iPhone

Begin forwarded message:

From: "McGonagle, Kevin" <mcgonagle.kevin@epa.gov>
Date: May 24, 2017 at 2:25:30 PM MDT
To: AO OPA OMR CLIPS <AO_OPA_OMR_CLIPS@epa.gov>
Subject: E&E News: Path on Clean Power Plan 'yet to be determined' — Pruitt, 5/24/17

E&E News

https://www.eenews.net/eenewspm/2017/05/24/stories/1060055102

Path on Clean Power Plan 'yet to be determined' — Pruitt

By Emily Holden 5/24/17

U.S. EPA Administrator Scott Pruitt called American action on climate change a "bad business deal," promoted fossil energy and said his agency hasn't yet determined whether to replace the Clean Power Plan.

In his most extensive public remarks since taking office, Pruitt told a small gathering at a conference sponsored by the law firm Faegre Baker Daniels LLP that EPA would focus on three core principles: "the rule of law," "process" and "cooperative federalism."

"We're getting back to the basics," Pruitt said.

Pruitt called regulatory uncertainty, in the energy world and beyond, the "biggest impediment to economic growth" in recent years. Environmental advocates argue that pro-climate policies could boost the GDP.

Pruitt noted that carbon levels are lower than in the 1990s, attributing that to innovation and technology, not government intervention.

The global Paris climate deal "represents the rest of the world applauding as we penalize ourselves and hurt our economy," he said. He called the agreement a "bumper sticker" for the Obama administration and said it was "mostly talk and little action."

He also contended the United States wouldn't have met its obligations with regulations on the books. Environmentalists don't agree. Bruce Nilles, head of the Sierra Club's Beyond Coal campaign, countered that "it is bad for business to keep betting on coal" when utilities are working to cut emissions.

Pruitt said the Obama administration's signature climate rule, the Clean Power Plan, which would have called on states and utilities to cut power plant carbon emissions, was a "reimagination of authority." He said it would have cost $292 billion, citing figures from a report prepared for the American Coalition for Clean Coal Electricity that were far higher than estimates from the Obama EPA.

President Trump has directed EPA to review the Clean Power Plan, with an eye toward unwinding it. Legal experts have suggested EPA might want to replace the rule with something less stringent to avoid lawsuits for not acting on the agency's previous finding that carbon emissions are a danger to public health. A new rule could focus solely on efficiency improvements at coal plants, for example. The White House has struggled with which route to take, however.

Asked whether EPA could replace the regulation, Pruitt said, "That's yet to be determined."

He contrasted the Clean Power Plan to the Waters of the U.S. rule, which he said would require new definitions of regulated waterways.

"On Clean Power Plan, I think it's yet to be determined," he said. "I think there's a fair question to be asked and answered on that issue with stationary sources. What are the tools in the toolbox?"

Pruitt said EPA has "struck out" twice before on carbon dioxide emissions. He noted one Supreme Court decision that upheld EPA's ability to regulate greenhouse gases from large sources but stopped it from regulating smaller ones. He also referenced the Supreme Court stay on implementing the Clean Power Plan, which is still in effect.

Pruitt said he asked lawmakers during his confirmation process what laws could be used to regulate CO2 from power plants. He added that he believes the way the Obama administration pursued standards was illegal and was instrumental in his decision as Oklahoma attorney general to bring a case against EPA.

He argued that the 1990 amendments to the Clean Air Act were focused on local and regional air pollutants, not carbon.

Superfund

Pruitt also defended an Energy Department grid reliability study that would explore whether renewable power is pushing coal-fired power plants offline, but he added that the government shouldn't pick winners and losers.

He said pushing for 100 percent renewable power is "just not wise" and that "we need to have fuel diversity."

Nilles said, "Ending carbon pollution is critical if we are to avoid warming above 1.5 degrees — hence the push for 100 percent."

Pruitt said his agency can do a better job than the Obama administration in cleaning up pollution, even if it has less money.

In recent weeks, EPA has announced a renewed focus on Superfund sites, which Pruitt says the Obama administration failed to address. Superfund spending would fall by about a third under Trump's budget proposal.

Pruitt said that "leadership, attitude, management and focus" would be "key to restoring a commonsense Superfund portfolio."

Faegre Baker Daniels principal Andrew Wheeler, who is reportedly being considered for EPA's deputy administrator position, moderated questions for Pruitt and asked about his timeline for filling the job (Greenwire, March 24).

Pruitt didn't give a deadline but did note EPA's 10 regional office heads don't need Senate approval and could be in place quickly. He said that would speed communications with regulated industries. Staffers have denied speculation that EPA might close some regional offices.

Kevin McGonagle

Office of Media Relations Intern

U.S. Environmental Protection Agency

Telephone: (202)-564-4524

mcgonagle.kevin@epa.gov

To: Personal Email/Ex. 6 - Don Benton
From: Bangerter, Layne
Sent: Thur 7/27/2017 3:13:45 PM
Subject: Fwd: The Hill: EPA transition official dismisses climate science strategy as 'silliness', 7/27/17

Sent from my iPhone

Begin forwarded message:

From: "Sparacino, Jessica" <sparacino.jessica@epa.gov>
Date: July 27, 2017 at 10:19:10 AM EDT
To: AO OPA OMR CLIPS <AO_OPA_OMR_CLIPS@epa.gov>
Subject: The Hill: EPA transition official dismisses climate science strategy as 'silliness', 7/27/17

The Hill

http://thehill.com/policy/energy-environment/343976-epa-transition-official-dismisses-pruitt-climate-science-strategy

EPA transition official dismisses climate science strategy as 'silliness'

By: Devin Henry, 7/26/17, 4:29 p.m.

A former transition official at the Environmental Protection Agency (EPA) is dismissing the agency's plan to debate climate change science as "silliness."

EPA Administrator Scott Pruitt is planning to deploy a “red team, blue team” debate over the scientific consensus around climate change. But David Schnare, a 34-year EPA veteran and former transition official for the Trump administration, dismissed that approach in an op-ed for InsideEPA.

“The Red team-blue team concept simply does not apply within the scientific community,” he wrote.

“That … is not how science works. Science is supposed to be done by individuals ‘disinterested’ in the outcome of their observations. It is not supposed to be a political blood sport.”

The former transition official called Pruitt’s proposal to televise debates on climate change “an extension of failure to understand how science works” because a televised structure is too limiting.

Schnare said scientific discussions into climate change should be conducted instead by the White House’s Office of Science and Technology Policy, which is currently writing a “National Climate Assessment” report.

The EPA did not immediately respond to a request for comment on Schnare’s article.

Schnare retired from the EPA in 2011 and returned to the agency as a transition official once Trump was elected. He has publicly questioned climate science and was a frequent critic of the agency under former President Barack Obama.

The former official wrote in his op-ed that he was in line for an appointment to be the agency’s Assistant Deputy Administrator position before he resigned from the transition team in March.

At the time, Schnare didn’t expand on why he left the agency. But he wrote in his op-ed this week that the transition team was facing “antagonism” by employees and “open hostility” from some Pruitt appointees.

Pruitt himself, Schnare wrote, rarely met with career staff to address “time- and policy-sensitive” issues facing the agency.

“In simple terms, Mr. Pruitt and I simply never meshed,” Schnare wrote. “In my case, Mr.

Pruitt and I had basic irreconcilable differences in management approach and professional ethics."

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Jessica Sparacino

US Environmental Protection Agency

Office of Public Affairs Intern

(202) 564-5327

WJCN 2502J

To: Ericksen, Doug[ericksen.doug@epa.gov]
From: Bridget DiCosmo
Sent: Tue 10/10/2017 2:25:51 PM
Subject: Clean Power Plan announcement

Hi, Doug,

I'm a reporter with energy intelligence. Is there a call scheduled today on the clean power plan? Or should we be expecting release of the proposal via press release at some point? I'm asking for planning purposes only because our daily deadline is on the early side, so any kind of heads up you might be able to give would be really, really helpful. I've tried emailing the general press box without any luck.

Many thanks,

Bridget

Bridget DiCosmo

Reporter, Energy Intelligence

202-662-0710

bdicosmo@energyintel.com

Oil&Money
The New York Times Energy Intelligence
October 17-19, 2017
InterContinental London Park Lane
Agenda Announced

To: Doug Ericksen Personal Email/Ex. 6
From: Ericksen, Doug
Sent: Tue 2/21/2017 12:48:42 PM
Subject: Emailing: Clean power Plandje.docx, Climate, GHG, coaldje.docx, endangerment findingdje.docx, Final - Climate Change (002).docx, GHG reportingdje.docx, Message points for Executive Orders that Impact the EPAdje.docx
Clean power Plandje.docx
Climate, GHG, coaldje.docx
endangerment findingdje.docx
Final - Climate Change (002).docx
GHG reportingdje.docx
Message points for Executive Orders that Impact the EPAdje.docx

Your message is ready to be sent with the following file or link attachments:

Clean power Plandje.docx
Climate, GHG, coaldje.docx
endangerment findingdje.docx
Final - Climate Change (002).docx
GHG reportingdje.docx
Message points for Executive Orders that Impact the EPAdje.docx

Note: To protect against computer viruses, e-mail programs may prevent sending or receiving certain types of file attachments. Check your e-mail security settings to determine how attachments are handled.

Message Points: Withdrawal of the EPA's "Clean Power Rule"

- The "Clean Power Rule" was a clear and unconstitutional over reach by the EPA. The past Administration attempted to circumvent the United States Congress and promulgate a rule exceeding their authority.

- Many states have been engaged in legal action on this rule and the courts have ruled in favor of the states to this stage.

- Under this Executive order we will withdraw the rule and work with the states and Congress ensure that we balance our economy, energy production, and our environment.

- This executive order will encourage domestic energy production, create jobs, propel our economy, and do it as the world leaders in technology and environmental protection.

Message Points: CLIMATE CHANGE, GREEN HOUSE GASES, WAR ON COAL EXECUTIVE ORDER

- The President has issued an executive order making it very clear that we will utilize domestic energy resources in an environmentally responsible fashion. I am looking forward to working with the career professionals at the EPA to implement this vision.

- Rule, regulations, and executive orders over the past eight years, and even longer, have harmed our ability to create good jobs in America. We will bring balance back to the system, we will protect our environment, and we will create new manufacturing opportunities in the states.

- The President's Executive Order eliminates the overreach of the EPA and focuses on State's rights by pulling back rules and regulations that clearly exceeded the authority of the EPA, such as the so called Clean Power Rule.

- This executive order will help return power back to the states where it belongs. The EPA will again become a partner with the states for environmental protection and economic development.

- Under this executive order we will return to science based decision making. More voices will be heard. There will be more seats at the table. Science will drive our decision making process.

Message Points: Endangerment Finding Reconsideration

- It is time to revisit the endangerment finding the carbon poses an air quality threat to human health.

- The Endangerment Finding provides the basis for many actions taken by the EPA since 2009. It is vitally important the United States that we apply the highest scientific rigor and process as we revisit this finding.

- The process used to reach conclusions in the 2009 Endangerment Finding needs to be improved to allow more voices to be heard and allow the science that was not considered to be considered.

- We will let the science guide us on this issue as we revisit the 2009 Finding.

- In order to accomplish the goals of the Executive Order we will apply "Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies."

EXECUTIVE ORDER

War on Coal:
Restoring the Rule of Law, Federalism, and Economic Growth
by Rescinding Climate Change Directives

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in recognition of Congress's power to determine whether and how to effectuate Federal regulation of greenhouse gas emissions, or otherwise respond to the potential for climate change; the opportunity costs imposed by federal climate change activities that diminish the ability of Departments and Agencies to meet their core responsibilities; the States' traditional power to regulate electricity generation, distribution, and use; the principle that the U.S. Environmental Protection Agency (EPA) shall, when implementing the Clean Air Act programs of this nation, work cooperatively with the States to achieve shared environmental goals; and the imperative to promote policies in the national interest and for the benefit of American workers and their families; it is hereby ordered as follows:

Section 1. *Policy.*

It is in the national interest to ensure that the nation's electricity is affordable, reliable, safe, secure, and clean, and available to be produced from coal, natural gas, nuclear power, hydropower, other renewables, and other domestic sources.

It is the policy of the United States that executive departments and agencies including the EPA shall take appropriate actions, to the extent consistent with applicable law, to ensure clean air and clean water for the American people in cooperation with the States and according to standards both as set forth by Congress, in respect of the proper roles of Congress and the States concerning these matters in our constitutional republic.

It is the policy of the United States that federal regulations and directives be based on careful consideration of science and principles of science reflecting input from the entirety of the scientific community; and that those agencies with statutory responsibility for regulation and formulation of directives integrate scientific knowledge in the first instance, rather than rely on that conducted by other units of government or international bodies.

It is the policy of the United States that when promulgating federal regulations for the environment, it is necessary to ensure that policy solutions comport with the law, provide substantially more benefits than the costs imposed, accurately gauge those costs, reflect the opportunity costs of policy solutions, achieve meaningful environmental improvements for the American people, and are developed through transparent procedures using the best available science.

Sec. 2. *Rescission of Certain Climate-Related Actions.*

(a) The following Presidential actions are hereby revoked:

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Executive Order 13754 of December 9, 2016, which addressed Northern Bering Sea Climate Resilience.

Executive Order 13653 of November 1, 2013, which required certain actions by the Federal government and other entities concerning climate change;

Executive Order 13677 of September 23, 2014 (Climate-Resilient International Development), which set requirements for systematically integrating climate-resilience considerations into U.S. international development work;

The Presidential Memorandum of June 25, 2013, concerning "Power Sector Carbon Pollution Standards", 78 Fed. Reg. 39,535 (July 1, 2013);

The Report of the Executive Office of the President entitled, "The President's Climate Action Plan," dated June 2013; and,

The Presidential Memorandum of September 21, 2016, entitled, "Climate Change and National Security".

The Presidential Memorandum of December 5, 2013, entitled "Federal Leadership on Energy Management."

The Presidential Memorandum of February 03, 2010, entitled, "A Comprehensive Federal Strategy on Carbon Capture and Storage.

(b) Executive Order 13693 of March 19, 2015, (Planning for Federal Sustainability in the Next Decade), which directed Federal actions to improve environmental performance and Federal sustainability, is amended by deleting: (1) section 1 through section 15; (2) the first sentence of section 16(a); (3) "Therefore," of the second sentence of section 16(a); (3) sections 16(d) through 16(e); and sections 17 through 20.

(c) The Administrator of EPA, the Council on Environmental Quality (CEQ), and heads of all executive departments and agencies shall (i) promptly identify every order, rule, regulation, guideline, or policy implementing or enforcing the Presidential actions listed in subparagraph (a); (ii) specify the source of authority for each; (iii) shall terminate, effective today, any actions based on said Presidential actions immediately, and otherwise stay and move to rescind each such activity (including funding) until the Office of Management and Budget authorizes/directs reinvestment, modification or cessation of the program/project, unless required unambiguously by statute.

Sec. 3. United Nations Framework Convention on Climate Change (UNFCCC).

(a) On March 17, 2016, the State of Palestine became a Party to the UNFCCC, an affiliated organization of the United Nations. Since March 17, 2016, the United States has continued to make contributions, including financial contributions, to the Convention, which are contrary to section 410(1) of Public Law 103-236, the Foreign Relations Authorization Act, Fiscal Years

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1994 and 1995, and are violations of the Antideficiency Act.

(b) Each Executive Department or Agency shall immediately terminate, effective today, all contributions, including financial contributions, to the UNFCCC, including its subsidiary bodies, its financial mechanisms (Green Climate Fund and Global Environment Facility), the Least Developed Countries Fund, the Special Climate Change Fund, the Adaptation Fund, as well to the Intergovernmental Panel on Climate Change (IPCC) for any UNFCCC-requested Special Report, Methodological Report, or Technical Report.

(c) Each Executive Department or Agency who have made contributions, including financial contributions, to the UNFCCC, from March 17, 2016 to today, are directed to report immediately the amounts of those contributions to the Office of Management and Budget and to make every effort to recover those amounts from the UNFCCC, including its subsidiary bodies, its financial mechanisms (Green Climate Fund and Global Environment Facility), the Least Developed Countries Fund, the Special Climate Change Fund, the Adaptation Fund, as well from the Intergovernmental Panel on Climate Change (IPCC), as appropriate.

(d) Pursuant to Article 25 of the UNFCCC, the United States withdraws from the UNFCCC, including the "Paris Agreement" of 2015.

(e) The Department of State is directed to immediately give written notification of its withdrawal to the Depository per Article 25(1) of the UNFCCC, to wit, the Secretary-General of the United Nations.

Sec. 4. *Withdrawal of the EPA's "Clean Power Plan" and Related Rules.*

(a) On February 10, 2015, the United States Supreme Court stayed implementation of EPA's "Clean Power Plan", which regulation remains stayed by that Court's order. Section 705 of the Administrative Procedures Act, 5 U.S.C. 705, provides further legal authority for this Administration to establish an additional executive stay of the Clean Power Plan. In particular, Section 705 authorizes the Administration, when it "finds that justice so requires," to postpone the effective date of agency action pending judicial review.

For the reasons justifying the stay order of the Supreme Court, and other pertinent reasons set forth by the States opposing the Clean Power Plan and related rules, I hereby find that justice requires a permanent, administrative stay and consideration for revision or withdrawal of the Clean Power Plan and similar and related rules. To that end, the Administrator of EPA shall promptly administratively stay the final rules listed in subparagraph (b) pursuant to the authority recognized by Section 705 of the Administrative Procedure Act.

The Administrator of the EPA shall also consider petitions filed with the Agency to reconsider the Clean Power Plan and, where appropriate, grant such petitions where the effect of such grants would effectuate the purposes of this Executive Order.

The Administrator of EPA shall immediately take all steps necessary to effectuate the lawful withdrawal and rescission of the final rules listed in subparagraph (b) below, along with any orders, rules, regulations, guidelines, or policies implementing or enforcing those final rules, to the extent consistent with law, and shall terminate, effective today, any actions based on those rules. The Administrator shall also promptly take final action to withdraw the proposed rules

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listed in subparagraph (b) below. Where appropriate, the Administrator shall simultaneously take action to promulgate in revised form any of the rules listed in subparagraph (b) below.

(b) Final or proposed rules for withdrawal or recession pursuant to subparagraph (a):

Final Rule, "Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units," published at 80 Federal Register 64661 (October 23, 2015) (also known as the "Clean Power Plan").

Final Rule, "Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units," published at 80 Federal Register 64509 (October 23, 2015).

Final Rule, "Standards of Performance for Municipal Solid Waste Landfills" published at 81 Federal Register 59332 (August 29, 2016).

Final Rule, "Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources," published at 81 Federal Register 35824 (June 3, 2016).

Final Rule, "Source Determination for Certain Emission Units in the Oil and Natural Gas Sector," published at 81 Federal Register 35622 (June 3, 2016).

Final Rule, "Finding That Greenhouse Gas Emissions From Aircraft Cause or Contribute to Air Pollution That May Reasonably Be Anticipated To Endanger Public Health and Welfare," published at 81 Federal Register 54421 (August 15, 20167); and the associated EPA denial of the Biogenic CO2 Coalition's petition for reconsideration of this final action.

Revised Guidance, "Guidance for Implementing Section 141 of the Energy Independence and Security Act of 2007, Federal Vehicle Fleets and Low Greenhouse Gas-Emitting Vehicles," published at EPA-420-B-16-055 (May 2016).

Proposed Rule, "Federal Plan Requirements for Greenhouse Gas Emissions From Electric Utility Generating Units Constructed on or Before January 8, 2014; Model Trading Rules; Amendments to Framework Regulations; Proposed Rule," 80 Federal Register 64966 (October 23, 2015).

Proposed Rule, "Revisions to the Prevention of Significant Deterioration (PSD) and Title V Greenhouse Gas (GHG) Permitting Regulations and Establishment of a Significant Emissions Rate (SER) for GHG Emissions Under the PSD Program," published at 81 Federal Register 68110 (October 3, 2016).

(c) The Administrator shall have the discretion to commence administrative proceedings both to reconsider and to rescind the rules listed in subparagraph (b) in a manner that is consistent with the Clean Air Act and other applicable law including the limitations on the Administrator's discretion and consistent with constitutional principles of federalism and separation of powers, while also providing for significant interagency input in the Administrator's reconsideration processes and any subsequent related rulemaking processes, if any.

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(d) The Administrator shall rescind EPA's "Legal Memorandum Accompanying Clean Power Plan for Certain Issues," which was published in conjunction with the Clean Power Plan, and said memorandum shall be of no further force or effect.

(e) With respect to litigation before the Federal courts related to rules listed in subparagraph (b) of this Section, the Administrator shall take all available measures to effectuate the directive in subparagraph (a), including by promptly directing the U.S. Department of Justice to seek remand of the final rules listed in subparagraph (b) by judicial orders holding all litigation concerning the final rules listed in subparagraph (b) in abeyance until such time as the Administrator takes final action to rescind the Clean Power Plan. The Administrator shall immediately cease all efforts related to implementation of the actions listed in subparagraph (b), including without limitation by immediately ceasing any expenditures related to implementation of the final rules listed in subparagraph (b) except as directly required by applicable appropriations.

(f) The Secretary of the Interior shall immediately take all steps necessary to effectuate the lawful withdrawal and recission of the Final Rule, "Oil and Gas: Hydraulic Fracturing on Federal and Indian Lands," published at 80 Federal Register 16128 (March 26, 2016), and all other rules and guidance published pursuant thereto.

Sec. 5. *Withdrawal of the Greenhouse Gases Endangerment Finding*

Pursuant to Section 705 of the Administrative Procedures Act, 5 U.S.C. 705, I hereby find that justice requires a permanent, administrative stay and revision or withdrawal of the "Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act" published at 74 Federal Register 66496 (December 15, 2009).

The Administrator of the EPA shall also consider petitions filed with the Agency to reconsider the this or any other related endangerment finding and, where appropriate, grant such petitions where the effect of such grants would effectuate the purposes of this Executive Order.

In conducting its reconsideration, revision or withdrawal of endangerment findings, EPA shall rigorously apply EPA and OMB "Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies."

Sec. 6. *GHG Reporting Rule*

The EPA Administrator shall review and, unless not justified by sound science or legal constraints, grant requests or petitions for reconsideration of the Subpart W Greenhouse Gas Reporting rule, and engage in rule-making intended to remedy that rule's most onerous requirements.

Sec. 7. *Social Cost of Greenhouse Gases*

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(a) I find that multiple independent reviews of the basis for estimating a social cost of carbon or greenhouse gases document the fundamental weaknesses in these estimators. They fail to meet the requirements of appropriate use of information disseminated by federal agencies under the Information Quality Act guidelines and as such are without sufficient quality, objectivity, utility, and integrity to support decision-making regarding the value of greenhouse gas reductions.

(b) The Interagency Working Group on Social Cost of Greenhouse Gases shall be dissolved immediately.

(c) The guidance document titled "Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866" (July 2015), and all predecessor or successor documents, and any other guidance or policies promulgated thereto are hereby rescinded.

(d) The guidance document titled "Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide" (August 2016), and all predecessor or successor documents, and any other guidance or policies promulgated thereto is hereby rescinded.

(e) All regulatory agencies and any Executive Branch Department or Agency preparing environmental assessments or impact statements shall immediately suspend use of "Social Cost of Carbon" or the "Social Cost of Greenhouse Gases" or the "Social Cost of Methane" or the "Social Cost of Nitrous Oxide" estimates in any regulatory or National Environmental Policy Act (NEPA) analyses.

(f) Each Agency or Department shall (i) report to OMB, CEQ and CEA each instance in which the "Social Cost of Carbon" or the "Social Cost of Greenhouse Gases" or the "Social Cost of Methane" or the "Social Cost of Nitrous Oxide" has been used (specifying the regulation, guidance or analysis); (ii) amend any environmental assessments or environmental impact analyses prepared under NEPA, withdrawing any reliance upon an estimated "Social Cost of Carbon" or the "Social Cost of Greenhouse Gases" or the "Social Cost of Methane" or the "Social Cost of Nitrous Oxide"; and (iii) amend any regulatory impact analysis for any major rule to eliminating any reliance upon "Social Cost of Carbon" or the "Social Cost of Greenhouse Gases" or the "Social Cost of Methane" or the "Social Cost of Nitrous Oxide" estimates.

Sec. 8. NEPA

Consonant with other sections of this Executive Order, the following memorandum and guidance promulgated by the Council on Environmental Quality is hereby revoked:

> Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews, Dated August 1, 2016.

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Each Agency or Department shall (i) report to CEQ and CEA each instance in which NEPA analyses incorporated or otherwise applied the above identified Final Guidance, or drafts of that Guidance (specifying the regulation, guidance or analysis); (ii) amend any environmental assessments or environmental impact analyses prepared under NEPA, withdrawing any reliance upon the Draft or Final Guidance; and (iii) amend any regulatory impact analysis for any major rule to eliminating any reliance upon the Draft or Final Guidance.

Sec. 9. *General Provisions*

(a) Nothing in this order shall be construed to impair or otherwise affect (i) authority granted by law to a department or agency, or the head thereof; or (ii) functions of the Director of the Office of Management and Budget relating to budget, administrative, or legislative proposals.

(b) This order shall be implemented consistent with applicable law and subject to the availability of appropriations.

(c) This order is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

THE WHITE HOUSE,
January 20, 2017

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Message Points: Green House Gas Reporting Rule

- The President has directed the EPA through Executive Order to fully review the Green House Gas Reporting Rule.

- Under this direction I will work with the career professionals at the EPA reconsider this rule, and work to remedy the most onerous aspects of this rule.

- We will grant requests or petitions for reconsideration as we work to fix this rule.

Message points

For Overall Theme on Executive Orders that Impact the EPA

- The President of the United States has issued a number of Executive Orders that give direction to the Environmental Protection Agency. I am looking forward to working with the career professionals at the EPA to implement these Executive Orders.

- The Executive orders issued by the President will focus our time, our resources, and our energy on the core functions of the EPA—Protecting public health and the environment. We are looking forward to the challenge.

- The President has sent a clear message with his executive orders, we are going to protect public health and the environment while creating more manufacturing jobs here in America and utilizing our vast energy resources. I know that we can do it.

- Executive Orders issued by the President make it clear that we are going to expand the number people at the table, not limit the number. We are going hear from more voices, not fewer. We are going to become more transparent, not less.

- Science will drive the decisions of the EPA. We will increase the number of scientists who have the ability to shape our future, not limit the number. EPA shall rigorously apply EPA and OMB "Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies".

- We need to understand and remember that when a person uses the word "consensus" they are no longer speaking as a scientist but as a politician.

- Over the past 8 years, and even longer, the EPA has drifted away from its core mission of protecting public health and the environment. The Executive Orders issued by the President are the first steps towards returning to the core mission.

- The Executive Orders issued by the President make it clear we are going to invest in America, we are going to work with States. We are going to drive resources to projects that clean up and protect our environment, to projects that ensure safe drinking water, and we will move away from those activities which are not part of our core mission.

TEXT OF EO:

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in recognition of Congress's power to determine whether and how to effectuate

Federal regulation of greenhouse gas emissions, or otherwise respond to the potential for climate change; the opportunity costs imposed by federal climate change activities that diminish the ability of Departments and Agencies to meet their core responsibilities; the States' traditional power to regulate electricity generation, distribution, and use; the principle that the U.S. Environmental Protection Agency (EPA) shall, when implementing the Clean Air Act programs of this nation, work cooperatively with the States to achieve shared environmental goals; and the imperative to promote policies in the national interest and for the benefit of American workers and their families; it is hereby ordered as follows:

Section 1. *Policy.*

It is in the national interest to ensure that the nation's electricity is affordable, reliable, safe, secure, and clean, and available to be produced from coal, natural gas, nuclear power, hydropower, other renewables, and other domestic sources.

It is the policy of the United States that executive departments and agencies including the EPA shall take appropriate actions, to the extent consistent with applicable law, to ensure clean air and clean water for the American people in cooperation with the States and according to standards both as set forth by Congress, in respect of the proper roles of Congress and the States concerning these matters in our constitutional republic.

It is the policy of the United States that federal regulations and directives be based on careful consideration of science and principles of science reflecting input from the entirety of the scientific community; and that those agencies with statutory responsibility for regulation and formulation of directives integrate scientific knowledge in the first instance, rather than rely on that conducted by other units of government or international bodies.

It is the policy of the United States that when promulgating federal regulations for the environment, it is necessary to ensure that policy solutions comport with the law, provide substantially more benefits than the costs imposed, accurately gauge those costs, reflect the opportunity costs of policy solutions, achieve meaningful environmental improvements for the American people, and are developed through transparent procedures using the best available science.

To: Benton, Donald[benton.donald@epa.gov]; Munoz, Charles[munoz.charles@epa.gov]; Schnare, David[schnare.david@epa.gov]; Schwab, Justin[schwab.justin@epa.gov]
From: Ericksen, Doug
Sent: Fri 1/27/2017 8:37:34 PM
Subject: FW: Reporter Inquiry - Clean Power Plan Petition for Review Appeal
~WRD000.jpg

From: Michael Phillis [mailto:michael.phillis@law360.com]
Sent: Friday, January 27, 2017 3:35 PM
To: ericksen.doug@epamail.epa.gov
Subject: Reporter Inquiry - Clean Power Plan Petition for Review Appeal

Hello,

I'm a reporter with Law360. This week, a number of states asked the D.C. Circuit to consider overturning EPA's denials of their petition to review the Clean Power Plan.

I'm writing to ask for your thoughts on the actions the states are taking? Do you support it and will the EPA defend its rule before the D.C. Circuit?

Thank you in advance for your time.

Sincerely,

Michael Phillis

Reporter, Law360

michael.phillis@law360.com

646.350.1399

Legal News & Data

111 W. 19th Street, 5th Floor

New York, NY 10011

To: Kreutzer, David[kreutzer.david@epa.gov]
From: Diana Furchtgott-Roth
Sent: Thur 3/30/2017 12:32:22 PM
Subject: Criticisms of EPA's Clean Power Plan Analysis

Dear David,

I published a piece today on ten problems with EPA's Clean Power Plan cost-benefit analysis. It might help you answer criticisms of President Trump's review of the Clean Power Plan. Feel free to send it around.

https://economics21.org/html/ten-problems-epa%E2%80%99s-clean-power-plan-analysis-2275.html

Do you have time for lunch one of these days?

Best,

Diana

Diana Furchtgott-Roth

Senior Fellow and Director, Economics21

Manhattan Institute for Policy Research

1200 New Hampshire Avenue, Suite 575

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Personal Email/Ex. 6 (mobile)

Diana Furchtgott-Roth

Senior Fellow and Director, Economics21

Manhattan Institute for Policy Research

1200 New Hampshire Avenue, Suite 575

Washington, DC 20036

202.776.2029 (direct)

Personal Phone/Ex. 6

To: Kreutzer, David[kreutzer.david@epa.gov]; McGartland, Al[McGartland.Al@epa.gov]
Cc: Leonard Smith[lenny@maths.ox.ac.uk]; Cressie, Noel A.[ncressie@uow.edu.au]; pfd33@drexel.edu[pfd33@drexel.edu]
From: Pierson, Steve
Sent: Fri 3/24/2017 3:34:40 PM
Subject: Thank you for meeting with us--Climate Science
removed.txt

Dear David and Al,

Thank you very much for meeting with us on Monday. We appreciated your time, the opportunity, and the candid discussion. Lenny, Noel, and Peter are copied on this message so that you have their email addresses.

We hope Monday discussion was the start of an ongoing dialogue and we will stay in touch to continue such exchanges.

Sincerely,

Steve

Steve Pierson, Ph.D.

Director of Science Policy

American Statistical Association
Promoting the Practice and Profession of Statistics®
732 North Washington Street
Alexandria, VA 22314-1943
(703) 302-1841

www.amstat.org/policy

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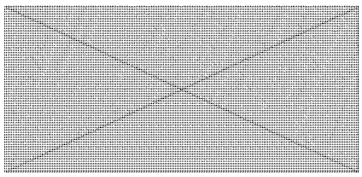

To: Kreutzer, David[kreutzer.david@epa.gov]; Hupp, Sydney[hupp.sydney@epa.gov]
Cc: McGartland, Al[McGartland.Al@epa.gov]; Dravis, Samantha[dravis.samantha@epa.gov]
From: Pierson, Steve
Sent: Sat 3/18/2017 5:19:21 PM
Subject: RE: Meeting Request for March 20-21--climate science

Dear David,

I'm really sorry for the inactive links at the letter. I paste the footnote below with active links.

If still possible, we'd like to plan on 4:30 pm, Monday. The Hill meetings are Tuesday and their schedules are quite full.

We look forward to meet you and Al.

Sincerely,

Steve

The conclusions in this and the preceding paragraph reflect the scientific consensus represented by, for example, the U.S. Global Change Research Program, the U.S. National Academies, and Intergovernmental Panel on Climate Change. Many scientific societies have endorsed these findings in their own statements, including the American Association for the Advancement of Science, American Chemical Society, American Geophysical Union, American Meteorological Society, American Statistical Association, Ecological Society of America, and Geological Society of America.

From: Kreutzer, David [mailto:kreutzer.david@epa.gov]
Sent: Friday, March 17, 2017 7:31 PM
To: Hupp, Sydney; Pierson, Steve
Cc: McGartland, Al; Dravis, Samantha
Subject: Re: Meeting Request for March 20-21--climate science

Dear Steve,

Administrator Pruitt's office has asked that Al McGartland and I take this meeting as the administrator is unable to do so. Al was out of the office all day and probably hasn't seen this request yet. So I think it would be best to aim for Tuesday.

I can meet anytime after 10 except for 3-4.

Please let us know what times could work for you and let us know who will be joining you. If you want an actual discussion, I ask that you limit your group to 5 people. The interpersonal dynamics of one or two talking with twenty just doesn't work. If you just want to deliver a letter and make a statement then the size of the group doesn't matter.

Also, the letter you linked to in your message has a footnote with apparent links to statements by various societies. However, there are no active links for any of them. Please, send copies of the statements or functional links to the statements.

I look forward to meeting you and your colleagues.

Sincerely,

David

David Kreutzer, Ph.D.

Deputy Associate Administrator for Policy

Sent from my iPhone

On Mar 17, 2017, at 4:10 PM, Hupp, Sydney <hupp.sydney@epa.gov> wrote:

Hi David and Al,

I'm not sure if we have had the opportunity to meet yet but I am handling scheduling for Administrator Pruitt. Samantha asked me to reach out to you both and ask if you would please handle the meeting below? It is time sensitive as they are requesting a meeting next week. We are unable to do so on our end but would like for a meeting with them to still happen. Please let me know if you are able to get a meeting arranged. Thank you in advance and hopefully our paths cross soon!

Thanks!

Sydney

From: Hope, Brian
Sent: Friday, March 17, 2017 2:54 PM
To: Dickerson, Aaron <dickerson.aaron@epa.gov>; Hupp, Sydney <hupp.sydney@epa.gov>
Subject: FW: Meeting Request for March 20-21--climate science

From: Pierson, Steve [mailto:spierson@amstat.org]
Sent: Friday, March 17, 2017 11:17 AM
To: Pruitt, Scott <Pruitt.Scott@epa.gov>
Subject: RE: Meeting Request for March 20-21--climate science

Hello,

I write to follow up the meeting request below for early next week. Might Administrator Pruitt be available?

Thank you for your consideration.

Sincerely,

Steve

From: Pierson, Steve
Sent: Friday, March 10, 2017 3:58 PM
To: 'Pruitt.scott@Epa.gov'
Subject: FW: Meeting Request for March 21--climate science

Dear Administrator Pruitt,

I write to request a meeting with you for Monday or Tuesday, March 20-21 for scientists participating in the seventh annual Climate Science Day (CSD). We would like to discuss climate science with you and offer our help to you on this issue. We have no policy ask and respect that science is but one input of many to policymaking. We also recognize that policymaking is beyond the expertise of our members. Our goal is for the you to be informed by the best available science, which we believe is provided by scientific associations. By virtue of these societies representing tens of thousands and sometime hundreds of thousands of members, we believe the scientific societies are uniquely position to present a balanced view of the science.

Climate Science Day (CSD) is organized by about a dozen science professional societies whose purpose is to connect scientists across a wide range of disciplines involving climate change with the Administration and Members of Congress. Besides the American Statistical Association, participating CSD organizations include the American Geophysical Union, the American Meteorological Society, the American Chemical Society, the American Association for the Advancement of Science, and the Crops/Agronomy/Soil Societies.

27 scientists are scheduled to be in DC for CSD and we would schedule a subset of them to meet with you if the meeting were accepted. The scientific societies' view of the changing climate is summarized in this 2016 letter to Congress signed by 31 scientific professional

societies or institutions: http://www.aaas.org/sites/default/files/06282016.pdf.

Thank you for your consideration.

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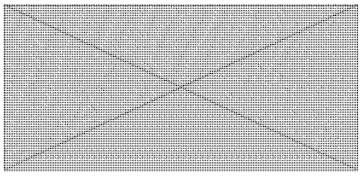

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To: Kreutzer, David[kreutzer.david@epa.gov]
From: McGartland, Al
Sent: Sat 3/18/2017 4:31:18 PM
Subject: Re: Meeting Request for March 20-21--climate science

Ok. We are set for 4:30. Sometimes these types of meetings are to just listen.

Sent from my iPhone

On Mar 18, 2017, at 11:08 AM, Kreutzer, David <kreutzer.david@epa.gov> wrote:

> I think 4:30 works for everybody. I want to have a chance to review the various statements and have a chance to read up on whoever is coming with him.
>
> Sent from my iPhone
>
> On Mar 18, 2017, at 6:21 AM, McGartland, Al <McGartland.Al@epa.gov> wrote:
>
>> Oh. Sorry. I read your email to say you were tied up in the afternoon until 1:30 and another meeting from 3:09 to 4:00. I see you now meant tied up all day until 1:30. If he contacts me I will steer him to another time. In fact I will email him.
>>
>> Sent from my iPhone
>>
>> On Mar 17, 2017, at 11:34 PM, Kreutzer, David <kreutzer.david@epa.gov> wrote:
>>
>>> 10 is not so good for me.
>>>
>>> Sent from my iPhone
>>>
>>> On Mar 17, 2017, at 8:30 PM, McGartland, Al <McGartland.Al@epa.gov> wrote:
>>>
>>>> We can make any of those times work. I look forward to your call.
>>>>
>>>> Have a great weekend. And I hope your daughter commitments are treasured.
>>>>
>>>> Best,
>>>>
>>>> Al
>>>>
>>>> Sent from my iPhone

On Mar 17, 2017, at 8:23 PM, Pierson, Steve < Personal Email/Ex. 6 > wrote:

Dear Al and David,

Thank you very much for your messages and willingness to meet. We appreciate the opportunity. I think I can make Monday at 4:30 work if that is not too late in the day. Monday morning at 10 might also work. I'll round up four other people and be back in touch.

A discussion is what we'd like and we're not there to deliver a letter. I'm sorry though for the bad links in the letter. I'll provide those over the weekend.

Al, I appreciate you providing the cell number. I hope to try you early in the afternoon after some daughter commitments are wrapped up. I would be calling from my cell: Personal Phone/Ex. 6

Sincerely,

Steve

From: Kreutzer, David [mailto:kreutzer.david@epa.gov]
Sent: Friday, March 17, 2017 7:31 PM
To: Hupp, Sydney; Pierson, Steve
Cc: McGartland, Al; Dravis, Samantha
Subject: Re: Meeting Request for March 20-21--climate science

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I look forward to meeting you and your colleagues.

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Deputy Associate Administrator for Policy

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Thanks!

Sydney

From: Hope, Brian
Sent: Friday, March 17, 2017 2:54 PM
To: Dickerson, Aaron <dickerson.aaron@epa.gov>; Hupp, Sydney <hupp.sydney@epa.gov>
Subject: FW: Meeting Request for March 20-21--climate science

From: Pierson, Steve Personal Email/Ex. 6
Sent: Friday, March 17, 2017 11:17 AM
To: Pruitt, Scott < Personal Email/Ex. 6 >
Subject: RE: Meeting Request for March 20-21--climate science

Hello,

I write to follow up the meeting request below for early next week. Might Administrator Pruitt be available?

Thank you for your consideration.

Sincerely,

Steve

From: Pierson, Steve
Sent: Friday, March 10, 2017 3:58 PM
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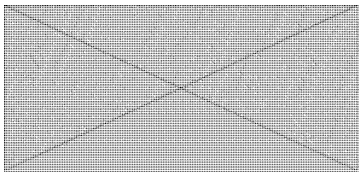

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To: Hupp, Sydney[hupp.sydney@epa.gov]
Cc: Kreutzer, David[kreutzer.david@epa.gov]; Dravis, Samantha[dravis.samantha@epa.gov]
From: McGartland, Al
Sent: Fri 3/17/2017 10:36:06 PM
Subject: Re: Meeting Request for March 20-21--climate science

Hi. Will do. To be clear, I read your email as wanting David and I to reach out to them and schedule a meeting.

I'm happy to do so.

Sent from my iPhone

On Mar 17, 2017, at 4:10 PM, Hupp, Sydney <hupp.sydney@epa.gov> wrote:

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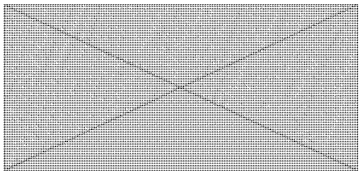

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To: Kreutzer, David[kreutzer.david@epa.gov]; McGartland, Al[McGartland.Al@epa.gov]
Cc: Dravis, Samantha[dravis.samantha@epa.gov]
From: Hupp, Sydney
Sent: Fri 3/17/2017 8:10:03 PM
Subject: FW: Meeting Request for March 20-21--climate science
removed.txt

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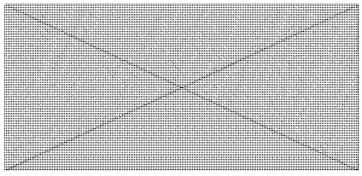

To: Kreutzer, David[kreutzer.david@epa.gov]; Gunasekara, Mandy[Gunasekara.Mandy@epa.gov]; Freire, JP[Freire.JP@epa.gov]
From: Dravis, Samantha
Sent: Thur 3/30/2017 9:06:08 PM
Subject: RE: Criticisms of EPA's Clean Power Plan Analysis

Thanks, David.

From: Kreutzer, David
Sent: Thursday, March 30, 2017 4:38 PM
To: Gunasekara, Mandy <Gunasekara.Mandy@epa.gov>; Dravis, Samantha <dravis.samantha@epa.gov>; Freire, JP <Freire.JP@epa.gov>
Subject: FW: Criticisms of EPA's Clean Power Plan Analysis

Diana sends these along.

From: Diana Furchtgott-Roth [mailto:dfr@manhattan-institute.org]
Sent: Thursday, March 30, 2017 8:32 AM
To: Kreutzer, David <kreutzer.david@epa.gov>
Subject: Criticisms of EPA's Clean Power Plan Analysis

Dear David,

I published a piece today on ten problems with EPA's Clean Power Plan cost-benefit analysis. It might help you answer criticisms of President Trump's review of the Clean Power Plan. Feel free to send it around.

https://economics21.org/html/ten-problems-epa%E2%80%99s-clean-power-plan-analysis-2275.html

Do you have time for lunch one of these days?

Best,

Diana

Diana Furchtgott-Roth

Senior Fellow and Director, Economics21

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Washington, DC 20036

202.776.2029 (direct)

Personal Phone/Ex. 6 (mobile)

To: Kreutzer, David[kreutzer.david@epa.gov]; colmanz@csmonitor.com[colmanz@csmonitor.com]
Cc: Ericksen, Doug[ericksen.doug@epa.gov]
From: Konkus, John
Sent: Wed 2/22/2017 10:34:27 PM
Subject: RE: Endangerment finding

Zack please send all questions to press@epa.gov. Thank you.

-----Original Message-----
From: Kreutzer, David
Sent: Wednesday, February 22, 2017 5:32 PM
To: colmanz@csmonitor.com
Cc: Konkus, John <konkus.john@epa.gov>; Ericksen, Doug <ericksen.doug@epa.gov>
Subject: Re: Endangerment finding

For the moment, anyway, all communications are going through John Konkus and Doug Ericksen (copied).

David

Sent from my iPhone

> On Feb 22, 2017, at 5:03 PM, Zack Colman <colmanz@csmonitor.com> wrote:
>
> Hi David,
>
> Zack Colman here with CSMonitor -- we met back in my Washington Examiner/The Hill days and I was one of the annoying reporters who mobbed you at the AEI carbon tax panel a few weeks back (sorry!).
>
> Wanted to know if you had time to chat about the endangerment finding. Had a couple questions about procedure. Spoke to Sen. Inhofe who mentioned the idea of opening up the science and including different findings. Not sure how that would impact the endangerment finding — whether that would mean a less aggressive GHG policy was needed, or whether it is just the beginning of an avenue to submit new literature that would then need to go through the regulatory process.
>
> Anyway, that's not the only question I have with respect to the endangerment finding, but that's a good place to start. Can email me here or get me at 248.563.9744.
>
> Thanks,
>
> -Zack
> --
> Zack Colman
>
> Deputy Energy/Enviro Editor
> Christian Science Monitor
> Knight Science Journalism fellow at MIT, '15-16
> 248.563.9744
> Twitter: @zcolman

To: Kreutzer, David[kreutzer.david@epa.gov]
Cc: Konkus, John[konkus.john@epa.gov]; Ericksen, Doug[ericksen.doug@epa.gov]
From: Zack Colman
Sent: Wed 2/22/2017 10:33:54 PM
Subject: Re: Endangerment finding

Sure thing, David. To Doug and John - would love to strike up a convo on the endangerment finding. Trying to get a better sense of the ins and outs and procedure here. Also, would you mind checking to see that I'm on your email list? I didn't receive any of the releases when Administrator Pruitt was confirmed.
Thanks!

-Zack

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Hi David,
Zack Colman here with CSMonitor -- we met back in my Washington Examiner/The Hill days and I was one of the annoying reporters who mobbed you at the AEI carbon tax panel a few weeks back (sorry!).

Wanted to know if you had time to chat about the endangerment finding. Had a couple questions about procedure. Spoke to Sen. Inhofe who mentioned the idea of opening up the science and including different findings. Not sure how that would impact the endangerment finding — whether that would mean a less aggressive GHG policy was needed, or whether it is just the beginning of an avenue to submit new literature that would then need to go through the regulatory process.

Anyway, that's not the only question I have with respect to the endangerment finding, but that's a good place to start. Can email me here or get me at 248.563.9744.

Thanks,

-Zack
--
Zack Colman

Deputy Energy/Enviro Editor
Christian Science Monitor
Knight Science Journalism fellow at MIT, '15-16
248.563.9744
Twitter: @zcolman

To: Kreutzer, David[kreutzer.david@epa.gov]
From: Scientific Integrity Whistleblower Project
Sent: Thur 11/2/2017 11:43:26 AM
Subject: How we protect scientific integrity

David,

Scientific integrity is the foundation of our government's scientific research and achievement. For decades, the thousands of US Government scientists at agencies like the EPA, NASA, NSF and many others were free to follow the facts where they led. From cleaning up our nation's air and water to predicting hurricane paths and conducting basic scientific research, our government scientists have helped increase our economic productivity, quality of life and save lives.

Although Republican and Democratic administrations may have disagreed on how to incorporate scientific findings into the policy arena, government scientists were free to publish and share their findings with other scientists and the public at large free from political interference. Unfortunately, the current administration has chosen to engage in an all-out war on science.

Before inauguration day, President Trump's transition team requested the names of staffers who worked on climate change initiatives.[1] In March, an office within the Department of Interior banned staff from using the phrases "climate change" and "Paris Agreement" in agency communications.[2] Interior Secretary Ryan Zinke even went so far as to accuse more than a third of his workforce as being "not loyal to the flag".[3] Just last week the EPA barred three scientists from speaking about climate change at a conference.[4] The list goes on and on.

All of this led to the administration being charged with "creating a hostile environment for federal agency scientists".[5] That's why today, 314 Action, a nationwide pro-science nonprofit with a membership of nearly a quarter of a million scientists and pro-science advocates from all over the country is launching the **Scientific Integrity Whistleblower Project (www.speakoutforscience.org)** to shine a light on scientific wrongdoing in this administration.

The **Scientific Integrity Whistleblower Project** (**www.speakoutforscience.org**) allows government scientists or others who have witnessed malfeasance, science being silenced or other evidence of this administration's war on science to anonymously and securely provide details and evidence directly to one of our attorneys. Please visit our website at **www.speakoutforscience.org** to see all the methods in which you can securely and anonymously share messages and files with our attorneys. In addition, our attorneys will be available to answer calls starting this next week Tuesday, November 7, 2017 from 11:00 a.m.-2:00 p.m. We ask that you do not contact our attorneys when you are at work or when you are on duty, and plan to provide additional hours for our attorney hotline in the future.

Our lawyers at Garvey Schubert Barer have asked us to let you know that the law generally provides whistleblower protections for government scientists who challenge censorship or make disclosures related to the integrity of the scientific process. In particular, the law protects disclosures of information that an employee reasonably believes are evidence of censorship related to research, analysis, or technical information that cause, or will cause, gross government waste or mismanagement, an abuse of authority, a substantial and specific danger to public health or safety, or any violation of law. You should consult the EPA's website for additional information about whistleblower protections at the EPA and how they relate to non-disclosure agreements signed by EPA employees.[6] **Please do not submit any information if doing so would violate any law, rule or regulation.**

Speaking out in this climate can be a difficult decision, but recently some have finally started to shed a light on scientific wrongdoing. Winning the war on science isn't about politics, it's about putting our country first. Speak up. Speak out.

Sincerely,

Scientific Integrity Whistleblower Project

[1] https://www.washingtonpost.com/news/energy-environment/wp/2016/12/09/trump-transition-team-for-energy-department-seeks-names-of-employees-involved-in-climate-meetings

[2] https://www.politico.com/story/2017/03/energy-department-climate-change-phrases-banned-236655

[3] https://www.washingtonpost.com/news/energy-environment/wp/2017/09/26/zinke-says-a-third-of-interiors-staff-is-disloyal-to-trump-and-promises-huge-changes

[4] https://www.nytimes.com/2017/10/22/climate/epa-scientists.html

[5] https://www.washingtonpost.com/news/powerpost/wp/2017/07/25/has-trump-sidelined-restricted-government-scientists-yes

[6] https://www.epa.gov/ocr/whistleblower-protections-epa-and-how-they-relate-non-disclosure-agreements-signed-epa-employees

You received this message because you an an employee of a US Government agency that conducts scientific research and your contact information is publicly available. If you would no longer like to receive emails from us, please click here to unsubscribe.

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To: Pierson, Steve[spierson@amstat.org]; McGartland, Al[McGartland.Al@epa.gov]
Cc: Leonard Smith[lenny@maths.ox.ac.uk]; Cressie, Noel A.[ncressie@uow.edu.au]; pfd33@drexel.edu[pfd33@drexel.edu]; Dravis, Samantha[dravis.samantha@epa.gov]
From: Kreutzer, David
Sent: Fri 3/24/2017 4:39:14 PM
Subject: RE: Thank you for meeting with us--Climate Science

Steve,

I enjoyed the discussion and the chance to meet all of you.

Thanks very much for taking the time to come to the EPA.

David

From: Pierson, Steve [mailto:spierson@amstat.org]
Sent: Friday, March 24, 2017 11:35 AM
To: Kreutzer, David <kreutzer.david@epa.gov>; McGartland, Al <McGartland.Al@epa.gov>
Cc: Leonard Smith <lenny@maths.ox.ac.uk>; Cressie, Noel A. <ncressie@uow.edu.au>; pfd33@drexel.edu
Subject: Thank you for meeting with us--Climate Science

Dear David and Al,

Thank you very much for meeting with us on Monday. We appreciated your time, the opportunity, and the candid discussion. Lenny, Noel, and Peter are copied on this message so that you have their email addresses.

We hope Monday discussion was the start of an ongoing dialogue and we will stay in touch to continue such exchanges.

Sincerely,

Steve

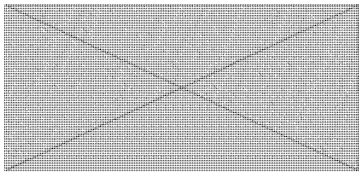
Steve Pierson, Ph.D.

Director of Science Policy

American Statistical Association
Promoting the Practice and Profession of Statistics®
732 North Washington Street
Alexandria, VA 22314-1943
(703) 302-1841

www.amstat.org/policy

For ASA science policy updates, follow us on Twitter: @ASA_SciPol



To: Diana Furchtgott-Roth[dfr@manhattan-institute.org]
From: Kreutzer, David
Sent: Thur 3/30/2017 8:42:40 PM
Subject: RE: Criticisms of EPA's Clean Power Plan Analysis

Diana,

I'd be happy to have lunch sometime, but want to be sure I'm not offering you a bait and switch deal. I'm leaving EPA tomorrow and plan to be back at Heritage on April 10th.

I'm taking a 10-day break from all policy and politics discussion. Feel free to contact me after the 10th. My personal email is Personal Email/Ex. 6

Thanks,

David

From: Diana Furchtgott-Roth [mailto:dfr@manhattan-institute.org]
Sent: Thursday, March 30, 2017 8:32 AM
To: Kreutzer, David <kreutzer.david@epa.gov>
Subject: Criticisms of EPA's Clean Power Plan Analysis

Dear David,

I published a piece today on ten problems with EPA's Clean Power Plan cost-benefit analysis. It might help you answer criticisms of President Trump's review of the Clean Power Plan. Feel free to send it around.

https://economics21.org/html/ten-problems-epa%E2%80%99s-clean-power-plan-analysis-2275.html

Do you have time for lunch one of these days?

Best,

Diana

Diana Furchtgott-Roth

Senior Fellow and Director, Economics21

Manhattan Institute for Policy Research

1200 New Hampshire Avenue, Suite 575

Washington, DC 20036

202.776.2029 (direct)

Personal Phone/Ex. 6

Diana Furchtgott-Roth

Senior Fellow and Director, Economics21

Manhattan Institute for Policy Research

1200 New Hampshire Avenue, Suite 575

Washington, DC 20036

202.776.2029 (direct)

Personal Phone/Ex. 6

To: Gunasekara, Mandy[Gunasekara.Mandy@epa.gov]; Dravis, Samantha[dravis.samantha@epa.gov]; Freire, JP[Freire.JP@epa.gov]
From: Kreutzer, David
Sent: Thur 3/30/2017 8:38:23 PM
Subject: FW: Criticisms of EPA's Clean Power Plan Analysis

Diana sends these along.

From: Diana Furchtgott-Roth [mailto:dfr@manhattan-institute.org]
Sent: Thursday, March 30, 2017 8:32 AM
To: Kreutzer, David <kreutzer.david@epa.gov>
Subject: Criticisms of EPA's Clean Power Plan Analysis

Dear David,

I published a piece today on ten problems with EPA's Clean Power Plan cost-benefit analysis. It might help you answer criticisms of President Trump's review of the Clean Power Plan. Feel free to send it around.

https://economics21.org/html/ten-problems-epa%E2%80%99s-clean-power-plan-analysis-2275.html

Do you have time for lunch one of these days?

Best,

Diana

Diana Furchtgott-Roth

Senior Fellow and Director, Economics21

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1200 New Hampshire Avenue, Suite 575

Washington, DC 20036

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Diana Furchtgott-Roth

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Manhattan Institute for Policy Research

1200 New Hampshire Avenue, Suite 575

Washington, DC 20036

202.776.2029 (direct)

Personal Phone/Ex. 6

To: colmanz@csmonitor.com[colmanz@csmonitor.com]
Cc: Konkus, John[konkus.john@epa.gov]; Ericksen, Doug[ericksen.doug@epa.gov]
From: Kreutzer, David
Sent: Wed 2/22/2017 10:32:13 PM
Subject: Re: Endangerment finding

For the moment, anyway, all communications are going through John Konkus and Doug Ericksen (copied).

David

Sent from my iPhone

> On Feb 22, 2017, at 5:03 PM, Zack Colman <colmanz@csmonitor.com> wrote:
>
> Hi David,
>
> Zack Colman here with CSMonitor -- we met back in my Washington Examiner/The Hill days and I was one of the annoying reporters who mobbed you at the AEI carbon tax panel a few weeks back (sorry!).
>
> Wanted to know if you had time to chat about the endangerment finding. Had a couple questions about procedure. Spoke to Sen. Inhofe who mentioned the idea of opening up the science and including different findings. Not sure how that would impact the endangerment finding — whether that would mean a less aggressive GHG policy was needed, or whether it is just the beginning of an avenue to submit new literature that would then need to go through the regulatory process.
>
> Anyway, that's not the only question I have with respect to the endangerment finding, but that's a good place to start. Can email me here or get me at 248.563.9744.
>
> Thanks,
>
> -Zack
> --
> Zack Colman
>
> Deputy Energy/Enviro Editor
> Christian Science Monitor
> Knight Science Journalism fellow at MIT, '15-16
> 248.563.9744
> Twitter: @zcolman

To: Hupp, Sydney[hupp.sydney@epa.gov]; McGartland, Al[McGartland.Al@epa.gov]
Cc: Dravis, Samantha[dravis.samantha@epa.gov]
From: Kreutzer, David
Sent: Fri 3/17/2017 9:07:41 PM
Subject: RE: Meeting Request for March 20-21--climate science

I can do Monday 1:30-2:30 and after 4:30. Tuesday any time other than 3-4.

David

From: Hupp, Sydney
Sent: Friday, March 17, 2017 4:10 PM
To: Kreutzer, David <kreutzer.david@epa.gov>; McGartland, Al <McGartland.Al@epa.gov>
Cc: Dravis, Samantha <dravis.samantha@epa.gov>
Subject: FW: Meeting Request for March 20-21--climate science

Hi David and Al,

I'm not sure if we have had the opportunity to meet yet but I am handling scheduling for Administrator Pruitt. Samantha asked me to reach out to you both and ask if you would please handle the meeting below? It is time sensitive as they are requesting a meeting next week. We are unable to do so on our end but would like for a meeting with them to still happen. Please let me know if you are able to get a meeting arranged. Thank you in advance and hopefully our paths cross soon!

Thanks!

Sydney

From: Hope, Brian
Sent: Friday, March 17, 2017 2:54 PM
To: Dickerson, Aaron <dickerson.aaron@epa.gov>; Hupp, Sydney <hupp.sydney@epa.gov>
Subject: FW: Meeting Request for March 20-21--climate science

From: Pierson, Steve [mailto:spierson@amstat.org]
Sent: Friday, March 17, 2017 11:17 AM
To: Pruitt, Scott <Pruitt.Scott@epa.gov>
Subject: RE: Meeting Request for March 20-21--climate science

Hello,

I write to follow up the meeting request below for early next week. Might Administrator Pruitt be available?

Thank you for your consideration.

Sincerely,

Steve

From: Pierson, Steve
Sent: Friday, March 10, 2017 3:58 PM
To: 'Pruitt.scott@Epa.gov'
Subject: FW: Meeting Request for March 21--climate science

Dear Administrator Pruitt,

I write to request a meeting with you for Monday or Tuesday, March 20-21 for scientists participating in the seventh annual Climate Science Day (CSD). We would like to discuss

climate science with you and offer our help to you on this issue. We have no policy ask and respect that science is but one input of many to policymaking. We also recognize that policymaking is beyond the expertise of our members. Our goal is for the you to be informed by the best available science, which we believe is provided by scientific associations. By virtue of these societies representing tens of thousands and sometime hundreds of thousands of members, we believe the scientific societies are uniquely position to present a balanced view of the science.

Climate Science Day (CSD) is organized by about a dozen science professional societies whose purpose is to connect scientists across a wide range of disciplines involving climate change with the Administration and Members of Congress. Besides the American Statistical Association, participating CSD organizations include the American Geophysical Union, the American Meteorological Society, the American Chemical Society, the American Association for the Advancement of Science, and the Crops/Agronomy/Soil Societies.

27 scientists are scheduled to be in DC for CSD and we would schedule a subset of them to meet with you if the meeting were accepted. The scientific societies' view of the changing climate is summarized in this 2016 letter to Congress signed by 31 scientific professional societies or institutions: http://www.aaas.org/sites/default/files/06282016.pdf.

Thank you for your consideration.

Sincerely,

Steve

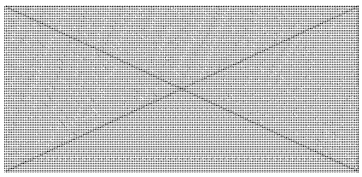
Steve Pierson, Ph.D.

Director of Science Policy

American Statistical Association
Promoting the Practice and Profession of Statistics®
732 North Washington Street
Alexandria, VA 22314-1943
(703) 302-1841

www.amstat.org/policy

For ASA science policy updates, follow us on Twitter: @ASA_SciPol



To: Schwab, Justin[schwab.justin@epa.gov]; Schnare, David[schnare.david@epa.gov]
Cc: Schmidt, Lorie[Schmidt.Lorie@epa.gov]; Minoli, Kevin[Minoli.Kevin@epa.gov]
From: Srinivasan, Gautam
Sent: Thur 2/23/2017 1:58:25 AM
Subject: RE: Follow up on endangerment
Coal. Resp. Reg. 684 F.3d 102 DC Cir.doc
Mass v EPA.RTF
EPA final endangerment brief in CRR.PDF
HR Rep No 95-294 pp 43-51.pdf
Reconsid response Vol 1.pdf
Reconsid response Vol 2.pdf
Reconsid response Vol 3.pdf

David and Justin- The links below and the attachments to this email provide the information you requested at our meeting last week. If you need anything further, please let Lorie or me know.

(1) Proposed and final GHG endangerment findings:

- 2009 vehicle endangerment finding
  - Proposal: 74 FR 18886 (available at https://www.gpo.gov/fdsys/pkg/FR-2009-04-24/pdf/E9-9339.pdf#page=2)
  - Final: 74 FR 66496 (available at https://www.gpo.gov/fdsys/pkg/FR-2009-12-15/pdf/E9-29537.pdf#page=3)
  - Notice of denial of petitions for reconsideration: 75 FR 49556 (available at https://www.gpo.gov/fdsys/pkg/FR-2010-08-13/pdf/2010-19153.pdf#page=2). EPA also prepared a three volume response to these petitions, which is attached for your information.

- 2016 aircraft endangerment finding
  - Proposal: 80 FR 37758 (available at https://www.gpo.gov/fdsys/pkg/FR-2015-07-01/pdf/2015-15192.pdf#page=2)
  - Final: 81 FR 54422 (available at https://www.gpo.gov/fdsys/pkg/FR-2016-08-15/pdf/2016-18399.pdf#page=2)

- 2015 111(b) rule for GHG emissions from power plants
  - Proposal: 79 FR 1430 (new sources) (available at https://www.gpo.gov/fdsys/pkg/FR-2014-01-08/pdf/2013-28668.pdf#page=2) ; 79 FR 34960 (modified and reconstructed sources) (available at https://www.gpo.gov/fdsys/pkg/FR-2014-06-18/pdf/2014-13725.pdf#page=2)

- Final: 80 FR 64510 (available at https://www.gpo.gov/fdsys/pkg/FR-2015-10-23/pdf/2015-22837.pdf#page=1)

- 2016 oil and gas sector emission standards for new, reconstructed, and modified sources
  - Proposal: 80 FR 56593 (available at https://www.gpo.gov/fdsys/pkg/FR-2015-09-18/pdf/2015-21023.pdf#page=1)
  - Final: 81 FR 35824 (available at https://www.gpo.gov/fdsys/pkg/FR-2016-06-03/pdf/2016-11971.pdf#page=2)

(2) The D.C. Circuit decision in *Coalition for Responsible Regulation v. EPA*, 684 F.3d 102 (D.C. Circuit 2012) is attached, which affirmed both EPA's 2009 endangerment finding and its denial of the petitions for reconsideration of that finding. Also attached the Supreme Court decision in *Massachusetts v. EPA*, 549 U.S. 497 (2007), as that decision also discusses the findings under section 202(a).

(3) Our brief before the D.C. Circuit in *Coalition for Responsible Regulation* discusses the legislative history on 202(a)(1). The brief is attached; see pages 30-34. Also attached is a reprint of an excerpt of the legislative history that is discussed in the brief and in the 2009 and 2016 endangerment findings for motor vehicles and aircraft (H.R. Rep. No 95-294, pp. 43-51, *reprinted in* A Legislative History of the Clean Air Act Amendments of 1977: A Continuation of the Clean Air Act Amendments of 1970 Together with a Section-by-Section Index, Vol. 4 (1978), pp. 2510 – 2518.)

Again, please let us know what else you need. We look forward to continuing the conversation.

++++++++++++

202-564-5647 (o)

Personal Phone/Ex. 6 (c)

From: Schnare, David
Sent: Friday, February 17, 2017 3:41 PM

To: Schmidt, Lorie <Schmidt.Lorie@epa.gov>
Cc: Schwab, Justin <schwab.justin@epa.gov>; Minoli, Kevin <Minoli.Kevin@epa.gov>; Srinivasan, Gautam <Srinivasan.Gautam@epa.gov>
Subject: Re: Follow up on endangerment

Thank you. Very timely.

dschnare

Sent from my iPhone

On Feb 17, 2017, at 3:39 PM, Schmidt, Lorie <Schmidt.Lorie@epa.gov> wrote:

David and Justin,

I have asked a staff attorney to pull together our GHG endangerment findings, the DC Circuit case addressing our 2009 GHG endangerment finding, and legislative history information related to endangerment.

Our goal is to email these to you on Tuesday or Wednesday. If that timing is problematic, please let me know.

Have a good week-end,

Lorie

Lorie Schmidt

Associate General Counsel, Air and Radiation

Office of General Counsel

US Environmental Protection Agency

(202)564-1681

Warning
As of: Oct 12, 2016

COALITION FOR RESPONSIBLE REGULATION, INC., ET AL., PETITIONERS v. ENVIRONMENTAL PROTECTION AGENCY, RESPONDENT, STATE OF MICHIGAN, ET AL., INTERVENORS; COALITION FOR RESPONSIBLE REGULATION, INC., ET AL., PETITIONERS v. ENVIRONMENTAL PROTECTION AGENCY, RESPONDENT, AMERICAN FROZEN FOOD INSTITUTE, ET AL., INTERVENORS; COALITION FOR RESPONSIBLE REGULATION, INC., ET AL., PETITIONERS v. ENVIRONMENTAL PROTECTION AGENCY, RESPONDENT, LANGBOARD, INC. - MDF, ET AL., INTERVENORS; AMERICAN CHEMISTRY COUNCIL, PETITIONER v. ENVIRONMENTAL PROTECTION AGENCY AND LISA PEREZ JACKSON, ADMINISTRATOR, U.S. ENVIRONMENTAL PROTECTION AGENCY, RESPONDENTS, CHAMBER OF COMMERCE OF THE UNITED STATES OF AMERICA, ET AL., INTERVENORS

No. 09-1322 Consolidated with 10-1024, 10-1025, 10-1026, 10-1030, 10-1035, 10-1036, 10-1037, 10-1038, 10-1039, 10-1040, 10-1041, 10-1042, 10-1044, 10-1045, 10-1046, 10-1234, 10-1235, 10-1239, 10-1245, 10-1281, 10-1310, 10-1318, 10-1319, 10-1320, 10-1321, No. 10-1073 Consolidated with 10-1083, 10-1099, 10-1109, 10-1110, 10-1114, 10-1118, 10-1119, 10-1120, 10-1122, 10-1123, 10-1124, 10-1125, 10-1126, 10-1127, 10-1128, 10-1129, 10-1131, 10-1132, 10-1145, 10-1147, 10-1148, 10-1199, 10-1200, 10-1201, 10-1202, 10-1203, 10-1206, 10-1207, 10-1208, 10-1210, 10-1211, 10-1212, 10-1213, 10-1216, 10-1218, 10-1219, 10-1220, 10-1221, 10-1222, No. 10-1092 Consolidated with 10-1094, 10-1134, 10-1143, 10-1144, 10-1152, 10-1156, 10-1158, 10-1159, 10-1160, 10-1161, 10-1162, 10-1163, 10-1164, 10-1166, 10-1182, No. 10-1167 Consolidated with 10-1168, 10-1169, 10-1170, 10-1173, 10-1174, 10-1175, 10-1176, 10-1177, 10-1178, 10-1179, 10-1180

UNITED STATES COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT

684 F.3d 102; *401 U.S. App. D.C. 306; 2012 U.S. App. LEXIS 12980; 42 ELR 20141; 74 ERC (BNA) 2161*

February 28, 2012, Argued; February 29, 2012, Argued
June 26, 2012, Decided

SUBSEQUENT HISTORY: Rehearing, en banc, denied by *Coalition for Responsible Regulation v. EPA, 2012 U.S. App. LEXIS 26313 (D.C. Cir., Dec. 20, 2012)*
Rehearing denied by *Coalition for Responsible Regulation, Inc. v. EPA, 2012 U.S. App. LEXIS 26315 (D.C. Cir., Dec. 20, 2012)*
Rehearing, en banc, denied by *Coalition for Responsible Regulation, Inc. v. EPA, 2012 U.S. App. LEXIS 25997 (D.C. Cir., 2012)*
US Supreme Court certiorari granted by, in part *Util. Air Regulatory Group v. EPA, 134 S. Ct. 418, 187 L. Ed. 2d 278, 2013 U.S. LEXIS 7380 (U.S., 2013)*
US Supreme Court certiorari denied by *Virginia v. EPA, 134 S. Ct. 418, 187*

L. Ed. 2d 279, 2013 U.S. LEXIS 7378 (U.S., 2013)
US Supreme Court certiorari denied by *Pac. Legal Found. v. EPA, 134 S. Ct. 418, 187 L. Ed. 2d 279, 2013 U.S. LEXIS 7427 (U.S., 2013)*
US Supreme Court certiorari denied by *Coalition for Responsible Regulation, Inc. v. EPA, 134 S. Ct. 468, 187 L. Ed. 2d 279, 2013 U.S. LEXIS 7530 (U.S., 2013)*
US Supreme Court certiorari granted by *Southeastern Legal Found., Inc. v. EPA, 134 S. Ct. 419, 187 L. Ed. 2d 278, 2013 U.S. LEXIS 7546 (U.S., 2013)*
US Supreme Court certiorari granted by, in part *Texas v. EPA, 134 S. Ct. 419, 187 L. Ed. 2d 278, 2013 U.S. LEXIS 7448 (U.S., 2013)*
US Supreme Court certiorari granted by, in part *Am. Chemistry Council v. EPA, 134 S. Ct. 468, 187 L. Ed. 2d 278, 2013 U.S. LEXIS 7443 (U.S., 2013)*
US Supreme Court certiorari granted by, in part *Chamber of Commerce v. EPA, 134 S. Ct. 468, 187 L. Ed. 2d 278, 2013 U.S. LEXIS 7399 (U.S., 2013)*
US Supreme Court certiorari granted by, in part *Energy-Intensive Mfrs. Working Group on Greenhouse Gas Regulation v. EPA, 134 S. Ct. 418, 187 L. Ed. 2d 278, 2013 U.S. LEXIS 7483 (U.S., 2013)*
Affirmed in part and reversed in part by *Util. Air Regulatory Group v. EPA, 134 S. Ct. 2427, 189 L. Ed. 2d 372, 2014 U.S. LEXIS 4377 (U.S., 2014)*
Amended by, Petition denied by *Coalition for Responsible Regulation, Inc. v. EPA, 2015 U.S. App. LEXIS 11132 (D.C. Cir., Apr. 10, 2015)*

PRIOR HISTORY: [***1]
On Petitions for Review of Final Actions of the Environmental Protection Agency.
Coalition for Responsible Regulation, Inc. v. EPA, 2010 U.S. App. LEXIS 26980 (D.C. Cir., Dec. 10, 2010)

COUNSEL: Patrick R. Day, Harry W. MacDougald, and Jeffrey Bossert Clark argued the causes for Non-State Petitioners and Supporting Intervenors. With them on the briefs were John J. Burns, Attorney General, Office of the Attorney General of the State of Alaska, Steven E. Mulder, Chief Assistant Attorney General, Peter Glaser, Mark E. Nagle, Matthew Dukes, Paul D. Phillips, John A. Bryson, Ellen Steen, Eric Groten, John P. Elwood, James A. Holtkamp, Chet M. Thompson, Robin S. Conrad, Rachel L. Brand, Sheldon Gilbert, Quentin Riegel, Jeffrey A. Rosen, Robert R. Gasaway, William H. Burgess, Sam Kazman, Hans Bader, Matthew G. Paulson, Harry Moy Ng, Michele Marie Schoeppe, Michael R. Barr, Alexandra M. Walsh, Adam J. White, Jeffrey A. Lamken, Timothy K. Webster, Roger R. Martella, Neal J. Cabral, Theodore Hadzi-Antich, Ashley C. Parrish, Cynthia A. M. Stroman, Scott C. Oostdyk, [***2] Gordon R. Alphonso, Shannon L. Goessling, Edward A. Kazmarek, F. William Brownell, Norman W. Fichthorn, Henry V. Nickel, and Allison D. Wood. Paul D. Clement, Mark W. DeLaquil, Andrew M. Grossman, and David B. Rivin, Jr. entered appearances.

E. Duncan Getchell, Jr., Solicitor General, Office of the Attorney General for the Commonwealth of Virginia, argued the cause for State Petitioners Texas and Virginia on Denial of Reconsideration of the Endangerment Finding and State Petitioners and Supporting Intervenors on Endangerment Finding Delegation Issues. With him on the briefs were Kenneth T. Cuccinelli, II, Attorney General, Stephen R. McCullough, Senior Appellate Counsel, Charles E. James Jr., Chief Deputy Attorney General, and Wesley G. Russell, Jr., Deputy Attorney General.

Greg Abbott, Attorney General, Office of the Attorney General for the State of Texas, Bill Cobb, Deputy Attorney General for Civil Litigation, J. Reed Clay, Jr., Special Assistant and Senior Counsel to the Attorney General, Jonathan F. Mitchell, Solicitor General, Michael P. Murphy,

Assistant Solicitor General, Luther Strange III, Attorney General, Office of the Attorney General for the State of Alabama, Pamela Jo [***3] Bondi, Attorney General, Office of the Attorney General for the State of Florida, Gregory F. Zoeller, Attorney General, Office of the Attorney General for the State of Indiana, Jack Conway, Attorney General, Office of the Attorney General for the Commonwealth of Kentucky, James D. "Buddy" Caldwell, Attorney General, Office of the Attorney General for the State of Louisiana, Bill Schuette, Attorney General, Office of the Attorney General for the State of Michigan, John J. Bursch, Solicitor General, Neil D. Gordon, Assistant Attorney General, Gary C. Rikard, Jon Bruning, Attorney General, Office of the Attorney General for the State of Nebraska, Katherine J. Spohn, Special Counsel to the Attorney General, Wayne Stenehjem, Attorney General, Office of the Attorney General for the State of North Dakota, Margaret Olson, Assistant Attorney General, Scott Pruitt, Attorney General, Office of the Attorney General for the State of Oklahoma, Alan Wilson, Attorney General, Office of the Attorney General for the State of South Carolina, Marty Jackley, Attorney General, Office of the Attorney General for the States of South Dakota, Roxanne Giedd, Chief, Civil Litigation Division, Mark L. Shurtleff, [***4] Attorney General, Office of the Attorney General for the State of Utah, and Kenneth T. Cuccinelli, II, Attorney General, Office of the Attorney General for the Commonwealth of Virginia were on the briefs for State Petitioners and Supporting Intervenors. Robert D. Tambling, Assistant Attorney General, Office of the Attorney General for the State of Alabama, entered an appearance.

Christian J. Ward, Scott A. Keller, and April L. Farris were on the brief for amici curiae Scientists in support of Petitioners.

Derek Schmidt, Attorney General, Office of the Attorney General for the State of Kansas, and John Campbell, Chief Deputy Attorney General, were on the brief for amicus curiae State of Kansas in support of Petitioners.

Martin R. Levin, Michael J. O'Neill, Donald M. Falk, Mark S. Kaufman, Steven J. Lechner, and Richard P. Hutchison were on the brief for amici curiae Landmark Legal Foundation, et al. in support of Petitioners.

Jon M. Lipshultz and Angeline Purdy, Attorneys, U.S. Department of Justice, argued the causes for respondent. With them on the brief were John Hannon, Carol Holmes, and Steven Silverman, U.S. Environmental Protection Agency, Attorneys. Thomas A. Lorenzen, Attorney, [***5] U.S. Department of Justice, entered an appearance.

Carol Iancu, Assistant Attorney General, Office of the Attorney General for the Commonwealth of Massachusetts, argued the cause for State and Environmental Intervenors in support of respondents. With her on the briefs were Martha Coakley, Attorney General, William L. Pardee, Attorney Assistant General, Sean H. Donahue, Howard I. Fox, David S. Baron, Megan Ceronsky, Vickie L. Patton, Peter Zalzal, Kamala D. Harris, Attorney General, Office of the Attorney General for the State of California, Kathleen A. Kenealy, Senior Assistant Attorney General, Marc N. Melnick and Nicholas Stern, Deputy Attorneys General, Joseph R. Biden, III, Attorney General, Office of the Attorney General for the State of Delaware, Valerie M. Satterfield, Deputy Attorney General, George Jepsen, Attorney General, Office of the Attorney General for the State of Connecticut, Kimberly P. Massicotte, Matthew I. Levine, Scott N. Koschwitz, Assistant Attorneys General, Lisa Madigan, Attorney General, Office of the Attorney General for the State of Illinois, Gerald T. Karr, Assistant Attorney General, Thomas J. Miller, Attorney General, Office of the Attorney General for [***6] the State of

Iowa, David R. Sheridan, Assistant Attorney General, Douglas F. Gansler, Attorney General, Office of the Attorney General for the State of Maryland, Mary E. Raivel, Assistant Attorney General, Michael A. Delaney, Attorney General, Office of the Attorney General for the State of New Hampshire, K. Allen Brooks, Senior Assistant Attorney General, William J. Schneider, Attorney General, Office of the Attorney General for the State of Maine, Gerald D. Reid, Assistant Attorney General, Lori Swanson, Attorney General, Office of the Attorney General for the State of Minnesota, Jocelyn F. Olson, Assistant Attorney General, Gary K. King, Attorney General, Office of the Attorney General for the State of New Mexico, Stephen R. Farris, Assistant Attorney General, Eric T. Schneiderman, Attorney General, Office of the Attorney General for the State of New York, Michael J. Myers and Yueh-Ru Chu, Assistant Attorneys General, John Kroger, Attorney General, Office of the Attorney General for the State of Oregon, Paul Logan, Assistant Attorney-in-Charge, Robert M. McKenna, Attorney General, Office of the Attorney General for the State of Washington, Leslie R. Seffern, Assistant Attorney General, [***7] Peter F. Kilmartin, Attorney General, Office of the Attorney General for the State of Rhode Island, Gregory S. Schultz, Special Assistant Attorney General, William H. Sorrell, Attorney General, Office of the Attorney General for the State of Vermont, Thea J. Schwartz, Assistant Attorney General, Christopher King, Assistant Corporation Counsel, Corporation Counsel for the City Of New York, Ann B. Weeks, Helen D. Silver, David Doniger, Meleah Geertsma, Morgan Butler, Frank W. Rambo, Joseph Mendelson III, Craig Holt Segall, and Joanne Spalding.

Deborah Sivas, Douglas A. Ruley, Edward Lloyd, and Susan J. Kraham were on the brief for amici curiae America's Great Waters Coalition, et al. in support of respondent. James K. Thornton entered an appearance.

Jonathan F. Mitchell, Solicitor General, Office of the Attorney General for the State of Texas, argued the cause for State Petitioners and Supporting Intervenor. With him on the briefs were Gregg Abbott, Attorney General, Bill Cobb, Deputy Attorney General, J. Reed Clay, Jr., Special Assistant and Senior Counsel to the Attorney General, Michael P. Murphy and James P. Sullivan, Assistant Solicitors General, Luther Strange, Attorney General, [***8] Office of the Attorney General for the State of Alabama, Herman Robinson, Donald Trahan, Kathy M. Wright, Gary C. Rikard, John Bruning, Attorney General, Office of the Attorney General for the State of Nebraska, Katherine J. Spohn, Special Counsel, Wayne Stenehjem, Attorney General, Office of the Attorney General for the State of North Dakota, Margaret Olson, Assistant Attorney General, Alan Wilson, Attorney General, Office of the Attorney General for the State of South Carolina, J. Emory Smith, Jr., Assistant Deputy Attorney General, Marty Jackley, Attorney General, Office of the Attorney General for the State of South Dakota, Roxanne Giedd, Chief, and Kenneth T. Cuccinelli, II, Attorney General, Office of the Attorney General for the Commonwealth of Virginia. Mark W. DeLaquil, Earle D. Getchell, Jr., Assistant Attorney General, Office of the Attorney General for the Commonwealth of Virginia, Andrew M. Grossman, David B. Rivkin, Jr., and Robert D. Tambling, Assistant Attorney General, Office of the Attorney General for the State of Alabama, entered appearances.

F. William Brownell and Peter Keisler argued the causes for Non-State Petitioners and Supporting Intervenors. With them on [***9] the briefs were Norman W. Fichthorn, Henry V. Nickel, Allison D. Wood, Charles H. Knauss, Shannon S. Broome, Timothy K. Webster, Roger R. Martella, Eric Groten, Patrick R. Day, John A. Bryson, Matthew G. Paulson, John P. Elwood, Paul D. Phillips, James A. Holtkamp, Shannon

L. Goessling, Harry W. MacDougald, William H. Lewis, Jr., Ronald J. Tenpas, Gordon R. Alphonso, Edward A. Kazmarek, Chet M. Thompson, Neal J. Cabral, Scott C. Oostdyk, Richard P. Hutchison, John J. McMackin, Jr., Robin S. Conrad, Sheldon Gilbert, Michael W. Steinberg, Levi McAllister, Jeffrey A. Rosen, Robert R. Gasaway, Jeffrey Bossert Clark, William H. Burgess, Ashley C. Parrish, Cynthia A.M. Stroman, Ellen Steen, Leslie Sue Ritts, Peter Glaser, Mark E. Nagle, Terry J. Satterlee, Thomas J. Grever, Margaret Claiborne Campbell, Bryon W. Kirkpatrick, Quentin Riegel, Elizabeth Gaudio, Elizabeth Henry Warner, Harry Moy Ng, Michele Marie Schoeppe, Thomas J. Ward, and Peter H. Wyckoff. Mark A. Behrens, Paul D. Clement, Matthew Dukes, Virginia L. Hudson, and David B. Salmons entered appearances.

Jonathan S. Massey was on the brief for amicus curiae Municipal Gas Commission of Missouri.

John G. Horne, II, Samuel B. Boxerman [***10] and Leslie A. Hulse were on the brief for amici curiae the Commonwealth of Kentucky and the American Chemistry Council in support of petitioners. Angus Macbeth entered an appearance.

Amanda Shafer Berman and Perry M Rosen, Attorneys, U.S. Department of Justice, argued the causes for respondents. With them on the briefs were Howard Hoffman, Elliott Zenick, Brian Doster, and David Orlin, Counsel, U.S. Environmental Protection Agency. Thomas A. Lorenzen and Kim N. Smaczniak, Attorneys, U.S. Department of Justice, and John D. Gunter, II and Michele L. Walter, Counsel, U.S. Environmental Protection Agency, entered appearances.

Sean H. Donahue and Michael J. Myers argued the causes for State and Environmental Intervenors in support of respondents. With them on the briefs were Vickie L. Patton, Pamela A. Campos, Megan Ceronsky, Petere Zalzal, Eric T. Schneiderman, Attorney General, Office of the Attorney General for the State of New York, Barbara D. Underwood, Solicitor General, Morgan A. Costello, Assistant Attorney General, Monica Wagner, Howard I. Fox, David S. Baron, Lisa Madigan, Attorney General, Office of the Attorney General for the State of Illinois, Gerald T. Karr, Assistant Attorney [***11] General, Joanne Spalding, Nathan Matthews, Craig Holt Segall, Kamala D. Harris, Attorney General, Office of the Attorney General for the State of California, Kathleen A. Kenealy, Senior Assistant Attorney General, Susan Durbin, Raissa Lerner, Marc N. Melnick, and Nicholas Stern, Deputy Attorneys General, Martha Coakley, Attorney General, Office of the Attorney General for the Commonwealth of Massachusetts, William L. Pardee and Carol Iancu, Assistant Attorneys General, David Doniger, Meleah Geertsma, William J. Schneider, Attorney General, Office of the Attorney General for the State of Maine, Gerald D. Ried, Assistant Attorney General, Ann B. Weeks, Helen D. Silver, Thomas J. Miller, Attorney General, Office of the Attorney General for the State of Iowa, David R. Sheridan, Assistant Attorney General, Douglas F. Gansler, Attorney General, Office of the Attorney General for the State of Maryland, Mary Raivel, Deputy Attorney General, Michael A. Delaney, Attorney General, Office of the Attorney General for the State of New Hampshire, K. Allen Brooks, Senior Assistant Attorney General, Barbara Baird, William B.Wong, Peter F. Kilmartin, Attorney General, Office of the Attorney General [***12] for the State of Rhode Island, Gregory S. Schultz, Special Assistant Attorney General, Frank Rambo, Morgan Butler, Gary K. King, Attorney General, Office of the Attorney General for the State of New Mexico, Stephen Farris, Assistant Attorney General, John Kroger, Attorney General, Office of the Attorney General for the State of Oregon, Paul Logan, Assistant Attorney-in-Charge, Roy Cooper, Attorney General, Office of the

Zalzal, Eric T. Schneiderman, Attorney General, Office of the Attorney General for the State of New York, Barbara D. Underwood, Solicitor General, Morgan A. Costello, Assistant Attorney General, Monica Wagner, Howard I. Fox, David S. Baron, Lisa Madigan, Attorney General, Office of the Attorney General for the State of Illinois, Gerald T. Karr, Assistant Attorney [***11] General, Joanne Spalding, Nathan Matthews, Craig Holt Segall, Kamala D. Harris, Attorney General, Office of the Attorney General for the State of California, Kathleen A. Kenealy, Senior Assistant Attorney General, Susan Durbin, Raissa Lerner, Marc N. Melnick, and Nicholas Stern, Deputy Attorneys General, Martha Coakley, Attorney General, Office of the Attorney General for the Commonwealth of Massachusetts, William L. Pardee and Carol Iancu, Assistant Attorneys General, David Doniger, Meleah Geertsma, William J. Schneider, Attorney General, Office of the Attorney General for the State of Maine, Gerald D. Ried, Assistant Attorney General, Ann B. Weeks, Helen D. Silver, Thomas J. Miller, Attorney General, Office of the Attorney General for the State of Iowa, David R. Sheridan, Assistant Attorney General, Douglas F. Gansler, Attorney General, Office of the Attorney General for the State of Maryland, Mary Raivel, Deputy Attorney General, Michael A. Delaney, Attorney General, Office of the Attorney General for the State of New Hampshire, K. Allen Brooks, Senior Assistant Attorney General, Barbara Baird, William B.Wong, Peter F. Kilmartin, Attorney General, Office of the Attorney General [***12] for the State of Rhode Island, Gregory S. Schultz, Special Assistant Attorney General, Frank Rambo, Morgan Butler, Gary K. King, Attorney General, Office of the Attorney General for the State of New Mexico, Stephen Farris, Assistant Attorney General, John Kroger, Attorney General, Office of the Attorney General for the State of Oregon, Paul Logan, Assistant Attorney-in-Charge, Roy Cooper, Attorney General, Office of the Attorney General for the State of North Carolina, and J. Allen Jernigan and Marc Bernstein, Special Deputy Attorneys General. Kenneth P. Alex and Gavin G. McCabe, Deputy Assistant Attorneys General, Office of the Attorney General for the State of California, entered appearances.

Peter Glaser argued the cause for petitioners. With him on the briefs were John P. Elwood, Eric Groten, Patrick R. Day, John A. Bryson, Shannon L. Goessling, Harry W. MacDougald, Paul D. Phillips, James A. Holtkamp, Edward A. Kazmarek, Chet M. Thompson, Sam Kazman, Hans Bader, Gordon R. Alphonso, Richard P. Hutchison, Neal J. Cabral, Scott C. Oostdyk, Ronald J. Tenpas, Michael W. Steinberg, Levi McAllister, John J. McMackin Jr., Robin S. Conrad, Rachel L. Brand, Sheldon Gilbert, F. William Brownell, [***13] Norman W. Fichthorn, Henry V. Nickel, Allison D. Wood, Ashley C. Parrish, Cynthia A.M. Stroman, Mark E. Nagle, Michael Higgins, Ellen Steen, Timothy K. Webster, Roger R. Martella, Matthew G. Paulson, Charles H. Knauss, Shannon S. Broome, Quentin Riegel, Elizabeth Gaudio, Thomas J. Ward, Harry Moy Ng, and Michele Marie Schoeppe.

Greg Abbott, Attorney General, Office of the Attorney General for the State of Texas, Bill Cobb, Deputy Attorney General for Civil Litigation, Jonathan F. Mitchell, Solicitor General, J. Reed Clay Jr., Special Assistant and Senior Counsel to the Attorney General, Michael P. Murphy, Assistant Solicitor General, Luther Strange, Attorney General, Office of the Attorney General for the State of Alabama, Samuel S. Olens, Attorney General, Office of the Attorney General for the State of Georgia, John E. Hennelly, Senior Assistant Attorney General, Gary C. Rikard, Jon C. Bruning, Attorney General, Office of the Attorney General for the State of Nebraska, Katherine J. Spohn, Special Counsel to the Attorney General, Wayne K. Stenehjem, Attorney General, Office of the Attorney General for the State of North

Dakota, Margaret Olson, Assistant Attorney General, Alan Wilson, [***14] Attorney General, Office of the Attorney General for the State of South Carolina, J. Emory Smith, Jr., Assistant Deputy Attorney General, Marty Jackley, Attorney General, Office of the Attorney General for the State of North Dakota, Roxanne Giedd, Chief, Civil Litigation Division, and Kenneth T. Cuccinelli, II, Attorney General, Office of the Attorney General for the Commonwealth of Virginia, were on the briefs for State Petitioners and Supporting Intervenor. Paul D. Clement, James W. Coleman, Wayne J. D'Angelo, Mark W. DeLaquil, E. Duncan Getchell Jr., Solicitor General, Office of the Attorney General for the Commonwealth of Virginia, Andrew M. Grossman, Virginia L. Hudson, David B. Rivkin Jr., and Robert D. Tambling, Assistant Attorney General, Office of the Attorney General for the State of Alabama, entered appearances.

Samuel B. Boxerman and Leslie A. Hulse were on the brief for amicus curiae American Chemistry Council in support of petitioners. Angus Macbeth entered an appearance.

Eric G. Hostetler, Attorney, U.S. Department of Justice, argued the cause for respondents. With him on the brief were John Hannon and Steven Silverman, Attorneys, U.S. Environmental Protection Agency.

Raymond [***15] B. Ludwiszewski argued the cause for intervenors Association of Global Automakers, et al. With him on the brief were Kathleen M. Sullivan, Sanford I. Weisburst, and William B. Adams.

Gavin G. McCabe, Deputy Attorney General, Office of the Attorney General for the State of California, argued the cause for intervenor State of California. On the brief were Kamala D. Harris, Attorney General, Kathleen A. Kenealy, Senior Assistant Attorney General, Marc N. Melnick and Nicholas Stern, Deputy Attorneys General, Sean H. Donahue, Howard I. Fox, David S. Baron, Pamela Campos, Megan Ceronsky, Vickie L. Patton, Peter Zalzal, Joseph R. Biden, III, Attorney General, Office of the Attorney General for the State of Delaware, Valerie M. Satterfield, Deputy Attorney General, Thomas J. Miller, Attorney General, Office of the Attorney General for the State of Iowa, David R. Sheridan, Assistant Attorney General, Douglas F. Gansler, Attorney General, Office of the Attorney General for the State of Maryland, Roberta R. James, Assistant Attorney General, Lisa Madigan, Attorney General, Office of the Attorney General for the State of Illinois, Gerald T. Karr, Assistant Attorney General, William T. Schneider, [***16] Attorney General, Office of the Attorney General for the State of Maine, Gerald D. Reid, Assistant Attorney General, Martha Coakley, Attorney General, Office of the Attorney General for the Commonwealth of Massachusetts, Carol Iancu, Tracy Triplett, and William L. Pardee, Assistant Attorneys General, Gary K. King, Attorney General, Office of the Attorney General for the State of New Mexico, Stephen R. Farris, Assistant Attorney General, John Kroger, Attorney General, Office of the Attorney General for the State of Oregon, Paul Logan, Assistant Attorney-in-Charge, William H. Sorrell, Attorney General, Office of the Attorney General for the State of Vermont, Thea J. Schwartz, Assistant Attorney General, Eric T. Schneiderman, Attorney General, Office of the Attorney General for the State of New York, Michael J. Myers and Yueh-Ru Chu, Assistant Attorneys General, Peter F. Kilmartin, Attorney General, Office of the Attorney General for the State of Rhode Island, Gregory S. Schultz, Special Assistant Attorney General, Robert M. McKenna, Attorney General, Office of the Attorney General for the State of Washington, Leslie R. Seffern, Assistant Attorney General, Christopher King, Assistant [***17] Corporation Counsel, Corporation Counsel for the City of New York, Joanne Spalding, Craig Holt Segall, David Doniger and Meleah Geertsma. Judith A. Stahl Moore, Assistant

Megan Ceronsky, Vickie L. Patton, Peter Zalzal, Joseph R. Biden, III, Attorney General, Office of the Attorney General for the State of Delaware, Valerie M. Satterfield, Deputy Attorney General, Thomas J. Miller, Attorney General, Office of the Attorney General for the State of Iowa, David R. Sheridan, Assistant Attorney General, Douglas F. Gansler, Attorney General, Office of the Attorney General for the State of Maryland, Roberta R. James, Assistant Attorney General, Lisa Madigan, Attorney General, Office of the Attorney General for the State of Illinois, Gerald T. Karr, Assistant Attorney General, William T. Schneider, [***16] Attorney General, Office of the Attorney General for the State of Maine, Gerald D. Reid, Assistant Attorney General, Martha Coakley, Attorney General, Office of the Attorney General for the Commonwealth of Massachusetts, Carol Iancu, Tracy Triplett, and William L. Pardee, Assistant Attorneys General, Gary K. King, Attorney General, Office of the Attorney General for the State of New Mexico, Stephen R. Farris, Assistant Attorney General, John Kroger, Attorney General, Office of the Attorney General for the State of Oregon, Paul Logan, Assistant Attorney-in-Charge, William H. Sorrell, Attorney General, Office of the Attorney General for the State of Vermont, Thea J. Schwartz, Assistant Attorney General, Eric T. Schneiderman, Attorney General, Office of the Attorney General for the State of New York, Michael J. Myers and Yueh-Ru Chu, Assistant Attorneys General, Peter F. Kilmartin, Attorney General, Office of the Attorney General for the State of Rhode Island, Gregory S. Schultz, Special Assistant Attorney General, Robert M. McKenna, Attorney General, Office of the Attorney General for the State of Washington, Leslie R. Seffern, Assistant Attorney General, Christopher King, Assistant [***17] Corporation Counsel, Corporation Counsel for the City of New York, Joanne Spalding, Craig Holt Segall, David Doniger and Meleah Geertsma. Judith A. Stahl Moore, Assistant Attorney General, Office of the Attorney General for the State of New Mexico, and John D. Walke entered appearances.

Richard E. Ayres, Jessica L. Olson, and Kristin L. Hines were on the brief for amicus curiae Honeywell International, Inc. in support of respondents.

Richard L. Revesz, Michael A. Livermore, and Jennifer S. Rosenberg were on the brief for amicus curiae institute for policy integrity at new york university school of law in support of respondents.

Timothy K. Webster, Roger R. Martella, Jr., James W. Coleman, William H. Lewis, Jr., Ronald J. Tenpas, Charles H. Knauss, Shannon S. Broome, Bryan M. Killian, and Matthew G. Paulson were on the briefs for petitioners. Peter D. Keisler, Leslie A. Hulse, and Quentin Riegel entered appearances.

Amanda Shafer Berman and Perry M. Rosen, Attorneys, U.S. Department of Justice, and Elliott Zenick and Howard J. Hoffman, Counsel, U.S. Environmental Protection Agency, were on the brief for respondents. Jon M. Lipshultz, Senior Counsel, U.S. Department of Justice, entered and [***18] appearance.

Ann Brewster Weeks, Sean H. Donahue, Vickie Patton, Peter Zalzal, Joanne Spalding, Craig Segall, David Doniger, and Meleah Geertsma were on the brief of intervenors in support of respondents. David S. Baron, Pamela A. Campos, Colin C. O'Brien, and John D. Walke entered appearances.

Vera P. Pardee, Brendan R. Cummings, and Kevin P. Bundy were on the brief for amicus curiae Center for Biological Diversity in support of respondents.

JUDGES: Before: SENTELLE, Chief Judge; ROGERS and TATEL, Circuit Judges.

OPINION

[*113] [**317] Opinion for the Court filed PER CURIAM.

Per Curiam: Following the Supreme Court's decision in *Massachusetts v. EPA, 549 U.S. 497, 127 S. Ct. 1438, 167 L. Ed. 2d 248 (2007)*which clarified that greenhouse gases are an "air pollutant" subject to regulation under the Clean Air Act (CAA)--the Environmental Protection Agency promulgated a series of greenhouse gas-related rules. First, EPA issued an Endangerment Finding, in which it determined that greenhouse gases may "reasonably be anticipated to endanger public health or welfare." *See 42 U.S.C. § 7521(a)(1)*. Next, it issued the Tailpipe Rule, which set emission standards for cars and light trucks. Finally, EPA determined that the CAA requires major stationary sources of greenhouse [***19] gases to obtain construction and operating permits. But because immediate regulation of all such sources would result in overwhelming permitting burdens on permitting authorities and sources, EPA issued the Timing and Tailoring Rules, in which it determined that only the largest stationary sources would initially be subject to permitting requirements.

Petitioners, various states and industry groups, challenge all these rules, arguing that they are based on improper constructions of the CAA and are otherwise arbitrary and capricious. But for the reasons set forth below, we conclude: 1) the Endangerment Finding and Tailpipe Rule are neither arbitrary nor capricious; 2) EPA's interpretation of the governing CAA provisions is unambiguously correct; and 3) no petitioner has standing to challenge the Timing and Tailoring Rules. We thus dismiss for lack of jurisdiction all petitions for [*114] [**318] review of the Timing and Tailoring Rules, and deny the remainder of the petitions.

I.

We begin with a brief primer on greenhouse gases. As their name suggests, when released into the atmosphere, these gases act "like the ceiling of a greenhouse, trapping solar energy and retarding the escape of reflected heat." [***20] *Massachusetts v. EPA, 549 U.S. at 505*. A wide variety of modern human activities result in greenhouse gas emissions; cars, power plants, and industrial sites all release significant amounts of these heat-trapping gases. In recent decades "[a] well-documented rise in global temperatures has coincided with a significant increase in the concentration of [greenhouse gases] in the atmosphere." *Id. at 504-05*. Many scientists believe that mankind's greenhouse gas emissions are driving this climate change. These scientists predict that global climate change will cause a host of deleterious consequences, including drought, increasingly severe weather events, and rising sea levels.

The genesis of this litigation came in 2007, when the Supreme Court held in *Massachusetts v. EPA* that greenhouse gases "unambiguous[ly]" may be regulated as an "air pollutant" under the Clean Air Act ("CAA"). *Id. at 529*. Squarely rejecting the contention--then advanced by EPA--that "greenhouse gases cannot be 'air pollutants' within the meaning of the Act," *id. at 513*, the Court held that the CAA's definition of "air pollutant" "embraces *all* airborne compounds of whatever stripe." *Id. at 529* (emphasis added). Moreover, [***21] because the CAA requires EPA to establish motor-vehicle emission standards for "any air pollutant . . . which may reasonably be anticipated to endanger public health or welfare," *42 U.S.C. § 7521(a)(1)* (emphasis added), the Court held that EPA had a "statutory obligation" to regulate harmful greenhouse gases. *Id. at 534*. "Under the clear terms of the Clean Air Act," the Court concluded, "EPA can avoid taking further action only if it determines that greenhouse gases do not contribute to climate change or if it provides some reasonable explanation

as to why it cannot or will not exercise its discretion to determine whether they do." *Id. at 533*. The Court thus directed EPA to determine "whether sufficient information exists to make an endangerment finding" for greenhouse gases. *Id. at 534*.

Massachusetts v. EPA spurred a cascading series of greenhouse gas-related rules and regulations. First, in direct response to the Supreme Court's directive, EPA issued an Endangerment Finding for greenhouse gases. *Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act* ("Endangerment Finding"), *74 Fed. Reg. 66,496 (Dec. 15, 2009)*. The Endangerment [***22] Finding defined as a single "air pollutant" an "aggregate group of six long-lived and directly-emitted greenhouse gases" that are "well mixed" together in the atmosphere and cause global climate change: carbon dioxide, methane, nitrous oxide, hydroflourocarbons, perflourocarbons, and sulfur hexafluoride. *Id. at 66,536-37*. Following "common practice," EPA measured the impact of these gases on a "carbon dioxide equivalent basis," (CO_2e) which is based on the gases' "warming effect relative to carbon dioxide . . . over a specified timeframe." *Id. at 66,519*. (Using the carbon dioxide equivalent equation, for example, a mixture of X amount of nitrous oxide and Y amount of sulfur hexafluoride is expressed as Z amount of CO_2e). After compiling and [*115] [**319] considering a considerable body of scientific evidence, EPA concluded that motor-vehicle emissions of these six well-mixed gases "contribute to the total greenhouse gas air pollution, and thus to the climate change problem, which is reasonably anticipated to endanger public health and welfare." *Id. at 66,499*.

Next, and pursuant to the CAA's requirement that EPA establish motor-vehicle emission standards for "any air pollutant . . . which may reasonably [***23] be anticipated to endanger public health or welfare," *42 U.S.C. § 7521(a)(1)*, the agency promulgated its Tailpipe Rule for greenhouse gases. *Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule* ("Tailpipe Rule"), *75 Fed. Reg. 25,324 (May 7, 2010)*. Effective January 2, 2011, the Tailpipe Rule set greenhouse gas emission standards for cars and light trucks as part of a joint rulemaking with fuel economy standards issued by the National Highway Traffic Safety Administration (NHTSA). *Id.* at 25,326.

Under EPA's longstanding interpretation of the CAA, the Tailpipe Rule automatically triggered regulation of stationary greenhouse gas emitters under two separate sections of the Act. The first, the Prevention of Significant Deterioration of Air Quality (PSD) program, requires state-issued construction permits for certain types of stationary sources--for example, iron and steel mill plants--if they have the potential to emit over 100 tons per year (tpy) of "any air pollutant." *See 42 U.S.C. § 7475; 7479(1)*. All other stationary sources are subject to PSD permitting if they have the potential to emit over 250 tpy of "any air pollutant." *Id.* [***24] *§ 7479(1)*. The second provision, Title V, requires state-issued operating permits for stationary sources that have the potential to emit at least 100 tpy of "any air pollutant." *Id. § 7602(j)*. EPA has long interpreted the phrase "any air pollutant" in both these provisions to mean any air pollutant that is regulated under the CAA. *See Requirements for Preparation, Adoption, and Submittal of Implementation Plans; Approval and Promulgation of Implementation Plans* ("1980 Implementation Plan Requirements"), *45 Fed. Reg. 52,676, 52,711 (Aug. 7, 1980)* (PSD program); *Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule* ("Tailoring Rule"), *75 Fed. Reg. 31,514, 31,553-*

54 (June 3, 2010) (discussing history of Title V regulation and applicability). And once the Tailpipe Rule set motor-vehicle emission standards for greenhouse gases, they became a regulated pollutant under the Act, requiring PSD and Title V greenhouse permitting.

Acting pursuant to this longstanding interpretation of the PSD and Title V programs, EPA issued two rules phasing in stationary source greenhouse gas regulation. First, in the Timing Rule, EPA concluded that an air pollutant becomes "subject [***25] to regulation" under the Clean Air Act--and thus subject to PSD and Title V permitting--only once a regulation requiring control of that pollutant takes effect. *Reconsideration of Interpretation of Regulations That Determine Pollutants Covered by Clean Air Act Permitting Programs* ("Timing Rule"), *75 Fed. Reg. 17,004 (Apr. 2, 2010)*. Therefore, EPA concluded, major stationary emitters of greenhouse gases would be subject to PSD and Title V permitting regulations on January 2, 2011--the date on which the Tailpipe Rule became effective, and thus, the date when greenhouse gases first became regulated under the CAA. *Id.* at 17,019.

Next, EPA promulgated the Tailoring Rule. In the Tailoring Rule, EPA noted [*116] [**320] that greenhouse gases are emitted in far greater volumes than other pollutants. Indeed, millions of industrial, residential, and commercial sources exceed the 100/250 tpy statutory emissions threshold for CO_2e. Tailoring Rule, *75 Fed. Reg. at 31,534-36*. Immediately adding these sources to the PSD and Title V programs would, EPA predicted, result in tremendous costs to industry and state permitting authorities. *See id.* As a result, EPA announced that it was "relieving overwhelming permitting [***26] burdens that would, in the absence of this rule, fall on permitting authorities and sources." *Id. at 31,516*. Departing from the CAA's 100/250 tpy emissions threshold, the Tailoring Rule provided that only the largest sources--those exceeding 75,000 or 100,000 tpy CO_2e, depending on the program and project--would initially be subject to greenhouse gas permitting. *Id. at 31,523*. (The Tailoring Rule further provided that regulated sources must also emit greenhouse gases at levels that exceed the 100/250 tpy emissions threshold on a *mass* basis. That is, they must emit over 100/250 tpy of actual pollutants, in addition to exceeding the 75,000/100,000 tpy carbon dioxide equivalent. *Id. at 31,523*.)

A number of groups--including states and regulated industries--filed petitions for review of EPA's greenhouse gas regulations, contending that the agency misconstrued the CAA and otherwise acted arbitrarily and capriciously. This appeal consolidates the petitions for review of the four aforementioned rules: the Endangerment Finding, the Tailpipe Rule, the Timing Rule, and the Tailoring Rule.

"The Clean Air Act empowers us to reverse the Administrator's action in rulemaking if it is 'arbitrary, capricious, [***27] an abuse of discretion, or otherwise not in accordance with the law.'" *Med. Waste Inst. & Energy Recovery Council v. EPA, 645 F.3d 420, 424, 396 U.S. App. D.C. 99 (D.C. Cir. 2011)* (quoting *42 U.S.C. § 7607(d)(9)(A)*). Questions of statutory interpretation are governed by the familiar *Chevron* two-step: "First . . . if the intent of Congress is clear, that is the end of the matter; for the court, as well as the agency, must give effect to the unambiguously expressed intent of Congress." *Chevron, U.S.A. Inc. v. Natural Resources Defense Council, Inc., 467 U.S. 837, 842-43, 104 S. Ct. 2778, 81 L. Ed. 2d 694 (1984)*. But "if the statute is silent or ambiguous with respect to the specific issue, the question for the court is whether the agency's answer is based on a permissible construction of the statute." *Id. at*

843.

This opinion proceeds in several steps. Part II explains why the Endangerment Finding was neither arbitrary nor capricious, while Part III does the same for the Tailpipe Rule. Turning to stationary source regulation, Part IV examines whether any petitioners may timely challenge EPA's longstanding interpretation of the PSD statute. Because we conclude that they may, Part V addresses the merits of their statutory arguments, and explains [***28] why EPA's interpretation of the CAA was compelled by the statute. Next, Part VI explains why petitioners lack standing to challenge the Timing and Tailoring Rules themselves. Finally, Part VII disposes of several arguments that have nothing to do with the rules under review, and thus are not properly before us.

II.

We turn first to State and Industry Petitioners' challenges to the Endangerment Finding, the first of the series of rules EPA issued after the Supreme Court remanded *Massachusetts v. EPA*. In the decision ordering the remand, the Supreme Court held that EPA had failed in its [*117] [**321] statutory obligations when it "offered no reasoned explanation for its refusal to decide whether greenhouse gases cause or contribute to climate change." *Massachusetts v. EPA, 549 U.S. at 534*. On remand, EPA compiled a substantial scientific record, which is before us in the present review, and determined that "greenhouse gases in the atmosphere may reasonably be anticipated both to endanger public health and to endanger public welfare." *Endangerment Finding, 74 Fed. Reg. at 66,497*. EPA went on to find that motor-vehicle emissions of greenhouse gases "contribute to the total greenhouse gas air pollution, [***29] and thus to the climate change problem, which is reasonably anticipated to endanger public health and welfare." *Id. at 66,499*.

State and Industry Petitioners challenge several aspects of EPA's decision, including (1) EPA's interpretation of CAA § 202(a)(1), which sets out the endangerment-finding standard; (2) the adequacy of the scientific record supporting the Endangerment Finding; (3) EPA's decision not to "quantify" the risk of endangerment to public health or welfare created by climate change; (4) EPA's choice to define the "air pollutant" at issue as an aggregate of six greenhouse gases; (5) EPA's failure to consult its Science Advisory Board before issuing the Endangerment Finding; and (6) EPA's denial of all petitions for reconsideration of the Endangerment Finding. We ultimately conclude that the Endangerment Finding is consistent with *Massachusetts v. EPA* and the text and structure of the CAA, and is adequately supported by the administrative record.

A.

Industry Petitioners contend that EPA improperly interpreted CAA § 202(a)(1) as restricting the Endangerment Finding to a science-based judgment devoid of considerations of policy concerns and regulatory consequences. They assert [***30] that CAA § 202(a)(1) requires EPA to consider, *e.g.*, the benefits of activities that require greenhouse gas emissions, the effectiveness of emissions regulation triggered by the Endangerment Finding, and the potential for societal adaptation to or mitigation of climate change. They maintain that eschewing those considerations also made the Endangerment Finding arbitrary and capricious.

These contentions are foreclosed by the language of the statute and the Supreme Court's decision in *Massachusetts v. EPA*. Section 202(a) of the CAA states in relevant part that EPA's Administrator

> shall by regulation prescribe (and from time to time revise) in accordance with the provisions of this

> section, standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.

42 U.S.C. § 7521(a)(1). This language requires that the endangerment evaluation "relate to whether an air pollutant 'cause[s], or contribute[s] [***31] to, air pollution which may reasonably be anticipated to endanger public health or welfare.'" *Massachusetts v. EPA, 549 U.S. at 532-33*. At bottom, § 202(a)(1) requires EPA to answer only two questions: whether particular "air pollution"--here, greenhouse gases--"may reasonably be anticipated to endanger public health or welfare," and whether motor-vehicle emissions "cause, or contribute to" that endangerment.

These questions require a "scientific judgment" about the potential risks greenhouse gas emissions pose to public health [*118] [**322] or welfare--not policy discussions. *Massachusetts v. EPA, 549 U.S. at 534*. In *Massachusetts v. EPA*, the Supreme Court rebuffed an attempt by EPA itself to inject considerations of policy into its decision. At the time, EPA had "offered a laundry list of reasons not to regulate" greenhouse gases, including

> that a number of voluntary Executive Branch programs already provide an effective response to the threat of global warming, that regulating greenhouse gases might impair the President's ability to negotiate with "key developing nations" to reduce emissions, and that curtailing motor-vehicle emissions would reflect "an inefficient, piecemeal approach to address the [***32] climate change issue."

Id. at 533 (citations omitted). The Court noted that "these policy judgments . . . have nothing to do with whether greenhouse gas emissions contribute to climate change. Still less do they amount to a reasoned justification for declining to form a scientific judgment." *Id. at 533-34*. In the Court's view, EPA's policy-based explanations contained "no reasoned explanation for [EPA's] refusal to decide" the key part of the endangerment inquiry: "whether greenhouse gases cause or contribute to climate change." *Id. at 534*.

As in *Massachusetts v. EPA*, a "laundry list of reasons not to regulate" simply has "nothing to do with whether greenhouse gas emissions contribute to climate change." *Id. at 533-34*. The additional exercises State and Industry Petitioners would have EPA undertake--*e.g.*, performing a cost-benefit analysis for greenhouse gases, gauging the effectiveness of whatever emission standards EPA would enact to limit greenhouse gases, and predicting society's adaptive response to the dangers or harms caused by climate change--do not inform the "scientific judgment" that § 202(a)(1) requires of EPA. Instead of focusing on the question whether greenhouse gas emissions [***33] may reasonably be anticipated to endanger public health or welfare, the factors State and Industry Petitioners put forth only address what might happen were EPA to answer that question in the affirmative. As EPA stated in the Endangerment Finding, such inquiries "muddle the rather straightforward scientific judgment about whether there may be endangerment by throwing the potential impact of responding to the danger into the initial question." *74 Fed. Reg. at 66,515*. To be sure, the subsection following §

202(a)(1), § 202(a)(2), requires that EPA address limited questions about the cost of compliance with new emission standards and the availability of technology for meeting those standards, *see infra* Part III, but these judgments are not part of the § 202(a)(1) endangerment inquiry. The Supreme Court made clear in *Massachusetts v. EPA* that it was not addressing the question "whether policy concerns can inform EPA's actions in the event that it makes such a finding," *549 U.S. at 534-35*, but that policy concerns were not part of the calculus for the determination of the endangerment finding in the first instance. The Supreme Court emphasized that it was holding "that EPA must ground its [***34] reasons for action or inaction in the statute." *Id. at 535*. The statute speaks in terms of endangerment, not in terms of policy, and EPA has complied with the statute.

State and Industry Petitioners insist that because statutes should be interpreted to avoid absurd results, EPA should have considered at least the "absurd" consequences that would follow from an endangerment [*119] [**323] finding for greenhouse gases. Specifically: having made an endangerment finding, EPA will proceed to promulgate emission standards under § 202(a)(1). Issuing those standards triggers regulation--under EPA's PSD and Title V programs--of stationary sources that emit greenhouse gases at levels above longstanding statutory thresholds. Because greenhouse gases are emitted in much higher volumes than other air pollutants, hundreds of thousands of small stationary sources would exceed those thresholds. This would subject those sources to PSD and Title V permitting requirements despite what Petitioners claim was Congress's clear intent that the requirements apply only to large industrial sources. Petitioners assert that even EPA believed such overbroad regulation to be an absurd result, which it attempted to rectify by adopting [***35] the Tailoring Rule to raise the statutory thresholds, *see infra* Part VI.

However "absurd" Petitioners consider this consequence, though, it is still irrelevant to the endangerment inquiry. That EPA adjusted the statutory thresholds to accommodate regulation of greenhouse gases emitted by stationary sources may indicate that the CAA is a regulatory scheme less-than-perfectly tailored to dealing with greenhouse gases. But the Supreme Court has already held that EPA indeed wields the authority to regulate greenhouse gases under the CAA. *See Massachusetts v. EPA*. The plain language of § 202(a)(1) of that Act does not leave room for EPA to consider as part of the endangerment inquiry the stationary-source regulation triggered by an endangerment finding, even if the degree of regulation triggered might at a later stage be characterized as "absurd."

B.

State and Industry Petitioners next challenge the adequacy of the scientific record underlying the Endangerment Finding, objecting to both the type of evidence upon which EPA relied and EPA's decision to make an Endangerment Finding in light of what Industry Petitioners view as significant scientific uncertainty. Neither objection has merit.

1.

As [***36] an initial matter, State and Industry Petitioners question EPA's reliance on "major assessments" addressing greenhouse gases and climate change issued by the Intergovernmental Panel on Climate Change (IPCC), the U.S. Global Climate Research Program (USGCRP), and the National Research Council (NRC). *Endangerment Finding, 74 Fed. Reg. at 66,510-11*. These peer-reviewed assessments synthesized thousands of individual studies on various aspects of greenhouse gases and climate change and drew "overarching conclusions" about the

state of the science in this field. *Id. at 66,511*. The assessments provide data and information on, *inter alia*, "the amount of greenhouse gases being emitted by human activities"; their continued accumulation in the atmosphere; the resulting observed changes to Earth's energy balance, temperature and climate at global and regional levels, and other "climate-sensitive sectors and systems of the human and natural environment"; the extent to which these changes "can be attributed to human-induced buildup of atmospheric greenhouse gases"; "future projected climate change"; and "projected risks and impacts to human health, society and the environment."*Id. at 66,510-11*.

State [***37] and Industry Petitioners assert that EPA improperly "delegated" its judgment to the IPCC, USGCRP, and NRC by relying on these assessments of climate-change science. *See U.S. Telecom Ass'n v.* [*120] [**324] *FCC, 359 F.3d 554, 566, 360 U.S. App. D.C. 202 (D.C. Cir. 2004)*. This argument is little more than a semantic trick. EPA did not delegate, explicitly or otherwise, any decision-making to any of those entities. EPA simply did here what it and other decision-makers often must do to make a science-based judgment: it sought out and reviewed existing scientific evidence to determine whether a particular finding was warranted. It makes no difference that much of the scientific evidence in large part consisted of "syntheses" of individual studies and research. Even individual studies and research papers often synthesize past work in an area and then build upon it. This is how science works. EPA is not required to re-prove the existence of the atom every time it approaches a scientific question.

Moreover, it appears from the record that EPA used the assessment reports not as substitutes for its own judgment but as evidence upon which it relied to make that judgment. EPA evaluated the processes used to develop the various assessment [***38] reports, reviewed their contents, and considered the depth of the scientific consensus the reports represented. Based on these evaluations, EPA determined the assessments represented the best source material to use in deciding whether greenhouse gas emissions may be reasonably anticipated to endanger public health or welfare. *Endangerment Finding, 74 Fed. Reg. at 66,510-11*. It then reviewed those reports along with comments relevant to the scientific considerations involved to determine whether the evidence warranted an endangerment finding for greenhouse gases as it was required to do under the Supreme Court's mandate in *Massachusetts v. EPA*.

2.

Industry Petitioners also assert that the scientific evidence does not adequately support the Endangerment Finding. As we have stated before in reviewing the science-based decisions of agencies such as EPA, "[a]lthough we perform a searching and careful inquiry into the facts underlying the agency's decisions, we will presume the validity of agency action as long as a rational basis for it is presented." *Am. Farm Bureau Fed'n v. EPA, 559 F.3d 512, 519, 385 U.S. App. D.C. 83 (D.C. Cir. 2009)* (internal quotation marks omitted). In so doing, "we give an extreme degree [***39] of deference to the agency when it is evaluating scientific data within its technical expertise." *Id.* (internal quotation marks omitted).

The body of scientific evidence marshaled by EPA in support of the Endangerment Finding is substantial. EPA's scientific evidence of record included support for the proposition that greenhouse gases trap heat on earth that would otherwise dissipate into space; that this "greenhouse effect" warms the climate; that human activity is contributing to increased atmospheric levels of greenhouse gases; and that the climate system is warming.

Based on this scientific record,

EPA made the linchpin finding: in its judgment, the "root cause" of the recently observed climate change is "very likely" the observed increase in anthropogenic greenhouse gas emissions. *Endangerment Finding, 74 Fed. Reg. at 66,518*. EPA found support for this finding in three lines of evidence. First, it drew upon our "basic physical understanding" of the impacts of various natural and manmade changes on the climate system. For instance, EPA relied on evidence that the past half-century of warming has occurred at a time when natural forces such as solar and volcanic activity likely would [***40] have produced cooling. Endangerment Finding, Response to Comments (RTC) Vol. 3, at 20. Other evidence supports EPA's conclusion that the observed warming pattern [*121] [**325] --warming of the bottommost layer of the atmosphere and cooling immediately above it--is consistent with greenhouse-gas causation. *Id.*

EPA further relied upon evidence of historical estimates of past climate change, supporting EPA's conclusion that global temperatures over the last half-century are unusual. *Endangerment Finding, 74 Fed. Reg. at 66,518*. Scientific studies upon which EPA relied place high confidence in the assertion that global mean surface temperatures over the last few decades are higher than at any time in the last four centuries. Technical Support Document for the Endangerment Finding (TSD), at 31. These studies also show, albeit with significant uncertainty, that temperatures at many individual locations were higher over the last twenty-five years than during any period of comparable length since 900 A.D. *Id.*

For its third line of evidence that anthropogenic emissions of greenhouse gases spurred the perceived warming trend, EPA turned to computer-based climate-model simulations. Scientists have used global climate [***41] models built on basic principles of physics and scientific knowledge about the climate to try to simulate the recent climate change. These models have only been able to replicate the observed warming by including anthropogenic emissions of greenhouse gases in the simulations. *Endangerment Finding, 74 Fed. Reg. at 66,523*.

To recap, EPA had before it substantial record evidence that anthropogenic emissions of greenhouse gases "very likely" caused warming of the climate over the last several decades. EPA further had evidence of current and future effects of this warming on public health and welfare. Relying again upon substantial scientific evidence, EPA determined that anthropogenically induced climate change threatens both public health and public welfare. It found that extreme weather events, changes in air quality, increases in food- and water-borne pathogens, and increases in temperatures are likely to have adverse health effects. *Id. at 66,497-98*. The record also supports EPA's conclusion that climate change endangers human welfare by creating risk to food production and agriculture, forestry, energy, infrastructure, ecosystems, and wildlife. Substantial evidence further supported [***42] EPA's conclusion that the warming resulting from the greenhouse gas emissions could be expected to create risks to water resources and in general to coastal areas as a result of expected increase in sea level. *Id. at 66,498*. Finally, EPA determined from substantial evidence that motor-vehicle emissions of greenhouse gases contribute to climate change and thus to the endangerment of public health and welfare.

Industry Petitioners do not find fault with much of the substantial record EPA amassed in support of the Endangerment Finding. Rather, they contend that the record evidences too much uncertainty to support that judgment. But the existence of some uncertainty does not, without more, warrant invalidation of an endangerment finding. If a statute is "precautionary in nature" and

"designed to protect the public health," and the relevant evidence is "difficult to come by, uncertain, or conflicting because it is on the frontiers of scientific knowledge," EPA need not provide "rigorous step-by-step proof of cause and effect" to support an endangerment finding. *Ethyl Corp. v. EPA, 541 F.2d 1, 28, 176 U.S. App. D.C. 373 (D.C. Cir. 1976)*. As we have stated before, "Awaiting certainty will often allow for only reactive, [***43] not preventive, regulation." *Id. at 25*.

Congress did not restrict EPA to remedial regulation when it enacted CAA § 202(a). That section mandates that [*122] [**326] EPA promulgate new emission standards if it determines that the air pollution at issue "may reasonably be anticipated to endanger public health or welfare." *42 U.S.C. § 7521(a)(1)*. This language requires a precautionary, forward-looking scientific judgment about the risks of a particular air pollutant, consistent with the CAA's "precautionary and preventive orientation." *Lead Indus. Ass'n, Inc. v. EPA, 647 F.2d 1130, 1155, 208 U.S. App. D.C. 1 (D.C. Cir. 1980)*. Requiring that EPA find "certain" endangerment of public health or welfare before regulating greenhouse gases would effectively prevent EPA from doing the job Congress gave it in § 202(a)--utilizing emission standards to prevent reasonably anticipated endangerment from maturing into concrete harm. *Cf. id.* ("[R]equiring EPA to wait until it can conclusively demonstrate that a particular effect is adverse to health before it acts is inconsistent with both the [CAA]'s precautionary and preventive orientation and the nature of the Administrator's statutory responsibilities. Congress provided that the Administrator [***44] is to use his judgment in setting air quality standards precisely to permit him to act in the face of uncertainty.").

In *Massachusetts v. EPA* the Supreme Court confirmed that EPA may make an endangerment finding despite lingering scientific uncertainty. Indeed, the Court held that the existence of "some residual uncertainty" did not excuse EPA's decision to decline to regulate greenhouse gases. *Massachusetts v. EPA, 549 U.S. at 534*. To avoid regulating emissions of greenhouse gases, EPA would need to show "scientific uncertainty . . . so profound that it precludes EPA from making a reasoned judgment as to whether greenhouse gases contribute to global warming." *Id.* Clearly, then, EPA may issue an endangerment finding even while the scientific record still contains at least "some residual uncertainty." Industry Petitioners have shown no more than that.

In the end, Petitioners are asking us to re-weigh the scientific evidence before EPA and reach our own conclusion. This is not our role. As with other reviews of administrative proceedings, we do not determine the convincing force of evidence, nor the conclusion it should support, but only whether the conclusion reached by EPA is supported [***45] by substantial evidence when considered on the record as a whole. *See, e.g., New York v. EPA, 413 F.3d 3, 30, 367 U.S. App. D.C. 3 (D.C. Cir. 2005)*. When EPA evaluates scientific evidence in its bailiwick, we ask only that it take the scientific record into account "in a rational manner." *Am. Petroleum Inst. v. Costle, 665 F.2d 1176, 1187, 214 U.S. App. D.C. 358 (D.C. Cir. 1981)*. Industry Petitioners have not shown that EPA failed to do so here.

C.

State Petitioners, here led by Texas, contend that the Endangerment Finding is arbitrary and capricious because EPA did not "define," "measure," or "quantify" either the atmospheric concentration at which greenhouse gases endanger public health or welfare, the rate or type of climate change that it anticipates will endanger public health or welfare, or the risks or impacts of climate change. According to Texas,

without defining these thresholds and distinguishing "safe" climate change from climate change that endangers, EPA's Endangerment Finding is just a "subjective conviction."

It is true that EPA did not provide a quantitative threshold at which greenhouse gases or climate change will endanger or cause certain impacts to public health or welfare. The text of CAA § 202(a)(1) does not [***46] require that EPA set a precise numerical value as part of an endangerment finding. Quite the opposite; the § 202(a)(1) inquiry necessarily [*123] [**327] entails a case-by-case, sliding-scale approach to endangerment because "[d]anger . . . is not set by a fixed probability of harm, but rather is composed of reciprocal elements of risk and harm, or probability and severity." *Ethyl, 541 F.2d at 18*. EPA need not establish a minimum threshold of risk or harm before determining whether an air pollutant endangers. It may base an endangerment finding on "a lesser risk of greater harm . . . or a greater risk of lesser harm" or any combination in between. *Id.*

Ethyl is instructive. There, EPA made an endangerment finding for airborne lead. During its endangerment inquiry, EPA initially tried to do what Texas asks of it here: find a specific concentration of the air pollutant below which it would be considered "safe" and above which it would endanger public health. *Id. at 56*. However, EPA abandoned that approach because it failed to account for "the wide variability of dietary lead intake" and lacked predictive value. EPA substituted a "more qualitative" approach, which relied on "predictions based on uncertain [***47] data" along with clinical studies. *Id. at 56-57*. This court upheld the endangerment finding that used that qualitative approach despite the lack of a specific endangerment "threshold."

In its essence, Texas's call for quantification of the endangerment is no more than a specialized version of Industry Petitioners' claim that the scientific record contains too much uncertainty to find endangerment. EPA relied on a substantial record of empirical data and scientific evidence, making many specific and often quantitative findings regarding the impacts of greenhouse gases on climate change and the effects of climate change on public health and welfare. Its failure to distill this ocean of evidence into a specific number at which greenhouse gases cause "dangerous" climate change is a function of the precautionary thrust of the CAA and the multivariate and sometimes uncertain nature of climate science, not a sign of arbitrary or capricious decision-making.

D.

EPA defined both the "air pollution" and the "air pollutant" that are the subject of the Endangerment Finding as an aggregate of six greenhouse gases, which EPA called "well mixed greenhouse gases": carbon dioxide (CO_2), methane (CH_4), [***48] nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Industry Petitioners argue that EPA's decision to include PFCs and SF_6 in this group of greenhouse gases was arbitrary and capricious primarily because motor vehicles generally do not emit these two gases.

No petitioner for review of the Endangerment Finding has established standing to make this argument. Industry Petitioners concede that EPA's decision to regulate PFCs and SF_6 along with the other four greenhouse gases does not injure any motor-vehicle-related petitioner. Nor has any non-motor-vehicle-related petitioner shown an injury-in-fact resulting from EPA's inclusion of these two gases in the six-gas amalgam of "well-mixed greenhouse gases." At oral argument, Industry Petitioners asserted for the first time that certain utility companies--members of associations that petitioned for review of the

Endangerment Finding--own utility transformers that emit SF_6. However, they never demonstrated or even definitively asserted that any of these companies would not be subject to regulation or permitting requirements but for EPA's decision to include SF_6 as part of the "well-mixed greenhouse [***49] gases" that are the subject of the Endangerment Finding. *See Sierra Club v. EPA, 292 F.3d 895, 898-900,* [*124] [**328] *352 U.S. App. D.C. 191 (D.C. Cir. 2002)* (requiring that a petitioner seeking review of agency action demonstrate standing by affidavit or other evidence if standing is not "self-evident" from the administrative record). Absent a petitioner with standing to challenge EPA's inclusion of PFCs and SF_6 in the "air pollution" at issue, this court lacks jurisdiction to address the merits of Industry Petitioners' contention.

E.

EPA did not submit the Endangerment Finding for review by its Science Advisory Board (SAB). Industry Petitioners claim that EPA's failure to do so violates its mandate to "make available" to the SAB "any proposed criteria document, standard, limitation, or regulation under the Clean Air Act" at the time it provides the same "to any other Federal agency for formal review and comment." *42 U.S.C. § 4365(c)(1); see Am. Petroleum Inst., 665 F.2d at 1188.*

To begin with, it is not clear that EPA provided the Endangerment Finding "to any other Federal agency for formal review and comment," which triggers this duty to submit a regulation to the SAB. EPA only submitted a draft of the Endangerment Finding [***50] to the Office of Information and Regulatory Affairs pursuant to Executive Order 12,866. EPA contends that this was merely an *informal* review process, not "formal review and comment"--at least when compared with a statutory review-and-comment requirement in which other agencies are given the opportunity to provide written comments about the impacts of a proposed regulation on the reviewing agency's universe of responsibility. *See, e.g., 49 U.S.C. § 32902(j).* Industry Petitioners failed to respond to this contention.

In any event, even if EPA violated its mandate by failing to submit the Endangerment Finding to the SAB, Industry Petitioners have not shown that this error was "of such central relevance to the rule that there is a substantial likelihood that the rule would have been significantly changed if such errors had not been made." *42 U.S.C. § 7607(d)(8); see Am. Petroleum Inst., 665 F.2d at 1188-89* (applying this standard to EPA's failure to submit an ozone standard to the SAB).

F.

Lastly, State Petitioners maintain that EPA erred by denying all ten petitions for reconsideration of the Endangerment Finding. Those petitions asserted that internal emails and documents released from the [***51] University of East Anglia's Climate Research Unit (CRU)--a contributor to one of the global temperature records and to the IPCC's assessment report--undermined the scientific evidence supporting the Endangerment Finding by calling into question whether the IPCC scientists adhered to "best science practices." *EPA's Denial of the Petitions To Reconsider the Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act* ("Reconsideration Denial"), *75 Fed. Reg. 49,556, 49,556-57 (Aug. 13, 2010).* The petitions pointed to factual mistakes in the IPCC's assessment report resulting from the use of non-peer-reviewed studies and several scientific studies postdating the Endangerment Finding as evidence that the Endangerment Finding was flawed. *Id.*

On August 13, 2010, EPA issued a denial of the petitions for reconsideration accompanied by a 360-page response to petitions (RTP). *Id.* at 49,556. It determined that the

petitions did not provide substantial support for the argument that the Endangerment Finding should be revised. According to EPA, the petitioners' claims [*125] [**329] based on the CRU documents were exaggerated, contradicted by other evidence, and not [***52] a material or reliable basis for questioning the credibility of the body of science at issue; two of the factual inaccuracies alleged in the petitions were in fact mistakes, but both were "tangential and minor" and did not change the key IPCC conclusions; and the new scientific studies raised by some petitions were either already considered by EPA, misinterpreted or misrepresented by petitioners, or put forth without acknowledging other new studies. *Id. at 49,557-58*.

1.

EPA is required to convene a proceeding for reconsideration of a rule if a party raising an objection to the rule

> can demonstrate to the Administrator that it was impracticable to raise such objection within such time or if the grounds for such objection arose after the period for public comment (but within the time specified for judicial review) and if such objection is of central relevance to the outcome of the rule.

42 U.S.C. § 7607(d)(7)(B). For the purpose of determining whether to commence reconsideration of a rule, EPA considers an objection to be of "central relevance to the outcome" of that rule "if it provides substantial support for the argument that the regulation should be revised." *Reconsideration Denial, 75 Fed. Reg. at 49,561*.

State [***53] Petitioners have not provided substantial support for their argument that the Endangerment Finding should be revised. State Petitioners point out that some studies the IPCC referenced in its assessment were not peer-reviewed, but they ignore the fact that (1) the IPCC assessment relied on around 18,000 studies that were peer-reviewed, and (2) the IPCC's report development procedures expressly permitted the inclusion in the assessment of some non-peer-reviewed studies ("gray" literature).

Moreover, as EPA determined, the limited inaccurate information developed from the gray literature does not appear sufficient to undermine the substantial overall evidentiary support for the Endangerment Finding. State Petitioners have not, as they assert, uncovered a "pattern" of flawed science. Only two of the errors they point out seem to be errors at all, and EPA relied on neither in making the Endangerment Finding. First, as State Petitioners assert, the IPCC misstated the percentage of the Netherlands that is below sea level, a statistic that was used for background information. However, the IPCC corrected the error, and EPA concluded that the error was "minor and had no impact," and the Endangerment [***54] Finding did not refer to the statistic in any way. *Id. at 49,576-77*. Second, the IPCC acknowledged misstating the rate at which Himalayan glaciers are receding. EPA also did not rely on that projection in the Endangerment Finding. *Id. at 49,577*.

State Petitioners also contend that a new study contradicts EPA's reliance on a projection of more violent storms in the future as a result of climate change, but the study they cite only concerns past trends, not projected future storms. The record shows that EPA considered the new studies on storm trends and concluded that the studies were consistent with the Endangerment Finding. In sum, State Petitioners have failed to show that these isolated "errors" provide substantial support for their argument to overturn the Endangerment Finding.

2.

State Petitioners' further argument that EPA erred in denying reconsideration fails as well. These Petitioners claim EPA erred by failing to provide notice [*126] [**330] and comment before denying the petitions for reconsideration because EPA's inclusion of a 360-page RTP amounted to a revision of the Endangerment Finding, and revision of a rule requires notice and comment. The RTP, however, appears to be exactly what [***55] EPA called it--a response to the petitions for reconsideration, not a revision of the Endangerment Finding itself. EPA certainly may deny petitions for reconsideration of a rule and provide an explanation for that denial, including by providing support for that decision, without triggering a new round of notice and comment for the rule.

III.

State and Industry Petitioners contend that in promulgating the Tailpipe Rule, EPA relied on an improper interpretation of CAA § 202(a)(1), and was arbitrary and capricious in failing to justify and consider the cost impacts of its conclusion that the Rule triggers stationary-source regulation under the PSD and Title V provisions. They do not challenge the substantive standards of the Rule and focus principally on EPA's failure to consider the cost of stationary-source permitting requirements triggered by the Rule. Positing an absurd-consequences scenario, Petitioners maintain that if EPA had considered these costs it "would have been forced" to exclude carbon dioxide from the scope of the emission standards, to decline to issue greenhouse gas emission standards at all, or "to interpret the statute so as not to automatically trigger stationary source [***56] regulation." Industry Tailpipe Br. 17; *see also* Industry Tailpipe Reply Br. 8-9. Both the plain text of Section 202(a) and precedent refute Petitioners' contentions.

A.

Section 202(a)(1) provides:

> The Administrator shall by regulation prescribe . . . standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.

42 U.S.C. § 7521(a)(1). By employing the verb "shall," Congress vested a non-discretionary duty in EPA. *See Sierra Club v. Jackson, 648 F.3d 848, 856, 396 U.S. App. D.C. 297 (D.C. Cir. 2011)*. The plain text of Section 202(a)(1) thus refutes Industry Petitioners' contention that EPA had discretion to defer issuance of motor-vehicle emission standards on the basis of stationary-source costs. Neither the adjacent text nor the statutory context otherwise condition this clear "language of command," *id.* (citation omitted). Having made the Endangerment Finding pursuant to CAA § 202(a), *42 U.S.C. § 7521(a)*, EPA lacked discretion to defer promulgation of the Tailpipe Rule on the basis of its trigger of stationary-source [***57] permitting requirements under the PSD program and Title V.

The Supreme Court's decision in *Massachusetts v. EPA* compels this interpretation of Section 202(a)(1). "If EPA makes a finding of endangerment, the Clean Air Act requires the [a]gency to regulate emissions of the deleterious pollutant from new motor vehicles." *549 U.S. at 533*. "Under the clear terms of the Clean Air Act, EPA can avoid taking further action *only if* it determines that greenhouse gases do not contribute to climate change

or if it provides some reasonable explanation as to why it cannot or will not exercise its discretion to determine whether they do." *Id.* (emphasis added). In the Endangerment Finding, EPA determined that motor-vehicle emissions contribute to greenhouse gas emissions that, [*127] [**331] in turn, endanger the public health and welfare; the agency therefore was in no position to "avoid taking further action," *id.*, by deferring promulgation of the Tailpipe Rule. Given the non-discretionary duty in Section 202(a)(1) and the limited flexibility available under Section 202(a)(2), which this court has held relates only to the motor-vehicle industry, *see infra* Part III.C, EPA had no statutory basis on which it could "ground [***58] [any] reasons for" further inaction, *Massachusetts v. EPA, 549 U.S. at 535*.

The plain text of Section 202(a)(1) also negates Industry Petitioners' contention that EPA had discretion to defer the Tailpipe Rule on the basis of NHTSA's authority to regulate fuel economy. The Supreme Court dismissed a near-identical argument in *Massachusetts v. EPA*, rejecting the suggestion that EPA could decline to regulate carbon-dioxide emissions because the Department of Transportation (DOT) had independent authority to set fuel-efficiency standards. *Id. at 531-32*. "[T]hat DOT sets mileage standards in no way licenses EPA to shirk its environmental responsibilities," because EPA's duty to promulgate emission standards derives from "a statutory obligation wholly independent of DOT's mandate to promote energy efficiency." *Id. at 532*. Just as EPA lacks authority to refuse to regulate on the grounds of NHTSA's regulatory authority, EPA cannot defer regulation on that basis. A comparison of the relevant statutes bolsters this conclusion. *Compare 49 U.S.C. § 32902(f)* ("When deciding maximum feasible average fuel economy . . . , the Secretary of Transportation shall consider . . . the effect of other motor [***59] vehicle standards of the Government on fuel economy . . . ."), *with 42 U.S.C. § 7521(a)* (including no such direction). Nor, applying the same reasoning, was EPA required to treat NHTSA's proposed regulations as establishing the baseline for the Tailpipe Rule. Furthermore, the Tailpipe Rule provides benefits above and beyond those resulting from NHTSA's fuel-economy standards. *See, e.g., Tailpipe Rule, 75 Fed. Reg. at 25,490 (Table III.F.1-2), 25,636 (Table IV.G.1-4)*. Petitioners' related contentions regarding the PSD permitting triggers are addressed in Part V.

B.

Turning to the APA, Industry Petitioners contend, relying on *Small Refiner Lead Phase-Down Task Force v. EPA, 705 F.2d 506, 525, 227 U.S. App. D.C. 201 (D.C. Cir. 1983)*, and *Ethyl Corp. v. EPA, 541 F.2d 1, 176 U.S. App. D.C. 373 (D.C. Cir. 1976)*, that EPA failed both to justify the Tailpipe Rule in terms of the risk identified in the Endangerment Finding and to show that the proposed standards "would meaningfully mitigate the alleged endangerment," Industry Tailpipe Br. 35. Instead, they maintain that EPA "separated these two integral steps," *id. at 11*, and "concluded that it had no obligation to show . . . 'the resulting emissions control strategy or strategies will have [***60] some significant degree of harm reduction or effectiveness in addressing the endangerment,'" *id. at 11-12* (quoting *Endangerment Finding, 74 Fed. Reg. at 66,508*). These contentions fail.

Petitioners' reliance on *Small Refiner, 705 F.2d at 525*, is misplaced; the court there laid out guidelines for assessing EPA's discretion to set numerical standards and Petitioners do not challenge the substance of the emission standards. In *Ethyl, 541 F.2d at 7*, the court assessed the scope of EPA's authority, under CAA § 211(c)(1), *42 U.S.C. § 1857f-6c(c)(1) (1970) (currently codified as amended at 42*

U.S.C. § 7545(c)(1)), to regulate lead particulate in motor-vehicle emissions. The court rejected the argument that the [*128] [**332] regulations had to "be premised upon factual proof of actual harm," *Ethyl, 541 F.2d at 12*, and instead deferred to EPA's reasonable interpretation that regulations could be based on a "significant risk of harm," *id. at 13*. Nothing in *Ethyl* implied that EPA's authority to regulate was conditioned on evidence of a particular level of mitigation; only a showing of significant *contribution* was required. EPA made such a determination in the Endangerment Finding, concluding that vehicle emissions [***61] are a significant contributor to domestic greenhouse gas emissions. *See, e.g., Endangerment Finding, 74 Fed. Reg. at 66,499*. Further, in the preamble to the Tailpipe Rule itself, EPA found that the emission standards would result in meaningful mitigation of greenhouse gas emissions. For example, EPA estimated that the Rule would result in a reduction of about 960 million metric tons of CO_2e emissions over the lifetime of the model year 2012-2016 vehicles affected by the new standards. *See Tailpipe Rule, 75 Fed. Reg. at 25,488-90*. Other precedent is likewise unhelpful to Petitioners: in *Chemical Manufacturers Association v. EPA, 217 F.3d 861, 866, 342 U.S. App. D.C. 355 (D.C. Cir. 2000)*, "nothing in the record" indicated that the challenged regulatory program would "directly or indirectly, further the Clean Air Act's environmental goals," whereas here the record is fulsome, *see supra* Part II.

C.

Petitioners also invoke Section 202(a)(2) as support for their contention that EPA must consider stationary-source costs in the Tailpipe Rule. Section 202(a)(2) provides:

> Any regulation prescribed under paragraph (1) of this subsection . . . shall take effect after such period as the Administrator finds necessary to permit [***62] the development and application of the requisite technology, giving appropriate consideration to the cost of compliance within such period.

42 U.S.C. § 7521(a)(2). State Petitioners maintain the reference to compliance costs encompasses those experienced by stationary sources under the PSD program, while Industry Petitioners maintain stationary-source costs are a relevant factor in EPA's Section 202(a)(1) rulemaking. This court, however, has held that the Section 202(a)(2) reference to compliance costs encompasses only the cost to the motor-vehicle industry to come into compliance with the new emission standards, and does not mandate consideration of costs to other entities not directly subject to the proposed standards. *See Motor & Equip. Mfrs. Ass'n, Inc. v. EPA, 627 F.2d 1095, 1118, 201 U.S. App. D.C. 109 (D.C. Cir. 1979)*.

D.

Petitioners' remaining challenges to the Tailpipe Rule fail as well. In Part II, the court rejects the contention that the Tailpipe Rule fails due to flaws in the underlying Endangerment Finding. The record also refutes Industry Petitioners' suggestion that EPA "employed a shell game to avoid," Industry Tailpipe Reply Br. 9 (capitalization removed), responding to comments regarding stationary-source [***63] costs. Industry Tailpipe Br. 19-20; *see also* Industry Tailpipe Reply Br. 14-15. EPA adequately responded to "significant comments," *42 U.S.C. § 7607(d)(6)(B)*. *See, e.g., Tailpipe Rule, 75 Fed. Reg. at 25,401-02*; Tailpipe Rule, Response to Comments at 7-65 to 7-69. And, assuming other statutory mandates provide a basis for judicial review, *see* Industry

Tailpipe Br. 21-22 (listing mandates); *see, e.g., Small Refiner, 705 F.2d at 537-39*, the record shows EPA's compliance, see *Tailpipe Rule, 75 Fed. Reg. at 25,539-42*, and that EPA was not arbitrary and capricious [*129] [**333] by not considering stationary-source costs in its analyses. *See, e.g., Michigan v. EPA, 213 F.3d 663, 689, 341 U.S. App. D.C. 306 (D.C. Cir. 2000); Mid-Tex Elec. Coop., Inc. v. FERC, 773 F.2d 327, 341-42, 249 U.S. App. D.C. 64 (D.C. Cir. 1985)*. EPA's economic impact assessment conducted pursuant to CAA § 317, *42 U.S.C. § 7617*, does not provide grounds for granting the petitions because Petitioners' contentions that EPA, "[i]n defiance of these requirements, . . . refused to estimate or even consider the costs of the [Tailpipe Rule] for stationary sources," Industry Tailpipe Br. 22, are no more than another attempt to avoid the plain text of Section 202(a). *See also 42 U.S.C. § 7617(e)*.

IV.

We [***64] turn next to the stationary source regulations. As noted *supra* in Part I, EPA's interpretation of the CAA requires PSD and Title V permits for stationary sources whose potential emissions exceed statutory thresholds for *any* regulated pollutant--including greenhouse gases. Industry Petitioners now challenge EPA's longstanding interpretation of the scope of the permitting requirements for construction and modification of major emitting facilities under CAA Sections 165(a) and 169(1), *42 U.S.C. §§ 7475(a)* & *7479(1)* ("the PSD permitting triggers"). EPA maintains that this challenge is untimely because its interpretation of the PSD permitting triggers was set forth in its 1978, 1980, and 2002 Rules.

In 1978, EPA defined "major stationary source" as a source that emits major amounts of "any air pollutant regulated under the [CAA]." *Part 51--Requirements for Preparation, Adoption, and Submittal of Implementation Plans; Prevention of Significant Air Quality Deterioration* ("1978 Implementation Plan Requirements"), *43 Fed. Reg. 26,380, 26,382 (June 19, 1978)*. Industry petitioners' challenge to the 1978 Rule in *Alabama Power Co. v. Costle, 636 F.2d 323, 204 U.S. App. D.C. 51 (D.C. Cir. 1980)* reflected their understanding [***65] that EPA would apply the PSD permitting program to both pollutants regulated pursuant to National Ambient Air Quality Standards (NAAQS) and other regulated pollutants. *See* Br. for Industry Pet'rs on Regulation of Pollutants other than Sulfur Dioxide and Particulates, No. 78-1006 (and consolidated cases) (Dec. 19, 1978) at 10, 12. In the 1980 Rule, EPA highlighted that to be subject to PSD review, a "source need only emit *any* pollutant in major amounts (i.e., the amounts specified in [CAA § 169(1)]) and be located in an area designated attainment or unclassifiable for that or any other pollutant." 1980 Implementation Plan Requirements, *45 Fed. Reg. at 52,711* (emphasis in original). EPA explained that "*any* pollutant" meant "both criteria pollutants, for which national ambient air quality standards have been promulgated, and non-criteria pollutants subject to regulation under the Act." *Id.* The same explanation of EPA's interpretation appeared in the *2002 Rule. Prevention of Significant Deterioration and Nonattainment New Source Review, 67 Fed. Reg. 80,186, 80,239-40, 80,264 (Dec. 31, 2002)*.

CAA *Section 307(b)(1)* provides that a petition for review of any promulgated nationally applicable [***66] regulations:

> "shall be filed within sixty days from the date notice of such promulgation . . . appears in the Federal Register, except that if such petition is based solely on grounds arising after such sixtieth day, then any petition for review . . . shall be filed

> within sixty days after such grounds arise."

42 U.S.C. § 7607(b)(1). The exception encompasses the occurrence of an event that ripens a claim. *See Chamber of Commerce v. EPA, 642 F.3d 192, 208 n.14, 395 U.S. App. D.C. 193 (D.C. Cir. 2011); Am. Rd. & Transp. Builders Ass'n* [*130] [**334] *v. EPA, 588 F.3d 1109, 1113, 388 U.S. App. D.C. 435 (D.C. Cir. 2009)*. EPA acknowledges this precedent, but maintains that the "new grounds" exception is narrow and inapplicable because Industry Petitioners' challenge to EPA's interpretation of the PSD permitting triggers is based on legal arguments that were available during the normal judicial review periods for the 1978, 1980, and 2002 Rules, and the "new ground" on which they now rely is a factual development, namely the regulation of greenhouse gases by the Tailpipe Rule. This is correct so far as it goes, but fails to demonstrate that Industry Petitioners' challenge is untimely.

Industry Petitioners point out that two petitioners--the National Association [***67] of Home Builders (NAHB) and National Oilseed Processors Association (NOPA) -- have newly ripened claims as a result of the Tailpipe Rule, which had the effect of expanding the PSD program to never-regulated sources:

> o NAHB's members construct single family homes, apartment buildings, and commercial buildings. According to the Vice President of Legal Affairs, prior to the Tailpipe Rule, no member of NAHB was a major source of any regulated pollutant, and thus no member was ever required to obtain a PSD permit. Decl. of Thomas J. Ward, Vice President of Legal Affairs for NAHB, ¶ 6 (May 10, 2011). Since the Tailpipe Rule rendered greenhouse gases a regulated pollutant, it is now certain that NAHB members that engage in construction projects that emit greenhouse gases in major amounts will have to obtain PSD permits sometime in the future. *Id.* at ¶¶ 7, 8. Indeed, EPA estimated that 6,397 multifamily buildings and 515 single family homes would trigger PSD review annually absent the Tailoring Rule. *See Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule; Proposed Rule* ("Proposed Tailoring Rule"), *74 Fed. Reg. 55,292, 55,338 (Oct. 27, 2009)*.
>
> o NOPA's members are [***68] large companies that monthly produce millions of tons of vegetable meals and over a billion pounds of oils from oilseeds, such as soybeans. *See, e.g.*, NOPA, January 2012 Statistical Report (Feb. 14, 2012) *available at www.nopa.org*; NOPA, February 2012 Statistical Report (Mar. 14, 2012), *available at www.nopa.org*. According to the Executive Vice President of Regulatory Affairs, NOPA members operate facilities that are major sources of criteria pollutants and, for this reason, are subject to PSD review. Decl. of David C. Ailor, Executive Vice President of Regulatory Affairs of NOPA, ¶ 8 (May 10, 2011). Prior to promulgation of the Tailpipe Rule, no member's facility had triggered PSD review by virtue of emissions of a non-criteria pollutant. *Id.* Now that greenhouse gases are a regulated non-criteria

> pollutant, many NOPA members will have to obtain PSD permits as result of their facilities' emissions of a non-criteria pollutant. *Id.* at ¶¶ 9,10. For some NOPA members this time is not far off because renovations to their facilities will result in greenhouse gas emissions above the significance thresholds set by the Tailoring Rule, *75 Fed. Reg. at 31,567. Id.* at ¶ 9.

Industry Petitioners [***69] thus maintain that because NAHB and NOPA filed their petitions on July 6, 2010, within 60 days of the promulgation of the Tailpipe Rule in the Federal Register on May 7, 2010, their challenges are timely.

"Ripeness, while often spoken of as a justiciability doctrine distinct from standing, in fact shares the constitutional requirement of standing that an injury in fact be certainly impending." *Nat'l Treasury* [*131] [**335] *Emp. Union v. United States, 101 F.3d 1423, 1427, 322 U.S. App. D.C. 135 (D.C. Cir. 1996)*. During an initial review period, although purely legal claims may be justiciable and, thus, prudentially ripe, a party without an immediate or threatened injury lacks a constitutionally ripe claim. *See Baltimore Gas & Elec. Co. v. ICC, 672 F.2d 146, 149, 217 U.S. App. D.C. 293 (D.C. Cir. 1982)*. EPA's position would conflate the constitutional and prudential considerations. Constitutional ripeness exists where a challenge "involve[s], at least in part, the existence of a live 'Case or Controversy.'" *Duke Power Co. v. Carolina Envtl. Study Group, 438 U.S. 59, 81, 98 S. Ct. 2620, 57 L. Ed. 2d 595 (1978)*. Prudential considerations embodied in the ripeness doctrine relate to "the fitness of the issues for judicial decision and the hardship to the parties of withholding court [***70] consideration." *Abbott Labs. v. Gardner, 387 U.S. 136, 149, 87 S. Ct. 1507, 18 L. Ed. 2d 681 (1967); see Duke Power, 438 U.S. at 81*. Standing to challenge agency action exists where a petitioner can demonstrate an "injury in fact" that is fairly traceable to the challenged action and is likely to be redressed by a favorable judicial decision. *Reytblatt v. NRC, 105 F.3d 715, 721, 323 U.S. App. D.C. 101 (D.C. Cir. 1997)* (citing *Lujan v. Defenders of Wildlife, 504 U.S. 555, 560-61, 112 S. Ct. 2130, 119 L. Ed. 2d 351 (1992))*.

Had NAHB and NOPA challenged EPA's interpretation of the PSD permitting triggers in 1978, 1980, or 2002, as EPA suggests, the court would have lacked jurisdiction under *Article III of the Constitution* because their alleged injuries were only speculative. *See, e.g., Occidental Permian Ltd. v. FERC, 673 F.3d 1024, 1026, 400 U.S. App. D.C. 60 (D.C. Cir. 2012); Baltimore Gas & Elec. Co., 672 F.2d at 149*. At that time, NAHB and NOPA could have shown only the possibility that their members would be injured if EPA were someday to determine that greenhouse gases were a pollutant that endangers human health and welfare and to adopt a rule regulating the greenhouse gas emissions of stationary sources. EPA does not challenge the assertions in the NAHB and NOPA declarations, which establish [***71] no such rule was promulgated prior to the Tailpipe Rule.

The NAHB and NOPA challenges ceased to be speculative when EPA promulgated the Tailpipe Rule regulating greenhouse gases and their challenges ripened because of the "substantial probability" of injury to them. *See Baltimore Gas & Elec. Co., 672 F.2d at 149*. Although, as EPA notes, other Industry Petitioners' challenges to EPA's interpretation of the PSD permitting triggers ripened decades earlier, this court has assured petitioners with unripe claims that "they will not be foreclosed from judicial review when the appropriate time

comes," *Grand Canyon Air Tour Coalition v. FAA, 154 F.3d 455, 473, 332 U.S. App. D.C. 133 (D.C. Cir. 1998)*, and that they "need not fear preclusion by reason of the 60-day stipulation [barring judicial review]," *Baltimore Gas & Elec. Co., 672 F.2d at 149-50*. EPA expresses concern that allowing NAHB and NOPA to litigate their newly ripened claims will have far-reaching implications for finality of agency actions, but "the ripeness doctrine reflects a judgment that the disadvantages of a premature review that may prove too abstract or unnecessary ordinarily outweigh the additional costs of -- even repetitive -- . . . litigation." [***72] *Ohio Forestry Ass'n, Inc. v. Sierra Club, 523 U.S. 726, 735, 118 S. Ct. 1665, 140 L. Ed. 2d 921 (1998)*. Some limitations inhere in doctrines such as *stare decisis* or the law-of-the-circuit doctrine, *see LaShawn A. v. Barry, 87 F.3d 1389, 1395, 318 U.S. App. D.C. 380 (D.C. Cir. 1996)* (en banc).

Because petitioners NAHB and NOPA's challenges to EPA's PSD permitting triggers are newly ripened upon promulgation of the Tailpipe Rule and they filed petitions [*132] [**336] for review within sixty days thereof, their challenge to EPA's interpretation of the PSD permitting triggers is timely.

V.

Having established that Industry Petitioners' challenges to the PSD permitting triggers are both timely and ripe, we turn to the merits of their claims.

A.

CAA Title I, Part C--entitled "Prevention of Significant Deterioration of Air Quality" (PSD)--largely focuses on the maintenance of national ambient air quality standards (NAAQS). Under the PSD program, EPA designates specific pollutants as "NAAQS pollutants" and sets national ambient air quality standards for those pollutants--requiring, for example, that the concentration of a given NAAQS pollutant may not exceed more than a certain number of parts per billion in the ambient air. *See generally 42 U.S.C. § 7407*. Thus far, EPA [***73] has designated six NAAQS pollutants: carbon monoxide, lead, nitrogen dioxide, ozone, particle pollution, and sulfur dioxide. None of these NAAQS pollutants is one of the six well-mixed greenhouse gases defined as an "air pollutant" in the Endangerment Finding. *See* Environmental Protection Agency, National Ambient Air Quality Standards, *available at* http://www.epa.gov/air/criteria.html (last visited May 3, 2012); *Endangerment Finding, 74 Fed. Reg. 66,536-37*.

Acting upon information submitted by states, EPA then determines whether each region of the country is in "attainment" or "nonattainment" with the promulgated air quality standard for each NAAQS pollutant, or, alternatively, whether a region is "unclassifiable" for that pollutant. *42 U.S.C. § 7407(d)(1)(A)*. An area in attainment for a NAAQS pollutant is "any area . . . that meets the . . . ambient air quality standard for the pollutant." *Id. § 7407(d)(1)(A)(ii)*. By contrast, an area in nonattainment for a NAAQS pollutant is "any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national . . . ambient air quality standard for the pollutant." *Id. § 7407(d)(1)(A)(i)*. Finally, [***74] an unclassifiable area is any area that "cannot be classified on the basis of available information as meeting or not meeting the . . . ambient air quality standard for the pollutant." *Id. § 7407(d)(1)(A)(iii)*.

The PSD program applies to those areas of the United States designated as in "attainment" or "unclassifiable" for any NAAQS pollutant, *see id. § 7471*, and requires permits for major emitting facilities embarking on construction

or modification projects in those regions. *Id. § 7475(a)*. A separate part of Title I of the CAA, Part D, governs the construction and modification of sources in nonattainment regions. *See id. §§ 7501, 7502*. It bears emphasis that attainment classifications are pollutant-specific: depending on the levels of each NAAQS pollutant in an area, a region can be designated as in attainment for NAAQS pollutant A, but in nonattainment for NAAQS pollutant B. If a major emitting facility in such a region wishes to undertake a construction or modification project, both Part C and Part D's substantive requirements apply--that is, the source must obtain a general PSD permit and must also abide by Part D's more stringent, pollutant-specific requirements for any NAAQS pollutants [***75] for which the area is in nonattainment. *See* 1980 Implementation Plan Requirements, *45 Fed. Reg. at 52,711-12* ("where a source emits in major amounts a pollutant for which the area in which the source would locate is designated nonattainment, Part D NSR [*133] [**337] rather than Part C PSD review should apply *to those pollutants*.") (emphasis added).

The key substantive provision in the PSD program is CAA Section 165(a), which establishes permitting requirements for "major emitting facilities" located in attainment or unclassifiable regions. In relevant part, section 165(a) provides that "[n]o major emitting facility . . . may be constructed in any area to which this part applies unless" the facility obtains a PSD permit. *42 U.S.C. § 7475(a)*. To obtain a PSD permit, a covered source must, among other things, install the "best available control technology [BACT] for each pollutant subject to regulation under [the CAA]"--regardless of whether that pollutant is a NAAQS pollutant. *Id. § 7475(a)(4)*. Since the Tailpipe Rule became effective, EPA has regulated automotive greenhouse gas emissions under Title II of the Act. Thus, greenhouse gases are now a "pollutant subject to regulation under" the Act, and, [***76] as required by the statute itself, any "major emitting facility" covered by the PSD program must install BACT for greenhouse gases. *See id.*

The dispute in this case centers largely on the scope of the PSD program--specifically, which stationary sources count as "major emitting facilities" subject to regulation. CAA Section 169(1) defines "major emitting facility," for the purposes of the PSD program, as a stationary source "which emit[s], or [has] the potential to emit" either 100 tons per year (tpy) or 250 tpy of "*any air pollutant*." *42 U.S.C. § 7479(1)* (emphasis added). As discussed *supra* in Part I, whether the 100 or 250 tpy threshold applies depends on the type of source. Certain listed categories of sources--for example, iron and steel mill plants--qualify as "major emitting facilities" if they have the potential to emit over 100 tons per year of "any air pollutant." *Id.* All other stationary sources are "major emitting facilities" if they have the potential to emit over 250 tons per year of "any air pollutant." *Id.*

As mentioned above, since 1978 EPA has interpreted the phrase "any air pollutant" in the definition of "major emitting facility" as "any air pollutant regulated under the [***77] CAA." *See* 1978 Implementation Plan Requirements, *43 Fed. Reg. at 26,388, 26,403*; *supra* Part IV. Thus, because the PSD program covers "major emitting facilities" in "any area to which this part applies," *42 U.S.C. § 7475*, EPA requires PSD permits for stationary sources that 1) are located in an area designated as attainment or unclassifiable for any NAAQS pollutant, and 2) emit 100/250 tpy of any regulated air pollutant, regardless of whether that pollutant is itself a NAAQS pollutant. *See* 1980 Implementation Plan Requirements, *45 Fed. Reg. at 52,710-11*. Consequently, once the Tailpipe Rule took effect and made greenhouse gases a regulated

pollutant under Title II of the Act, the PSD program automatically applied to facilities emitting over 100/250 tpy of greenhouse gases. But because immediate regulation of greenhouse gas-emitting sources exceeding the 100/250 tpy benchmark would result in "overwhelming permitting burdens that would . . . fall on permitting authorities and sources," Tailoring Rule, *75 Fed. Reg. at 31,516*, EPA's Tailoring Rule provided that, for now, sources are subject to PSD permitting requirements only if they have the potential to emit over 100,000 tpy of greenhouse [***78] gases (for a construction project) or 75,000 tpy (for a modification project). *Id. at 31,523; see also infra*, Part VI.

According to EPA, its longstanding interpretation of the phrase "any air pollutant"--"any air pollutant regulated under the CAA"--is compelled by the statute. *See id. at 31,517*. Disputing this [*134] [**338] point, Industry Petitioners argue that the phrase is capable of a far more circumscribed meaning and that EPA could have--and should have--avoided extending the PSD permitting program to major greenhouse gas emitters. For the reasons discussed below, we agree with EPA that its longstanding interpretation of the PSD permitting trigger is statutorily compelled. Thus, as EPA argues, it "must give effect to the unambiguously expressed intent of Congress," *Chevron, 467 U.S. at 843*, which here requires PSD coverage for major emitters of any regulated air pollutant.

We begin our analysis, as we must, with the statute's plain language. *See Chevron, 467 U.S. at 842* ("First, always, is the question whether Congress has directly spoken to the precise question at issue."). CAA Section 169(1) requires PSD permits for stationary sources emitting major amounts of "*any* air pollutant." *42 U.S.C. § 7479(1)* [***79] (emphasis added). On its face, "the word 'any' has an expansive meaning, that is, 'one or some indiscriminately of whatever kind,'" *United States v. Gonzales, 520 U.S. 1, 5, 117 S. Ct. 1032, 137 L. Ed. 2d 132 (1997)* (quoting WEBSTER'S THIRD NEW INTERNATIONAL DICTIONARY 97 (1976)). Greenhouse gases are indisputably an "air pollutant." *See Massachusetts v. EPA, 549 U.S. at 528-29*. Congress's use of the broad, indiscriminate modifier "any" thus strongly suggests that the phrase "any air pollutant" encompasses greenhouse gases.

This plain-language reading of the statute is buttressed by the Supreme Court's decision in *Massachusetts v. EPA*. There the Court determined that CAA's overarching definition of "air pollutant" in Section 302(g)--which applies to all provisions of the Act, including the PSD program--unambiguously includes greenhouse gases. Noting that "[t]he Clean Air Act's sweeping definition of 'air pollutant' includes 'any air pollution agent or combination of such agents . . . . which is emitted into or otherwise enters the ambient air," the Court held that "the definition embraces *all* airborne compounds of whatever stripe, *and underscores that intent through repeated use of the word 'any.'*" *Id. at 529* (quoting *42 U.S.C. § 7602(g)*) [***80] (second and third emphases added). Crucially for purposes of the issue before us, the Court concluded that "[t]he statute is unambiguous." *Id.*

Thus, we are faced with a statutory term--"air pollutant"--that the Supreme Court has determined unambiguously encompasses greenhouse gases. This phrase is preceded by the expansive term "any," a word the Court held "underscores" Congress's intent to include "all" air pollutants "of whatever stripe." *See id.* Absent some compelling reason to think otherwise, "'any' . . . means any," *Ford v. Mabus, 629 F.3d 198, 206, 393 U.S. App. D.C. 400 (D.C. Cir. 2010)*, and Petitioners have given us no reason to construe that word narrowly here. To the contrary: given both the statute's plain language and the Supreme Court's decision in *Massachusetts v. EPA*, we have little trouble concluding that

the phrase "any air pollutant" includes *all* regulated air pollutants, including greenhouse gases.

In reaching this conclusion, we recognize that EPA's definition of "any air pollutant" slightly narrows the literal statutory definition, which nowhere requires that "any air pollutant" be a *regulated* pollutant. *See 42 U.S.C. § 7479(1)*. But this does not make the statutory language ambiguous. Indeed, [***81] "any regulated air pollutant" is the only logical reading of the statute. The CAA's universal definition of "air pollutant"--the one at issue in *Massachusetts v. EPA*--provides that the term includes "any physical, chemical, biological [or] radioactive . . . substance or matter which is [*135] [**339] emitted into or otherwise enters the ambient air." *Id. § 7602(g)*. Of course, nothing in the CAA requires regulation of a substance simply because it qualifies as an "air pollutant" under this broad definition. As discussed *supra* in Parts II and III, for example, the Act requires EPA to prescribe motor vehicle "standards applicable to the emission of any air pollutant" only if that pollutant "cause[s], or contribute[s] to, air pollution which may reasonably be anticipated to endanger public health or welfare." *Id. § 7521(a)(1)*. But if "any air pollutant" in the definition of "major emitting facility" was read to encompass both regulated and nonregulated air pollutants, sources could qualify as major emitting facilities--and thus be subjected to PSD permitting requirements--if they emitted 100/250 tpy of a "physical, chemical, [or] biological" substance EPA had determined was harmless. It is absurd to think [***82] that Congress intended to subject stationary sources to the PSD permitting requirements due to emissions of substances that do not "endanger public health or welfare." *Id. § 7521(a)(1)*. Thus, "any regulated air pollutant" is, in this context, the only plausible reading of "any air pollutant."

We find further support for this definition throughout the CAA. First, as previously mentioned, the PSD program provides that all major emitting facilities must install BACT for "each pollutant subject to regulation under [the CAA]." *Id. § 7475(a)(4)*. "Each pollutant subject to regulation under" the Act is, of course, synonymous with "any air pollutant regulated under the Act." Thus, EPA's interpretation of "any air pollutant" in the definition of "major emitting facilities" harmonizes the PSD program's scope (i.e., which pollutants trigger PSD coverage) with its substantive requirements (i.e., which pollutants must be controlled to obtain a permit). In other words, because a covered source must control greenhouse gas emissions, it makes sense that major emissions of greenhouse gases would subject that source to the PSD program.

Second, a PSD permittee is required to establish that it

> will not cause, [***83] or contribute to, air pollution in excess of any (A) maximum allowable increase or maximum allowable concentration for any pollutant in any area to which this part applies more than one time per year, (B) national ambient air quality standard in any air quality control region, or (C) any other applicable emission standard or standard of performance under [the CAA].

Id. *§ 7475(a)(3)*. *Subsections (A)* and *(B)* prohibit a permitted source from contributing to a concentration of NAAQS pollutants that exceeds EPA's standards. By contrast, *subsection (C)* has an entirely different focus: it prohibits a permitted source from causing or contributing to air pollution in excess of *any* CAA emission standard. Thus, as EPA notes, "what this provision

establishes is that while the PSD program was certainly directed towards NAAQS-criteria pollutants, it also was directed at maintaining air quality for other pollutants regulated under other provisions." EPA Timing & Tailoring Br. 101. EPA's determination that "any air pollutant" means "any air pollutant regulated under the Act"--encompassing the greenhouse gases regulated under Title II--is entirely consistent with this focus.

Finally, Congress made perfectly [***84] clear that the PSD program was meant to protect against precisely the types of harms caused by greenhouse gases. The PSD provision contains a section entitled "Congressional declaration of purpose," which provides, in relevant part, that "[t]he purposes of this part are . . . to protect public health and welfare from any actual or potential [*136] [**340] adverse effect which in the Administrator's judgment may reasonably be anticipated to occur from air pollution." *42 U.S.C. § 7470(1)*. The CAA further provides that "[a]ll language referring to effects on welfare includes, but is not limited to, effects on . . . weather . . . and climate." *Id. § 7602(h)*. As previously noted, EPA in the Endangerment Finding "marshaled . . . substantial . . . . scientific evidence . . . for the proposition that greenhouse gases trap heat on earth that would otherwise dissipate into space [and] that this 'greenhouse effect' warms the climate." Part II, *supra* at 28-29. It further concluded that this "anthropogenically induced climate change" was likely to threaten the public welfare through, among other things, "extreme weather events." *Id.* at 15-16. Thus, one express purpose of the program is to protect against the [***85] harms caused by greenhouse gases.

In sum, we are faced with a statutory term--"any air pollutant"--that the Supreme Court has determined is "expansive," and "unambiguous[ly]" includes greenhouse gases. *Massachusetts v. EPA, 549 U.S. at 529*. Moreover, the PSD program requires covered sources to install control technology for "each pollutant" regulated under the CAA, *42 U.S.C. § 7475(a)(4)*, and to establish that they "will not cause, or contribute to, air pollution in excess of *any* . . . emission standard . . . under [the CAA]." *Id. § 7475(a)(3)* (emphasis added). These provisions demonstrate that the PSD program was intended to control pollutants regulated under every section of the Act. Finally, Congress's "Declaration of Purpose" expressly states that the PSD program was meant, in part, to protect against adverse effects on "weather" and "climate"--precisely the types of harm caused by greenhouse gases. *See id. § 7470(1)*. Given all this, we have little trouble concluding that "any air pollutant" in the definition of "major emitting facility" unambiguously means "any air pollutant regulated under the CAA."

B.

Industry Petitioners offer three alternative interpretations of the PSD permitting [***86] triggers, none of which cast doubt on the unambiguous nature of the statute.

As a preliminary matter, we note that none of Petitioners' alternative interpretations applies to Title V. To the contrary, all of the proposed alternative interpretations are based on the structure of--and purported Congressional intent behind--the PSD program. Indeed, Industry Petitioners never argue that their proposed alternative interpretations are relevant to Title V. Petitioners have thus forfeited any challenges to EPA's greenhouse gas-inclusive interpretation of Title V. *See, e.g., Nat'l Steel & Shipbuilding Co. v. NLRB, 156 F.3d 1268, 1273, 332 U.S. App. D.C. 240 (D.C. Cir. 1998)* (petitioners forfeit an argument by failing to raise it in their opening brief).

Industry Petitioners' first alternative is simple enough. Because

the PSD program focuses on "the air people breathe in certain geographically defined . . . areas," Coalition for Responsible Reg. Timing & Tailoring Br. 38, Industry Petitioners contend that the term "pollutant" in the PSD statute encompasses only air pollutants that, unlike greenhouse gases, "pollute locally." *Id.* at 35. Industry Petitioners would thus apply a greenhouse gas-exclusive interpretation of "pollutant" [***87] throughout the statute's PSD provision. Under this reading, a source would qualify as a "major emitting facility" only if it emits 100/250 tpy of "any air pollutant" except greenhouse gases. *See 42 U.S.C. § 7479(1)*. Moreover, sources that *are* subject to PSD permitting requirements [*137] [**341] would be required to install BACT for "each pollutant subject to regulation under [the CAA]"--except greenhouse gases. *Id. § 7475(a)(4)*.

We can easily dispose of Industry Petitioners' argument that the PSD program's "concerns with local emissions," Coalition for Responsible Reg. Timing & Tailoring Br. 36, somehow limit the BACT provision. The statutory text provides, without qualification, that covered sources must install the "best available control technology for *each pollutant subject to regulation* under [the CAA]." *42 U.S.C. § 7475(a)(4)* (emphasis added). Because greenhouse gases are indisputably a pollutant subject to regulation under the Act, it is crystal clear that PSD permittees must install BACT for greenhouse gases. "When the words of a statute are unambiguous . . . judicial inquiry is complete." *Connecticut Nat'l Bank v. Germain, 503 U.S. 249, 254, 112 S. Ct. 1146, 117 L. Ed. 2d 391 (1992)* (internal quotation marks omitted).

Equally [***88] without merit is Industry Petitioners' argument that the PSD program's regional focus requires a greenhouse gas-exclusive interpretation of "any air pollutant" in the definition of "major emitting facility." In support of this contention, Industry Petitioners note that CAA Section 161 provides that states' implementation plans for the PSD program "shall contain emission limitations and such other measures as may be necessary . . . to prevent *significant deterioration of air quality in each region*." *42 U.S.C. § 7471* (emphasis added). The term "air quality," Industry Petitioners contend, implies a focus on "the air people breathe," and the term "in each region" suggests that Congress was concerned about local, not global, effects. *See* Coalition for Responsible Reg. Timing & Tailoring Br. 36. Moreover, Industry Petitioners note that when Congress enacted the PSD program in 1977, it did so "against the backdrop of a known universe of CAA-regulated pollutants." *Id.* All these pollutants, Industry Petitioners argue, "were regulated because they could cause elevated ground-level concentrations in ambient air people breathe." *Id.* And as Industry Petitioners point out, EPA itself has concluded [***89] that greenhouse gases are problematic for reasons other than local health and environmental concerns. In EPA's Advance Notice of Proposed Rulemaking for the regulations at issue here, for example, the agency noted that "[a] significant difference between the major [greenhouse gases] and most air pollutants regulated under the CAA is that [greenhouse gases] have much longer atmospheric lifetimes [and] . . . can remain in the atmosphere for decades to centuries." *Regulating Greenhouse Gas Emissions Under the Clean Air Act* ("Greenhouse Gas Advance Notice"), *73 Fed. Reg. 44,354, 44,400-01 (July 30, 2008)*. Moreover, "unlike traditional air pollutants," greenhouse gases "become well mixed throughout the global atmosphere so that the long-term distribution of [greenhouse gas] concentrations is not dependant on local emission sources." *Id.* Thus, Industry Petitioners conclude, greenhouse gases are problematic for reasons entirely distinct from the local concerns that provided the basis for the PSD program. Given

this, the phrase "any air pollutant" cannot be applied to greenhouse gases in the context of the regionally-focused PSD program.

As an initial matter, we note that the Supreme Court [***90] rejected a very similar argument in *Massachusetts v. EPA*. There, EPA attempted to distinguish between greenhouse gases and other air pollution agents "because greenhouse gases permeate the world's atmosphere rather than a limited area near the earth's surface." [*138] [**342] *Massachusetts v. EPA, 549 U.S. at 529 n.26*. The Court held that this was "a plainly unreasonable reading of a sweeping statutory provision designed to capture '*any* physical, chemical . . . substance or matter which is emitted into or otherwise enters the ambient air," *id.* (quoting *42 U.S.C. § 7602(g)*), thus rejecting the dissent's view that "EPA's exclusion of greenhouse gases . . . is entitled to deference." *Id.* As the Court noted, the purported distinction between greenhouse gases and "traditional" air pollutants "finds no support in the text of the statute, which uses the phrase 'the ambient air' without distinguishing between atmospheric layers." *Id.* *Massachusetts v. EPA* thus forecloses Industry Petitioners' argument that because greenhouse gases do not "cause elevated ground-level concentrations in ambient air people breathe," Coalition for Responsible Reg. Timing & Tailoring Br. 36, EPA should have adopted a greenhouse [***91] gas-exclusive interpretation of "any air pollutant."

We also have little trouble disposing of Industry Petitioners' argument that the PSD program is specifically focused solely on localized air pollution. True, as Industry Petitioners note, one part of the PSD program requires states to "prevent significant deterioration of air quality in each region." *42 U.S.C. § 7471* (emphasis added). But while localized air quality is obviously one concern of the PSD program, a comprehensive reading of the statute shows it was also meant to address a much broader range of harms. As an initial matter, the PSD provision's "Congressional declaration of purpose" section expansively provides that the program is intended "to protect public health and welfare from any actual or potential adverse effect . . . *from air pollution*." *Id. § 7470(1)* (emphasis added). Nothing in this section limits the PSD program to adverse effects on local air quality; to the contrary, the word "any" here gives this clause an "expansive meaning" which we see "no reason to contravene." *New York, 443 F.3d at 885* (internal quotation marks omitted). Indeed, the CAA expressly provides that effects on "welfare" means "effects on . [***92] . . weather . . . and climate." *42 U.S.C. § 7602(h)*. It seems quite clear to us, then, that the PSD program was intended to protect against precisely the types of harms caused by greenhouse gases. This broad understanding of the PSD program's scope is buttressed by the fact that the program requires covered sources to control "each pollutant subject to regulation under [the CAA]," and further requires sources to comply with "*any* . . . emission standard" under the CAA. *Id. §§ 7475(a)(3); (a)(4)* (emphasis added). These substantive requirements amount to further evidence that Congress wanted the PSD program to cover all regulated pollutants, regardless of the type of harm those pollutants cause.

In light of the PSD program's broad scope of regulation and the express purposes of the program, we conclude--consistent with the Supreme Court in *Massachusetts v. EPA*--that Industry Petitioners' greenhouse gas-exclusive interpretation of "pollutant" is "a plainly unreasonable reading" of the statute. *Massachusetts v. EPA, 549 U.S. at 529 n.26*.

2.

For their second alternative interpretation, Industry Petitioners argue that the PSD program's

definition of "major emitting facility" establishes a "pollutant-specific [***93] situs requirement." Am. Chemistry Council Br. 33. Under this reading of the statute, a stationary source is subject to PSD permitting requirements only if "(1) a source has major emissions of a NAAQS criteria pollutant and (2) the source is located [*139] [**343] in an area attaining *that pollutant's*" air quality standard. Coalition for Responsible Reg. Timing & Tailoring Br. 23. Thus, for example, a source would be subject to the PSD permitting requirements if it 1) emits over 100/250 tpy of sulfur dioxide (a NAAQS criteria pollutant), and 2) is located in an area that is in "attainment," or is "unclassifiable," for sulfur dioxide. But under this approach, a stationary source could never be subject to the PSD program solely because of its greenhouse gas emissions. After all, Industry Petitioners observe, EPA declined to make greenhouse gases a NAAQS criteria pollutant. Instead, EPA regulated greenhouse gases only under Title II of the Act, dealing with motor vehicle emissions. Because "no major source of [greenhouse gases] can be located in an area attaining the nonexistent [air quality standard] for [greenhouse gases]," *id.* at 24, Industry Petitioners point out that their reading of the statute [***94] would bring no new stationary sources under the PSD program's ambit--alleviating any "absurd results" caused by excessive permitting requirements, *id.* at 25.

Industry Petitioners emphasize that, unlike their first proposed alternative, nothing in this approach would "wholly exempt [greenhouse gases] from PSD." Coalition for Responsible Reg. Timing & Tailoring Reply Br. 20. Although a pollutant-specific situs requirement would limit the *number* of sources subject to the PSD program, nothing in this proposed reading of the statute would alter the substantive requirements for PSD permits, including the requirement that all regulated sources install BACT "for each pollutant subject to regulation under [the CAA]." *42 U.S.C. § 7475(a)(4)*. So, for example, under this interpretation, a hypothetical stationary source emitting more than 100/250 tpy of sulfur dioxide and located in an area designated as "in attainment" for sulfur dioxide, must still install BACT for "each pollutant subject to regulation" under the Act, including greenhouse gases. Their key point, though, is that sources emitting only major amounts of greenhouse gases--but not major amounts of a NAAQS criteria pollutant--would escape [***95] PSD permitting requirements.

Industry Petitioners' argument in support of this interpretation proceeds in several steps. First, they argue that the term "any air pollutant," though "capacious and flexible by itself," "is a chameleon term" when placed in certain contexts. Am. Chemistry Council Br. 38. Indeed, Industry Petitioners note that EPA has already narrowed the literal meaning of the term "any air pollutant" here. After all, and as discussed *supra*, although the statutory term "air pollutant" includes "any physical [or] chemical . . . substance or matter," *42 U.S.C. § 7602(g)*, EPA has long maintained that the term "any air pollutant" in the definition of "major emitting facility" encompasses only air pollutants regulated under the Act. Moreover, Industry Petitioners point out that when interpreting CAA Part C, Subpart 2, entitled "Visibility Protection," EPA determined that the term "any pollutant" in the definition of "major stationary source" meant "any visibility-impairing pollutant." *See* Coalition for Responsible Reg. Timing & Tailoring Br. 34 (emphasis added). The statute's definition of "major stationary source" in the visibility-protection subpart is quite similar to the [***96] definition of "major emitting facility" in the PSD subpart: for the purposes of the visibility program, a "major stationary source" is defined as a

"stationary source[ ] with the potential to emit 250 tons or more of any pollutant." *42 U.S.C. § 7491(g)(7)); compare 42 U.S.C. § 7479(1)* ("major emitting facility" for the purposes of the PSD program is a source which "emit[s], or [has] the potential to emit," [*140] [**344] either 100 or 250 tons per year "of any air pollutant"). These narrowed interpretations, Industry Petitioners argue, prove that the seemingly capacious term "any air pollutant" is, notwithstanding that the Supreme Court called this term "expansive" and "sweeping," *Massachusetts v. EPA, 549 U.S. at 529 nn.25-26*, capable of a far more circumscribed meaning.

According to Industry Petitioners, EPA should have adopted that more circumscribed meaning by interpreting "any air pollutant" as establishing a pollutant-specific situs requirement. As Industry Petitioners point out, the PSD program requires permits for "major emitting facilit[ies] . . . in any area to which this part applies," *42 U.S.C. § 7479(1)*, and defines "major emitting facilities" as stationary sources emitting 100/250 tpy [***97] of "any air pollutant." *Id. § 7475(a)*. In this context, Industry Petitioners contend, the phrases "any air pollutant" and "in any area to which this part applies" must be read in concert. And, Industry Petitioners argue, these phrases "*together* mean" that a source is subject to PSD permitting requirements only if it emits major amounts of "any [NAAQS] air pollutant whose NAAQS an area is attaining." Am. Chemistry Council Br. 33.

In support of this supposedly holistic interpretation of the statute, Industry Petitioners cite CAA § 163(b), a different section of the PSD provision in which the phrase "any air pollutant" and "any area to which this part applies" are used in conjunction with one another. Unlike § 165(a), which sets permitting requirements for sources covered by the PSD program, § 163 provides guidelines for *areas* designated as "in attainment" under the program. Specifically, § 163(b) limits the "maximum allowable increase in concentrations of" airborne NAAQS pollutants that may occur in an attainment area before that area's "attainment" status is jeopardized. *See 42 U.S.C. § 7473(b)(1). Subsections (1) through (3) of § 163(b)*--not directly relevant here--set limits on the maximum [***98] allowable increases for two specific NAAQS pollutants, sulfur dioxide and particulate matter. *Subsection (4)* is a catchall provision, which limits the maximum allowable increases for all other NAAQS pollutants. It is in *subsection (4)* that Industry Petitioners find what they believe is their payoff: the terms "any air pollutant" and "any area to which this part applies" in conjunction with one another. *Section 163(b)(4)* provides:

> The maximum allowable concentration of *any air pollutant in any area to which this part* applies shall not exceed a concentration for such pollutant for each period of exposure equal to--
>
> (A) the concentration permitted under the national secondary ambient air quality standard, or
>
> (B) the concentration permitted under the national primary ambient air quality standard,
>
> whichever concentration is lowest for such pollutant for such period of exposure.

42 U.S.C. § 7473(b)(4) (emphasis added). As Industry Petitioners correctly point out, in this context

the phrase "any air pollutant" must mean "any NAAQS pollutant," and "in any area to which this part applies" must mean "any area that is in attainment for that NAAQS pollutant." After all, the statute states that the "maximum [***99] allowable concentration of any air pollutant . . . shall not exceed" either the primary or secondary national ambient air quality standards. But, as Industry Petitioners observe, national ambient air standards exist only for NAAQS pollutants, so even if "any air pollutant" in CAA § 163(b)(4) was read to include non-NAAQS [*141] [**345] pollutants, the phrase, in context, would have no practical effect for those pollutants. Moreover, "any area to which this part applies" must mean "any area that is in attainment for that NAAQS pollutant," because if an area was in nonattainment for a particular pollutant, Part D--rather than the PSD program--would govern emissions limits for that specific pollutant. *See id. § 7501(2)* ("[t]he term 'nonattainment area' means, for any air pollutant, an area which is designated 'nonattainment' with respect to that pollutant"); *§ 7502(c)* (setting out required "Nonattainment plan provisions"). Finally, Industry Petitioners correctly note that a pollutant-specific reading of the phrase "air pollutant" must also apply to CAA § 165(a)(3)(A), which prohibits PSD permittees from "caus[ing], or contribut[ing] to, air pollution in excess of any . . . maximum allowable concentration [***100] for *any air pollutant in any area to which this part applies* more than one time per year." *Id. § 7475(a)(3)(A)* (emphasis added). This clause, as Industry Petitioners point out, piggybacks off the NAAQS pollutant-specific definition of "maximum allowable concentration" in § 163(b)(4), prophylactically restricting PSD permittees from endangering an area's attainment status. *See* Am. Chemistry Council Br. 32 (describing the interplay between the two provisions as "Section 163(b)(4) (and Section 165(a)(3)(A), which implements it) . . .").

Based on all of this, Industry Petitioners conclude that because the phrase "any air pollutant in any area to which this part applies" in § 163(b)(4) means "any NAAQS pollutant in any area in attainment for that NAAQS pollutant," an identical reading must apply to the definition of "major emitting facility." As a result, a stationary source may be subject to the PSD program only if it emits 100/250 tpy of any NAAQS pollutant and is located in an area designated as in attainment for that NAAQS pollutant. We are unpersuaded.

Although we agree that the term "any air pollutant" is, in some contexts, capable of narrower interpretations, we see nothing in the [***101] definition of "major emitting facility" that would allow EPA to adopt a NAAQS pollutant-specific reading of that phrase. The contrast with the visibility program is instructive. There, EPA determined that "any pollutant" in the definition of "major stationary source" meant "any visibility-impairing pollutant." *See 40 C.F.R. pt. 51, App. Y, § II.A.* But as EPA notes, the entire visibility program, codified in CAA Part C, Subpart 2, deals with visibility-impairing pollutants, as reflected in that subpart's title: "Visibility Protection." *See* 42 U.S.C. prec. *§ 7491*. From this, "it naturally follows that EPA's regulations under that section should address 'visibilityimpairing pollutants.'" EPA Timing & Tailoring Br. 99 n.19. No similar guidance can be garnered from Part C, Subpart 1, which contains the phrase "any air pollutant" at issue here. Dealing with far more than NAAQS pollutants, Part C, Subpart 1 requires, for example, covered sources to install BACT for "each pollutant subject to regulation under [the CAA]." *42 U.S.C. § 7475(a)(4)*. Indeed, Subpart 1 is simply--and expansively--entitled "Clean Air." *Id.* prec. *§ 7470*. Moreover, Congress designed the PSD program broadly to protect [***102] against "adverse effect[s]"

on "public health and welfare," *Id. § 7470(1)*, including effects on global problems like weather and climate. *Id. § 7602(h)*.

Furthermore, the phrases "any air pollutant" and "in any area to which this part applies" are used differently in Section 163(b)(4) and in the PSD program's definition of "major emitting facility." The presumption that "[a] term appearing in [*142] [**346] several places in a statutory text is generally read the same way each time it appears," *Ratzlaf v. United States, 510 U.S. 135, 143, 114 S. Ct. 655, 126 L. Ed. 2d 615 (1994)*, "readily yields whenever there is such variation in the connection in which the words are used as reasonably to warrant the conclusion that they were employed in different parts of the act with different intent," *Atl. Cleans & Dryers, Inc. v. United States, 286 U.S. 427, 433, 52 S. Ct. 607, 76 L. Ed. 1204 (1933)*. Here, the focus and structure of § 163(b)(4) is entirely distinct from the PSD permitting trigger. *Section 163(b)(4)* provides that "[t]he maximum allowable concentration of any air pollutant in any area to which this part applies shall not exceed a [particular] concentration." *42 U.S.C. § 7473(b)(4)*. By contrast, § 165(a) provides that "[n]o major emitting facility . . . may be [***103] constructed in any area to which this part applies" unless certain conditions are met, *id. § 7475(a)*, and § 169(1) defines "major emitting facility" as any stationary source that emits or has the potential to emit threshold amounts of "any air pollutant," *id. § 7479(1)*. The differences between these two provisions are manifest. In § 163(b)(4), the phrases "any air pollutant" and "in any area to which this part applies" appear next to one another, and it is the concentration of the pollutant in an area that matters. In the PSD permitting trigger, the phrases appear in different subsections and it is the location of the facility that matters. Section 163(b)(4) thus does nothing to undermine the unambiguous meaning of "any air pollutant" in the definition of "major emitting facility."

Industry Petitioners' pollutant-specific reading of "any air pollutant" is further undermined by contrasting Part C of the Act (the PSD program) with Part D (which regulates areas in nonattainment). Unlike Part C, Part D is expressly pollutant-specific, providing that "[t]he term 'nonattainment area' means, for any air pollutant, an area which is designated 'nonattainment' *with respect to that pollutant*." [***104] *Id. § 7501(2)* (emphasis added). Congress thus clearly knew how to promulgate a narrow, pollutant-specific definition of "any air pollutant." That it did so in Part D but not in Part C strongly suggests that the phrase "any air pollutant" in Part C was meant to be construed broadly. *Keene Corp. v. United States, 508 U.S. 200, 208, 113 S. Ct. 2035, 124 L. Ed. 2d 118 (1993)* ("[W]here Congress includes particular language in one section of a statute but omits it in another . . . , it is generally presumed that Congress acts intentionally and purposely in the disparate inclusion or exclusion.") (quoting *Russello v. United States, 464 U.S. 16, 23, 104 S. Ct. 296, 78 L. Ed. 2d 17 (1983))*.

A final point: Industry Petitioners observe that every area in the country has always been in attainment for at least one NAAQS criteria pollutant. *See Tailoring Rule, 75 Fed. Reg. at 31,561*. Thus, pursuant to EPA's pollutant-indifferent reading of § 165(a), under which a major emitting facility must abide by PSD requirements so long as it is located in an attainment area for *any* NAAQS pollutant, every facility in the United States has always been in an "area to which this part applies." Consequently, Industry Petitioners argue, "[i]f EPA's interpretation were right, Congress [***105] simply could have left out the phrase 'in any area to which this part applies'" in the PSD permitting trigger. Am.

Chemistry Council Br. 36. But "Congress does not enact 'stillborn' laws," *id.* (quoting *Sosa v. Alvarez-Machain, 542 U.S. 692, 714, 124 S. Ct. 2739, 159 L. Ed. 2d 718 (2004))*, and interpretations that render statutory language superfluous are disfavored. Am. Chemistry Council Reply Br. 19. The fact that the PSD program has applied [*143] [**347] nationwide since its inception, Industry Petitioners conclude, thus militates against EPA's pollutant-indifferent approach.

This argument fails at its premise, for Industry Petitioners confuse a lack of practical import with a lack of meaning. To say that the phrase "in any area to which this part applies" is currently without practical import is quite different than showing that the phrase means nothing. Indeed, under different circumstances, the phrase would have a significant effect. If, hypothetically, one area of the country was designated as "nonattainment" for every NAAQS pollutant, the phrase "in any area to which this part applies" would limit PSD coverage, as covered sources in that area would be subject only to Part D requirements. In fact, Environmental Intervenors point [***106] out that when Congress drafted the PSD permitting triggers "the prospect that some areas could be in nonattainment for all NAAQS was not far-fetched." Sierra Club Historic Reg. Br. 23. "In the years leading up to 1977, EPA air quality data identified a number of areas that failed to meet all five of the then-current [air quality standards] for which EPA had gathered data." *Id.* Accordingly, "in any area to which this part applies" is a meaningful phrase under EPA's pollutant-indifferent interpretation of the PSD permitting triggers: it provides that sources need not obtain PSD permits if they are located in areas designated "nonattainment" for all six NAAQS pollutants.

In short, although we agree with Industry Petitioners that phrases like "any air pollutant" are, in certain contexts, capable of a more limited meaning, they have failed to identify any reasons that the phrase should be read narrowly here. Nor do we know of one. We thus conclude that EPA's 34-year-old interpretation of the PSD permitting triggers is statutorily compelled: a source must obtain a permit if it emits major amounts of any regulated pollutant and is located in an area that is in attainment or unclassifiable [***107] for any NAAQS pollutant.

3.

We can quickly dispose of Industry Petitioners' third alternative interpretation, namely, that in order to regulate new pollutants through the PSD program, EPA was required to go through the process prescribed by CAA § 166. Section 166 provides specific steps that EPA must take when designating new "pollutants for which national ambient air quality standards" apply. *42 U.S.C. § 7476(a)*. Here, Industry Petitioners argue, EPA unlawfully failed to follow the steps laid out in Section 166, including a required study of the pollutant and a one-year delay before the effective date of regulations, before adding greenhouse gases "to the PSD [c]onstellation." Coalition for Responsible Reg. Timing & Tailoring Br. 41.

This argument fails on its face. By its terms, § 166 applies only to new "pollutants *for which national ambient air quality standards*" apply, *42 U.S.C. § 7476(a)* (emphasis added), i.e., NAAQS criteria pollutants for which regions may be classified as in "attainment," "non-attainment," or "unclassifiable." And EPA never classified greenhouse gases as a NAAQS criteria pollutant. Instead, it simply determined that under § 165, major emitters of greenhouse gases [***108] are subject to the PSD program and all covered sources must install BACT for greenhouse gases. Contrary to Industry Petitioners' arguments, then, § 166 has no bearing on this addition of greenhouse gases into "the PSD [c]onstellation." Coalition for Responsible Reg. Timing

& Tailoring Br. 41. Indeed, we rejected a nearly identical argument in [**348] [*144] *Alabama Power*, holding that there is "no implied or apparent conflict between sections 165 and 166; nor . . . must the requirements of section 165 be 'subsumed' with those of section 166." *Alabama Power, 636 F.2d at 406*. Stating what should have been obvious from the text of the statute, we concluded: "[S]ection 166 has a different focus from section 165." *Id*.

Thus, because EPA has never classified greenhouse gases as a NAAQS criteria pollutant, the § 166 requirements are entirely inapplicable here. This section of the CAA has absolutely no bearing on our conclusion that EPA's interpretation of the PSD permitting trigger is compelled by the statute itself.

VI.

Having concluded that the CAA requires PSD and Title V permits for major emitters of greenhouse gases, we turn to Petitioners' challenges to the Tailoring and Timing Rules themselves. As an [***109] initial matter, we note that Petitioners fail to make any real arguments against the Timing Rule. To be sure, at one point State Petitioners contend that the Timing Rule constitutes an attempt "to extend the PSD and Title V permitting requirements to greenhouse-gas emissions," State Pet'rs' Timing & Tailoring Br. 67. This is plainly incorrect. As discussed in the previous section, greenhouse gases are regulated under PSD and Title V pursuant to automatic operation of the CAA. All the Timing Rule did was delay the applicability of these programs, providing that major emitters of greenhouse gases would be subject to PSD and Title V permitting requirements only once the Tailpipe Rule actually took effect on January 2, 2011. *See Timing Rule, 75 Fed. Reg. at 17,017-19*. Despite this, Petitioners confusingly urge us to vacate "[t]he Tailoring *and* Timing Rules," *e.g*. State Pet'rs' Timing & Tailoring Br. 24 (emphasis added), although it is unclear what practical effect vacature of the Timing Rule would have. Nonetheless, given this phrasing of their argument, and given our conclusion that Petitioners lack Article III standing to challenge *both* rules, we shall, where appropriate, discuss the [***110] Timing Rule in conjunction with the Tailoring Rule.

In the Tailoring Rule, EPA announced that it was "relieving overwhelming permitting burdens that would, in the absence of this rule, fall on permitting authorities and sources." *Tailoring Rule, 75 Fed. Reg. at 31,516*. Although the PSD statute requires permits for sources with the potential to emit 100/250 tpy of "any air pollutant," *42 U.S.C. § 7479(1)*, EPA noted that immediate application of that threshold to greenhouse gas-emitting sources would cause permit applications to jump from 280 per year to over 81,000 per year. *Tailoring Rule, 75 Fed. Reg. at 31,554*. Many of these applications would come from commercial and residential sources, which would "each incur, on average, almost $60,000 in PSD permitting expenses." *Id. at 31,556*. Similarly, if the Title V 100 tpy threshold applied immediately to greenhouse gases, sources needing operating permits would jump from 14,700 per year to 6.1 million per year. *Id. at 31,562*. "The great majority of these sources would be small commercial and residential sources" which "would incur, on average, expenses of $23,175." *Id*. And were permitting authorities required to hire the 230,000 full-time [***111] employees necessary to address these permit applications, "authorities would face over $21 billion in additional permitting costs each year due to [greenhouse gases], compared to the current program cost of $62 million each year." *Id. at 31,563*.

[*145] [**349] Thus, instead of immediately requiring permits for all sources exceeding the 100/250 tpy emissions threshold, EPA decided to "phas[e] in the applicability of

these programs to [greenhouse gas] sources, starting with the largest [greenhouse gas] emitters." *Id. at 31,514*. The Tailoring Rule established the first two steps in this phased-in process. During Step One, only sources that were "subject to PSD requirements for their conventional pollutants anyway" (i.e., those sources that exceeded the statutory emissions threshold for non-greenhouse gas pollutants) were required to install BACT for their greenhouse gas emissions. *Id. at 31,567*. Step Two, which took effect on July 1, 2011, also requires PSD permits for sources with the potential to emit over 100,000 tpy CO_2e after a proposed construction project, or 75,000 tpy CO_2e after a proposed modification project. *Id. at 31,523*. Step Two further requires Title V permits for sources which have the [***112] potential to emit over 100,000 tpy CO_2e. *Id. at 31,516*. EPA has since proposed--but has yet to finalize--a "Step Three," which would maintain the current thresholds while the agency evaluates the possibility of regulating smaller sources. *See* EPA's 28(j) Letter 1-2, February 27, 2012.

In the Tailoring Rule, EPA justified its phased-in approach on three interrelated grounds, each of which rests on a distinct doctrine of administrative law. First, EPA concluded "the costs to sources and administrative burdens . . . that would result from [immediate] application of the PSD and title V programs . . .at the statutory levels . . . should be considered 'absurd results,'" which Congress never intended. *Id. at 31,517; see Am. Water Works Ass'n v. EPA, 40 F.3d 1266, 1271, 309 U.S. App. D.C. 235 (D.C. Cir. 1994)* ("[W]here a literal reading of a statutory term would lead to absurd results, the term simply has no meaning . . and is the proper subject of construction by EPA and the courts."). Thus, under the "absurd results" doctrine, EPA concluded that the PSD and Title V programs "should not [immediately] be read to apply to all [greenhouse gas] sources at or above the 100/250 tpy threshold." *Tailoring Rule, 75 Fed. Reg. at 31,554*. [***113] Second, emphasizing that immediate regulation at the 100/250 tpy threshold would cause tremendous administrative burden, EPA justified its deviation from this threshold on the basis of the "administrative necessity" doctrine. *Id. at 31,576; see Envtl. Def. Fund, Inc. v. EPA, 636 F.2d 1267, 1283, 205 U.S. App. D.C. 139 (D.C. Cir. 1980)* ("[A]n agency may depart from the requirements of a regulatory statute . . . to cope with the administrative impossibility of applying the commands of the substantive statute."). Finally, asserting that there exists a judicial doctrine that allows agencies to implement regulatory programs in a piecemeal fashion, EPA stated that the Tailoring Rule was justified pursuant to this "one-step-at-a-time" doctrine. *Tailoring Rule, 75 Fed. Reg. at 31,578; see Massachusetts v. EPA, 549 U.S. at 524* ("Agencies, like legislatures, do not generally resolve massive problems in one fell regulatory swoop.").

Petitioners--particularly State Petitioners--argue that none of these doctrines permit EPA to "depart unilaterally from the [CAA's] permitting thresholds and replace them with numbers of its own choosing." State Pet'rs' Timing & Tailoring Br. 29. Admitting the "lamentable policy consequences [***114] of adhering to the unambiguous numerical thresholds in the Clean Air Act," State Petitioners rather colorfully argue that EPA's attempts to alleviate those burdens "establish only that EPA is acting as a benevolent dictator rather than a tyrant." *Id. at 26*. And because EPA exceeded the boundaries of its lawful authority, [*146] [**350] Petitioners urge us to vacate the Tailoring Rule.

Before we may address the merits of these claims, however, we must determine whether we have jurisdiction. "No principle," the Supreme Court has repeatedly explained, "is more fundamental to

the judiciary's proper role in our system of government than the constitutional limitation of federal-court jurisdiction to actual cases or controversies." *Raines v. Byrd, 521 U.S. 811, 818, 117 S. Ct. 2312, 138 L. Ed. 2d 849 (1997)* (internal quotation marks omitted). The doctrine of standing "is an essential and unchanging part of the case-or-controversy requirement." *Lujan v. Defenders of Wildlife, 504 U.S. 555, 560, 112 S. Ct. 2130, 119 L. Ed. 2d 351 (1992)*. To establish standing, a petitioner must have suffered an "injury in fact" that is 1) "concrete and particularized . . . [and] actual or imminent, not conjectural or hypothetical," 2) was caused by the conduct complained of, and 3) is "likely, [***115] as opposed to merely speculative [to] be redressed by a favorable decision." *Id. at 560-61* (internal quotation marks and citations omitted).

Petitioners fall far short of these "irreducible constitutional . . . elements" of standing, *id. at 560*. Simply put, Petitioners have failed to establish that the Timing and Tailoring Rules caused them "injury in fact," much less injury that could be redressed by the Rules' vacatur. Industry Petitioners contend that they are injured because they are subject to regulation of greenhouse gases, Coalition for Responsible Reg. Timing & Tailoring Br. 14. State Petitioners claim injury because they own some regulated sources and because they now carry a heavier administrative burden. State Pet'rs' Timing & Tailoring Br. 22-23. But as discussed above, *see supra* Part V, the CAA mandates PSD and Title V coverage for major emitters of greenhouse gases. Thus, Industry Petitioners were regulated and State Petitioners required to issue permits not because of anything EPA did in the Timing and Tailoring Rules, but by automatic operation of the statute. Given this, neither the Timing nor Tailoring Rules caused the injury Petitioners allege: having to comply with [***116] PSD and Title V for greenhouse gases.

Indeed, the Timing and Tailoring Rules actually mitigate Petitioners' purported injuries. Without the Timing Rule, Petitioners may well have been subject to PSD and Title V for greenhouse gases before January 2, 2011. Without the Tailoring Rule, an even greater number of industry and state-owned sources would be subject to PSD and Title V, and state authorities would be overwhelmed with millions of additional permit applications. Thus, Petitioners have failed to "show that, absent the government's allegedly unlawful actions, there is a substantial probability that they would not be injured and that, if the court affords the relief requested, the injury will be removed." *Chamber of Commerce v. EPA, 642 F.3d 192, 201, 395 U.S. App. D.C. 193 (D.C. Cir. 2011)* (quotations and alterations omitted). Far from it. If anything, vacature of the Tailoring Rule would significantly exacerbate Petitioners' injuries.

Attempting to remedy this obvious jurisdictional defect, State Petitioners present two alternative theories, neither of which comes close to meeting the "irreducible constitutional . . . elements" of standing. *Lujan, 504 U.S. at 560*. First, State Petitioners counterintuitively [***117] suggest that they actually want EPA to immediately "appl[y] the 100/250 tpy permitting thresholds to greenhouse-gas emissions." State Pet'rs' Timing & Tailoring Reply Br. 15. Admitting that vacature of the Tailoring Rule would result in astronomical costs and unleash chaos on permitting [*147] [**351] authorities, State Petitioners predict that Congress will be forced to enact "corrective legislation" to relieve the overwhelming permitting burdens on permitting authorities and sources, thus mitigating their purported injuries. *Id.*

This theory fails. To establish standing, plaintiffs must demonstrate that it is "likely, as opposed to merely speculative, that the injury will be redressed by a favorable

decision," *Lujan, 504 U.S. at 561* (internal quotation marks omitted), but here, State Petitioners simply hypothesize that Congress will enact "corrective legislation." State Pet'rs' Timing & Tailoring Reply Br. 15. We have serious doubts as to whether, for standing purposes, it is ever "likely" that Congress will enact legislation at all. After all, a proposed bill must make it through committees in both the House of Representatives and the Senate and garner a majority of votes in both chambers--overcoming, [***118] perhaps, a filibuster in the Senate. If passed, the bill must then be signed into law by the President, or go back to Congress so that it may attempt to override his veto. As a generation of schoolchildren knows, "by that time, it's very unlikely that [a bill will] become a law. It's not easy to become a law." Schoolhouse Rock, *I'm Just a Bill, at 2:41, available at* http://video.google.com/videoplay?docid=7266360872513258185# (last visited June 1, 2012).

And even if the astronomical costs associated with a 100/250 tpy permitting threshold make *some* Congressional action likely, State Petitioners are still unable to show that it is "likely, as opposed to merely speculative," *Lujan, 504 U.S. at 561*, that Congress will redress their injury. State Petitioners apparently assume that if the 100/250 tpy permitting threshold was immediately applied to greenhouse gases, Congress would exempt those pollutants from the PSD and Title V programs entirely. But this is just one of many forms "corrective legislation" could take. For example, were we to vacate the Tailoring Rule, Congress could decide to readopt its key provisions in the PSD and Title V statutes. Or it could set PSD and Title V permitting [***119] thresholds at 25,000 tpy for greenhouse gases--higher than the 100/250 tpy threshold, but lower (and thus more costly to Petitioners) than the thresholds promulgated in the Tailoring Rule. Or it could do something else entirely. All of this is guesswork, which is precisely the point: State Petitioners' faith that Congress will alleviate their injury is inherently speculative.

State Petitioners' second alternative theory of standing fares no better. In their reply brief, they contend that even if vacating the Timing or Tailoring Rules would indeed exacerbate their costs and administrative burdens (the purported injuries they claimed in their opening brief), "then State Petitioners can establish Article III standing under *Massachusetts* by asserting injuries caused by EPA's failure to regulate sooner." State Pet'rs' Timing & Tailoring Reply Br. 5. Essentially, State Petitioners' reply brief contends that, contrary to the position taken in the opening brief, they want more regulation, not less, and that they wanted regulation sooner rather than later. And because the Commonwealth of Massachusetts had standing to seek regulation of greenhouse gases in *Massachusetts v. EPA*, State Petitioners [***120] argue that they now have standing to seek more regulation of greenhouse gases as well.

This argument is completely without merit. As an initial matter, we are aware of no authority which permits a party to assert an entirely new injury (and thus, an entirely new theory of standing) in its reply brief. Quite to the contrary, we have held that, where standing is not self-evident, [*148] [**352] "[i]n its *opening* brief, the petitioner should . . . include . . . a concise recitation of the basis upon which it claims standing." *Sierra Club v. EPA, 292 F.3d 895, 901, 352 U.S. App. D.C. 191 (D.C. Cir. 2002)* (emphasis added); see also *D.C. Cir. R. 28(a)(7)* ("[i]n cases involving direct review in this court of administrative actions, the brief of the appellant or petitioner must set forth the basis for the claim of standing."); *American Library Ass'n v. FCC, 401 F.3d 489, 493-94, 365 U.S. App. D.C. 207 (D.C. Cir. 2005)* (discussing limitations on this

principle). After all, "it is often the case . . . that some of the relevant facts are known only to the petitioner, to the exclusion of both the respondent and the court." *Sierra Club, 292 F.3d at 901*. If "the petitioner does not submit evidence of those facts with its opening brief," the respondent is "left [***121] to flail at the unknown in an attempt to prove the negative." *Id*. This principle is particularly important here, for State Petitioners' asserted fear of global warming stands in stark contrast to the position they took throughout this litigation. In an earlier brief, for example, they characterized the Endangerment Finding as "a subjective conviction" State Pet'rs' Endangerment Br. 19, "supported by highly uncertain climate forecasts," *id. at 18*, and "offer[ing] no criteria for determining a harmful, as opposed to a safe, climate," *id. at 17*. Given this, EPA could not possibly have anticipated that State Petitioners, abruptly donning what they themselves call "an environmentalist hat," State Pet'rs' Timing & Tailoring Reply Br. 4, would assert that global warming causes them concrete and particularized harm.

In any event, State Petitioners fail to cite any record evidence to suggest that they are adversely affected by global climate change. This is in stark contrast to the evidence put forward in *Massachusetts v. EPA*, where the Commonwealth submitted unchallenged affidavits and declarations showing that 1) rising sea tides due to global warming had "already begun to swallow Massachusetts' [***122] coastal land," and 2) "[t]he severity of that injury will only increase over the course of the next century." *Massachusetts v. EPA, 549 U.S. at 522-23*. These specific, factual submissions were key to the standing analysis in *Massachusetts v. EPA*: the Court held that "petitioners' *submissions as they pertain to Massachusetts* have satisfied the most demanding standards of the adversarial process." *Id. at 521* (emphasis added). It is true, as State Petitioners emphasize, that the Supreme Court held that states are "entitled to special solicitude in our standing analysis." *Id. at 522*. But nothing in the Court's opinion remotely suggests that states are somehow exempt from the burden of establishing a concrete and particularized injury in fact. State Petitioners, like Industry Petitioners, failed to do so here. We shall thus dismiss all challenges to the Timing and Tailoring Rules for lack of jurisdiction.

VII.

Following promulgation of the Timing and Tailoring Rules, EPA issued a series of rules ordering states to revise their PSD State Implementation Plans (SIPs) to accommodate greenhouse gas regulation. *See Action to Ensure Authority to Issue Permits Under the Prevention of Significant Deterioration Program to Sources of Greenhouse Gas Emissions: Finding of Substantial Inadequacy and SIP Call, 75 Fed. Reg. 53,892 (Sept. 2, 2010), 75 Fed. Reg. 77,698 (Dec. 13, 2010);* [***123] *Action to Ensure Authority to Issue Permits Under the Prevention of Significant Deterioration Program to Sources of Greenhouse Gas Emissions: Finding of Failure to Submit State Implementation Plan Revisions Required for Greenhouse* [*149] [**353] *Gases, 75 Fed. Reg. 81,874 (Dec. 29, 2010)*. Industry Petitioners present several challenges to these SIP-related rules. But our review in this case is limited to four EPA decisions: the Endangerment Finding, the Tailpipe Rule, and the Timing and Tailoring Rules. We thus lack jurisdiction over the SIP-related rules. Moreover, challenges to these rules are currently pending in at least two separate cases before this court. *See Utility Air Regulatory Group v. EPA*, No. 11-1037 (consolidating various challenges); *Texas v. EPA*, No. 10-1425 (challenge brought by Texas). We decline Industry Petitioners'

invitation to rule on the merits of cases which are properly before different panels.

VIII.

For the foregoing reasons, we dismiss all petitions for review of the Timing and Tailoring Rules, and deny the remainder of the petitions.

So ordered.

ORAL ARGUMENT SCHEDULED FOR FEBRUARY 28, 2012

IN THE UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

No. 09-1322, and consolidated cases (Complex)

COALITION FOR RESPONSIBLE REGULATION, et al.,

Petitioners,

v.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AND
LISA P. JACKSON, ADMINISTRATOR,

Respondents.

ON CONSOLIDATED PETITIONS FOR REVIEW OF FINAL ACTIONS
BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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DATED: November 14, 2011 (Final Brief (corrected))

RESPONDENTS' CERTIFICATE AS TO PARTIES, RULINGS, AND RELATED CASES

Pursuant to D.C. Circuit R. 28(a)(1), Respondents United States Environmental Protection Agency ("EPA") and Lisa P. Jackson, Administrator of EPA, submit this certificate as to parties, rulings and related cases.

(A) Parties and amici: With two exceptions, the parties and amici to this action are those set forth in the certificates filed with the Joint Opening Brief of Non-State Petitioners and Supporting Intervenors (hereinafter "Ind. Br."), the Brief of Texas for State Petitioners and Supporting Intervenors (hereinafter "Tx. Br."), and the Opening Brief for State Petitioners Texas and Virginia on Denial of Reconsideration of the Endangerment Finding and of State Petitioners and Supporting State Intervenors on Endangerment Finding Delegation Issues (hereinafter "Va. Br."). The exceptions are: (1) on July 7, 2011, the Court granted the State of Kansas leave to file an amicus brief in support of Petitioners; and (2) on August 5, 2011, the Court granted the Commonwealth of Pennsylvania's motion to withdraw as an Intervenor.

(B) Rulings under review: This case is a set of consolidated petitions for review of EPA's "Endangerment Finding," 74 Fed. Reg. 66,496 (Dec. 15, 2009), and denial of petitions to reconsider the Endangerment Finding ("Reconsideration Denial"), 75 Fed. Reg. 49,556 (Aug. 13, 2010).

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(C) Related cases: Each of the petitions for review consolidated under No. 09-1322 is related. In addition, pursuant to this Court's prior orders, this case (No. 09-1322) will be argued before the same panel as the consolidated actions in Nos. 10-1167, 10-1092, and 10-1073.

DATED: November 14, 2011

/s/ Angeline Purdy
Counsel for Respondents

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GLOSSARY

ANPR	Advanced Notice of Proposed Rulemaking
AR4	Fourth Assessment Report (Intergovernmental Panel on Climate Change)
CAA	Clean Air Act or the Act
CAFE	corporate average fuel economy
CH_4	methane
CO_2	carbon dioxide
DOT	United States Department of Transportation
EPA	Respondent United States Environmental Protection Agency
HFCs	hydroflourocarbons
IPCC	Intergovernmental Panel on Climate Change
Ind. Br.	Joint Opening Brief of Non-State Petitioners and Supporting Intervenors
JA	Joint Appendix
Kan. Br.	Brief Amicus Curiae of the State of Kansas in Support of Petitioners
NAAQS	national ambient air quality standards
N_2O	nitrous oxide
NHTSA	National Highway Traffic Safety Administration
NRC	National Research Council of the National Academies

Non-State Amicus Br.	Brief of Amici Curiae in Support of Petitioners
PFCs	perflourocarbons
PM	particulate matter
PSD	prevention of significant deterioration
RTC	Response to Comments
RTP	Response to Petitions to Reconsider Endangerment Finding
SAB	Science Advisory Board
SF_6	sulfur hexafluoride
TSD	Technical Support Document
Tx. Br.	Brief of Texas for State Petitioners and Supporting Intervenors
USGCRP	United States Global Change Research Program
Va. Br.	Opening Brief for State Petitioners Texas and Virginia on Denial of Reconsideration of the Endangerment Finding and of State Petitioners and Supporting State Intervenors on Endangerment Finding Delegation Issues
VOCs	volatile organic chemicals
W/m^2	watts per square meter

INTRODUCTION

In Massachusetts v. EPA, 549 U.S. 497, 529, 533 (2007), the Supreme Court reversed EPA's denial of a petition seeking regulation of greenhouse gas emissions from new motor vehicles under section 202(a) of the Clean Air Act ("CAA" or the "Act"), 42 U.S.C. § 7521(a). See 68 Fed. Reg. 52,922 (Sept. 8, 2003). The Court required EPA to determine on remand whether greenhouse gases endanger public health or welfare, or else explain why it could not, focusing the Agency's inquiry narrowly on the science. General "policy judgments" that are not grounded in the statutory endangerment factors "have nothing to do with whether greenhouse gas emissions contribute to climate change" and cannot provide a "reasoned justification for declining to form a scientific judgment." Id. at 533-34. The Court further instructed that "residual uncertainty" about the science of climate change is "irrelevant" to EPA's inquiry; only "scientific uncertainty . . . so profound that it precludes EPA from making a reasoned judgment as to whether greenhouse gases contribute to global warming" could justify a decision not to regulate.

In the December 2009 "Endangerment Finding," the Administrator determined that greenhouse gas concentrations in the atmosphere may reasonably be anticipated to endanger public health and welfare and that emissions from motor vehicles contribute to this pollution. 74 Fed. Reg. 66,496 (Dec. 15, 2009). In support of this judgment, the Agency explained, inter alia, that greenhouse gas

concentrations in the atmosphere have risen to unprecedented levels as the result of human activities, that this buildup of atmospheric gases has been a substantial cause of warming over the past half-century, and that this warming is causing and will continue to cause a variety of adverse effects to human health and welfare in this country. Numerous parties filed administrative petitions for reconsideration and the Administrator denied those petitions in the "Reconsideration Denial." 75 Fed. Reg. 49,556 (Aug. 13, 2010). This case, No. 09-1322, is a consolidated set of petitions for review of the Endangerment Finding and the Reconsideration Denial.

As we will explain herein, the conclusions reached by EPA in both the Endangerment Finding and the Reconsideration Denial are fully consistent with the statute and are well-supported, if not compelled, by the scientific information in the extensive administrative record compiled by EPA. Indeed, many of the arguments Petitioners present in this case are similar to those the Supreme Court rejected in Massachusetts, e.g., that Congress could not possibly have intended EPA to regulate greenhouse gases under the Act, that the science of climate change is too uncertain, that the costs of regulating are too great, and that greenhouse gas emissions from new motor vehicles are better addressed through the Department of Transportation's ("DOT's") fuel economy standards.

Because section 202(a) obligates EPA to issue vehicle emission standards following a positive endangerment finding, see Massachusetts, 549 U.S. at 532,

EPA then promulgated greenhouse gas standards for new light-duty motor vehicles for model years 2012-2016. See 75 Fed. Reg. 25,324 (May 7, 2010) (the "Vehicle Rule," challenged in No. 10-1092). Significantly, no one challenges the substance of the Vehicle Rule's emission standards (i.e., no one contends either that they are too stringent or not stringent enough).

Instead, although the Endangerment Finding and the Vehicle Rule address greenhouse gas emissions from motor vehicles, a substantial part of Petitioners' challenges to those actions is based on concerns about the costs and other burdens of regulating such emissions from *stationary* sources. This is because once greenhouse gas emissions from motor vehicles became regulated through the Vehicle Rule, the Act automatically made certain large stationary sources of greenhouse gas emissions (such as factories and power plants) subject to the CAA prevention of significant deterioration ("PSD") and Title V permit programs. On these issues, the Administrator properly determined that she had no leeway to decline to find endangerment or to decline to promulgate greenhouse gas standards for motor vehicles solely to stave off stationary source regulation of greenhouse gas emissions, given her clear responsibilities under the statute and the compelling scientific record regarding endangerment.

The Agency nonetheless took action to assure that regulation of greenhouse gas emissions from stationary sources under the PSD and Title V programs would

be implemented in the most appropriate and orderly manner possible. First, in the "Timing Decision," 75 Fed. Reg. 17,004 (Apr. 2, 2010), EPA determined that greenhouse gases did not become "subject to regulation" (and thus subject to PSD and Title V requirements) until January 2, 2011, the first date on which certain newly-manufactured vehicles must comply with the emission standards in the Vehicle Rule. Second, in the "Tailoring Rule," 75 Fed. Reg. 31,514 (June 3, 2010), EPA developed a format and timeframe to phase-in PSD and Title V requirements in a manner that accounts for the practical constraints of the permitting system, starting with the largest sources of greenhouse gas emissions. The challenges to the Timing Decision and the Tailoring Rule have been consolidated in No. 10-1073.

As demonstrated below, there is overwhelming legal and technical support for the Administrator's judgment that greenhouse gases may reasonably be anticipated to endanger public health and welfare, and that motor vehicle emissions contribute to the problem. Further, as EPA's briefs in all these companion cases collectively show, the Endangerment Finding, the Vehicle Rule, the Timing Decision, and the Tailoring Rule represent, as a whole, a regulatory response to climate change that is fair, feasible, and faithful to the Agency's duties under the Act.

JURISDICTION

The consolidated petitions for review of the Endangerment Finding and Reconsideration Denial were timely filed pursuant to 42 U.S.C. § 7607(b). The Court does not need to scrutinize the standing of all Petitioners since at least some Petitioners appear to have alleged standing adequately to challenge the Endangerment Finding based on asserted injuries as fleet purchasers of motor vehicles. See Ind. Br. 12; Va. Br. 21; Tx. Br. 14; see also, e.g., Massachusetts v. EPA, 549 U.S. at 518.

STATUTES AND REGULATIONS

The pertinent statutes and regulations are set forth in the addendum to Petitioners' briefs. EPA has also included certain frequently-cited authorities in the addendum to this brief.

STATEMENT OF ISSUES

Section 202(a)(1) of the Act, 42 U.S.C. § 7521(a)(1), directs the Administrator to determine whether, in her "judgment," "air pollution" (in this case the mix of six greenhouse gases in the atmosphere) may "reasonably be anticipated to endanger public health or welfare." If the Administrator determines that it does, the statute directs her to determine whether motor vehicle emissions "cause" or "contribute" to this "air pollution." Id. If the Administrator answers that question in the affirmative, the Act requires the Agency to set emission standards taking

into account the cost and technology factors set forth in Section 202(a)(2), 42 U.S.C. § 7521(a)(2). Against this background:

1. Did EPA reasonably construe Section 202(a)(1) to limit the endangerment inquiry to scientific issues bearing on the Administrator's "judgment" as to the effects of atmospheric greenhouse gas concentrations on public health and welfare, and the question of whether greenhouse gas emissions from motor vehicles cause or contribute to that air pollution?

2. Did the extensive administrative record compiled by EPA, including a 210-page technical support document ("TSD"), an 11-volume response to comments document ("RTC"), and a 50-page Federal Register notice, adequately explain and support the Administrator's judgment that elevated concentrations of greenhouse gases in the atmosphere may reasonably be anticipated to endanger public health and welfare?

3. Did EPA properly deny the petitions for administrative reconsideration of the Endangerment Finding, where, among other things, the Petitioners failed to raise issues of "central relevance" and could have but failed to raise some issues in comments on the proposed Endangerment Finding?

4. Did EPA reasonably define the "air pollutant" at issue in this case to be a mix of six greenhouse gases that are all directly-emitted, long-lived, contributors to climate change?

5. Did EPA reasonably decline to construe Section 202(a)(1) as requiring the Agency to gauge the presence or absence of an endangerment through a quantitative assessment of safe and unsafe levels of air pollution and climate change?

6. Did EPA reasonably decline to construe Section 202(a)(1) as requiring EPA to determine, before making an endangerment finding, the extent to which motor vehicle emission standards could ameliorate any endangerment?

7. Does Section 202(a)(1) preclude EPA from considering (or at least not require EPA to consider), before making an endangerment finding, additional factors not mentioned in Section 202(a)(1), such as the impact of possible stationary source regulation of greenhouse gas emissions, the social benefits of pollution-causing activities, and the extent to which society can mitigate, or adapt to, the adverse effects of climate change?

8. Are Petitioners' claims concerning review of the Endangerment Finding by the Science Advisory Board ("SAB") barred by various waiver principles and, in any event, meritless?

STATEMENT OF THE CASE

The central issue at the core of this case – climate change – is undoubtedly one of "unusual importance," Massachusetts v. EPA, 549 U.S. at 506, and "[t]he harms associated with climate change are serious and well-recognized." Id. at 521.

Yet, as in Massachusetts, "[a]lthough this case comes to us in the context of a highly controversial question – global warming – it actually presents a quite traditional legal issue: has the Environmental Protection Agency complied with the Clean Air Act?" Massachusetts v. EPA, 415 F.3d 50, 82 (D.C. Cir. 2005) (Tatel, J., dissenting), reversed, 549 U.S. 497 (2007). In this case, the Endangerment Finding and Reconsideration Denial must be upheld because those decisions are fully consistent with the Act and are well-supported by a comprehensive administrative record.

STATEMENT OF FACTS

I. STATUTORY BACKGROUND

A. Definitions.

Section 302(g) of the Act, 42 U.S.C. § 7602(g), defines "air pollutant" as "any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive . . . substance or matter which is emitted into or otherwise enters the ambient air[,]" including any precursors to the formation of such air pollutant. The term "effects on welfare" is defined by Section 302(h), 42 U.S.C. § 7602(h), to include "effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to . . . property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being . . . ."

B. CAA Mobile Source Provisions.

Title II of the Act, 42 U.S.C. §§ 7521-7590, establishes a regulatory framework for controlling pollution from motor vehicles and other mobile sources. Section 202(a)(1), 42 U.S.C. § 7521(a)(1), authorizes EPA to establish standards for "the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in [the Administrator's] judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare." Once the Administrator makes such a positive "endangerment finding," the Act requires her to issue emission standards taking into account specified technological and cost considerations. Id. § 7521(a)(1)&(2).

C. The PSD Program.

The primary requirement of the prevention of significant deterioration ("PSD") program, adopted as part of the 1977 amendments to the Act, is a permitting requirement for stationary sources. See Part C of Title I of the CAA, 42 U.S.C. §§ 7470-7492. Congress described the overall purpose of the PSD program as, inter alia, "to protect public health and welfare from any actual or potential adverse effect which in the Administrator's judgment may reasonably be anticipate[d] to occur from air pollution . . . notwithstanding attainment and maintenance of all national ambient air quality standards." 42 U.S.C. § 7470(1).

Generally speaking, under section 165(a) of the Act, 42 U.S.C. § 7475(a), a "major emitting facility" may not be constructed or modified without first obtaining a pre-construction permit under the PSD program. A modification of an existing major emitting facility is defined by statute as a physical change or change in the method of operation that results in an increase in the amount of any air pollutant. 42 U.S.C. § 7479(2)(C); 42 U.S.C. § 7411(a)(4). Consistent with these statutory provisions, under longstanding EPA regulations, the PSD permit requirement can be triggered by, inter alia, emissions of the specified quantities of "[a]ny pollutant that otherwise is subject to regulation under the Act." 40 C.F.R. § 52.21(a)(1)-(2), (b)(50)(d)(iv); see also id. § 51.166(a)(1)-(2), (49)(iv).

D. The Title V Operating Permit Program.

In 1990, Congress enacted Title V of the Act, 42 U.S.C. §§ 7661-7661f, which establishes an operating permit program covering stationary sources of air pollution. Under this "Title V" permit program, all CAA requirements applicable to a particular source are contained in a comprehensive permit. The permit requirement applies to, among other sources, any "major source" within the meaning of section 501(2) of the Act, 42 U.S.C. § 7661(2).

II. THE ENDANGERMENT FINDING

As noted above, following the Supreme Court's 2007 decision in Massachusetts, EPA was directed to reconsider its denial of an administrative petition seeking regulation of greenhouse gas emissions from motor vehicles. In December 2009, EPA issued the Endangerment Finding. In that Finding, the Administrator defined the relevant Section 202 "air pollution" as the atmospheric mix of six long-lived and directly-emitted greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydroflourocarbons (HFCs), perflourocarbons (PFCs), and sulfur hexafluoride (SF_6). 74 Fed. Reg. at 66,497, 66,516-22. The Administrator further found that this air pollution may "reasonably be anticipated both to endanger public health and to endanger public welfare," and that greenhouse gas emissions from new motor vehicles and engines contribute to this air pollution. 74 Fed. Reg. at 66,496-97, 66,523-36. EPA then issued greenhouse gas emissions standards for new light-duty motor vehicles through the Vehicle Rule. 75 Fed. Reg. 25,324 (May 7, 2010). Finally, in August 2010, EPA denied petitions seeking reconsideration of the Endangerment Finding in the Reconsideration Denial. See 75 Fed. Reg. 49,556 (Aug. 13, 2010).

Along with the Endangerment Finding, EPA issued a 210-page TSD detailing the Agency's summary of the state of the science and relevant emissions data. A draft TSD had been released as part of the lengthy Advance Notice of

Proposed Rulemaking ("ANPR") published on July 30, 2008 (73 Fed. Reg. 44,354), and was later revised and updated to reflect more recent science assessments and following comments received during the 120-day public comment period on the ANPR. 74 Fed. Reg. at 66,510. The revised TSD published with the proposed Endangerment Finding in April, 2009 was again updated in response to public comments received during the 60-day comment period. Id.; EPA HQ OAR 2009-0171-11639 (JA 3547-55). EPA also published an 11-volume response to comments with the final Endangerment Finding.[1]

A. The Administrator's Approach To Evaluating The Evidence.

The Administrator relied on thorough and peer-reviewed assessments of climate change science prepared by the Intergovernmental Panel on Climate Change ("IPCC"), the United States Global Change Research Program ("USGCRP"), and the National Research Council of the National Academies ("NRC") as the primary scientific and technical basis for the Endangerment Finding. EPA evaluated these assessments in several ways: by reviewing the process employed to develop each assessment, by reviewing their substantive content in light of in-house expertise, and by taking into consideration the depth of scientific consensus represented in the assessments. Response to Petitions to

[1] Excerpts from the TSD and RTC are set forth in the Joint Appendix. The complete TSD, RTC, and other related documents are available at http://www.epa.gov/climatechange/endangerment.html (last visited Nov. 10, 2011).

Reconsider Endangerment Finding ("RTP") 3-2 (JA 4833-37); see also 74 Fed. Reg. at 66,510-12; 75 Fed. Reg. at 49,581-82. EPA also took comment on using these assessments as the primary scientific and technical basis for its determination, and affirmed its view after considering comments. 74 Fed. Reg. at 66,510-12.

The Administrator concluded that the scientific assessments of the IPCC, the USGCRP, and the NRC were "the best reference materials for determining the general state of knowledge on the scientific and technical issues before the agency in making an endangerment decision." 74 Fed. Reg. at 66,511. These assessments comprehensively address the scientific issues the Administrator had to examine, providing her both data and information on a wide range of issues pertinent to the Endangerment Finding. 74 Fed. Reg. at 66,510. They are recent, and represent the current state of knowledge on key elements of the endangerment analysis. 74 Fed. Reg. at 66,511. They are also comprehensive, evaluating and synthesizing thousands of individual studies to convey the consensus of the body of scientific literature. Id.; see also RTC 1-2 (JA 3561-63) (assessments "look at the range of the scientific literature without 'cherry-picking'"); RTC 1-14 (JA 3568-74) (discussing IPCC assessment process). These assessments have been rigorously reviewed not only by the expert community, but also by United States government agencies and scientists; indeed, EPA itself took an active part in reviewing and

approving these assessments. 74 Fed. Reg. at 66,511. The assessments therefore "essentially represent the U.S. government's view of the state of knowledge on greenhouse gases and climate change." Id.

B. Scientific Support For The Endangerment Finding.

As we now summarize, EPA concluded that the "air pollution" consisting of the six globally well-mixed greenhouse gases may reasonably be anticipated to endanger public health and welfare.

Greenhouse gases cause warming: Greenhouse gases in the atmosphere trap heat on Earth that would otherwise escape into space. 74 Fed. Reg. at 66,517. These gases are part of the natural greenhouse effect that keeps the planet habitable. As greenhouse gases are added to the atmosphere, the natural greenhouse effect is intensified and the planet warms. 74 Fed. Reg. at 66,499.

Levels of greenhouse gases are increasing in the atmosphere due to human activity: Evidence shows that atmospheric greenhouse gas concentrations "are at elevated and essentially unprecedented levels" as the result of human activities. 74 Fed. Reg. at 66,517. Since pre-industrial times, carbon dioxide concentrations have increased by 38%; methane levels by 149%; and nitrous oxide by 23%. Id. Data reaching farther back in time show current atmospheric concentrations of CO_2 and methane are above the natural range compared to at least the last 650,000 years. Id.

The climate is warming: Datasets developed by the National Oceanic and Atmospheric Administration and the National Aeronautics and Space Administration of the United States and the United Kingdom's Hadley Center all show a global average warming trend over the last century, with the greatest warming occurring over the last 30 years. 74 Fed. Reg. at 66,517. All three datasets showed that 8 of the 10 warmest years on record had occurred since 2001, and that the 20 warmest years on record had all occurred since 1981. Id. Global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period in the preceding four centuries. Id. Observational evidence around the globe shows that warming is occurring – e.g., there is widespread melting of snow and ice; global average sea level is rising; and widespread changes in extreme temperatures have been observed in all world regions in the last 50 years. Id. at 66,517-18.

Recent warming has been attributed to the increase in greenhouse gases: EPA's conclusion that anthropogenic greenhouse gas emissions very likely caused most of the past half-century of warming is based on three lines of evidence:

> The first line of evidence arises from our basic physical understanding of the effects of changing concentrations of greenhouse gases, natural factors, and other human impacts on the climate system. The second line of evidence arises from indirect, historical estimates of past climate changes that suggest that the changes in global surface temperature over the last several decades are unusual. The third line of

> evidence arises from the use of computer-based climate models to simulate the likely patterns of response to the climate system to different forcing mechanisms (both natural and anthropogenic).

74 Fed. Reg. at 66,518. The first two lines of evidence include the information discussed above. In addition, the past half century of warming has occurred at a time when natural forces such as solar activity and volcanoes would likely have produced *cooling*, not warming. Id. The vertical pattern of observed warming – with warming in the bottommost layer of the atmosphere and cooling immediately above – is consistent with warming caused by greenhouse gases, and inconsistent with other possible causes. 75 Fed. Reg. at 49,566; RTC 3-35 (JA 3840-42). The third line of evidence is that multiple analyses using various climate models show that the observed warming can only be reproduced by incorporating *both* natural and man-made influences on the climate. 74 Fed. Reg. at 66,518; see also 75 Fed. Reg. at 49,565-67.

Warming of the climate threatens human health and welfare: EPA comprehensively considered "both observed and projected effects of greenhouse gases in the atmosphere, their effect on climate, and the public health and welfare risks and impacts associated with such climate change."[2] 74 Fed. Reg. at 66,497.

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[2] Because the vast majority of impacts are related to climate change, the general public (and this brief) uses the term "climate change" as short-hand for all such impacts. Other relevant impacts associated with elevated concentrations of CO_2 include ocean acidification and potential growth stimulus to plants. 74 Fed. Reg. at 66,532, 66,534.

The Administrator used her best judgment, guided by the statute and based on the science, to weigh potential risks and benefits and to determine whether, on balance, those effects may reasonably be anticipated to endanger public health or welfare. Id.

Regarding public health, the Administrator evaluated "the risks associated with changes in air quality, increases in temperatures, changes in extreme weather events, increases in food-and water-borne pathogens, and changes in aeroallergens" associated with climate change. 74 Fed. Reg. at 66,497, 66,524-31. Adverse effects observed and projected to occur include risks of sickness or mortality from reduced air quality, intensified heat waves, and more frequent and intense storms. 74 Fed. Reg. at 66,497-99, 66,516-36. The Administrator also considered that certain populations (e.g., children and the elderly) are more vulnerable to these effects. 74 Fed. Reg. at 66,526. The Administrator ultimately determined that "the public health of current generations is endangered," and that public health threats will mount over time as greenhouse gases continue to accumulate in the atmosphere. 74 Fed. Reg. at 66,524.

Regarding public welfare, the Administrator likewise considered the "multiple pathways" by which climate change generates risks. 74 Fed. Reg. at 66,531. Adverse public welfare effects observed to date and projected to occur in the future include increased drought, sea level rise, harm to agriculture, and harm

to wildlife and ecosystems. The Administrator found that the balance of evidence in every area considered provides support for an endangerment finding to public welfare, with strong support in the areas of water resources, sea level rise and coastal areas, infrastructure and settlements, ecosystems and wildlife, and adverse effects of extreme weather events. Id. at 66,497-99, 66,530-36.

C. The "Cause or Contribute" Finding.

For purposes of the "cause or contribute" finding, EPA defined the relevant "air pollutant" as "the aggregate group of the same six long-lived and directly-emitted greenhouse gases [used to define the relevant air pollution]," referred to in the Endangerment Finding as well-mixed greenhouse gases.[3] 74 Fed. Reg. at 66,536; see also id. at 66,499. These six gases share several common attributes that make their aggregation logical – among other things, all are directly-emitted, long-lived, and have well-understood heating effects. 74 Fed. Reg. at 66,537. After looking at both the share of global and of U.S. aggregate greenhouse gas emissions represented by emissions from Section 202(a) sources, the Administrator found that emissions of well-mixed greenhouse gases from new motor vehicles and

[3] The concept of defining an aggregation of compounds as a single "air pollutant" is not new. 74 Fed. Reg. at 66,540-41; infra at 80-81.

new motor vehicle engines "contribute" to the "air pollution" for which the endangerment finding was made.[4] 74 Fed. Reg. at 66,499, 66,537-45.

D. The Denial of Reconsideration.

EPA received ten voluminous petitions seeking administrative reconsideration of the Endangerment Finding. See 42 U.S.C. § 7607(d)(7)(B). These petitions raised two primary categories of objections regarding climate science. They challenged the validity of certain temperature data, arguing that it had been distorted, concealed, or manipulated by certain climate scientists. 75 Fed. Reg. at 49,570-76. The petitions also alleged that new information demonstrated mistakes and biases in analyses conducted by, or for, the IPCC, which they claimed undermined EPA's use of those analyses. Id. at 49,569-83.[5] These Petitioners' arguments focused on email communications involving scientists at the Climate Research Unit ("CRU") of the University of East Anglia in the United Kingdom (the so-called "climategate" emails). See id. at 49,563.

After a comprehensive review, EPA concluded that the arguments and evidence in these petitions were inadequate, generally unscientific, and failed to

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[4] For example, the Administrator noted that the amount of annual greenhouse gas emissions from Section 202(a) sources in the United States ranked behind only greenhouse gas emissions from China, the United States as a whole, Russia, and India. 74 Fed. Reg. at 66,539.

[5] The petitions for reconsideration also raised legal objections that EPA rejected as untimely and not of central relevance to the Endangerment Finding. 75 Fed. Reg. at 49,584-94.

show that the science supporting the Endangerment Finding was flawed, misinterpreted, or inappropriately applied. 75 Fed. Reg. at 49,557. As EPA explained, its understanding of how manmade emissions contribute to climate change, and of the risks and impacts of such change, "has been decades in the making," and has only become clearer over time – and Petitioners offered nothing to alter or undermine that understanding. Id. In general, EPA found that Petitioners relied on exaggerated, isolated, out-of-context evidence that was insufficient to challenge "the voluminous and well-documented body of science that is the technical foundation of the Administrator's Endangerment Finding." Id.; see also id. at 49,570.

EPA's conclusion was consistent with those reached by multiple independent bodies examining the CRU emails. Id. at 49,557. Although these inquiries concluded that some of the CRU's procedures could be improved, they – like EPA – ultimately found "no evidence of scientific misconduct or intentional data manipulation on the part of the climate researchers associated with the CRU e-mails." Id. at 49,558.

EPA thus denied the petitions because the Petitioners failed to provide substantial support for the argument that the Endangerment Finding should be revised, and therefore their objections were not of "central relevance" to that Finding. 75 Fed. Reg. at 49,558, 49,583-84; see generally id. at 49,563-84,

49,584-94 (detailing EPA's response to scientific, legal, and policy claims). EPA also concluded that, in many cases, the reconsideration Petitioners had failed to demonstrate that it would have been impracticable to raise their comments during the public comment period. Id.[6]

STANDARD OF REVIEW

This case is subject to the standard of review set forth in CAA Section 307(d)(9), 42 U.S.C. § 7607(d)(9),[7] under which the Court asks whether the challenged action was "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." Id. This standard of review "is a narrow one," and the Court is not "to substitute its judgment for that of the agency." Citizens to Preserve Overton Park, Inc. v. Volpe, 401 U.S. 402, 416 (1971). The pertinent question is simply "whether the [agency's] decision was based on a consideration of the relevant factors and whether there has been a clear error of judgment."

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[6] The three-volume RTP provides a more detailed response to the petitions. Pertinent excerpts are included in the Joint Appendix. A complete copy of the RTP, as well as the administrative petitions and other related materials, is available at http://www.epa.gov/climatechange/endangerment/petitions.html (last visited Nov. 10, 2011).

[7] The requirements of CAA Section 307(d) apply to a set of enumerated agency actions and any other EPA action so designated by the Agency. See 42 U.S.C. § 7607(d)(1). Here, EPA noted the application of Section 307(d) in both the proposed and final Endangerment Finding. See 74 Fed. Reg. at 18,886, 18,889 n.4 (Apr. 24, 2009) (proposal); 74 Fed. Reg. at 66,504-05 (final). As discussed herein, Petitioners challenge some aspects of the application of Section 307(d)(8), 42 U.S.C. § 7607(d)(8), to their claims regarding review by the Science Advisory Board, but they do not otherwise challenge the application of Section 307(d) to the Endangerment Finding.

Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co., 463 U.S. 29, 43-44 (1983).

Particular deference is given to an agency with regard to technical matters within its area of expertise.[8] Although Petitioners acknowledge this general rule, they wrongly contend that EPA forfeited this deference by using third-party scientific assessments as the primary scientific and technical basis for the Endangerment Finding.[9] See Ind. Br. 42-43. Petitioners base this argument on Achernar Broad. Co. v. FCC, 62 F.3d 1441, 1447 (D.C. Cir. 1995), but Achernar concerned an agency's failure to consider options other than a complete denial of the license application at issue. There is nothing in the opinion to suggest that the Court withheld deference from the agency based on the agency's failure to exercise its own technical expertise. Id. at 1447-48.[10] By contrast, in this case, there can be no serious contention that EPA failed to consider any aspect of the complex scientific issues underlying the Endangerment Finding. See infra II.B.-D. Petitioners' claims that the record does not support the Endangerment Finding are

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[8] See Baltimore Gas & Elec. Co. v. NRDC, 462 U.S. 87, 103 (1983); see also, e.g., West Virginia v. EPA, 362 F.3d 861, 867-68 (D.C. Cir. 2004).

[9] Petitioners' claim that EPA did not exercise independent judgment in evaluating the scientific evidence and making the Endangerment Finding, see Ind. Br. 42-43, is addressed infra at 36-38

[10] Petitioners also cite NLRB v. P.I.E. Nationwide, Inc., 923 F.2d 506, 518 n.16 (7th Cir. 1991) for the proposition that an agency "must exercise its touted expertise and explain the rationale and factual basis for its decision.'" (citation omitted) As discussed in detail below, EPA has done so.

not a basis for denying EPA deference on what is inarguably a highly complex scientific issue on which EPA has expertise. To the contrary, Petitioners' arguments are to be assessed *in light of* that deference.

Judicial deference also extends to an agency's interpretation of a statute it administers. Chevron U.S.A. Inc. v. NRDC, 467 U.S. 837, 842-45 (1984). Under the first step of Chevron, if Congress has "directly spoken to the precise question at issue," that intent must be given effect. 467 U.S. at 842-43. However, under Chevron's second step, "if the statute is silent or ambiguous with respect to the specific issue, the question for the court is whether the agency's answer is based on a permissible construction of the statute." Id. at 843.

SUMMARY OF ARGUMENT

The Endangerment Finding and the Reconsideration Denial are entirely consistent with the Act and more than amply explained by the Agency and supported by the record. Perhaps because of this, Petitioners' challenges to these actions are mostly indirect and take insufficient account of the comprehensive administrative record and the requirements of the statute. Petitioners argue at length that the legal and technical framework for the Endangerment Finding should be wholly (and unjustifiably) re-engineered to fit Petitioners' notion of rational decisionmaking, all the while ignoring that their preferred approach is completely at odds with clear congressional intent. They also pay scant attention to the actual,

articulated basis for EPA's scientific findings, and instead focus almost entirely on their own inappropriate and unjustified characterization of the record. Such tactics do not meet Petitioners' burden of proving that the Endangerment Finding and Reconsideration Denial are arbitrary, capricious, or contrary to law.

In the first part of this brief, we explain why the basic legal framework EPA used to analyze the endangerment question is entirely consistent with the statute, its legislative history, and applicable judicial guidance. The present version of Section 202(a)(1), 42 U.S.C. § 7521(a)(1), was drafted specifically to endorse this Court's en banc decision in Ethyl Corp. v. EPA, 541 F.2d 1 (D.C. Cir. 1976), which articulated an approach to "endangerment" that focuses on prevention of adverse impacts to public health and welfare before they occur and, to that end, explicitly eliminated just the sort of empirical hurdles Petitioners advocate here.

Next, we explain in detail why the administrative record offers overwhelming support for the Agency's conclusion that air pollution, in the form of atmospheric concentrations of six greenhouse gases, may be reasonably anticipated to endanger public health and welfare. In fact, most of the key components of EPA's scientific analysis are essentially undisputed. Although Petitioners mount numerous scattershot challenges to the science and data on which EPA relied, these amount to little more than mistaken or essentially irrelevant characterizations of isolated parts of an abundant and convincing

technical record. The petitions for administrative reconsideration of the Endangerment Finding were based entirely on arguments that did not raise issues of "central relevance" to the Endangerment Finding within the meaning of CAA Section 307(d)(7)(B), 42 U.S.C. § 7607(d)(7)(B), and that in many cases could have been raised during the comment period. Accordingly, EPA also acted reasonably in denying those petitions.

Neither is there merit to Petitioners' contention that EPA erred in classifying the atmospheric mix of six long-lived, heat-trapping gases as the "air pollutant" that was the focus of the Agency's contribution analysis. Both the statute and EPA's regulatory precedent support such an approach. Furthermore, these gases, collectively, are the primary driver of the climate effects that are the focus of the Endangerment Finding and share common, relevant attributes that make their aggregation as a single air pollutant sensible. The air pollutant is properly defined as the same mix of gases as the air pollution.

It was more than reasonable for EPA to reject the suggestion that judging the presence or absence of an "endangerment" required the Agency to quantify safe and unsafe levels of risk from climate change and to gauge the extent to which subsequent emission standards might ameliorate these risks. EPA also reasonably deemed irrelevant to its endangerment analysis a variety of factors that are not mentioned in section 202(a)(1) and that do not directly relate to a determination of

the effects of the air pollution at issue. For example, Petitioners argue at length that EPA should have considered the impacts that eventual regulation of greenhouse gas emissions from stationary sources might have, but stationary source issues are nowhere even mentioned in Section 202(a)(1). EPA also correctly determined that consideration of other factors stressed by Petitioners – such as the alleged societal benefits of pollution-causing activities and the extent to which Americans might adapt to or mitigate adverse impacts to public health and welfare – is not required by Section 202(a)(1) and would be antithetical to congressional goals and intent.

Finally, Petitioners' claims concerning the alleged necessity of review by the SAB should be denied on waiver grounds and because they are meritless, in any event.

ARGUMENT

I. THE ENDANGERMENT FINDING IS PREMISED ON EPA'S SOUND AND APPROPRIATE CONSTRUCTION OF THE CLEAN AIR ACT

As discussed above, Section 202 of the Act, 42 U.S.C. § 7521, establishes a two-step path to regulation of emissions from new motor vehicles and engines. In the first step, pursuant to Section 202(a)(1), EPA is to determine whether, in the Administrator's "judgment," emissions of "any air pollutant" from such sources "cause or contribute" to "air pollution which may reasonably be anticipated to

endanger public health or welfare." 42 U.S.C. § 7521(a)(1). This is commonly referred to as an "endangerment" finding. If the Administrator makes a positive endangerment finding, EPA is directed to issue standards applicable to those emissions, id., taking into account the cost and technological factors set forth separately in subsection 202(a)(2), 42 U.S.C. § 7521(a)(2).

In this case, EPA made the Endangerment Finding in a separate proceeding from the emission standards (i.e., the Vehicle Rule). While this is a slightly different procedure than EPA has most often used in the past,[11] there is no substantive difference, since EPA customarily sets forth its "endangerment" analysis separately from its analysis of the related regulatory standards even where both are combined into one Federal Register notice.[12]

While Petitioners do not contest EPA's procedural discretion to make a separate endangerment finding, see Ind. Br. 13, they argue that EPA cannot make an endangerment finding unless it quantifies the degree of risk posed by the identified endangerment and finds that corresponding motor vehicle standards will

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[11] But see, e.g., 65 Fed. Reg. 76,790 (Dec. 7, 2000) (stand-alone endangerment finding for certain types of spark-ignition engines).

[12] See, e.g., 69 Fed. Reg. 38,958, 38,962-63 (June 29, 2004); 59 Fed. Reg. 31,306, 31,318 (June 17, 1994) (regulation of certain emissions from nonroad engines pursuant to CAA Section 213(a)(4), 42 U.S.C. § 7513(a)(4) (1994) (final rules); 68 Fed. Reg. 28,328, 28,336-37 (May 23, 2003); 58 Fed. Reg. 28,809, 28,845-46 (May 17, 1993) (nonroad engines proposed rules); see also, e.g., 66 Fed. Reg. 5002, 5007-08 (Jan. 18, 2001) (standards for highway heavy duty diesel engines and diesel sulfur fuel - final); 65 Fed. Reg. 35,430, 35,435-46 (June 2, 2000) (proposal).

substantially address that risk. Indeed, Petitioners even contend that EPA should have integrated certain aspects of *stationary* source regulation of greenhouse gas emissions into its analysis for the Endangerment Finding. As we discuss in Parts V and VI of this brief, infra, none of Petitioners' arguments on these points is correct.[13]

Instead, as we discuss in this section, EPA properly construed the statute (in light of its text, structure, legislative history, and applicable precedent) as requiring the Endangerment Finding to be focused solely on a precautionary, science-based judgment by the Administrator as to whether or not the motor vehicle emissions in question cause or contribute to air pollution that is reasonably anticipated to endanger public health or welfare. EPA's approach to the endangerment question should be upheld as, at the very least, "reasonable" under Chevron, 467 U.S. at 844.

A. The Endangerment Finding Is Properly Focused Solely on the Science Pertaining to the Public Health and Welfare Impacts of the Air Pollution Under Consideration.

As the Supreme Court made clear in Massachusetts, the endangerment and contribution criteria enumerated in Section 202(a)(1) limit the Agency to a science-

[13] Some of Petitioners' challenges appear to relate, at least in part, to the Vehicle Rule, which is not before the Court in this case. See, e.g., Ind. Br. 13, 24-28. EPA's record for the Vehicle Rule fully addresses all factors properly before the agency in adopting emissions standards, and any objections to the Vehicle Rule are properly raised in the litigation on that rule, not in this action.

based judgment as to whether greenhouse gas concentrations in the atmosphere constitute "air pollution" that may reasonably be anticipated to endanger public health or welfare, and whether vehicle emissions cause or contribute to that air pollution. 74 Fed. Reg. at 66,507 (citing Massachusetts, 549 U.S. at 532-34). The cost and technology considerations relevant to promulgation of subsequent mobile source emission standards are separately enumerated in the standard-setting provisions of Section 202(a)(2) of the Act, and it is solely in that context that Congress intended EPA to consider cost of compliance and the period necessary to permit the development and application of the requisite technology. See 74 Fed. Reg. at 66,508; see also Massachusetts, 549 U.S. at 533-34. Nor are issues regarding stationary sources, which are not mentioned in Section 202(a)(1) or (2) at all, related to "the science of greenhouse gases or climate change, or the impacts of climate change on public health or welfare." 74 Fed. Reg. at 66,515; see also id. at 66,500-01 ("EPA is limited to consideration of science when undertaking an endangerment finding . . . ."). As the Supreme Court stated ''EPA can avoid taking further action only if it determines that greenhouse gases do not contribute to climate change or if it provides some reasonable explanation as to why it cannot or will not exercise its discretion to determine whether they do.'' 549 U.S. at 533; see also id. at 533–34 (rejecting certain by EPA policy arguments, noting that those arguments "have nothing to do with whether greenhouse gas emissions contribute

to climate change. Still less do they amount to a reasoned justification for declining to form *a scientific judgment*'') (emphasis added). As EPA reasonably concluded, the Administrator "must base her decision about endangerment on the science, and not on policy considerations about the repercussions or impact of such a finding." 74 Fed. Reg. at 66,515.

B. The Legislative History of Section 202(a)(1) Confirms That "Endangerment" Is a Protective, Science-Based Judgment Focused Solely on the Potential Threat to Public Health and Welfare From Air Pollution.

Pertinent legislative history also confirms that an endangerment finding under Section 202(a)(1) was intended by Congress to be a protective, science-based judgment (not a fact-finding exercise) that is focused solely on potential threats to public health and welfare posed by air pollution.

The present text of the endangerment provision in Section 202(a)(1) was added by Congress in 1977 as an affirmation of Ethyl Corp v. EPA, 541 F.2d 1 (D.C. Cir. 1976) (en banc), which upheld EPA regulations restricting the amount of lead in gasoline. Before the Court in Ethyl was a pre-1977 fuel provision in Section 211(c)(1)(A), 42 U.S.C. § 1857f-6c(1)(A) (1976), which provided that EPA could regulate fuel additives whose emissions "will endanger the public health or welfare." See Ethyl, 541 F.2d at 7. After a thorough analysis, this Court concluded that even this older "will endanger" standard "is precautionary in nature

and does not require proof of actual harm before regulation is appropriate." Id. at 17.

The Court in Ethyl opined that "a determination of endangerment to public health is necessarily a question of policy that is to be based on an assessment of risks and that should not be bound by either the procedural or the substantive rigor proper for questions of fact." Id. at 24. Such an approach is particularly important in the environmental context, where an elusive search for scientific "certainty" will "often allow for only reactive, not preventive, regulation." Id. at 25.

The Ethyl court specifically distinguished the "will endanger the public health or welfare" provision from another CAA provision which required EPA to make a finding as to whether the fuel additive would impair the performance of emission control devices. See Ethyl, 541 F.2d at 23-24. The Court explained that those other provisions call for a "peculiarly factual finding" that is "inherently unlike" the endangerment standard: "[d]anger is a risk, and so must be decided by assessment of risks as well as by proof of facts." Id. at 24. The Court noted that in 1970, Congress had expressly considered, but rejected, a House bill that would have established fact-based findings that the Administrator would have had to make in conjunction with an endangerment finding. Id. at 21-23. Further, this aspect of the en banc Court's decision in Ethyl was vigorously criticized in the dissent, which would instead have imputed a fact-finding requirement into the

"will endanger" determination. See Ethyl, 541 F.2d at 94-97 (Wilkey, J., dissenting). Thus, this Court clearly, knowingly, and expressly rejected the argument that detailed fact-finding must accompany a "judgment" of endangerment under the Act.

When Congress amended the Act in 1977 to ratify the approach taken in Ethyl, it explained its goals in remarkable detail. See H.R. Rep. No. 95-294, at 43-51, reprinted in 1977 U.S.C.C.A.N. 1077, 1121-29.[14] Among other things, Congress stressed that it intended to emphasize "the preventative or precautionary nature of the act" and "the predominant value of protection of public health." Id. at 49, 1977 U.S.C.C.A.N. at 1127. Further, Congress stressed that it "authorize[d] the Administrator to weigh risks and make reasonable projections of future trends" and directed the Administrator "[t]o assure that the health of susceptible individuals, as well as healthy adults, will be encompassed in the term 'public health' . . . ." Id. at 49-50, 1977 U.S.C.C.A.N. at 1127-28.

Congress also recognized that in light of the inherent "uncertainties and limitations in the data which will be available to the Administrator," courts should conduct "adequate judicial review of the reasonableness of the Administrator's

[14] These revisions to the endangerment provisions in the Act were part of the House bill and were concurred in by the Senate. See 1977 U.S.C.C.A.N. 1502, 1564. The House Report was cited and discussed in both the D.C. Circuit and Supreme Court decisions in Massachusetts v. EPA. See Massachusetts v. EPA, 549 U.S. at 506 n.7; Massachusetts v. EPA, 415 F.3d 50, 76-77 (D.C. Cir. 2005) (Tatel, J., dissenting), reversed, 549 U.S. 497 (2007).

judgment in assessing risks" but should not "attempt[] to act 'as the equivalent of a combined Ph. D. in chemistry, biology, and statistics' . . . ." Id. at 50, 1977 U.S.C.C.A.N. at 1128. Congress therefore changed the former "will endanger" criterion to the present "may reasonably be anticipated to endanger," and expressly characterized the finding as an exercise of "judgment" by the Administrator. Id. at 51, 1977 U.S.C.C.A.N. at 1129. Congress explained that while the Administrator must exercise her judgment reasonably, and cannot base an endangerment finding on "'crystal ball' speculation," she is authorized to make "comparative assessment[s] of risks" and "projections of future possibilities" based on "extrapolat[ions] from limited data." Id. at 50-51, 1977 U.S.C.C.A.N. at 1128-29. In this regard, the Committee noted that it had considered and "expressly rejected" an amendment that would have deleted the phrase "in his judgment" and replaced it with a provision requiring factual findings instead. Id. at 51, 1977 U.S.C.C.A.N. at 1129.

A number of pertinent conclusions are apparent from the foregoing. First, Congress' overwhelming focus in crafting the present language of the endangerment provision in Section 202(a)(1) was the protection of the public from risks to health and welfare from air pollution. Second, Congress recognized that the Administrator must be able to take action even with incomplete and uncertain data if she is going to be able to effectuate the goal of acting to prevent harm

before it occurs.[15] Third, while Congress recognized that the Administrator must take reasonable account of available evidence, it also specifically intended an endangerment finding to be an exercise of judgment, not a factual finding. Fourth, Congress intended the Administrator's duty to protect public health to be quite broad, including, for example, the obligation to protect the health even of especially "sensitive" populations.

In sum, for all the foregoing reasons, EPA properly construed the Act as focusing an endangerment finding under Section 202(a)(1) solely on two questions: (1) whether "air pollution" (in this case atmospheric concentrations of six greenhouse gases) may reasonably be anticipated to endanger public health or welfare; and (2) whether motor vehicle emissions cause or contribute to this air pollution. As we will discuss in the following sections, EPA had overwhelming evidence in the record to support its judgment that both of these questions should be answered in the affirmative here, and ample legal basis to reject the alternative approaches to the endangerment inquiry advocated by Petitioners.

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[15] As EPA explained, see 74 Fed. Reg. at 66,508, Congress' discussion of "prevention" of harm was meant to rebut the suggestion that EPA should be precluded from making an endangerment finding before actual harm had occurred, and had nothing to do with any assessment of possible emission controls. Id.; see also H.R. Rep. No. 95-294, at 48-49, 1977 U.S.C.C.A.N. at 1126-27.

II. THE RECORD SUPPORTS THE ADMINISTRATOR'S FINDING THAT ELEVATED CONCENTRATIONS OF GREENHOUSE GASES ARE REASONABLY ANTICIPATED TO ENDANGER PUBLIC HEALTH AND WELFARE

The Endangerment Finding is based on an extensive, intensely scrutinized and peer-reviewed scientific record. See supra at 12-14; 74 Fed. Reg. at 66,497, 66,510-12. Much of the basic scientific information underlying the Administrator's finding is, moreover, essentially undisputed. That greenhouse gases trap heat; that trapped heat in turn warms the climate; that levels of greenhouse gases in the atmosphere are increasing; that this increase is caused by human activity; and that greenhouse gas levels in the atmosphere are projected to continue rising for the foreseeable future – none of this is seriously disputed.

Petitioners are unable to rebut these well-documented conclusions, and thus launch unfocused and unjustified attacks on isolated elements of the administrative record. Given EPA's comprehensive review of a robust scientific record, EPA's imperative to act to prevent harm even in the face of uncertainty, and the high degree of deference due EPA on matters of scientific interpretation within the Agency's core area of expertise, Petitioners' attacks fail. [16]

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[16] Petitioners suggest that EPA rushed the Endangerment Finding for policy reasons. See Ind. Br. 5-6, 33; see also Kan. Br. 7. EPA explained, however, that given the ten years since the original petition, it had "a responsibility to respond to the Supreme Court's decision and to fulfill its obligation under current law," and that there was "good reason to act now given the urgency of the threat of climate change and the compelling scientific evidence." 74 Fed. Reg. 66,500-01.

A. The Administrator Relied On Well-Founded Science to Make Her Judgment.

The Administrator properly relied on the thorough assessments prepared by the IPCC, the NRC, and the USGCRP as the primary scientific and technical basis for the Endangerment Finding. 74 Fed. Reg. at 66,510-12; 75 Fed. Reg. at 49,581-82. In EPA's view, these assessments were, and remain, the best source materials for determining the state of science with regard to climate change.[17] 74 Fed. Reg. at 66,511; supra at 13-14. The assessments synthesize an extensive body of scientific studies, and ultimately demonstrate the broad scientific consensus on how greenhouse gases affect the climate, as well as the impact of present and projected future climate changes on human health, society, and the environment.[18] 74 Fed. Reg. 66, 511. Both EPA's summary of the science and its rationale for relying primarily on these assessment reports underwent notice and comment. 74

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[17] A subsequent 2010 National Research Council assessment confirms the robustness of these analyses. This study is in the record supporting the denial of reconsideration. See National Research Council (NRC) (2010), Advancing the Science of Climate Change, National Academy Press, Washington, D.C., EPA HQ OAR-2009-0171-12091; 75 Fed. Reg. at 49,558.

[18] Contrary to Petitioners' contention, EPA was not required to place the "scientific data underlying" the hundreds to thousands of studies summarized in these assessments in the docket. See Va. Br. 30; see also Kan. Br. 26-27. This Court has flatly rejected the same argument in prior cases under the Act. See Coal. of Battery Recyclers Ass'n v. EPA, 604 F.3d 613, 622-23 (D.C. Cir. 2010); Am. Trucking Ass'ns v. EPA, 283 F.3d 355, 372 (D.C. Cir. 2002) ("requiring agencies to obtain and publicize the data underlying all studies on which they rely 'would be impractical and unnecessary'") (citation omitted).

Fed. Reg. at 18,894. EPA's conclusion that it "has no reason to believe that the assessment reports do not represent the best source material" for an endangerment finding, and that putting the existing assessments aside and attempting to develop a new assessment would not "provide any better basis for making the endangerment decision," 74 Fed. Reg. at 66,511, was thus reached only after a careful and thorough review.

Although the scientific assessments reviewed by EPA provided the principal source materials for the Endangerment Finding, the Administrator exercised her own judgment in making that Finding. See, e.g., 74 Fed. Reg. at 66,497 (Administrator determined that scientific evidence compellingly supports an endangerment finding; assessments by USGCRP, IPCC, and others "serve as the primary scientific basis supporting the Administrator's endangerment finding"); see generally id. at 66,497-99; RTP 3-2 (JA 4833-37). This Court has stated that an agency does not improperly delegate its authority or judgment merely by using work performed by outside parties as the factual basis for its decision making. See U.S. Telecom Ass'n v. FCC, 359 F.3d 554, 567-68 (D.C. Cir. 2004); United Steelworkers of Am. v. Marshall, 647 F.2d 1189, 1216-17 (D.C. Cir. 1980).[19]

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[19] In U.S. Telecomm Ass'n, the D.C. Circuit concluded that an agency had acted unlawfully by expressly delegating its decision-making authority to state commissions. 359 F.3d at 565; see Va. Br. 29. Petitioners do not allege that EPA expressly delegated its Section 202(a) authority, nor did EPA do so.

In United Steelworkers, the Court rejected an argument that an agency had improperly relied on outside consultants where the petitioning party "[could not] buttress its general allegation of excessive reliance with any specific proof that the Assistant Secretary failed to confront personally the essential evidence and arguments" at issue. 647 F.2d at 1217. As the Court elaborated, "unsupported allegation[s]" could not "overcome the presumption that agency officials and those who assist them have acted properly." Id. Petitioners' conclusory assertion that the Administrator did not exercise her own judgment (see, e.g. Ind. Br. 33, Va. Br. 31) is both "unsupported" by "specific proof" and directly contradicted by the administrative record. See generally Va. Br. 23, 27-30, 35; Ind. Br. 7-8, 33, 42; see also Amicus Brief of the State of Kansas ("Kan. Br.") 1-2.[20]

Neither can Petitioners overcome the overwhelming weight of the record establishing that the IPCC, NRC, and USGCRP assessments represent a "comprehensive assessment of the scientific literature," and the best possible scientific foundation for the Endangerment Finding.[21] See RTC 1-2 (JA 3561-63). Industry Petitioners suggest that the IPCC assessments are unreliable because the

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[20] Amicus State of Kansas claims that the IPCC "concluded that anthropogenic emissions endanger public health and welfare." Kan. Br. 2. Kansas' only support for the proposition that the *IPCC* reached this conclusion is a general citation to *EPA's* Endangerment Finding. See id. n.1. Kansas has thus provided no evidence that the IPCC, as opposed to EPA, was responsible for this conclusion.

[21] Petitioners' meritless arguments concerning alleged deficiencies in the IPCC assessment that were raised in the petitions for reconsideration are addressed infra at 73-75.

IPCC was allegedly chartered "for the express purpose of studying human-induced climate change." Ind. Br. 8. The IPCC, however, unquestionably considered *both* natural climate variability and human factors. See, e.g., TSD at 48 (JA 3396) (IPCC finds that manmade greenhouse gases, increasing solar output, and relative lack of volcanic activity contributed to temperature rise during early part of 20th century).[22]

There was, moreover, ample opportunity for public review and comment on these assessments and EPA's use of them. The 2008 ANPR sought comment on the best available science for an endangerment finding, including the IPCC and U.S. Climate Change Science Program (now the USGCRP). 73 Fed. Reg. at 44,425. The assessments also underwent their own peer review and (for the IPCC and the USGCRP) public review process.[23] 74 Fed. Reg. at 66,503. Counting the comment period for the ANPR and for the Endangerment Finding itself, the public had at least 180 days – six months – to comment on the scientific and technical

[22] Kansas' related claim that the IPCC "is not a scientific body but a political body," Kan. Br. 12, is backed by nothing more than Kansas' own speculations regarding the "expected" motivations of scientists participating in the IPCC.

[23] Petitioners claim that the public did not have an opportunity to comment on these assessments while they were being prepared, Va. Br. 34, but cite nothing to support this statement.

basis for that Finding. Petitioners offer no evidence to support their conclusory claim that this period was inadequate.[24] Va. Br. 34-35; see also Kan. Br. 25-26.

Petitioners' claim that EPA improperly delegated its judgment, or improperly relied on thorough scientific assessments, must therefore be rejected.

B. EPA's Conclusions Were Reached After Careful Consideration of Uncertainty.

Where a statute is precautionary, actions under that statute are designed to protect the public health, evidence is "difficult to come by, uncertain, or conflicting because it is on the frontiers of scientific knowledge," and the ultimate endangerment determination is "that of an expert administrator," the Court "will not demand rigorous step-by-step proof of cause and effect." Ethyl Corp., 541 F.2d at 27-28; see also Part I.B, supra. This is particularly true in the environmental context, where demanding scientific certainty would "often allow for only reactive, not preventive, regulation." Ethyl, 541 F.2d at 25. Section 202(a) is just such a provision; thus, EPA can act to prevent harm even in the face of uncertainty. See supra at 32-34; Lead Indust. Ass'n v. EPA, 647 F.2d 1130,

[24] Petitioners also suggest that EPA merely cited scientific assessments in its response to public comments. Va. Br. 35. Petitioners have, however, failed to offer even a single example of an allegedly inadequate comment response. See id. n.20. EPA naturally cited the assessments that form the primary technical and scientific basis for the Endangerment Finding; however, in doing so, it typically also considered the underlying literature. See, e.g., RTC 3-16 (JA 3823-25); RTC 3-28 (JA 3835-36); RTC 3-33 (JA 3838-39). The record thus contradicts Petitioners' claim that EPA "dismiss[ed]" public comments based on third-party disagreement. Va. Br. 35.

1155 (D.C. Cir. 1980) (requiring EPA to conclusively demonstrate adverse health effects would be inconsistent with precautionary and preventive nature of statute).

Given that Petitioners cannot reasonably claim that EPA is *required* to achieve 100% certainty, they turn to claiming that EPA *chose* to assign a near-100% level of certainty to its conclusions, as well as to the scientific evidence supporting those conclusions (the "high risk" aspect of Petitioners' high risk/high harm straw man). See, e.g., Ind. Br. 2, 43, 44, 45, 48. In fact, the 90-99% certainty Petitioners reference was used by the Administrator in regards to specific statements, including the Administrator's conclusion that "[m]ost of the observed increase in global average temperatures since the mid-20th century is very likely [i.e., 90 to 99% likely] due to the observed increase in anthropogenic greenhouse gas concentrations." 74 Fed. Reg. at 66,518. Petitioners improperly cite this Federal Register passage (which refers to the causes of recent warming, not the risks from climate change) to assert that EPA "is 90-99% certain that human-caused climate change threatens public health and welfare." Ind. Br. 2.

Petitioners do not offer any citations to support their claims that EPA was uniformly 90-99% certain of all aspects of the Endangerment Finding. See, e.g., Ind. Br. 44 (referring, without citation, to "EPA's 90-99% confidence risk assessment"); 54-55 (suggesting, without citation, that EPA claimed to be 90-99% certain of particular evidence). Petitioners cannot do so. In fact, the

Administrator's endangerment finding was based on a consideration of "the *totality* of scientific evidence, *some of which was assessed as being virtually certain . . . while other evidence was less certain*." RTC 1-35 (JA 3593) (emphasis added); see also 74 Fed. Reg. at 66,497 (recognizing variety in nature and potential risks and impacts of human-induced climate change), 66,506 (recognizing "varying degrees of uncertainty" in scientific issues).

The question for the Court is not whether EPA can demonstrate that the Endangerment Finding and the evidence supporting it are beyond questioning, or that every piece of evidence points only in support of that Finding.[25] It is, rather, whether EPA took all relevant record material into account in a "rational manner;" if it did so, the Court will not overrule EPA's expert judgment. See Am. Petroleum Inst. v. Costle, 665 F.2d 1176, 1187 (D.C. Cir. 1981). As discussed in

[25] Petitioners cite New York v. EPA, 413 F.3d 3, 31 (D.C. Cir. 2005) for the proposition that an agency "must offer [an] adequate rationale where 'evidence in the record may also support other conclusions.'" Ind. Br. 46. New York actually states that "the fact that the evidence in the record may also support other conclusions" *did not prevent the Court from concluding that EPA's decisions were rational and supported by the record*. 413 F.3d at 31 (citations and internal quotations omitted). To the extent Petitioners suggest the existence of conflicting or uncertain evidence calls EPA's conclusions into question, their argument is inconsistent with well-established precedent. See, e.g., Lead Indust., 647 F.2d at 1160 ("disagreement among the experts is inevitable when the issues involved are at the 'very frontiers of scientific knowledge,' and such disagreement does not preclude us from finding that the Administrator's decisions are adequately supported by the evidence in the record").

the following sections, EPA did so, and the robust administrative record fully supports the Endangerment Finding.

C. The Record Supports Attribution of Most of the Recent Climate Change to Manmade Greenhouse Gas Emissions.

EPA's conclusion that manmade greenhouse gas emissions have very likely caused most of the past half-century of warming is supported by three lines of evidence: a "basic physical understanding" of the impacts of various changes (both natural and manmade) on the climate system, historical estimates that suggest recent changes in global surface temperature are unusual, and computer-based models that simulate the climate's likely response to various forcing mechanisms. 74 Fed. Reg. at 66,518. Petitioners offer nothing that contradicts the overwhelming weight of the administrative record, which demonstrates that each of these three lines of evidence provides significant support for the Endangerment Finding.

1. The Endangerment Finding is consistent with a basic physical understanding of the climate.

Regarding the first line of evidence, Petitioners do not dispute certain basic physical facts about the effect of greenhouse gases. Ind. Br. 45 ("The physical properties of [greenhouse gases] are well understood . . ."); Ind. Br. 47 (greenhouse gases increase amount of heat retained in atmosphere). Instead, they suggest that there is too much uncertainty about *other* factors for EPA to have high confidence

that manmade greenhouse gases are very likely responsible for most recent warming. See Ind. Br. 44-46. Petitioners have, however, dramatically overstated the nature and significance of uncertainties in the record, and have failed to demonstrate that, when the record is viewed as a whole, EPA's conclusion regarding the likely cause of recent warming is arbitrary or capricious.

a. Solar energy.

Solar energy plays a key role in the earth's temperature, and a change in solar energy can lead to either warming or cooling of the climate. The assessment reports found that the warming of the past half-century occurred when natural forcings – including changes in solar activity – would likely have produced cooling, not warming. 74 Fed. Reg. at 66,518; see also, e.g., TSD at 50 (JA 3398) (natural external forcing factors would likely have produced cooling rather than warming during past half century). In addition, the pattern of recent warming in the atmosphere is consistent with warming from increased greenhouse gases, and inconsistent with warming from increased solar radiation. RTC 3-24, 3-25 (JA 3831-33). Petitioners do not contest this evidence.

Instead, Petitioners point to the IPCC's assignment of a low level of scientific understanding to a quantification of the heating effect of solar energy ("radiative forcing") from 1750 to 2005, and assert that this uncertainty is inconsistent with a conclusion that most of the recent warming is very likely

caused by human activity. See Ind. Br. 45. EPA's conclusion, however, concerns warming since the mid-20th century, not over the last 250 years. See IPCC Table 2.12 (JA 4987); TSD at 24 (JA 3372).[26] In addition, the IPCC categorized two specific factors related to solar energy as "uncertainties" over this 250-year time period: "relationship between proxy data and total solar irradiance," and "indirect ozone effects." Table 2.11, Ind. Br. C-3. The "proxy data" uncertainty refers to inferring historical solar activity by using *indirect* measures.[27] See RTC 3-35 (JA 3840-42). Importantly, for over a quarter of a century, there has been continuous *direct* monitoring of total solar energy – and in the table cited by Petitioners, the IPCC characterizes these direct measurements as a "certainty." Table 2.11, Ind. Br. C-3; RTC 3-24 (JA 3831-32).

EPA's conclusion regarding warming over the last half-century is thus supported by "certain" measurements of solar energy extending over half of that period. In addition, EPA properly accounted for uncertainty regarding historical solar irradiance by acknowledging solar heating effects as a *range*, not as an absolute figure. See TSD at 26 (JA 3374) ("[c]hanges in solar irradiance since

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[26] EPA referred to warming since 1750 to support the view that greenhouse gases are the largest of the manmade drivers of warming. 74 Fed. Reg. at 66,517, n.19.

[27] The "ozone effects" uncertainty refers to changes in the ozone layer due to changes in UV radiation from the sun. The IPCC estimated that accounting for UV variations could lead to a decrease in estimates of solar heating of up to 15%, meaning this uncertainty points to *less* warming attributable to solar activity, not more. IPCC Fourth Assessment Report ("AR4") at 192 (JA 4983).

1750 are estimated to cause a radiative forcing of . . . +.06 to +.30 W/m^2 ["watts per square meter," a measure of net heating effect]) (emphasis added); see also RTC 3-24 (JA 3831-32). Even the *maximum* warming effect that could have been caused by solar energy changes over the past 250 years (+.30 W/m^2) is only about 13% of the *minimum* +2.38 W/m^2 warming effect due to the increase in concentrations of the long-lived greenhouse gases during the same time period. See TSD at 24 (JA 3372); RTC 3-24 (JA 3831-32). Petitioners have not demonstrated that uncertainty regarding historical solar irradiance over 250 years undermines EPA's conclusions regarding the dominant cause of warming over the last half-century.

b. Reflection of solar energy.

Clouds and aerosols in the atmosphere reflect solar radiation, thus limiting solar warming of the climate. See AR4 at 96 (JA 4979). As with their claims regarding solar radiation, Petitioners argue that a low level of scientific understanding regarding the quantification of cloud effects on the climate over the last 250 years undermines EPA's conclusions regarding the cause of warming over the last half-century. Ind. Br. 45. And as with solar radiation, this uncertainty concerns quantifying effects over a much longer time period than the recent warming addressed in the Endangerment Finding. This uncertainty is again accounted for by expressing these effects as a range; moreover, heating caused by

increased greenhouse gases is shown to outweigh any potential cloud effects. See TSD at 23-24 and Figure 4.1 (JA 3371-72).

c. Climate feedbacks.

There is no dispute that greenhouse gases trap heat that would otherwise escape the planet; the more greenhouse gases in the atmosphere, the more heat is trapped. See supra at 14. "Feedbacks" are processes that can either amplify or dampen the climate system's initial response to heating – positive feedbacks tend to increase warming, while negative feedbacks tend to reduce warming. TSD at 26 (JA 3374). Contrary to Petitioners' claims, feedbacks are not "poorly understood," nor are they mere "assumptions." Ind. Br. 47; see also id. at 45. They result from scientific principles representing interactions between different elements of the climate system. For example, it is well-established that as air temperature increases, the air can hold more water. Increased water vapor in the atmosphere traps even more heat, thus causing even more warming (a positive feedback). See TSD at 26, 66 (JA 3374, 3414).

There is strong evidence that when all feedbacks are considered together and all uncertainties are accounted for, the net effect is one of increased warming – in other words, negative (cooling) feedbacks are insufficient to cancel positive (warming) feedbacks. See TSD at 66 (JA 3414) (IPCC concludes that climate sensitivity is very likely greater than 2.7°F, which means a net warming effect

from feedbacks). Petitioners' suggestion that the effect of greenhouse gases could somehow be "canceled" by feedbacks, Ind. Br. 45, is thus inconsistent with the administrative record.

Petitioners have, in sum, failed to demonstrate that recognized uncertainties regarding quantifying the precise effects of solar radiation, the reflection of that radiation by clouds and aerosols, and climate feedbacks undermine the Endangerment Finding.[28]

2. The record supports EPA's conclusions regarding temperature trends.

With respect to the second line of evidence, EPA concluded that historical estimates of past climate changes suggest that global average temperatures over the last half-century are unusual relative to at least the past 1,300 years (although uncertainty is significant prior to 1600). These historical estimates are based in part on various temperature reconstructions that the NRC found yield a generally consistent picture of temperature trends during the preceding millennium. See 74 Fed. Reg. at 66,518; 75 Fed. Reg. at 49,570-71; TSD 31-32 (JA 3379-80).

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[28] Petitioners point to "the climate's response to external forcings" as a purported fourth factor. Ind. Br. 44, 45. Changes in solar energy, reflectivity, and greenhouse gas concentrations are external forcings; the climate's response is what *follows* from these forcings. See AR4 at 96 (JA 4979). Petitioners' claim that modeled projections of this response are inaccurate, Ind. Br. 45, is addressed infra at 55.

Petitioners do not attack EPA's comparison of recent warming to the past 1300 years, but instead make straw man arguments. Petitioners contend that because EPA did not attribute a warming trend from 1910 to 1945 to greenhouse gas concentrations, EPA cannot so attribute later warming. Ind. Br. 52. EPA did not, however, state that the 1910-1945 warming trend was "not caused" by manmade greenhouse gases. To the contrary, EPA explicitly acknowledged that both greenhouse gas emissions and natural forces contributed to the earlier warming trend:

> *The IPCC . . . finds that anthropogenic [greenhouse gas] emissions were one of the influences contributing to temperature rise during the early part of the 20th century along with increasing solar output and a relative lack of volcanic activity.* During the 1950s and 1960s, when temperature leveled off, increases in aerosols from fossil fuels and other sources are thought to have cooled the planet. For example, the eruption of Mt. Agung in 1963 put large quantities of reflective dust into the atmosphere. The rapid warming since the 1970s has occurred in a period when the increase in [greenhouse gases] has dominated over all other factors.

TSD at 48 (JA 3396) (emphasis added); see also RTC 3-57 (JA 3855-56). Neither, by the same token, did EPA find that recent warming was solely caused by manmade greenhouse gas emissions (see Ind. Br. 52) – only that such emissions explained *most* of the warming in this period. See generally TSD at 47-53 (JA 3395-3401).

Petitioners' claim that there is some inconsistency between EPA's treatment of the 1910-1945 warming period and of post-1960s warming is therefore rebutted

by the administrative record. In neither case did EPA adopt the simple manmade/nature dichotomy that Petitioners posit. In both cases, EPA concluded that observed temperature change was based on both natural *and* manmade factors – what differs is the relative role of natural and manmade forces in different periods.

Petitioners also assert that EPA employed a "double standard" by allegedly "[relying] on a 21-year warming trend from 1977 to 1998" while also maintaining that it is difficult to determine the cause of warming over periods of less than fifty years. Ind. Br. 52-53, 54. Petitioners cite nothing in the record to support their assertion that EPA "relied" on warming during this particular period – nor could they, because EPA did not do so. See 74 Fed. Reg. at 66,518 (discussing observed global warming over past 50 years); RTC 2-45 (JA 3738-39) (warming over the last 50 years almost double that of last 100 years). Nowhere did EPA identify this 21-year span as a "period[] of pronounced temperature increases." Ind. Br. 52. Petitioners' purported "double standard" thus arises from the 1977-1998 straw man they set up, not from any time period EPA relied on.[29]

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[29] Petitioners claim that there has been no warming since 1998, and that EPA has "dismissed" this purported trend as "meaningless." Ind. Br. 53, 54. EPA acknowledged that some data sets show no real temperature trend from 1998 to 2008 when these years are viewed in isolation, RTC 3-4 (JA 3812-13), but did not conclude that there was no warming during that time period. More significantly, EPA explained that global temperatures from 1998-2008 remained "well above the long-term average," RTC 2-41 at 31 (JA 3737), and that the relatively flat

Petitioners likewise claim that EPA "touted" information regarding recent upward trends in CO_2 emissions, increased melting of Arctic ice, and increased sea level rise as "evidence for EPA's conclusions." Ind. Br. 53-54. Petitioners rely on a partially-quoted passage taken out of context. The statement is by the Academies of Science for the G8+5 countries, and was cited by EPA in response to comments "question[ing] the notion of scientific consensus around the conclusion of human-induced global warming." RTC 1-43 at 38, 40-41 (JA 3597, 3599-600). EPA cited this statement to demonstrate that major national and international scientific bodies have expressed support for the assessment literature upon which EPA relied. Id. at 40 (JA 3599). EPA did not, however, rely on the information in the quoted passage (which does not even discuss the cause of warming) to support its conclusion attributing most warming since the mid-20th century to increased greenhouse gases.

Petitioners also mischaracterize the conclusion EPA actually reached, i.e., that the evidence suggests that temperatures over the past half-century are unusually warm in comparison to the long-term past. Petitioners point out that there is significant uncertainty regarding the temperature record before 1600. This uncertainty was fully considered by EPA (which, contrary to Petitioners' assertion, did not label this evidence "compelling"). Ind. Br. 54-55; 74 Fed. Reg. 66,523;

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temperatures during this short period "do[] not fundamentally alter the longer term warming signal." TSD at 31 (JA 3379).

TSD at 31-32 (JA 3379-80); RTC 2-62 (JA 3747-49). Nor did EPA ever claim to be 90-99% certain of its conclusion on this particular point; it found only that the evidence suggests and supports this conclusion. See 74 Fed. Reg. at 66,523; see also RTP Section 1.1.2 at 8 (JA 4583 (Vol. X)); Ind. Br. 54-55. Petitioners do not argue that the evidence does not support EPA's actual, more limited, conclusion. Nor have they shown that it was arbitrary for EPA, having acknowledged the uncertainties, to rely on evidence concerning the long-term temperature record as one piece of support for its overall attribution of most recent warming to greenhouse gases.

3. EPA properly relied on climate models.

a. Climate models provide reasonable projections of long-term climate trends.

Computer-based climate model simulations are the third line of evidence supporting the attribution of recent temperature change to increases in greenhouse gases. As the Court has recognized, modeling is "an established technique of environmental analysis" that "facilitates timely decision making." Chem. Mfrs. Ass'n v. EPA, 28 F.3d 1259, 1264 (D.C. Cir. 1994); see also Small Refiner Lead Phase-Down Task Force v. EPA, 705 F.2d 506, 535 (D.C. Cir. 1983) (EPA has "undoubted power" to use models as long as it "explain[s] the assumptions and methodology used.") Global climate models developed over several decades simulate the climate's likely long-term response to natural and manmade forcing

mechanisms such as volcanic eruptions, changes in solar radiation, and changes in concentrations of greenhouse gases. These models are founded on basic principles of physics and scientific knowledge about the climate, are constantly tested against known climate conditions, and have been validated by simulating both current and past global climate situations for which there is observed data. Model results typically are presented as ranges, thus accounting for uncertainty. See generally RTC 4-1 (JA 3869-71); see also TSD at 63-64 (JA 3411-12); RTC 4-24, 4-25, 4-27 (JA 3888-90, 3892-93).

EPA has recognized that models are not completely certain (let alone "magic talismans," Ind. Br. 46). RTC 4-1 at 1 (JA 3869); RTC 4-27 (JA 3892-93). As EPA explained, however, "the issue at hand is not 'Are the models perfect?' but 'Are they reasonable and useful representations of our understanding of the climate system?'" RTC 4-27 at 25 (JA 3893); see also Chem. Mfrs. Ass'n, 28 F.3d at 1265 ("That the model does not fit every application perfectly is no criticism; a model is meant to simplify reality in order to make it tractable."); Appalachian Power Co. v. EPA, 135 F.3d 791, 802 (D.C. Cir. 1998) (invalidating model because it does not fit every data point "would be to defeat the purpose of using a model"). This issue was "thoroughly reviewed by the [United States Climate Change Science Program]," which – even after considering the uncertainties and limitations of climate models – described climate modeling as "one of the great success stories of

scientific simulation." RTC 4-27 at 25 (JA 3893). EPA is thus confident that climate models "are useful for attribution, projections, and understanding of climate phenomena," particularly on a large scale. Id.; see also RTC 4-1 at 2 (JA 3870).

Petitioners argue that the fact that temperatures have not risen steadily over the last 10 to 15 years is contrary to model projections, and that therefore climate models are unreliable because they "fail the basic test of predicting *recent* climate." Ind. Br. 48-49 (emphasis added). Climate models are, however, designed and used to project *long-term*, large-scale trends. Over relatively short periods, temperature trends can be heavily influenced by natural variability (e.g., El Niño), which can either amplify or mask the long-term trends that climate models project. See RTC 3-6 (JA 3814-15); RTC 4-47 (JA 3912-14). Over the long term, however, external forcings such as increased greenhouse gas concentrations play a much more significant role, and dominate changes from natural variability. See RTC 3-6 (JA 3814-15). There thus is no inconsistency between a decade of relatively flat temperatures and a modeled projection that over the long term temperatures will rise as greenhouse gas concentrations increase.[30]

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[30] Petitioners' claim that "no warming has occurred since 1998," and that therefore the understanding of the climate system reflected in the models must be wrong, is based on a mischaracterization of an email. See Ind. Br. 49-50. The author of the e-mail has himself rebutted Petitioners' interpretation. See RTP 1-21 (JA 4612-13 (Vol. X)) (quoting Dr. K. Trenberth) ("It is amazing to see this

Petitioners also claim that uncertainty regarding the sign of feedback (positive or negative) from "changes on extratopical clouds" contrasts with model "assumptions" of "positive cloud feedback."[31] Ind. Br. 47. Petitioners confuse the feedback from a subset of clouds (i.e., extratropical clouds) with cloud feedbacks globally. On a *global* scale, and taking into account the uncertainty over extratropical clouds, the IPCC recognized that virtually all models predict positive cloud feedbacks. There is significant uncertainty regarding the size of this feedback, but not regarding its warming effect. AR4 at 633 (JA 5006). EPA properly recognized, moreover, that cloud modeling is one source of uncertainty. RTC 4-3 at 5 (JA 3873); RTC 4-16 (JA 3882).

Neither is "the CO_2 signal . . . lost in the noise of model uncertainties." Ind. Br. 48. The supposed -25 W/m^2 "uncertainty range" that Petitioners point to is not an uncertainty range for model outputs at all.[32] It is derived from a graph

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particular quote lambasted so often. It stems from a paper I published this year bemoaning our inability to effectively monitor the energy flows associated with short-term climate variability. It is quite clear from the paper that I was not questioning the link between anthropogenic greenhouse gas emissions and warming, or even suggesting that recent temperatures are unusual in the context of short-term natural variability."). His comments on geoengineering relate to actions such as injecting reflective aerosols into the stratosphere, not to reducing greenhouse gas emissions. See RTP 1-26 (JA 4619-20 (Vol. X)); Ind. Br. 50.

[31] As discussed supra at 47, feedbacks are not "assumptions," but the result of the model's application of scientific principles.

[32] It does not appear that either this argument or Petitioners' "circular logic" argument (infra at 56) were raised in comments on the proposed Endangerment Finding. If Petitioners cannot demonstrate that they raised these concerns during

identifying the amount of solar reflection from clouds, for different latitudes, from each of several individual models. The -25 W/m^2 value is the maximum difference in reflectivity between the models for any one of the various latitudes, not the uncertainty range in the model results for any single model. See AR4, Ch. 8, Supp. Materials 8-27 (JA 5016). The variation across the models in global averages for cloud reflection is much closer, approximately -6 W/m2. AR4 at 610 (JA 5001). This difference in the models reflects somewhat different baselines for global cloud cover. What matters for purposes of model projections, however, is the *change* from baseline conditions. Regardless of the difference in baselines, *all* models calculate that increasing CO_2 concentrations will result in both direct warming from the CO_2 and a positive (warming) feedback from a change in clouds. AR 4 at 631-33 (JA 5004-06). Petitioners do not contest this fact. The direct and indirect warming from increased CO_2 is by no means lost in the "noise" of model results.

Petitioners also claim that EPA has "use[d] models that *assume* anthropogenic global warming to try to *prove* anthropogenic global warming." Ind. Br. 51. Models do not "assume" this result; rather, they rely on the basic laws of physics and scientific knowledge about the climate. The models simulate the effect of various changes – increases in greenhouse gas concentrations, changes in

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the comment period, these argument have been waived. See 42 U.S.C. § 7607 (d)(7)(b).

solar variability, changes in aerosol levels, and so forth – in light of these known physical principles. See TSD at 63 (JA 3411); RTC 4-1 (JA 3869-71). While models "are not the foundation of climate science," they are critical "tools used to better understand information and data from multiple sources and disciplines," and together with the other evidence in the record provide important support for EPA's conclusion that increases in manmade greenhouse gases are very likely the cause of most warming since the mid-20th century. RTC 4-1 at 1 (JA 3869).

b. Climate models have been properly validated.

Whether intentionally or not, Petitioners misunderstand the nature of model validation. Models are constantly tested against known climate conditions, and have been validated by simulating both current and past global climate situations. See TSD at 63 (JA 3411); RTC 4-1 (JA 3869-71); Dkt. No. 12197 at 23 (JA 5168). Petitioners ignore this evidence, pointing to a purported "problem of circular logic" allegedly derived from (1) using model-generated data to fill "gaps" in the observational record, and (2) using that augmented data to validate climate models. See Ind. Br. 50-51. As to the first point, the "observational record" is comprised of a variety of observations of factors such as temperature, wind, and precipitation across the globe, at various levels in the atmosphere, over time. See, e.g., Dkt. No. 12197 at 8 (JA 5153). It is not surprising that there are some regions or types of information for which there is less observed information than others; that there is a

varying quality of observed data; or that there is less information about historic events than about more recent conditions. For some purposes, the climate change scientific community uses modeling to augment observations by filling in unobserved regions in a manner consistent with the physics of the atmosphere.[33] See Dkt. No. 12197 at 17 (JA 5162).

Using the observational record with the augmented data described above provides "valuable benchmarks against which key features of model simulations can be meaningfully assessed." See Dkt. No. 12197 at 52 (JA 5189). Importantly, augmented observational records are typically used to validate models other than the ones that provided the augmented data in the first place. Finally, for many variables, models are validated by evaluating their ability to predict known current and past climate conditions, without augmented data. AR4 at 594-95 (JA 4999-5000). The "reanalysis" process that Petitioners attack is therefore neither circular (as they claim) nor the only means by which models are validated.

D. The Record Supports EPA's Finding That The Air Pollution May Reasonably Be Anticipated To Endanger Public Health And Welfare.

After reviewing a wide range of evidence, EPA found that climate change caused by greenhouse gas emissions may reasonably be anticipated to endanger

[33] For example, a model might be used to interpolate wind speed between different measured locations, in a manner consistent with observed temperatures between those locations.

public health and welfare in many ways. See supra at 16-18; 74 Fed. Reg. at 66,497-99, 66,523-36. Petitioners do not contest the body of evidence supporting these findings, or the overwhelming majority of EPA's conclusions, and do not otherwise demonstrate that EPA's endangerment finding was arbitrary or capricious.

1. EPA's findings on harm are supported by the record.

Petitioners again misstate both the nature and the uniformity of EPA's conclusions. See, e.g., Ind. Br. 4 (referring to EPA's purported "combined finding of high probability/high severity of harm"), 43 (same). Petitioners cite no record support for their claim that EPA found universally "severe" harm arising from climate change, or that EPA forecast an inevitable onslaught of "fire, floods, and pestilence." Ind. Br. 55; see also id. at 42. EPA's conclusions were, in fact, far more comprehensive and reasoned. EPA canvassed the evidence and carefully weighed the likelihood and severity of a range of potential harms to public health and welfare. See 74 Fed. Reg. at 66,506. Some projected harms are more significant, some less; some more likely, some less; some more imminent, some at greater reach. See generally 74 Fed. Reg. at 66,497-99, 66,524-36. The record shows that EPA did not make "crystal ball" projections, Ind. Br. 55, but instead carefully evaluated the evidence and drew reasoned and balanced conclusions from it.

The "laundry list" that Petitioners offer, Ind. Br. 55, covers only a fraction of the potential harms reviewed by EPA. Petitioners' list identifies instances in which EPA identified and accounted for an uncertainty in the evidence. See 74 Fed. Reg. at 66,524-36. Potential impacts on particulate matter (PM) levels, disease vectors, aeroallergens, forage quality, renewable energy production, and the power grid, Ind. Br. 55-56, were less certain than other impacts, and therefore were not impacts on which the Administrator placed "primary weight." See 74 Fed. Reg. at 66,525-26; TSD at 87-88 (JA 3435-36). Accounting for the strengths and weaknesses of the evidence demonstrates careful evaluation and reasoning, not arbitrariness.

Where Petitioners discuss factors that were of greater significance to the Endangerment Finding, they mischaracterize EPA's findings to suggest greater uncertainty than actually exists. For example, Petitioners truncated EPA's discussion of potential impacts on human settlements in a misleading manner. What EPA concluded is that "[e]ffects of climate change on human settlements in the United States are very likely to vary considerably according to location-specific vulnerabilities*, with the most vulnerable areas likely to include Alaska, flood-risk coastal zones and river basins, arid areas with associated water scarcity, and areas where the economic base is sensitive (CCSP, 2007a)."* TSD at 129 (JA 3477) (italics added to identify language omitted by Petitioners); see also

74 Fed. Reg. at 66,533 (discussing effects of sea level rise). Petitioners' omissions incorrectly imply that EPA expressed far more uncertainty than it actually did, since the omitted language identifies areas where the effects are more certain and potentially severe.

Petitioners also omit a key portion of the TSD's discussion of hurricanes, citing only the statement that frequency changes in hurricanes cannot be confidently projected. Ind. Br. 56. The prior sentence in the TSD, however, states that "[i]t is likely that hurricanes will become more intense, with stronger peak winds and more heavy precipitation . . . ." TSD at ES-4 (JA 3345); see also 74 Fed. Reg. at 66,524-25 (discussing increased storm severity). Thus, while EPA appropriately concludes there is less certainty of more hurricanes, it is relatively confident that climate change increases the risk of any given hurricane becoming more intense – a factor that legitimately contributed to the Endangerment Finding.

Petitioners similarly note that it is difficult to predict changes in ozone levels based solely on temperature, Ind. Br. 55, while omitting the fact that although there is expected to be regional and temporal variation, EPA found that the overall effect of climate change would be increased ozone levels, especially in the most populated and worst polluted regions. See 74 Fed. Reg. at 66,525. Further, Petitioners note that EPA recognized that it is not clear whether increased heat will prevent more cold-related deaths than it will cause heat-related deaths – but omit

the fact that the USGCRP study cited by EPA ultimately concluded that "increases in heat-related mortality due to global warming in the United States *are unlikely to be compensated for by decreases in cold-related mortality.*" Id. (emphasis added).

With regard to erosion and ecosystem loss, Petitioners note uncertainty over the degree to which these losses result from rises in sea level attributed to climate change, as opposed to other factors such as land subsidence. Ind. Br. 56. But they fail to acknowledge that (1) although EPA cannot precisely quantify the amount of such losses ultimately traceable to climate change, it is clear that climate change will make such losses worse; and (2) erosion and ecosystem loss were merely one of many impacts of sea level rise that EPA considered. See TSD at 118-120 (JA 3466-68); 74 Fed. Reg. at 66,533.

Petitioners complain that EPA's analysis is "one-sided," alleging that EPA "disregard[ed]" particular uncertain evidence of the benefits of climate change while crediting uncertain evidence of harm. Ind. Br. 56-57. To the contrary, the record demonstrates that EPA thoughtfully weighed this and other evidence of both the risks and the benefits of various potential impacts of climate change. See, e.g., 74 Fed. Reg. at 66,531 (in near term, concern for adverse effects in certain agricultural sectors is "generally comparable" to potential benefits, but over the long term evidence points towards increasing risk of net adverse effects on food production and agriculture); TSD 93-95 (JA 3441-43) (discussing multiple ways in

which climate change could either increase or decrease PM levels). The fact that EPA, after carefully weighing all record evidence and fully explaining its rationale, reached a different conclusion than Petitioners would prefer does not mean EPA's action was "one-sided" or arbitrary.

2. EPA properly found harm to both public health and welfare.

In concluding that greenhouse gases may reasonably be anticipated to endanger both public health and welfare, EPA interpreted the term "public health" to include health impacts arising from climate change caused by greenhouse gases, and did not limit itself to health effects from direct exposure to greenhouse gases.[34] See 74 Fed. Reg. at 66,526. EPA explained the basis for its interpretation in depth, and Petitioners offer no evidence that EPA's interpretation is unreasonable. See 74 Fed. Reg. at 66,526-29.

There is no support for Petitioners' claim that only direct, inhalational effects of exposure to an air pollutant qualify as impacts on "public health." See Ind. Br. 57-58. NRDC v. EPA, 902 F.2d 962 (D.C. Cir. 1990), vacated in other part, 921 F.2d 326 (D.C. Cir. 1991), Ind. Br. 58, does not support Petitioners' argument. In that case, the Court rejected the argument that EPA should have considered the health consequences of the unemployment that would allegedly

[34] Petitioners' conclusory assertion that evidence regarding public health effects in the United States is somehow lacking, Ind. Br. 58, is belied by the administrative record. 74 Fed. Reg. at 66,514, 66,523-26.

result from a too-stringent air quality standard. See id. at 972-73. The Court held that under the applicable statute, EPA could only consider "health effects relating to pollutants in the air." Id. at 973 (citing 42 U.S.C. § 7408(a)(2)). It did not say that such health effects had to originate from inhalation, or what Petitioners call "direct" effects. EPA has, moreover, previously considered effects other than direct, inhalational effects in finding a threat to public health. See, e.g., Coal. of Battery Recyclers v. EPA, 604 F.3d at 615 (public-health-based primary NAAQS includes consideration of adverse health effects from ingestion as well as inhalation of lead emitted into the air); see also Am. Trucking Ass'ns v. EPA, 175 F.3d 1027, 1051-53 (D.C. Cir. 1999) (in setting public-health-based NAAQS, EPA must consider potential for indirect health benefits from ozone in the atmosphere blocking UVb radiation), aff'd in part, rev'd in part sub. nom. Whitman v. Am. Trucking Ass'ns, 531 U.S. 457 (2001).

Even if Petitioners could demonstrate that harms to public health identified by EPA could be considered only as effects on public "welfare," EPA's findings would be proper. Section 202(a) requires a determination of whether air pollution may reasonably be anticipated to endanger "public health *or* [not "and"] welfare." 42 U.S.C. § 7521(a). EPA has thus found all that the statute requires.

III. EPA PROPERLY DENIED THE RECONSIDERATION PETITIONS

EPA received ten petitions for reconsideration of the Endangerment Finding (and seven supplements thereto). These petitions and supplements ran to over 500 pages, cited dozens of studies totaling hundreds of pages, and referenced more than 1000 emails and 300 pages of computer code. As we discuss in the following sections, after a thorough review EPA concluded that the evidence presented did not support the claims made in the petitions for reconsideration and did not offer any support for a revision of the Endangerment Finding.[35] See generally 75 Fed. Reg. at 49,556, 49,557-58, 49,563-78, 49,583-84. EPA therefore declined to convene a reconsideration proceeding.

A. EPA Was Entitled to Weigh the Evidence Submitted With The Reconsideration Petitions Before Deciding Whether to Grant Reconsideration.

Section 307(d)(7)(B) of the Act provides that if a petitioner can demonstrate both that it was "impracticable" to raise an objection during the comment period, or the grounds for that objection arose after the comment period, "*and [that] such objection is of central relevance to the outcome of the rule*," EPA shall convene a

[35] EPA also found that many of the objections raised in the petitions could have been raised during the comment period. See 75 Fed. Reg. at 49,584; 42 U.S.C. § 7607(d)(7)(B) (reconsideration petitioner required to demonstrate that it was impracticable to raise objection during original comment period). Petitioners do not challenge this aspect of EPA's decision.

reconsideration proceeding. 42 U.S.C. § 7607 (d)(7)(B) (emphasis added).[36] The "central relevance" standard places the burden on the party seeking to disturb a settled agency action to demonstrate that new evidence identified in the reconsideration petition would "provide *substantial support* for the argument that the regulation should be revised." 75 Fed. Reg. at 49,561 (emphasis added).

The "substantial support" standard "gives proper weight to . . . the importance Congress attributed to preserving the finality of agency rulemaking decisions." Id. This is a high standard, but not insurmountable. EPA did not, as Kansas claims, require that the reconsideration Petitioners demonstrate that their argument "must ultimately prevail." Kan. Br. 19; see also id. at 4. EPA did, however, reasonably require that information submitted with the reconsideration petitions, when viewed in the context of the entire record, substantially support the argument that the Endangerment Finding should be reopened.[37]

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[36] Petitioners appear to view EPA's Denial as analogous to an agency procedural error in promulgating a rule, arguing that EPA should have applied Section 307(d)(8) of the Act, 42 U.S.C. § 7607(d)(8). Va. Br. 22-23. Amicus State of Kansas, on the other hand, argues that EPA improperly applied Section 307(d)(8). Kan. Br. 19-21. Both are wrong. Section 307(d)(7)(B) explicitly governs administrative petitions for reconsideration, and EPA applied the Section 307(d)(7)(B) standard in considering the reconsideration petitions. See 75 Fed. Reg. at 49,561. EPA discussed the language in Section 307(d)(8) only in interpreting Section 307(d)(7)(B)'s "central relevance" language. See id.

[37] Petitioners argue that the length of EPA's response to the petitions for reconsideration means the claims made in the petitions must have warranted a reconsideration proceeding. See, e.g., Va. Br. 4, 14, 19. Petitioners offer no authority to support this page-count argument, and fail to explain why –

Petitioners pay only lip service to the principle that a party that seeks reconsideration must offer substantial support for its request, proposing to gut this requirement by prohibiting EPA from considering the weight or validity of evidence presented in a petition for reconsideration without first seeking public comment.[38] See Va. Br. 14, 23-24; see also Kan. Br. 9, 18-19. If EPA could not consider the merits of a petitioner's arguments and evidence, EPA would *never* be able to deny a reconsideration petition without first seeking comment. As long as a petition included any evidence or argument that, when viewed in the abstract and assumed to be correct, could substantially support an argument that an agency action should be revised, EPA would be forced to grant reconsideration – no matter how flawed the proffered evidence, or how insignificant in comparison to other evidence in the administrative record. Section 307(d)(7)(B) does not impose such a standard, and Petitioners offer no justification for their demand that EPA

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particularly in light of the length and complexity of the numerous reconsideration petitions – EPA should be penalized for providing a full and detailed explanation of its bases for declining to convene a reconsideration proceeding.

[38] Petitioners go so far as to argue that an agency "is *incapable* of knowing and deciding scientific matters in the absence of notice and comment." Va. Br. 17 (emphasis added). Unsurprisingly, the case cited as support for this extreme proposition says nothing of the sort. In Kennecott Corp. v. EPA, 684 F.2d 1007 (D.C. Cir. 1982), this Court held that EPA had violated the Act's procedural requirements by not including documents that formed part of the basis for its original action in the docket for public comment. Kennecott, 684 F.2d at 1018. In this case, by contrast, Petitioners argue that EPA should *reconsider* the Endangerment Finding based on new evidence submitted by the Petitioners. Nothing in Kennecott speaks to this situation. See generally 75 Fed. Reg. at 49,561-62 (discussing Kennecott).

consider a petitioner's evidence in a vacuum, assume its correctness, and decline to use the Agency's experience and expertise in evaluating that evidence and deciding whether to disturb a final agency action and convene a reconsideration proceeding.

B. EPA Was Not Required to Seek Public Comment on Material It Considered Before Denying the Reconsideration Petitions.

Petitioners argue that EPA improperly relied on documents placed in the docket after the close of the comment period on the Endangerment Finding in denying the petitions.[39] See Va. Br. 16; Kan. Br. 9-10, 21-22, 23-24. Almost half of the "more than four hundred documents," Va. Br. 16, placed in the docket after the close of the comment period on the Endangerment Finding were placed in the docket before signature of that Finding, and are properly part of the record for that action.[40] EPA also placed a number of documents in the record for the Denial after signature of the Finding, including the CRU emails that were a significant focus of the reconsideration petitions; independent investigations related to those emails;

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[39] In a related point, Petitioners contend that in denying the petitions for reconsideration, EPA altered the basis of the Endangerment Finding. See Va. Br. 14-16, 24-27 see also Kan. Br. 22. EPA's response to the petitions for reconsideration is solely that – a response, not a "supplement[]" to or revision of the Endangerment Finding. See Va. Br. 27. EPA's action on the petitions for reconsideration thus does not trigger the need for a new notice and comment period on the Endangerment Finding itself.

[40] These added documents are typical of those routinely added to an administrative record as EPA finalizes an action, including material updated since the original proposal; drafts provided for interagency review (required to be docketed by Section 307(d)(4)(B)(ii), but not part of the record); pre-publication versions of the Findings; the Response to Comments; the final TSD; and scientific articles and data cited by EPA in responding to public comments.

scientific articles cited in responding to the petitions for reconsideration; and final versions of the Denial and the Response to Petitions. The "additional" material placed in the record by EPA was in many cases submitted or referred to by Petitioners, or was otherwise directly relevant to responding to the reconsideration petitions.

The suggestion that an agency is not entitled to rely on the full record for the underlying agency action, or to place *any* additional material in the reconsideration record without seeking comment, again ignores the role of agency expertise and knowledge. See Va. Br. 4; Kan. Br. 9-10. Suppose, for example, that a reconsideration petitioner submits Study A which, on its face, could be viewed as rebutting some fact or principle that EPA relied on in making the Endangerment Finding. Suppose further that Studies B-G, additional studies in the relevant field, all refute the conclusions reached in Study A. Petitioners offer no authority for the proposition that EPA's only choices are to (a) pretend that studies B-G do not exist, or (b) convene a reconsideration proceeding in order to consider Studies B-G. This is not a hypothetical situation: as EPA noted in the Denial, in addition to Petitioners misstating the meaning and significance of recent scientific information in their petitions, "there are instances where the Petitioners have failed to

acknowledge other new studies in making their arguments." 75 Fed. Reg. at 49,584.[41]

In a related claim, Amicus State of Kansas argues that (1) by stating that a reconsideration petition may be filed regarding a "rule," Section 307(d)(7)(B) "necessarily includes the lawful record that supports the rule"; (2) Section 307(d)(6)(C) provides that a rule may not be based on material placed in the docket after its promulgation; and (3) EPA therefore could not consider any material other than that already in the docket or presented with the petitions for reconsideration. Kan. Br. 22-23. Section 307(d)(7)(B) contains no limitation on the record EPA may consider in acting on a petition for reconsideration. Nor does Kansas offer any logical justification for reading a statutory limitation on the *rulemaking* record as an additional, unstated limitation on the *reconsideration* record.

C. The CRU Emails Did Not Require EPA to Convene a Reconsideration Proceeding.

State Petitioners and amicus State of Kansas focus on the so-called "climategate" emails from the University of East Anglia's Climate Research Unit

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[41] Petitioners' claim that EPA improperly relied on a May 2010 National Research Council assessment, Va. Br. 16-17, is contradicted by the administrative record. See 75 Fed. Reg. at 49,558 (appropriately citing NRC assessment as "clear affirmation" that the scientific bases for the Endangerment Finding "are robust, credible, and appropriately characterized by EPA"); compare id. at 49,563-79 (discussing EPA's own review of science issues). The "no published criticisms" statement cited by Petitioners refers to studies cited *in* the NRC assessment, not to the assessment itself. See RTP 1-29 at 50 (JA 4625 (Vol. X)).

(the "CRU emails"), arguing that these emails undermined the Endangerment Finding and therefore required EPA to convene a reconsideration proceeding to consider them. See generally Va. Br. 10-11, 31-36; Kan. Br. 5-6, 8-9, 24. As EPA explained, the assertions made by Petitioners regarding these emails were "exaggerated," are "often contradicted by other evidence," and did not provide a "material or reliable basis to question the validity and credibility of the body of science underlying the Administrator's Endangerment Finding." 75 Fed. Reg.at 49,557.

EPA did not reach this conclusion lightly. It thoroughly reviewed and analyzed *all* of the emails presented in the reconsideration petitions. See, e.g., 75 Fed. Reg. at 49,557, 49,570-71, 49,573-74, 49,578-84.[42] EPA found that "[p]etitioners' assumptions and subjective assertions regarding what the e-mails purport to show about the state of climate change science are woefully inadequate pieces of evidence to challenge the voluminous and well documented body of science that is the technical foundation of the Administrator's Endangerment Finding." 75 Fed. Reg. at 49,584. As EPA noted, moreover, multiple independent investigative bodies similarly concluded that the CRU emails provided no evidence

[42] Petitioners' briefs repeat many of the claims regarding the CRU emails that were in the petitions for reconsideration, yet Petitioners barely acknowledge EPA's extensive and detailed analysis of those claims in the three-volume RTP. Even less do Petitioners respond to that analysis. In fact, Petitioners do not identify even a single alleged error in EPA's response.

of scientific misconduct or data manipulation by climate scientists, and did not cast doubt on the underlying body of science they had developed.[43] 75 Fed. Reg. at 49,558.

Petitioners claim that by failing to seek comment on the CRU emails, EPA left the record incomplete and denied the Court the benefit of EPA's response to comments. Va. Br. 17-18; Kan. Br. 24. First, Petitioners were free to raise their objections by filing petitions for reconsideration (and indeed the petitions that were submitted exceeded 500 pages). Second, a record that includes a 36-page Federal Register notice explaining the basis for EPA's denial of the reconsideration petitions and a three-volume Response to Petitions that examines in detail each and every issue and piece of evidence raised in the petitions clearly provides an adequate basis for judicial review.

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[43] Petitioners criticize these investigations on the ground that they allegedly failed to address whether the CRU emails "undercut the reliability of the science," Va. Br. 4, then reverse course and cite the investigations as support for their arguments regarding alleged uncertainties in the science. Va. Br. 4-8. EPA does not agree with Petitioners' characterization of the conclusions reached by the various investigations. Those investigations were, however, cited only as being "in line with *EPA's* review and analysis of [the CRU emails]." 74 Fed. Reg. at 49,557 (emphasis added); see also, e.g., id. at 49,578-79, 49,581-83 (discussing EPA analysis of CRU emails).

D. The Reconsideration Petitions Did Not Demonstrate Any Departure From EPA's Information Quality Guidelines or Call Into Question EPA's Use of the IPCC Reports.

EPA followed its Information Quality Act guidelines, relying on information that was, and is, "accurate, reliable, and unbiased." See Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Environmental Protection Agency (October, 2002), available at http://www.epa.gov/quality/informationguidelines (last visited Aug. 16, 2011). The guidelines may apply to a subsequent dissemination of the information in which EPA adopts, endorses, or uses the information to formulate or support a regulation, guidance, or other Agency decision or position. Id. at 16. The public comment process EPA used in the development of the Endangerment Finding provided for the thorough consideration of the information relied upon by EPA, and served the purposes of the Guidelines by providing an opportunity for correction of any information that does not comply with the Guidelines. See id. at 32. Petitioners have failed to demonstrate that the reconsideration petitions showed otherwise. See generally Va. Br. 31-36; Kan. Br. 12-18.

Petitioners claim that the reconsideration petitions demonstrated that the IPCC "frequently" relied on "unscientific," non-peer-reviewed studies. Va. Br. 33-34; see also Kan. Br. 14-16. Petitioners cannot support this conclusion, as the vast majority of studies reviewed by the IPCC were fully peer-reviewed. RTP 2-33 at

71 (JA 4812). The IPCC's policy recognized and allowed limited use of "gray" literature where necessary and appropriate. Id.; see also RTC 1-14 (JA 3568-74). The limited use of a small number of non-peer-reviewed studies among the much larger body of peer-reviewed material does not undermine the IPCC's overall conclusions, nor does it warrant reconsideration of EPA's reliance on those conclusions as the technical basis for the Endangerment Finding.

Petitioners also attack the IPCC's peer review process, claiming that IPCC authors are free to disregard critical comments or rewrite material after the close of the review period. Va. Br. 11; Kan. Br. 14-16. This is simply untrue; as EPA explained, each IPCC chapter has a separate review editor who is not involved with writing that chapter and is responsible for ensuring that all reviewer comments are appropriately addressed by the chapter authors. See RTP 2-31 (JA 4808-09). Kansas also claims that EPA ignored its own peer review policy by using government scientists as peer reviewers. Kan. Br. 26. However, EPA's peer-review policy allows for the use of non-EPA federal scientists as peer reviewers, which is what EPA did. See U.S. Environmental Protection Agency, Peer Review Handbook, 3rd Edition, 2006, at 26 (JA 5795) (peer reviewers "can come from EPA, another Federal agency, or from outside of the Federal government"); see also RTP 3-7 (JA 4842-44); RTC 1-10 (JA 3566).

Neither have Petitioners offered any support for their other attacks on the IPCC process. Va. Br. 10-11, 36; Kan. Br. 11, 16-18. Petitioners rely on various investigations of the CRU emails. See id. These investigations were not, as a general matter, directed at the IPCC process; they were, instead, limited to a review of practices at the CRU and by a particular researcher in the United States. The overall conclusion of the independent investigations has, moreover, been that, while some IPCC procedures could be improved, any procedural deficiencies did not cast doubt on either the work performed by the CRU or the IPCC's use of that work. See, e.g., The Independent Climate Change E-Mails Review at 11 (JA 5546).[44]

Finally, as we next discuss, the few alleged factual errors made by the IPCC either were not errors at all or were immaterial to the Endangerment Finding. The petitions to reconsider thus failed to support the Petitioners' claims that the science relied on in the Endangerment Finding should be reconsidered.

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[44] EPA responded in detail to Petitioners' conclusory claims of withheld, lost or destroyed data (RTP Sections 1.3.3.1-.2, JA 4641-48 (Vol. X)); RTP Sections 3.4.1.2, JA 4901-18), reliance on IPCC authors' own studies (RTP Section 2.2.3.2, JA 4787-89); conflicts of interest among IPCC personnel (RTP Section 2.2, JA 4775-4815), and attempts to stymie adverse studies (RTP Section 2.2.3.4, JA 4798-4806). See Va. Br. 10-11; Kan. Br. 15-16. Petitioners do not even attempt to identify any deficiencies in EPA's response.

E. Evidence Presented In The Reconsideration Petitions Did Not Provide Substantial Support For An Argument That The Endangerment Finding Should Be Reopened.

Petitioners point to a supposedly pervasive "pattern" of flawed science, but identify only a handful of isolated, insignificant alleged missteps. See Va. Br. 12; Kan. Br. 13-14. Only two of these are actually errors in the IPCC's assessment report, and neither was part of the basis for the Endangerment Finding. 75 Fed. Reg. 49,576. The claimed factual errors thus were clearly not of central relevance to the Endangerment Finding.

Percentage of Netherlands lying below sea level: The IPCC has acknowledged that, based on information received from the Netherlands, AR4 misstated the percentage of that country that is below sea level. The IPCC has since published a correction. In so doing, the IPCC confirmed that this statistic was originally used "for background information only, and the updated statistic remains consistent with overall conclusions." RTP 2-1 at 8 (JA 4749) (noting mistaken and correct percentages). EPA concluded that this error was "minor and inconsequential" to the Endangerment Finding, which did not in any way refer to or rely on the percentage of the Netherlands that is below sea level. Id. at 9 (JA 4750); see also 75 Fed. Reg. at 49,576.

Himalayan glaciers: The IPCC has acknowledged misstating the *rate* at which Himalayan glaciers are receding, but the fact that they *are* receding is not in

question. See 75 Fed. Reg. at 49,577; RTP 2-2 (JA 4750-51). Moreover, EPA did not rely on the erroneous projection in the Endangerment Finding. Id.

African agriculture yields: As explained in response to the petitions for reconsideration, the "policy paper" concerning agricultural yields that Petitioners attack was used in accordance with IPCC policies on "gray" literature. See RTP Section 2.1.7 at 24-25 (JA 4765-66). After a careful review, EPA concluded that statements made by the IPCC in reliance on the challenged paper were neither faulty nor included uncritically. Id. at 26 (JA 4767). In addition, this paper relates to impacts *outside* the United States, and therefore did not materially impact the Administrator's determination regarding impacts *within* the United States. Id. at 24-25 (JA 4765-66).

Amazon rain forests: The reaction of Amazon rain forests to reductions in precipitation is not discussed anywhere in the Endangerment Finding or TSD, and is thus of little relevance to the Finding. RTP 2-9 at 21 (JA 4762). EPA noted, moreover, that although the IPCC used a non-peer-reviewed study on this issue, that study was in turn based on peer-reviewed literature. Id.

Projections of more violent storms: Petitioners list "*projections* of more violent storms" as an alleged error, but cite references concerning *historical* trends in storms. Va. Br. 12 (emphasis added). EPA considered new studies submitted with the petitions for reconsideration concerning such trends, and concluded that

these studies were consistent with the TSD and the Endangerment Finding. RTP 1-85 at 143-44 (JA 4718-19).

EPA's discussion of these points demonstrates the weakness of Petitioners' claims regarding the quality or reliability of the scientific basis for the Endangerment Findings. All that State Petitioners can find to attack are minor, isolated errors (or non-errors) occurring in a few scattered studies selected from a multi-volume assessment containing thousands of pages of findings and conclusions. These attacks do not undermine the IPCC's conclusions or EPA's Endangerment Finding. See 75 Fed. Reg. at 49,558, 49,576-77.

IV. EPA REASONABLY CLASSIFIED SIX GASES AS ONE POLLUTANT

Section 202(a) requires EPA to determine whether emissions of any "air pollutant" from motor vehicles cause or contribute to "air pollution" that may reasonably be anticipated to endanger public health or welfare. 42 U.S.C. § 7521(a)(1). EPA concluded that an aggregate group of six greenhouse gases constitutes both the "air pollution" endangering health and welfare and the "air pollutant" that contributes to this pollution. See supra at 18-19; 74 Fed. Reg. at 66,536-38. EPA carefully set forth the common attributes shared by the six greenhouse gases that supported the Agency's decision to aggregate them as a

single air pollutant.[45] Among other things, these gases are all directly-emitted (i.e., not formed in the atmosphere through the interaction of precursor gases), long-lived (so they become globally well-mixed in the atmosphere), and have well-understood warming effects. 74 Fed. Reg. at 66,537. Importantly, the common attributes that EPA relied on in deciding to aggregate these gases as a single air *pollutant* are relevant as well to the air *pollution* for which greenhouse gases are agents – it is because of these commonly shared attributes that these six gases are known to be the primary driver of climate change and thus the primary focus of climate change science and policy. 74 Fed. Reg. at 66,517; RTC 10-1 (JA 3986-87).

Petitioners do not dispute this rationale, but argue instead that EPA's definition is inconsistent with the Act under Chevron. Ind. Br. 30-33. As to Chevron step one, Section 302(g) of the Act defines "air pollutant" as "*any air pollution agent or combination of such agents*, . . . which is emitted into or otherwise enters the ambient air." 42 U.S.C. § 7602(g) (emphasis added). As the Supreme Court held in Massachusetts, this is a "sweeping" definition, "embrac[ing] all airborne compounds of whatever stripe." 549 U.S. at 528. The

[45] Petitioners' claim that EPA improperly "group[ed] six *separate* air pollutants" into one, Ind. Br. 30 (emphasis added), misses the point. Each of the six substances individually is an "air pollution agent;" consistent with Section 302(g), 42 U.S.C. § 7602(g), EPA defined the combination of these agents as an "air pollutant."

Court further concluded that greenhouse gases "fit well" within this "capacious" definition, and that they are "unquestionably 'agents' of air pollution." Id. at 532, 529 n.26. Petitioners inexplicably assert that EPA has violated Chevron step one by doing precisely what the statute explicitly authorizes EPA to do. Ind. Br. 30-31. Given that Congress has "directly spoken to the precise question at issue," 467 U.S. at 842-43 – saying that EPA may consider a "combination of . . . agents" to be a single "air pollutant," which is precisely what EPA did here – Petitioners' conclusory Chevron step one argument necessarily fails.

Petitioners also inaccurately assert that EPA's grouping of six greenhouse gases as a single air pollutant is inconsistent with past Agency practice. Ind. Br. 30-31. They focus on EPA's grouping of particles of less than 2.5 microns in diameter as a single air pollutant ($PM_{2.5}$), but ignore the closer analog of volatile organic compounds (VOCs) or particulate matter (PM) – hundreds of different chemical compounds, all of which are treated as a single "air pollutant." See 74 Fed. Reg. at 66,540-41; see also id. at 66,537. VOCs, like the six gases at issue here (and, for that matter, like $PM_{2.5}$ or PM) are grouped as a single "pollutant" because they all have similar attributes and effects related to their impact on the air pollution. See 74 Fed. Reg. at 66,541; RTC 10-4 (JA 3990-91). Indeed, EPA's approach makes sense applying Petitioners' own argument regarding $PM_{2.5}$ to the greenhouse gas air pollutant, because "it is the [compound's greenhouse gas

effect], not its composition, that poses the relevant risks to public health and welfare." Ind. Br. at 31. EPA thus acted consistently with past Agency practice in grouping six greenhouse gases into a single "air pollutant."

Petitioners further claim that EPA's grouping of six greenhouse gases as the "air pollutant" "subverts" the purpose of the Act, Ind. Br. 31, but never explain precisely how. Section 202(a) requires a contribution finding for the *air pollutant*, not for each and every air pollution *agent* within a defined "air pollutant;" thus, the fact that EPA did not make a separate contribution finding for each of the six greenhouse gases individually is irrelevant. What matters for purposes of a Section 202 contribution analysis is the total amount of the greenhouse gas *air pollutant* emitted by motor vehicles, not the amount of each agent emitted.

Petitioners try to make much of the fact that motor vehicles do not emit all of the greenhouse gases in the defined "air pollutant."[46] Ind. Br. 31, 32-33. As EPA explained, the fact that these six greenhouse gases share relevant attributes and are similar agents of the same air pollution remains true regardless of what sources or source categories may emit the greenhouse gases. See 74 Fed. Reg. at 66,541; RTC 10-2 (JA 3987-89). Petitioners' approach would disregard the fact

[46] To the extent that Petitioners argue that EPA should not have included substances not emitted by motor vehicles in the definition of "air pollutant," Ind. Br. at 32, there is a serious question whether Petitioners have standing. Petitioners have not identified even one emissions source that is subject to regulation due to EPA's definition, but that would escape regulation if the definition of "air pollutant" did not include substances not emitted by motor vehicles.

that SF_6 and PFCs share common attributes with the other four greenhouse gases, simply because they are not emitted by motor vehicles, thus ignoring relevant scientific considerations. See RTC 10-2 (JA 3987-89).

Petitioners' approach would also produce odd and potentially cumbersome outcomes. If EPA were required to limit its definition of "air pollutant" according to which specific air pollution agents a particular source category emitted, the result would be the proliferation of multiple defined air pollutants, all very similar to one another in effect (as all contribute to climate change) and all containing many overlapping air pollution agents (such as CO_2, which is emitted by almost all sources), yet each differing from the other according to what is *not* emitted by a particular source category. Such an approach makes no sense, and is by no means compelled by the statute.

There is longstanding precedent for defining an air pollutant broadly, even if a particular source category may not emit every substance covered by that air pollutant. 74 Fed. Reg. at 66,541 (discussing heavy duty truck standards applicable to VOCs and PM, and noting "it is highly unlikely that heavy duty trucks emit every substance that is included in the group defined as VOC or PM"). Petitioners do not challenge EPA's conclusion that motor vehicle emissions contribute to the air pollution consisting of the six well-mixed greenhouse gases – a finding that EPA would have made even if it defined the relevant air pollutant to

consist solely of the four gases emitted by Section 202 sources. Id. Petitioners have thus failed to demonstrate that EPA's definition of "air pollutant" here to include substances not emitted by motor vehicles was unreasonable.

Finally, there is no support for Petitioners' claim that EPA's definition of "air pollutant" as an aggregate of six greenhouse gases will unfairly impact some stationary sources.[47] A coal mine would not be "subject to methane regulation because automobiles emit relatively large quantities of CO_2," but because the mine and motor vehicles both emit greenhouse gases. Nor would a facility emitting four tons of SF_6, 50 tons of CO_2, and 50 tons of N_2O (i.e., 104 tons of greenhouse gases, more than the 100-ton statutory threshold) become subject to permitting requirements because of a CO_2 equivalence calculation. Ind. Br. 31-32. If a source does not emit more than the required threshold amount of greenhouse gases on a mass basis, it will not be subject to PSD or Title V, regardless of the CO_2 equivalence of any greenhouse gas emissions. 75 Fed. Reg. at 31,514, 31,522.

V. EPA FULLY CONSIDERED AND REASONABLY REJECTED PETITIONERS' ALTERNATIVE ENDANGERMENT APPROACH

Petitioners argue that before exercising her judgment regarding endangerment, the Administrator must quantify risks and various climate metrics, and then, on the basis of these data, establish quantitative decision-making criteria

[47] EPA was not required to consider such impacts in making the Endangerment Finding. Infra at 108-110.

that distinguish harmful from safe climate change effects. See Ind. Br. 26-27; Tx. Br. 17, 21. They further suggest that even if the Agency completes this empirical task, she can only find endangerment if she can also answer the following question: "How might GHG regulation under CAA Section 202 reduce emissions in a way that would meaningfully address the alleged 'endangerment'?" Ind. Br. 27; see also Tx. Br. 19.

EPA fully considered and reasonably rejected the approach advocated by Petitioners. Below, we will first explain why EPA was not required to define "endangerment" in the quantitative terms advocated by Petitioners, and then discuss why the statute does not require EPA to include, as part of its endangerment inquiry, analysis and findings as to the extent to which any endangerment can be ameliorated by Section 202 emission standards.

A. EPA Was Not Required to Define "Endangerment" in the Quantitative Terms Advocated by Petitioners.

To begin with, Petitioners' arguments completely disregard the vast and compelling quantity of empirical data and scientific evidence that EPA *did* analyze and discuss in the Endangerment Finding. In support of its ultimate finding of endangerment, EPA made a wide array of more specific findings related to the impact of elevated atmospheric greenhouse gas concentrations on climate, as well as the associated health and welfare effects of such air pollution and climate change, and the Agency documented the scientific basis for these findings in an

extensive technical support document ("TSD").[48] These findings and data are discussed in detail in Part II, supra, but the key point here is that the Endangerment Finding rested on precisely the type of foundation contemplated by Congress in adopting the present version of section 202(a)(1). See 1977 U.S.C.C.A.N. at 1128-29. Properly understood, therefore, Petitioners cannot argue that EPA failed to support the Endangerment Finding with suitable technical data and analysis – it is indisputable that the Agency did so. Rather, they instead appear to contend that EPA also was required to shape these data into quantitative thresholds distinguishing "safe" from "unsafe" levels of climate change before it could find endangerment.

This argument is utterly inconsistent with the Ethyl decision, where the Court was explicit that endangerment is a fact-specific, case-by-case determination, with no minimum threshold for either risk or severity of harm. Ethyl, 541 F.2d at 18-20; see also 74 Fed. Reg. at 66,509; RTC Section 9.3.2 (JA 3971-74). Instead, EPA simply is to judge both the likelihood that harm will occur and the severity of the harm if it were to occur; varying combinations of risk and harm can amount to endangerment. Ethyl, 541 F.2d at 18-20. The Court stressed

[48] See 74 Fed. Reg. at 66,517-19 (describing the evidence showing that the concentration of six greenhouse gases is the primary driver of current and projected climate change), 66,523-36 (summarizing effects on health and welfare); see also Am. Elec. Power v. Connecticut, 131 S. Ct. 2527, 2532-33 (2011) (noting these and related findings).

that in reviewing the Administrator's endangerment determination "we will not demand rigorous step-by-step proof of cause and effect" and will uphold the determination as long as it is "rationally justified." Id. at 28.

Petitioners' description of this aspect of Ethyl is mistaken and incomplete. Petitioners suggest that the Court only upheld the endangerment finding in Ethyl because the Agency supposedly conducted an analysis that demonstrated in a quantitative fashion that the challenged fuel additive standards would lower airborne exposures in a way that would help keep blood lead levels in a "safe" range. Ind. Br. 25. By contrast, Petitioners argue, EPA's approach here was flawed because it involved a more "qualitative" analysis. Id. at 26. However, upon examination, the distinction Petitioners posit between this case and the cited portion of Ethyl simply does not exist.

As the Court in Ethyl noted, EPA *initially* attempted to develop an equation "to predict a person's blood lead level as a direct function of the air lead concentration to which he was exposed," which could "then be used to find a 'safe' air lead concentration to avoid elevated blood levels." Ethyl, 541 F.2d at 56. However, EPA later "abandoned" this "attempt to *quantify* a safe level of exposure" due to technical complications "and settled on its current, *more qualitative*, approach to the evidence." Id. (emphasis added). The analysis the Court upheld was therefore "much more modest in scope," id., and, in the end, was

a qualitative judgment based on review of a variety of studies analyzing the effects of airborne exposure to and ingestion of lead. Id. at 55-56. Thus, while there certainly was a significant empirical aspect to EPA's analysis in Ethyl (as there was in this case as well), EPA's ultimate use of these data was, in the Court's own words, essentially qualitative in nature, and the Court upheld that approach as sufficient even under the prior version of the statute.[49]

Furthermore, this Court has more recently repeatedly held that it is reasonable for EPA to base health and welfare-related findings in analogous contexts under the CAA and other environmental statutes on qualitative rather than quantitative information.[50] In sum, EPA does not need to quantify the myriad possible combinations of risk of harm and severity of harm, covering the very wide range of relevant climate and environmental circumstances, that would *not* constitute endangerment before it may make a fully rational judgment that the specific facts and circumstances here *do* in fact amount to endangerment.[51]

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[49] As discussed below, the Court's analysis was based on the risk from airborne lead, not the reduction in risk that the fuel control would achieve.

[50] See Am. Farm Bureau Fed'n v. EPA, 559 F.3d 512, 535 (D.C. Cir. 2009); Cement Kiln Recycling Coal. v. EPA, 493 F.3d 207, 223 (D.C. Cir. 2007); Am. Trucking Ass'ns v. EPA, 283 F.3d at 369; see also, e.g., Catawba County v. EPA, 571 F.3d 20, 39-40 (D.C. Cir. 2009) (upholding use of a qualitative weight of evidence approach in applying the contribution test to NAAQS designations).

[51] Cf. Lead Indus., 647 F.2d at 1161-62 (in determining the ambient level of an air pollutant that is requisite to protect public health with an adequate margin of safety, under CAA Section 109, 42 U.S.C. § 7409, EPA is not required to first

Imposing the burden of proof on EPA that Petitioners advocate would also conflict with the Supreme Court's admonition in Massachusetts that EPA cannot decline to make an endangerment finding merely because there is "some residual uncertainty." Massachusetts, 549 U.S. at 534. Instead, only uncertainty that is "so profound that it precludes EPA from making a reasoned judgment as to whether greenhouse gases contribute to global warming" could justify such inaction.

Also unavailing is the Non-State Amici's reference to Industrial Union Department, AFL-CIO v. American Petroleum Inst., 448 U.S. 607, 645 (1980), and a subsequent decision of this Court citing that case. See Brief of Amici Curiae In Support of Petitioners ("Non-State Amicus Br.") at 13-14. Most importantly, the plurality in Industrial Union stressed that, regardless of any problems with the particular analysis in front of it, in general the agency has just the sort of discretion to implement a preventative approach in making a threshold determination of risk that this Court articulated in Ethyl, free of the empirical constraints advocated by Petitioners. See Industrial Union, 448 U.S. at 655-56 (explaining, inter alia, that a threshold determination of risk "is not a mathematical straitjacket," the agency "has no duty to calculate the exact probability of harm," and it "is not required to support its finding that a significant risk exists with anything approaching scientific certainty"). The Court further stressed that the agency has "some leeway where its

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define a protective ambient level and then determine a margin of safety from that point).

findings must be made on the frontiers of scientific knowledge" and "so long as [the agency's findings] are supported by a body of reputable scientific thought, the Agency is free to use conservative assumptions in interpreting the data with respect to carcinogens, risking error on the side of overprotection rather than underprotection." Id. at 656; see also, e.g., Nat'l Maritime Safety Ass'n v. OSHA, No. 09-1050, 2011 WL 2417109, at *3, *5 (D.C. Cir. June 17, 2011) (following this aspect of Industrial Union and applying a similar deferential standard of review to OSHA rules for shipping).

For all of these reasons, as well as the reasons discussed in Part I, supra, EPA was not required to define endangerment in the empirical terms advocated by Petitioners.

B. The Extent to Which the Vehicle Rule Will Ameliorate Climate Change is Irrelevant to the Endangerment Finding.

In making the Endangerment Finding, EPA correctly rejected the suggestion that the Agency cannot make an affirmative endangerment finding unless it also finds that regulatory control measures "would prevent at least a substantial part of the danger from the global climate change at which the regulation is aimed." 74 Fed. Reg. at 66,507; see Ind. Br. 13-14, 28-29. Indeed, in Massachusetts, the Supreme Court rejected essentially the very argument Petitioners advance. See Massachusetts, 549 U.S. at 533 (characterizing "effective" voluntary measures as having "nothing to do with whether greenhouse gas emissions contribute to climate

change"), 534 (characterizing the effectiveness and appropriateness of greenhouse gas emission standards for motor vehicles as "irrelevant" to the endangerment finding).

The approach followed by EPA is consistent with the structure of Section 202(a). First, Congress separated the criteria governing the endangerment and contribution findings from the factors governing the establishment of emission standards. See 74 Fed. Reg. at 66,507; see also 42 U.S.C. § 7521(a)(1)&(2). After EPA makes a positive endangerment finding under Section 202(a)(1), issues associated with the cost and availability of controls are relevant to the subsequent setting of emission standards, as expressly provided for in Section 202(a)(2). See 42 U.S.C. § 7521(a)(2). Congress' express reference to cost and technology in Section 202(a)(2) reinforces the absence of any similar factor in Section 202(a)(1). See Whitman v. American Trucking Ass'ns, 531 U.S. 457, 466-68 (2001).

In addition, Section 202(a)(1) also specifically directs EPA to consider whether "air pollution" – not motor vehicle emissions – may reasonably be anticipated to present an "endangerment to public health or welfare." 42 U.S.C. § 7521(a)(1). Thus, the first and most important statutory inquiry for EPA – whether the "air pollution" (the atmospheric concentration of six greenhouse gases) may present an "endangerment" to public health or welfare – has no relationship to the origins of this air pollution. See 74 Fed. Reg. at 66,505-06. Rather, the source of

these emissions is only relevant to the second part of EPA's inquiry, whether motor vehicle emissions "cause or contribute" to the air pollution the Administrator has judged may reasonably be anticipated to endanger. Even in that part of Section 202(a)(1), however, there is no suggestion that Congress intended EPA to analyze the extent or adequacy of future emission *controls* as part of the initial "cause or contribute" finding. This is another strong indication from the structure of Section 202(a) that Congress did not intend the efficacy of potential control strategies, nor any other issue unrelated to the public health and welfare impacts of the air pollution under consideration, to be a relevant factor for EPA to have considered in the Endangerment Finding.

It is also worth noting that this separation between the endangerment determination and the setting of standards is repeated in comparable provisions of the Act, particularly those addressing the establishment of National Ambient Air Quality Standards ("NAAQS") under 42 U.S.C. §§ 7408-09. The "endangerment" finding under Section 108(a)(1), 42 U.S.C. § 7408(a)(1), can lead to the listing of an air pollutant, which leads to the development of "air quality criteria" under Section 108(a)(2), 42 U.S.C. § 7408(a)(2), and then establishment of a NAAQS under Section 109, 42 U.S.C. § 7409, at the level that is "requisite" to protect public health and welfare. Clearly EPA is not required to know the results of the subsequent NAAQS standard-setting in order to make the endangerment finding

under Section 108(a)(1). As with Section 202(a), Congress clearly contemplated that EPA would first determine that an air pollutant contributed to air pollution that endangered public health and welfare, and then that EPA would separately determine the appropriate level (or standard) for that pollutant.

Thus, not only is there nothing in Section 202(a)(1) itself that suggests EPA should consider the efficacy of emission standards as part of the Endangerment Finding, but this separation of endangerment and standard-setting criteria is repeated in comparable contexts throughout the Act, and certainly is not unusual or inappropriate as Petitioners suggest. See also, e.g., CAA Sections 111(b), 213(a)(4), and 231(a), 42 U.S.C. §§ 7411(b), 7547(a)(4), and 7571(a). In sum, it is Petitioners, not EPA, who would distort congressional intent by improperly collapsing these criteria into one decision, in effect revising section 202(a).

Petitioners' reliance on Small Refiner Lead Phase-Down Task Force v. EPA, 705 F.2d 506, 525 (D.C. Cir. 1983), is clearly misplaced. See Ind. Br. 24, 26. In the cited portion of Small Refiner, the Court considered whether the Agency had adequately explained why it imposed a uniform lead-content fuel standard on both small and large refiners when it had proposed to differentiate between the two. Small Refiner did not address the criteria for an endangerment finding (under the then-existing CAA Section 211(c)) at all; rather it addressed the appropriateness of the regulatory controls on small refiners (under then-existing CAA Section 211(g))

many years after the endangerment finding was made. See generally Small Refiner, 705 F.2d at 511-16. The aspect of Small Refiner Petitioners cite thus is irrelevant to this case. This case does not involve the setting of a regulatory standard under Section 202(a)(2), but instead solely involves the finding of whether an endangerment exists under Section 202(a)(1). If Small Refiner provides any pertinent guidance here, it supports EPA's approach because it clearly distinguishes the factors that guide a threshold finding of "endangerment" from those that guide the subsequent establishment of emission standards. See Small Refiner, 705 F.2d at 517.

Petitioners also inappropriately base much of their argument on these points on an obvious misreading of Ethyl, claiming that the Court framed the "relevant issue" in that case "not as whether there was evidence that environmental lead could be a public health hazard, but whether the record 'present[ed] a rational basis for the low-level regulations' that EPA actually adopted." Ind. Br. 24 (quoting Ethyl, 541 F.2d at 38). When read in context, it is clear that this quote is merely a general preface to the Court's substantive review of the EPA action before it. While the petitioners' challenge (and the Court's analysis) in Ethyl focused on the threshold "endangerment" question, that litigation, unlike this case, ultimately constituted a challenge to the substantive fuel additive standards themselves. See Ethyl, 541 F.2d at 10-11 (discussing procedural history and summarizing

Petitioners' challenges). Thus, it is not at all surprising that the Court would introduce its analysis with the type of shorthand quoted by Petitioners, which simply describes the overall nature of the claims before the Court (i.e., a challenge to the lead standards adopted by EPA), and recognizes that the rationality of the endangerment finding was a necessary legal prerequisite for adopting a fuel control under the statutory provision at issue. Petitioners' suggestion that this prefatory snippet from Ethyl was somehow meant to make a showing of regulatory efficacy the sine qua non of all "endangerment" determinations is wholly unjustified.

Petitioners then suggest that the Court's decision in Ethyl precluded EPA from making an endangerment finding unless the Agency first determined that the promulgated restrictions on leaded fuel additives would "fruitfully attack" certain very specific indicia of public health threats from lead that EPA cited to support the endangerment finding. Ind. Br. 25 (citing Ethyl, 541 F.2d at 31 & n.62, 55-65). However, in the cited portion of Ethyl, the Court was specifically addressing arguments that EPA's endangerment finding should only have considered the *incremental* effects on public health of lead from fuel additives, not the *cumulative* effects of such lead combined with lead from other sources. The Court's point was that the incremental approach advocated by Petitioners there was inappropriate in

gauging whether an endangerment was posed by lead-containing fuel additives.[52] By contrast, the Court pointed out (in the text cited by Petitioners) that the incremental effect of lead from fuel additives could be a relevant consideration in deciding what *control requirements* might be appropriate to address that endangerment under the pertinent provisions of the Act in place at that time.[53] Thus, read in context, the text on which Petitioners rely simply states that while the efficacy of potential regulatory approaches may be relevant to the selection of control requirements under the CAA provision at issue in that case, it has no bearing on the threshold question of whether or not the air pollution endangers public health or welfare. See 74 Fed. Reg. at 66,507-08.

Petitioners fare no better in their attempt to find such a limitation on the endangerment finding in Ethyl's review of EPA's scientific determinations. See Ind. Br. 25 (citing Ethyl, 541 F.2d at 55-65). Petitioners improperly characterize the appendices in Ethyl as addressing how EPA's lead regulation would lower exposures and ameliorate the underlying danger from airborne lead. To the contrary, the appendices deal exclusively with scientific studies concerning the risk

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[52] See Ethyl, 541 F.2d at 30-31 ("Congress understood that the body lead burden is caused by multiple sources" and that "[i]t did not mean for 'endanger' to be measured only in incremental terms").

[53] Ethyl, 541 F.2d at 31 n.62 ("While the incremental effect of lead emissions on the total body lead burden is of no practical value in determining whether health is endangered, it is of value, of course, in deciding whether the lead exposure problem can fruitfully be attacked through control of fuel additives."); see also 74 Fed. Reg. at 66,508 (discussing this aspect of Ethyl).

to health from airborne lead, whether inhaled or ingested as dust, such as clinical studies and epidemiologic studies. They do not discuss the control strategy adopted by EPA, the amount of reductions this strategy would achieve, or how these reductions would directly impact public health. The appendices do not give any indication that the Court was reviewing the efficacy of the control strategy in reviewing the science on which the endangerment finding was based. Moreover, as discussed in the preceding section, what is perhaps the most salient point about the appendices in Ethyl is that they reflect this Court's acceptance of a qualitative rather than quantitative analysis in this context.

As EPA aptly pointed out, Petitioners' approach would also be unworkable in practice. It would require EPA, at the time of the endangerment finding, to project the result and effectiveness of "perhaps not one, but even several, future rulemakings stretching over perhaps a decade or decades." 74 Fed. Reg. at 66,508. Contrary to Petitioners' argument, there is nothing in the statute or applicable judicial precedent that supports, let alone compels, this irrational and unwieldy result.

Finally, there is no merit to Petitioners' suggestion that EPA was required to defer making the Endangerment Finding until after undertaking a full analysis of the effect of updated fuel economy standards adopted by the National Highway Traffic Safety Administration ("NHTSA"). Ind. Br. 39-41. Petitioners base this

argument largely on the fact that the NHTSA's authorizing fuel-economy statute (the Energy Policy and Conservation Act, or "EPCA") was updated (by the Energy Independence and Security Act, or "EISA") after the Supreme Court decided Massachusetts. Id. at 40. However, this chronology is irrelevant. Regardless of the amendments Congress may have made to EPCA and when it made them, the operative provision here is Section 202(a)(1) of the Clean Air Act, and that provision has been unchanged since 1977. Under that section, EPA simply had no obligation to consider, as part of the Endangerment Finding, the impact of NHTSA's regulation; instead, issues such as this are governed exclusively by the regulatory criteria established by Congress in Section 202(a)(2), 42 U.S.C. § 7521(a)(2). Massachusetts, 549 U.S. at 532 ("that DOT sets mileage standards in no way licenses EPA to shirk its environmental responsibilities"); see also 74 Fed. Reg. at 66,507-08, 66,544; 75 Fed. Reg. at 49,589-90.[54]

[54] Petitioners also argue that there should be little practical need for EPA regulation of greenhouse gas emissions from motor vehicles once NHTSA's corporate average fuel economy ("CAFE") standards are updated. Ind. Br. 40. While these issues are legally irrelevant to the Endangerment Finding (for the reasons discussed in the text here), in response to reconsideration petitions raising this issue, the Agency explained that the EPA light- duty vehicle standards will achieve greater overall greenhouse gas reductions than CAFE standards. See 75 Fed. Reg. at 49,590. In fact, EPA's vehicle standards are projected to result in 47 percent greater greenhouse gas reductions than projected under the CAFE standards over the lives of model year 2012-2016 vehicles. 75 Fed. Reg. at 25,490, Table III.F.1-2; 75 Fed. Reg. 25,635-36, Table IV.G.1-4.

For all these reasons, as well as those discussed in Part I, supra, there simply is no support in the statute or applicable case law for Petitioners' suggestion that EPA should take into account the efficacy of emission standards before making an endangerment finding.

VI. EPA PROPERLY DECLINED TO CONSIDER THE ADDITIONAL FACTORS IDENTIFIED BY PETITIONERS AS PART OF ITS ENDANGERMENT ANALYSIS

This Court has long made clear that where a statute directs an agency to consider certain specific factors in making a determination, it is inappropriate for the agency to inject other factors into that analysis. See, e.g., Am. Petroleum Inst. v. EPA, 52 F.3d 1113, 1119-20 (D.C. Cir. 1995); Ethyl Corp. v. EPA, 51 F.3d 1053, 1059-60 (D.C. Cir. 1995); see also National Ass'n of Home Bldrs. v. Defenders of Wildlife, 551 U.S. 644, 663-64 (2007) (list of nine factors for challenged Clean Water Act program approval is "exclusive"). With even more direct relevance to this case, the Supreme Court held that the Administrator's exercise of "judgment" under the endangerment criterion of Section 202(a)(1) must "relate to whether an air pollutant 'cause[s], or contribute[s] to, air pollution which may reasonably be anticipated to endanger public health or welfare.'" Massachusetts, 549 U.S. at 532-33 (quoting 42 U.S.C. § 7521(a)(1)). The Court intended the Administrator to base her decision on science, not general "policy judgments" divorced from these statutory factors. Massachusetts, 549 U.S. at 533-

34. "Put another way," the Court added, "the use of the word 'judgment' is not a roving license to ignore the statutory text[;]" rather, it is "but a direction to exercise discretion within defined statutory limits." Id. at 533; see also Am. Elec. Power Co. v. Connecticut, 131 S. Ct. 2527, 2539 (2011) (quoting Massachusetts).

Yet, such a "license to ignore the statutory text" is essentially what Petitioners seek here. Specifically, Petitioners argue that EPA should have added a number of additional, unmentioned factors into the health and welfare endangerment criteria expressly set forth in Section 202(a)(1), namely, the costs and administrative burdens attendant to stationary source regulation of greenhouse gas emissions, the extent to which society can adapt to or mitigate the adverse effects of the endangerment and the extent to which adverse climate effects can be justified in the name of economic progress. These arguments are meritless.

Petitioners' approach would require EPA to turn a blind eye to air quality degradation and associated health and welfare impacts, so long as the increased pollution could in some sense be justified, tolerated, or adapted to in the name of "progress." However, as discussed in Part I.B, supra, Congress' express, overriding purpose in enacting the precautionary endangerment language in Section 202(a)(1) was to enable EPA to take action to avoid adverse impacts to public health and welfare from air pollution before they occur to the extent possible. See also 42 U.S.C. § 7401(b)(1) (general purpose of the Clean Air Act is

"*to protect and enhance the quality of the nation's air resources* so as to promote the public health and welfare and the productive capacity of the population") (emphasis added). For these and other reasons, EPA's determination that such considerations were irrelevant to the Endangerment Finding represented, at the very least, a "reasonable" construction of the statute that should be upheld under the second step of Chevron,[55] or, alternatively, a reasonable and well-explained determination under the deferential arbitrary or capricious standard of review.[56]

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[55] The Court need not reach the question of whether the statute unambiguously precludes EPA from considering these factors since, for the reasons discussed herein, at the very least it was reasonable for EPA to deem such factors irrelevant to its analysis. See Entergy Corp. v. Riverkeeper, Inc., 129 S. Ct. 1498, 1505 n.4 (2009) (rejecting argument that a Chevron step one analysis is required in every case since "surely if Congress has directly spoken to an issue then any agency interpretation contradicting what Congress has said would be unreasonable").

[56] We acknowledge that statutory questions bearing on the appropriate factors to consider in making an endangerment finding overlap with the Court's inquiry into whether the challenged action is arbitrary or capricious, which also in part asks whether the agency's decision "was based on a consideration of the relevant factors." Bowman Transp., Inc. v. Arkansas-Best Freight Sys., Inc., 419 U.S. 281, 285 (1974) (citation omitted). This Court has recognized such an overlap in other cases. See, e.g., Am. Fed'n of Gov't Employees v. Nicholson, 475 F.3d 341, 346 (D.C. Cir. 2007); Nat'l Ass'n of Regulatory Utility Comm'rs v. ICC, 41 F.3d 721, 726-27 (D.C. Cir. 1994). While admittedly a close question, the Court has suggested that analysis under the Chevron framework is more appropriate where (as here) the agency is acting pursuant to a relatively specific statutory provision, see Nat'l Ass'n of Regulatory Utility Comm'rs v. ICC, 41 F.3d at 727, so we have generally structured our argument accordingly. However, EPA believes the same analysis also demonstrates that the Agency's framework for addressing the endangerment question was neither arbitrary nor capricious.

A. EPA Was Not Required to Consider the Costs and Administrative Burdens Attendant to Stationary Source Regulation of Greenhouse Gas Emissions.

Petitioners argue that EPA was required to consider the possible effect of future regulation of stationary sources – and especially the costs and administrative burdens of such stationary source regulation – since: (1) the Endangerment Finding obligated EPA to issue corresponding emission standards for motor vehicles; (2) issuance of such standards (through the Vehicle Rule) made greenhouse gases "subject to regulation" under the Act; and (3) PSD and Title V permit requirements apply to stationary sources based on their emissions of any pollutant subject to regulation under the Act. See Ind. Br. 20-23; see also Non-State Amicus Br. at 19-31. EPA properly rejected this argument for a variety of reasons. See 75 Fed. Reg. at 49,584-89; 74 Fed. Reg. at 66,515-16.

1. Costs play no role in determining whether the air pollution endangers public health or welfare.

It was at the very least reasonable, under Chevron, for EPA to conclude that it was precluded from considering costs as part of the Endangerment Finding.

First, as discussed in Part I of this brief, supra, the only factors relevant to an endangerment finding under section 202(a)(1) are whether an endangerment to public health or welfare from the relevant air pollution may reasonably be anticipated. Where, as here, the scientific inquiry conducted by EPA indicates that these statutory criteria are met, the Administrator simply does not have the

discretion to decline to make a positive endangerment finding to serve other policy goals. See Massachusetts v. EPA, 549 U.S. at 532-35.

Petitioners suggest that EPA could decline to make an endangerment finding under Section 202 to stave off stationary source regulation under the Act's PSD program, see Ind. Br. 21; see also Non-State Amicus Br. 22-24, but there simply is no basis in Section 202(a)(1) for EPA to do so.[57] While it is true that the Act makes PSD requirements applicable to newly-regulated pollutants, including greenhouse gases, this reflects a congressional choice wholly independent of the focused health and welfare endangerment criteria established in Section 202(a)(1). See also Am. Elec. Power Corp. v. Connecticut, 131 S. Ct. at 2537 (noting that CAA "speaks directly" to regulation of carbon dioxide emissions from coal-fired power plants). The lack of any statutory support for Petitioners' approach indicates that it should be rejected as inconsistent with clear Congressional intent. At the very least, however, EPA acted reasonably and consistently with the statute in determining that the regulatory effects that may follow an endangerment finding

[57] Petitioners' citation to EPA's 2008 ANPR, see Ind. Br. 23, is irrelevant. In the cited portion of the ANPR, EPA simply described the potential relationships among various provisions of the Act and the possible statutory implications of a positive endangerment finding. See 73 Fed. Reg. 44,354, 44,418-20 (July 30, 2008). There is nothing in the ANPR that supports Petitioners' argument that EPA believed it could properly consider potential stationary source implications as a factor in making or declining to make an endangerment finding and, in any case, it is EPA's final Endangerment Finding, not the ANPR, that is the focus of judicial review here.

simply are not relevant factors in determining whether an endangerment to health or welfare exists from the air pollution. 74 Fed. Reg. at 66,515.

In this respect, EPA's position is somewhat like the position of the Department of Transportation in DOT v. Public Citizen, 541 U.S. 752 (2004). In that case, the Supreme Court held that where a statute limited DOT's regulatory authority exclusively to safety-related impacts of Mexican truck operations in the United States, the agency was not required by the CAA or the National Environmental Policy Act also to consider the environmental impacts of increased truck traffic that likely would result from promulgation of the safety regulations. Similarly, in this case Section 202(a)(1) simply has no provision that would allow EPA to delay, adjust, or avoid making the Endangerment Finding solely to address concerns about stationary source regulatory implications.

On these points, EPA also aptly analogized an endangerment finding to the setting of a national ambient air quality standard ("NAAQS") under section 109(b) of the Act, 42 U.S.C. § 7409(b), which in pertinent part calls on the Administrator to set standards that in her "judgment" are "requisite to protect the public health." See 74 Fed. Reg. at 66,515-16; see also Part V.B, supra. Like the endangerment provision at issue here, Section 109(b) is focused solely on the public health and welfare impacts of air pollution, and the Supreme Court has made clear that cost-related impacts may not be a factor in making this determination. 74 Fed. Reg. at

66,515-16 (citing Whitman v. Am. Trucking Ass'ns, 531 U.S. 457, 466 (2001)). The Court in Whitman noted that the Act expressly allows costs to be taken into account when EPA takes regulatory action under other provisions, and the Court refused to infer an "authorization to consider costs" into the health-focused NAAQS provision. Whitman, 531 U.S. at 466-67.[58] For this reason, whatever authority EPA may have to consider costs in other contexts, see Non-State Amicus Br. at 14, the Agency properly declined to consider costs under the endangerment criteria of Section 202(a)(1), since that health and welfare-based provision is similar in relevant respects to the NAAQS provisions at issue in Whitman.

As EPA further explained, the Supreme Court in Whitman also rejected the suggestion that the cost impacts of regulation should be considered part of the public health and welfare inquiry itself. See 74 Fed. Reg. at 66,516. In the portion of Whitman cited by EPA, the Court explained:

> Even so, respondents argue, many more factors than air pollution affect public health. In particular, the economic cost of implementing a very stringent standard might produce health losses sufficient to offset the health gains achieved in cleaning the air – for example, by closing down whole industries and thereby impoverishing the workers and consumers dependent upon those industries.

[58] See also 531 U.S. at 469 ("That factor [costs] is *both* so indirectly related to public health *and* so full of potential for canceling the conclusions drawn from direct health effects that it would surely have been expressly mentioned in §§ 108 and 109 had Congress meant it to be considered.") (emphasis in original).

Whitman, 531 U.S. at 466. While the Court found this proposition to be "unquestionably true," it also found that "Congress was unquestionably aware of it," but chose to address this issue by specifying in various provisions when, and to what extent, costs may properly be considered. Id. at 466-67 (citing Section 202(a)(2), among other provisions, as a specific provision providing for consideration of costs). The Court therefore rejected Petitioners' attempt to inject costs, implicitly, as a factor to be considered in establishing a NAAQS, a provision focused on public health and welfare effects of air pollution much like Section 202(a)(1). Id. at 467-68. The same reasoning applies here.

Ultimately, as EPA pointed out, Petitioners' concern about the costs and administrative burdens of stationary source regulation of greenhouse gas emissions pertains to the operation of the statute, not to any choices EPA made or had the authority to make in the Endangerment Finding. 74 Fed. Reg. at 66,515. Except where Congress so specifies (which is not the case here), EPA has no obligation to consider all the interrelationships among various provisions of the Act when taking regulatory action under one. See Small Refiner, 705 F.2d at 516-17 (rejecting contention that EPA needed to consider whether regulation of lead fuel additives under Section 211 of the Act was necessary to meet the lead NAAQS, noting that "when Congress wanted EPA to consider other sections of the Act before regulating fuel additives, it said so"). Simply put, EPA's authority and

responsibility to make an endangerment finding under Section 202(a) are completely separate from Congress' decision to apply the PSD program to any pollutant regulated under the Act.

EPA further aptly explained in response to comments that while Section 202(a) and the Supreme Court's guidance in Massachusetts gave EPA some discretion to delay making an endangerment finding if the available scientific information is insufficient to allow for an informed exercise of judgment, EPA does not have discretion to delay or avoid such a finding simply to serve policy concerns that have no foundation in the science and health and welfare-based factors set forth in Section 202(a)(1). 74 Fed. Reg. at 66,507-08, 66,515-16. EPA noted that the Endangerment Finding in and of itself did not trigger PSD requirements under then-current EPA policy, and that the Tailoring Rule (which at the time of the Endangerment Finding was only a proposed rule) would address the cost and administrative burden issues associated with the implementation of PSD and Title V permitting requirements for stationary sources of greenhouse gas emissions. Id. at 66,516 n.17; see also 74 Fed. Reg. 18,886, 18,905 n.29 (Apr. 24, 2009) (proposed rule preamble noting that Endangerment Finding itself would not trigger PSD requirements). EPA later reiterated these same points as part of the Reconsideration Denial. See 75 Fed. Reg. at 49,586 (endangerment inquiry under Section 202(a)(1) is limited to questions of public health and welfare stemming

from the air pollution, and does not allow the Agency to decline to issue an endangerment finding "based on concerns with implementing stationary source permitting"). Notably, Petitioners cannot point to any specific provision in Section 202 that would require – or even allow – EPA to alter, defer, or avoid an endangerment finding based on concerns about regulatory impacts on stationary sources.[59]

[59] The Non-State Amici present a variety of claims concerning EPA's alleged duty to consider economic impacts and other cost-related issues under Sections 317 and 321 of the Act, 42 U.S.C. §§ 7617, 7621, the Regulatory Flexibility Act ("RFA"), and Executive Order No. 12,866 ("EO 12866"). See Non-State Amicus Br. 7-12. Since no party to this case has raised any claims arising under these authorities, they may not be raised by the Non-State Amici. See D.C. Cir. R. 29(a) (amici may discuss "points not made or adequately elaborated upon in the principal brief" but only as "relevant to the issues before this court"); Edison Elec. Inst. v. OSHA, 849 F.2d 611, 625 (D.C. Cir. 1988) ("issues before the court" is limited to claims advanced by the parties); see also Michel v. Anderson, 14 F.3d 623, 625 (D.C. Cir. 1994) (Court does not entertain arguments presented only by an amicus unless it pertains to the Court's jurisdiction). In any event, EPA amply considered and discussed all of these issues in the rulemaking record, to the extent they were raised by commenters. See Response to Comments, Sections 11.5 (economic considerations, including CAA § 317 and EO 12,866) (JA 4010-16), 11.7.1 (RFA) (JA 4020-21); see also 74 Fed. Reg. at 66,545 (addressing statutory and executive order reviews including EO 12866 and RFA). No comments filed during the comment period on the Endangerment Finding raised claims based on CAA Section 321; accordingly, any claims premised on that provision are also waived by operation of 42 U.S.C. § 7607(d)(7)(B).

2. EPA also was not required to consider stationary source impacts as part of the Endangerment Finding to avoid allegedly absurd results.

Neither is there merit to Petitioners' related suggestion that EPA needed to consider stationary source impacts as part of the endangerment inquiry in order to avoid "absurd" results related to stationary sources. See, e.g., Ind. Br. 20, 23.

The gist of this argument, which was primarily presented to EPA as part of the reconsideration petitions, is that because EPA invoked the "absurd results" doctrine, in part, to justify the modified PSD and Title V applicability thresholds established in the Tailoring Rule, EPA had an obligation to interpret its "endangerment" authority in Section 202(a)(1) in such a way as to avoid that absurd result. See 75 Fed. Reg. at 49,586-89 (portion of Reconsideration Denial discussing these issues).[60] In denying those petitions, EPA correctly stressed at the outset that the absurdity that needs to be addressed is not in Section 202(a)(1),[61]

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[60] Specifically, Petitioners argue that the absurd results of applying the major stationary source statutory thresholds to greenhouse gases provide "reasons for action or inaction in the statute" that EPA can, if not must, rely on to decline to make an Endangerment Finding under Section 202(a). Ind. Br. 18-19 (quoting Massachusetts, 549 U.S. at 534-35); see also Non-State Amicus Br. 29-32. We note that the discussion of "absurd results" is only one facet of the analysis EPA set forth in conjunction with the Tailoring Rule, and we respectfully refer the Court to the preamble for the Tailoring Rule, 75 Fed. Reg. 31,514 (June 3, 2010), as well as EPA's briefing in No. 10-1073, for a more comprehensive discussion of that rule.

[61] Petitioners erroneously suggest that EPA views the Endangerment Finding as "the root cause of the absurdity," and that the Endangerment Finding "rests on an interpretation of the CAA … that results in 'absurd' consequences . . . ." Ind.

since that provision can be applied in a very straightforward way to determine whether or not atmospheric concentrations of greenhouse gases endanger public health or welfare. See 75 Fed. Reg. at 49,587. There is nothing absurd about regulating mobile source emissions of greenhouse gases under Section 202. Instead, the Agency explained, the absurdity only arises when the "major emitting facility" quantitative thresholds set forth in Section 169(1) of the Act, 42 U.S.C. § 7479(1), are applied to greenhouse gases. Therefore, EPA's efforts to address this absurd result through the Tailoring Rule are properly and narrowly focused on the stationary source provisions "where the absurdity originates," while leaving intact and giving full effect to other provisions of the Act, such as the mobile source provisions in Section 202(a)(1), which are necessary to serve the Act's goals of promoting public health and welfare, and which are not the cause of the absurdity. 75 Fed. Reg. at 49,586. Whereas the Tailoring Rule reasonably and narrowly resolves the absurdity by phasing-in stationary source regulation of greenhouse gas emissions starting with the largest emitters, Petitioners' blunt "solution" to the absurdity would indefinitely defer *any* regulation of greenhouse gas emissions from mobile *or* stationary sources. Id. at 49,587. As discussed in the preceding

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Br. 20. To the contrary, EPA explained that it is only the major stationary source statutory thresholds that would lead to absurd results if applied immediately to greenhouse gases. EPA did not take the position in the Endangerment Finding or subsequent actions that regulating greenhouse gases generally under the Act, or specifically under Section 202(a), is "absurd." 75 Fed. Reg. at 49,589.

section, there is nothing in Section 202(a)(1) that allows EPA to alter, defer, or avoid an otherwise-justified endangerment finding based on cost or other concerns unrelated to the science-based judgment of the impacts of air pollution on public health or welfare. EPA therefore correctly concluded that nothing in the Act or extant case law required or even permitted the Agency to pursue such an unwise and unjustified course.

For these reasons, EPA reasonably concluded that the costs and administrative burdens of stationary source regulation of greenhouse gases that may eventually flow from the Endangerment Finding simply were not relevant factors for EPA to consider in making the endangerment determination in the first instance.

B. EPA Was Not Required to Consider the Benefits of Pollution-Causing Activities.

Petitioners also argue that EPA should have considered the extent to which pollution-causing activities have benefitted society as part of the Agency's endangerment analysis. Ind. Br. 35-37. Exactly what Petitioners mean by this is unclear. Nearly *every* pollution-causing activity in the United States can be argued to have *some* social benefit (otherwise there presumably would be scant incentive to engage in the activity), but Congress has chosen to regulate the pollution caused by such activities under the CAA and countless other environmental statutes.

Petitioners may challenge the manner in which EPA considered the air

pollution in this case, but it is nonsensical to suggest that EPA somehow had to weigh all the alleged societal benefits of greenhouse gas-emitting activities before finding that atmospheric greenhouse gas concentrations may reasonably be anticipated to endanger public health and welfare under Section 202. As EPA explained: "The fact that we as a society are better off now than 100 years ago, and that processes that produce greenhouse gases are a large part of this improvement, does not mean that those processes do not have unintended adverse impacts." 74 Fed. Reg. at 66,516. The very point of Section 202 is that EPA should address these "unintended adverse impacts" as they are manifested in the specific form of air pollution caused or contributed to by motor vehicles. The Agency was not tasked by Congress to engage in a wide-ranging sociological and philosophical exercise to determine whether this air pollution is somehow "worth it."[62]

The authority cited by Petitioners is completely inapposite. For example, Petitioners rely on Competitive Enterprise Inst. v. NHTSA, 956 F.2d 321, 327 (D.C. Cir. 1992), noting that this Court required NHTSA to further consider safety impacts when setting fuel economy standards. Ind. Br. 35; see also Non-State Amicus Br. 13. While that point is true, Petitioners overlook that the Court was

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[62] See Ethyl, 541 F.2d at 6 ("It is only recently that we have begun to appreciate the danger posed by unregulated modification of the world around us, and have created watchdog agencies whose task it is to warn us, and protect us, when technological 'advances' present dangers unappreciated or unrevealed by their supporters.").

reviewing a fuel economy standard in light of the statutory criteria for setting such standards and stressed that the statute required NHTSA to consider "feasibility" and the Agency had long interpreted feasibility to include safety. Competitive Enterprise, 956 F.2d at 322. Here, by contrast, the weighing of air pollution detriments against economic and social benefits sought by Petitioners has absolutely no basis in the statutory requirement to make an endangerment determination concerning air pollution, and such an approach would in fact undermine the goals of that provision.

Petitioners also point to this Court's decision that EPA had to consider both positive and negative health effects from ambient levels of ozone pollution in setting a NAAQS for that pollutant. See Ind. Br. 35 (citing Am. Trucking Ass'ns v. EPA, 175 F.3d 1027, 1052 (D.C. Cir. 1999), aff'd in part, reversed in part on other grounds sub nom. Whitman v. Am. Trucking Ass'ns, 531 U.S. 457 (2001)). However, Petitioners are not arguing that EPA overlooked any positive effects of greenhouse gas concentrations in the atmosphere; rather, they are arguing that EPA should have (at least in part) simply ignored the negative effects of this pollution based on perceived social benefits from the activities that initially gave rise to the pollution-causing emissions.

For all the foregoing reasons, there simply is no justification for supposing that Congress, sub silentio, intended to block EPA from making an appropriate

endangerment determination under Section 202 until after the Agency balanced the adverse health and welfare effects of air pollution against the claimed social benefits of the activities giving rise to that pollution.

C. EPA Was Not Required to Consider the Extent to Which Society Might Adapt to or Mitigate the Effects of Pollution.

Petitioners also miss the mark in arguing that EPA was required to consider society's ability to adapt to, or mitigate, the adverse effects of climate change before determining endangerment. See Ind. Br. 37-39; Tx. Br. 21-22. Petitioners provide no specific examples of such adaptation and mitigation, but presumably they are referring generally to social, scientific, technological, or natural *responses* to climate change that will better enable humans to live with those effects *after* they have already occurred. (Adaptation generally refers to planning and actions to ameliorate present and anticipated harms, such as developing crops that are more drought-resistant. Mitigation generally refers to actions to reduce emissions of greenhouse gases.)

In response to comments on these issues, EPA began by acknowledging that adaptation and mitigation is "a strong focal area of scientists and policy makers, including EPA." 74 Fed. Reg. at 66,512. Indeed, to the extent Petitioners are challenging the autonomous ability of natural ecosystems to blunt the impacts of climate change, EPA's analysis took such adaptation into account to the extent "the literature on which [EPA's TSD] relies already uses assumptions about

autonomous adaptation when projecting the future effects of climate change." Id. That said, because adaptation and mitigation are otherwise "*responses* to endangerment," the Agency "determined that they are outside the scope of the endangerment analysis." Id.

EPA's approach to these issues reflects, at the very least, a reasonable construction of the statute. To begin with, were EPA to venture beyond the scientific record regarding adaptation of natural ecosystems to fully consider how society might adapt to or mitigate the effects of climate change, EPA would have to make judgments going far beyond "the kind of scientific or technical judgments that Congress envisioned for the endangerment test." 74 Fed. Reg. at 66,514. For example, EPA would have to formulate some estimate, going perhaps decades into the future, as to "the political actions likely to be taken by various local, State, and Federal governments" as well as "judgments on the business or other decisions that are likely to be made by companies or other organizations, or the changes in personal behavior that may be occasioned by the adverse impacts of air pollution." Id. This would both "dramatically increase the complexity of the issues before EPA," 74 Fed. Reg. at 66,513, and "would take EPA far away from the kind of judgments Congress envisioned for the endangerment test." Id. at 66,514.[63] The

[63] EPA set forth several reasons for not considering adaptation and mitigation as part of the endangerment determination; it did not, as Petitioners suggest, decline to do so *solely* because such an undertaking would be complex. Tx. Br. 22.

endangerment analysis, EPA reasoned, "involves evaluating the risks to public health and welfare from the air pollution if we do not take action to address it." Id. Adaptation and mitigation, on the other hand, "address an important but different issue – how much risk will remain assuming some projection of how people and society will respond to the threat." Id.

EPA's approach is consistent with the structure and intent of Section 202. As discussed above, Section 202(a) creates a two-part decision-making approach, separating the endangerment criteria in Section 202(a)(1) from the standard-setting criteria in Section 202(a)(2). See supra Parts I, V.B. In this way, the structure of the Act clearly supports the Administrator's approach of separating the analysis of whether an endangerment to public health or welfare "may reasonably be anticipated," 42 U.S.C. § 7521(a)(1), from the entirely separate inquiry as to what the proper shape and content of the regulatory response to this endangerment should be.

Further, when Congress amended the Act in 1977 to add the present "endangerment" language to Section 202, its overriding, express purpose was "[t]o emphasize the preventive or precautionary nature of the act, i.e., to assure that regulatory action can effectively *prevent* harm *before* it occurs . . . ." 1977 U.S.C.C.A.N. at 1127 (emphasis added). Congress intended EPA to take actions that would "assure that the health of susceptible individuals, as well as healthy

adults, will be encompassed in the term 'public health.'" Id. at 1128. Petitioners' argument thus stands in direct conflict with this purpose, since it would re-direct EPA's focus from prevention to after-the-fact remediation and accommodation, and would undercut the goal of protecting even the most vulnerable members of society from harm.

For all these reasons, EPA reasonably determined that adaptation and mitigation (other than the natural adaptation of ecosystems discussed above) generally are not factors the Agency was required to consider as part of its endangerment analysis.

VII. PETITIONERS' ARGUMENTS CONCERNING REVIEW BY THE SCIENCE ADVISORY BOARD HAVE BEEN WAIVED AND ARE, IN ANY EVENT, MERITLESS

The Science Advisory Board ("SAB") was established by Congress in 1978. See 42 U.S.C. § 4365; see also 1977 U.S.C.C.A.N. 3283-99. The SAB's members are appointed by the EPA Administrator, and its general purpose is to provide EPA with advice on certain types of scientific decisions. Of particular relevance to Petitioners' claims here is 42 U.S.C. § 4365(c)(1), which, inter alia, directs EPA to provide the SAB with "any proposed criteria document, standard, limitation, or regulation" under the Clean Air Act and other statutes. Upon review, the SAB may (but is not required to) provide scientific advice to the Administrator regarding the document in question. Id. § 4365(c)(2).

In this case, EPA did not submit the proposed Endangerment Finding to the SAB for review. No party submitted comments on the proposed Endangerment Finding raising the statutory argument made by Petitioners,[64] but some parties did raise this argument as part of their petitions for reconsideration. In its denial of those petitions, EPA explained that this argument was both procedurally defective (because it could have been raised during the comment period on the proposed Endangerment Finding) and substantively defective (because, among other things, the Endangerment Finding is not a "criteria document, standard, limitation, or regulation" within the meaning of 42 U.S.C. § 4365(c)(1)). See RTP 3-7 (JA 4842-44).

In their brief, Industry Petitioners argue, with little explanation, that EPA violated 42 U.S.C. § 4365 by failing to submit the proposed Endangerment Finding for SAB review. This argument must fail.

A. Any Challenges Regarding SAB Review Have Been Waived.

Under Section 307(d)(7)(B), 42 U.S.C. § 7607(d)(7)(B), parties may not seek judicial review of issues they failed to raise with "reasonable specificity" during the comment period. The only exception to this rule is if it was "impracticable" to raise the issue during that comment period; even in that case, a

[64] One commenter did generally suggest that EPA consult with the SAB regarding regulatory options that would follow the Endangerment Finding but no comments raised the statutory argument advanced by Petitioners herein.

party must first present the issue through a reconsideration petition to EPA, demonstrating why the issue could not have been raised and why it is "of central relevance to the outcome of the rule." Id. This Court enforces these requirements "strictly." NRDC v. EPA, 571 F.3d 1245, 1259 (D.C. Cir. 2009); Motor & Equip. Mfrs. Ass'n v. Nichols, 142 F.3d 449, 462 (D.C. Cir. 1998). In this case, EPA made an express finding in denying the reconsideration petitions that the SAB review issue could have been raised during the public comment period, and Petitioners have not contested this finding in their brief. Accordingly, Petitioners' present challenge on this issue should be denied on this basis alone.

Curiously, although Petitioners do not challenge the application here of Section 307(d)(7)(B), 42 U.S.C. § 7607(d)(7)(B), they do contend that Section 307(d)(8), 42 U.S.C. § 7607(d)(8), which discusses the general standard of review applicable to procedural claims, does not apply to their SAB review claim. Ind. Br. 60. To begin with, this argument is irrelevant. Since Petitioners, by their silence on the failure-to-comment issue, concede that their SAB review claim is completely barred as a threshold matter by operation of Section 307(d)(7)(B), it makes no difference what standard of review might apply to the claim under Section 307(d)(8) were it allowed to proceed.

In any event, Petitioners' Section 307(d)(8) argument is incorrect. The gist of that argument is that Section 307(d)(8) only applies to claims based on

procedural requirements established by the Clean Air Act itself, not on provisions such as 42 U.S.C. § 4365. Ind. Br. 60. However, in American Petroleum Institute v. Costle, 665 F.2d 1176, 1187-89 (D.C. Cir. 1981), this Court expressly applied the requirements of Section 307(d)(7)&(8), 42 U.S.C. § 7607(d)(7)&(8), to an SAB review claim similar to that presented by Petitioners here. Petitioners do not address, let alone distinguish, this aspect of American Petroleum and their reliance on Small Refiner Lead Phase-Down Task Force v. EPA, 705 F.2d 506, 522 (D.C. Cir. 1983), is wholly misplaced. The cited aspect of Small Refiner simply noted that Section 307(d)(8)'s standard of review was essentially meant to be something of a counterweight to Congress' decision to add "new procedural protections" in certain provisions of Section 307(d). Nothing in the cited discussion suggests that the Court viewed application of the standard of review in Section 307(d)(8) to be limited to claims based on procedural requirements created by Section 307(d) itself.

For all the foregoing reasons, Petitioners' SAB review claim is barred by the requirements of Section 307(d)(7)(B), 42 U.S.C. § 7607(d)(7)(B).

B. Petitioners' SAB Review Claim Is, in Any Event, Meritless.

Even if the Court were to reach the merits of Petitioners' SAB review claim it should deny that claim on its merits.

EPA posited two reasons why the SAB review requirement does not apply here. First, the Agency explained that the proposed Endangerment Finding was not a "criteria document, standard, limitation, or regulation" within the meaning of that provision. See RTP 3-7 (JA 4842-44). Second, EPA noted that this review requirement applies only when a proposal is submitted to other federal agencies for "formal" inter-agency review, and EPA believed that the type of inter-agency review conducted under EO 12,866, which was conducted here, was by contrast "informal." Id. Since Petitioners do not expressly contest either of these conclusions in their brief, they are conceded. See, e.g., American Wildlands v. Kempthorne, 530 F.3d 991, 1001 (D.C. Cir. 2008) (parties must fully develop arguments in opening brief and arguments made for first time in reply brief are waived).[65]

In light of EPA's reasonable and uncontested conclusion that the SAB review requirement in 42 U.S.C. § 4365(c)(1) does not apply here, Petitioners'

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[65] Petitioners do refer, without explanation, to the Endangerment Finding as a "rule" but this cannot be equated to a legal argument challenging EPA's conclusion that the Endangerment Finding is not a "criteria document, standard, limitation, or regulation" within the meaning of 42 U.S.C. § 4365(c)(1). In any event, EPA adequately explained in the record its basis for concluding that the Endangerment Finding is not a regulation. See RTC 11-7 (JA 4010).

arguments as to the extent to which SAB review may or may not have satisfied Section 307(d)(8)'s standard of review for procedural claims, Ind. Br. 60-61, simply are irrelevant. Simply put, if there is no actual procedural violation, it is irrelevant how "serious" the consequences of such a violation are alleged to be. However, even if the Court were to reach those issues, EPA reasonably explained why such review would not, in fact, undermine the scientific basis for the Endangerment Finding, which was based on multiple and comprehensive scientific assessments by distinguished American and international scientific bodies. See RTP 3-7 (JA 4842-44)

For all the foregoing reasons, Petitioners' claims regarding SAB review should either be dismissed by operation of CAA Section 307(d)(7)(B), 42 U.S.C. § 7607 (d)(7)(B), or denied on the merits.

CONCLUSION

For all the foregoing reasons, EPA properly found that air pollution in the form of atmospheric concentrations of six greenhouse gases may reasonably be anticipated to endanger public health or welfare and that emissions from motor vehicles cause or contribute to this air pollution. No more was required. Accordingly, the petitions for review should be denied.

Respectfully submitted,

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STATUTORY ADDENDUM

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§7408. Air quality criteria and control techniques

(a) Air pollutant list; publication and revision by Administrator; issuance of air quality criteria for air pollutants

(1) For the purpose of establishing national primary and secondary ambient air quality standards, the Administrator shall within 30 days after December 31, 1970, publish, and shall from time to time thereafter revise, a list which includes each air pollutant—

(A) emissions of which, in his judgment, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare;

(B) the presence of which in the ambient air results from numerous or diverse mobile or stationary sources; and

(C) for which air quality criteria had not been issued before December 31, 1970 but for which he plans to issue air quality criteria under this section.

(2) The Administrator shall issue air quality criteria for an air pollutant within 12 months after he has included such pollutant in a list under paragraph (1). Air quality criteria for an air pollutant shall accurately reflect the latest scientific knowledge useful in indicating the kind and extent of all identifiable effects on public health or welfare which may be expected from the presence of such pollutant in the ambient air, in varying quantities. The criteria for an air pollutant, to the extent practicable, shall include information on—

(A) those variable factors (including atmospheric conditions) which of themselves or in combination with other factors may alter the effects on public health or welfare of such air pollutant;

(B) the types of air pollutants which, when present in the atmosphere, may interact with such pollutant to produce an adverse effect on public health or welfare; and

(C) any known or anticipated adverse effects on welfare.

(b) Issuance by Administrator of information on air pollution control techniques; standing consulting committees for air pollutants; establishment; membership

(1) Simultaneously with the issuance of criteria under subsection (a) of this section, the Administrator shall, after consultation with appropriate advisory committees and Federal departments and agencies, issue to the States and appropriate air pollution control agencies information on air pollution control techniques, which information shall include data relating to the cost of installation and operation, energy requirements, emission reduction benefits, and environmental impact of the emission control technology. Such information shall include such data as are available on available technology and alternative methods of prevention and control of air pollution. Such information shall also include data on alternative fuels, processes, and operating methods which will result in elimination or significant reduction of emissions.

(2) In order to assist in the development of information on pollution control techniques, the Administrator may establish a standing consulting committee for each air pollutant included in a list published pursuant to subsection (a)(1) of this section, which shall be comprised of technically qualified individuals representative of State and local governments, industry, and the academic community. Each such committee shall submit, as appropriate, to the Administrator information related to that required by paragraph (1).

(c) Review, modification, and reissuance of criteria or information

The Administrator shall from time to time review, and, as appropriate, modify, and reissue any criteria or information on control techniques issued pursuant to this section. Not later than six months after August 7, 1977, the Administrator shall revise and reissue criteria relating to concentrations of NO_2 over such period (not more than three hours) as he deems appropriate. Such criteria shall include a discussion of nitric and nitrous acids, nitrites, nitrates, nitrosamines, and other carcinogenic and potentially carcinogenic derivatives of oxides of nitrogen.

(d) Publication in Federal Register; availability of copies for general public

The issuance of air quality criteria and information on air pollution control techniques shall be announced in the Federal Register and copies shall be made available to the general public.

(e) Transportation planning and guidelines

The Administrator shall, after consultation with the Secretary of Transportation, and after providing public notice and opportunity for comment, and with State and local officials, within nine months after November 15, 1990,[1] and periodically thereafter as necessary to maintain a continuous transportation-air quality planning process, update the June 1978 Transportation-Air Quality Planning Guidelines and publish guidance on the development and implementation of transportation and other measures necessary to demonstrate and maintain attainment of national ambient air quality standards. Such guidelines shall include information on—

(1) methods to identify and evaluate alternative planning and control activities;

(2) methods of reviewing plans on a regular basis as conditions change or new information is presented;

(3) identification of funds and other resources necessary to implement the plan, including interagency agreements on providing such funds and resources;

(4) methods to assure participation by the public in all phases of the planning process; and

(5) such other methods as the Administrator determines necessary to carry out a continuous planning process.

(f) Information regarding processes, procedures, and methods to reduce or control pollutants in transportation; reduction of mobile source related pollutants; reduction of impact on public health

(1) The Administrator shall publish and make available to appropriate Federal, State, and

[1] See Codification note below.

local environmental and transportation agencies not later than one year after November 15, 1990, and from time to time thereafter—

(A) information prepared, as appropriate, in consultation with the Secretary of Transportation, and after providing public notice and opportunity for comment, regarding the formulation and emission reduction potential of transportation control measures related to criteria pollutants and their precursors, including, but not limited to—

(i) programs for improved public transit;

(ii) restriction of certain roads or lanes to, or construction of such roads or lanes for use by, passenger buses or high occupancy vehicles;

(iii) employer-based transportation management plans, including incentives;

(iv) trip-reduction ordinances;

(v) traffic flow improvement programs that achieve emission reductions;

(vi) fringe and transportation corridor parking facilities serving multiple occupancy vehicle programs or transit service;

(vii) programs to limit or restrict vehicle use in downtown areas or other areas of emission concentration particularly during periods of peak use;

(viii) programs for the provision of all forms of high-occupancy, shared-ride services;

(ix) programs to limit portions of road surfaces or certain sections of the metropolitan area to the use of non-motorized vehicles or pedestrian use, both as to time and place;

(x) programs for secure bicycle storage facilities and other facilities, including bicycle lanes, for the convenience and protection of bicyclists, in both public and private areas;

(xi) programs to control extended idling of vehicles;

(xii) programs to reduce motor vehicle emissions, consistent with subchapter II of this chapter, which are caused by extreme cold start conditions;

(xiii) employer-sponsored programs to permit flexible work schedules;

(xiv) programs and ordinances to facilitate non-automobile travel, provision and utilization of mass transit, and to generally reduce the need for single-occupant vehicle travel, as part of transportation planning and development efforts of a locality, including programs and ordinances applicable to new shopping centers, special events, and other centers of vehicle activity;

(xv) programs for new construction and major reconstructions of paths, tracks or areas solely for the use by pedestrian or other non-motorized means of transportation when economically feasible and in the public interest. For purposes of this clause, the Administrator shall also consult with the Secretary of the Interior; and

(xvi) program to encourage the voluntary removal from use and the marketplace of pre-1980 model year light duty vehicles and pre-1980 model light duty trucks.[2]

(B) information on additional methods or strategies that will contribute to the reduction of mobile source related pollutants during periods in which any primary ambient air quality standard will be exceeded and during episodes for which an air pollution alert, warning, or emergency has been declared;

(C) information on other measures which may be employed to reduce the impact on public health or protect the health of sensitive or susceptible individuals or groups; and

(D) information on the extent to which any process, procedure, or method to reduce or control such air pollutant may cause an increase in the emissions or formation of any other pollutant.

(2) In publishing such information the Administrator shall also include an assessment of—

(A) the relative effectiveness of such processes, procedures, and methods;

(B) the potential effect of such processes, procedures, and methods on transportation systems and the provision of transportation services; and

(C) the environmental, energy, and economic impact of such processes, procedures, and methods.

(g) Assessment of risks to ecosystems

The Administrator may assess the risks to ecosystems from exposure to criteria air pollutants (as identified by the Administrator in the Administrator's sole discretion).

(h) RACT/BACT/LAER clearinghouse

The Administrator shall make information regarding emission control technology available to the States and to the general public through a central database. Such information shall include all control technology information received pursuant to State plan provisions requiring permits for sources, including operating permits for existing sources.

(July 14, 1955, ch. 360, title I, §108, as added Pub. L. 91–604, §4(a), Dec. 31, 1970, 84 Stat. 1678; amended Pub. L. 95–95, title I, §§104, 105, title IV, §401(a), Aug. 7, 1977, 91 Stat. 689, 790; Pub. L. 101–549, title I, §§108(a)–(c), (*o*), 111, Nov. 15, 1990, 104 Stat. 2465, 2466, 2469, 2470; Pub. L. 105–362, title XV, §1501(b), Nov. 10, 1998, 112 Stat. 3294.)

CODIFICATION

November 15, 1990, referred to in subsec. (e), was in the original "enactment of the Clean Air Act Amendments of 1989", and was translated as meaning the date of the enactment of Pub. L. 101–549, popularly known as the Clean Air Act Amendments of 1990, to reflect the probable intent of Congress.

Section was formerly classified to section 1857c–3 of this title.

PRIOR PROVISIONS

A prior section 108 of act July 14, 1955, was renumbered section 115 by Pub. L. 91–604 and is classified to section 7415 of this title.

AMENDMENTS

1998—Subsec. (f)(3), (4). Pub. L. 105–362 struck out par. (3), which required reports by the Secretary of Transportation and the Administrator to be submitted to Congress by Jan. 1, 1993, and every 3 years thereafter, reviewing and analyzing existing State and local air quality related transportation programs, evaluating

[2] So in original. The period probably should be a semicolon.

achievement of goals, and recommending changes to existing programs, and par. (4), which required that in each report after the first report the Secretary of Transportation include a description of the actions taken to implement the changes recommended in the preceding report.

1990—Subsec. (e). Pub. L. 101–549, §108(a), inserted first sentence and struck out former first sentence which read as follows: "The Administrator shall, after consultation with the Secretary of Transportation and the Secretary of Housing and Urban Development and State and local officials and within 180 days after August 7, 1977, and from time to time thereafter, publish guidelines on the basic program elements for the planning process assisted under section 7505 of this title."

Subsec. (f)(1). Pub. L. 101–549, §108(b), in introductory provisions, substituted present provisions for provisions relating to Federal agencies, States, and air pollution control agencies within either 6 months or one year after Aug. 7, 1977.

Subsec. (f)(1)(A). Pub. L. 101–549, §108(b), substituted present provisions for provisions relating to information prepared in cooperation with Secretary of Transportation, regarding processes, procedures, and methods to reduce certain pollutants.

Subsec. (f)(3), (4). Pub. L. 101–549, §111, added pars. (3) and (4).

Subsec. (g). Pub. L. 101–549, §108(o), added subsec. (g).

Subsec. (h). Pub. L. 101–549, §108(c), added subsec. (h).

1977—Subsec. (a)(1)(A). Pub. L. 95–95, §401(a), substituted "emissions of which, in his judgment, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare" for "which in his judgment has an adverse effect on public health or welfare".

Subsec. (b)(1). Pub. L. 95–95, §104(a), substituted "cost of installation and operation, energy requirements, emission reduction benefits, and environmental impact of the emission control technology" for "technology and costs of emission control".

Subsec. (c). Pub. L. 95–95, §104(b), inserted provision directing the Administrator, not later than six months after Aug. 7, 1977, to revise and reissue criteria relating to concentrations of NO_2 over such period (not more than three hours) as he deems appropriate, with the criteria to include a discussion of nitric and nitrous acids, nitrites, nitrates, nitrosamines, and other carcinogenic and potentially carcinogenic derivatives of oxides of nitrogen.

Subsecs. (e), (f). Pub. L. 95–95, §105, added subsecs. (e) and (f).

EFFECTIVE DATE OF 1977 AMENDMENT

Amendment by Pub. L. 95–95 effective Aug. 7, 1977, except as otherwise expressly provided, see section 406(d) of Pub. L. 95–95, set out as a note under section 7401 of this title.

MODIFICATION OR RESCISSION OF RULES, REGULATIONS, ORDERS, DETERMINATIONS, CONTRACTS, CERTIFICATIONS, AUTHORIZATIONS, DELEGATIONS, AND OTHER ACTIONS

All rules, regulations, orders, determinations, contracts, certifications, authorizations, delegations, or other actions duly issued, made, or taken by or pursuant to act July 14, 1955, the Clean Air Act, as in effect immediately prior to the date of enactment of Pub. L. 95–95 [Aug. 7, 1977] to continue in full force and effect until modified or rescinded in accordance with act July 14, 1955, as amended by Pub. L. 95–95 [this chapter], see section 406(b) of Pub. L. 95–95, set out as an Effective Date of 1977 Amendment note under section 7401 of this title.

§7409. National primary and secondary ambient air quality standards

(a) Promulgation

(1) The Administrator—

(A) within 30 days after December 31, 1970, shall publish proposed regulations prescribing a national primary ambient air quality standard and a national secondary ambient air quality standard for each air pollutant for which air quality criteria have been issued prior to such date; and

(B) after a reasonable time for interested persons to submit written comments thereon (but no later than 90 days after the initial publication of such proposed standards) shall by regulation promulgate such proposed national primary and secondary ambient air quality standards with such modifications as he deems appropriate.

(2) With respect to any air pollutant for which air quality criteria are issued after December 31, 1970, the Administrator shall publish, simultaneously with the issuance of such criteria and information, proposed national primary and secondary ambient air quality standards for any such pollutant. The procedure provided for in paragraph (1)(B) of this subsection shall apply to the promulgation of such standards.

(b) Protection of public health and welfare

(1) National primary ambient air quality standards, prescribed under subsection (a) of this section shall be ambient air quality standards the attainment and maintenance of which in the judgment of the Administrator, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health. Such primary standards may be revised in the same manner as promulgated.

(2) Any national secondary ambient air quality standard prescribed under subsection (a) of this section shall specify a level of air quality the attainment and maintenance of which in the judgment of the Administrator, based on such criteria, is requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of such air pollutant in the ambient air. Such secondary standards may be revised in the same manner as promulgated.

(c) National primary ambient air quality standard for nitrogen dioxide

The Administrator shall, not later than one year after August 7, 1977, promulgate a national primary ambient air quality standard for NO_2 concentrations over a period of not more than 3 hours unless, based on the criteria issued under section 7408(c) of this title, he finds that there is no significant evidence that such a standard for such a period is requisite to protect public health.

(d) Review and revision of criteria and standards; independent scientific review committee; appointment; advisory functions

(1) Not later than December 31, 1980, and at five-year intervals thereafter, the Administrator shall complete a thorough review of the criteria published under section 7408 of this title and the national ambient air quality standards promulgated under this section and shall make such revisions in such criteria and standards and promulgate such new standards as may be appropriate in accordance with section 7408 of this title and subsection (b) of this section. The Ad-

ministrator may review and revise criteria or promulgate new standards earlier or more frequently than required under this paragraph.

(2)(A) The Administrator shall appoint an independent scientific review committee composed of seven members including at least one member of the National Academy of Sciences, one physician, and one person representing State air pollution control agencies.

(B) Not later than January 1, 1980, and at five-year intervals thereafter, the committee referred to in subparagraph (A) shall complete a review of the criteria published under section 7408 of this title and the national primary and secondary ambient air quality standards promulgated under this section and shall recommend to the Administrator any new national ambient air quality standards and revisions of existing criteria and standards as may be appropriate under section 7408 of this title and subsection (b) of this section.

(C) Such committee shall also (i) advise the Administrator of areas in which additional knowledge is required to appraise the adequacy and basis of existing, new, or revised national ambient air quality standards, (ii) describe the research efforts necessary to provide the required information, (iii) advise the Administrator on the relative contribution to air pollution concentrations of natural as well as anthropogenic activity, and (iv) advise the Administrator of any adverse public health, welfare, social, economic, or energy effects which may result from various strategies for attainment and maintenance of such national ambient air quality standards.

(July 14, 1955, ch. 360, title I, §109, as added Pub. L. 91–604, §4(a), Dec. 31, 1970, 84 Stat. 1679; amended Pub. L. 95–95, title I, §106, Aug. 7, 1977, 91 Stat. 691.)

CODIFICATION

Section was formerly classified to section 1857c–4 of this title.

PRIOR PROVISIONS

A prior section 109 of act July 14, 1955, was renumbered section 116 by Pub. L. 91–604 and is classified to section 7416 of this title.

AMENDMENTS

1977—Subsec. (c). Pub. L. 95–95, §106(b), added subsec. (c).

Subsec. (d). Pub. L. 95–95, §106(a), added subsec. (d).

EFFECTIVE DATE OF 1977 AMENDMENT

Amendment by Pub. L. 95–95 effective Aug. 7, 1977, except as otherwise expressly provided, see section 406(d) of Pub. L. 95–95, set out as a note under section 7401 of this title.

MODIFICATION OR RESCISSION OF RULES, REGULATIONS, ORDERS, DETERMINATIONS, CONTRACTS, CERTIFICATIONS, AUTHORIZATIONS, DELEGATIONS, AND OTHER ACTIONS

All rules, regulations, orders, determinations, contracts, certifications, authorizations, delegations, or other actions duly issued, made, or taken by or pursuant to act July 14, 1955, the Clean Air Act, as in effect immediately prior to the date of enactment of Pub. L. 95–95 [Aug. 7, 1977] to continue in full force and effect until modified or rescinded in accordance with act July 14, 1955, as amended by Pub. L. 95–95 [this chapter], see section 406(b) of Pub. L. 95–95, set out as an Effective Date of 1977 Amendment note under section 7401 of this title.

TERMINATION OF ADVISORY COMMITTEES

Advisory committees established after Jan. 5, 1973, to terminate not later than the expiration of the 2-year period beginning on the date of their establishment, unless, in the case of a committee established by the President or an officer of the Federal Government, such committee is renewed by appropriate action prior to the expiration of such 2-year period, or in the case of a committee established by the Congress, its duration is otherwise provided for by law. See section 14 of Pub. L. 92–463, Oct. 6, 1972, 86 Stat. 776, set out in the Appendix to Title 5, Government Organization and Employees.

ROLE OF SECONDARY STANDARDS

Pub. L. 101–549, title VIII, §817, Nov. 15, 1990, 104 Stat. 2697, provided that:

"(a) REPORT.—The Administrator shall request the National Academy of Sciences to prepare a report to the Congress on the role of national secondary ambient air quality standards in protecting welfare and the environment. The report shall:

"(1) include information on the effects on welfare and the environment which are caused by ambient concentrations of pollutants listed pursuant to section 108 [42 U.S.C. 7408] and other pollutants which may be listed;

"(2) estimate welfare and environmental costs incurred as a result of such effects;

"(3) examine the role of secondary standards and the State implementation planning process in preventing such effects;

"(4) determine ambient concentrations of each such pollutant which would be adequate to protect welfare and the environment from such effects;

"(5) estimate the costs and other impacts of meeting secondary standards; and

"(6) consider other means consistent with the goals and objectives of the Clean Air Act [42 U.S.C. 7401 et seq.] which may be more effective than secondary standards in preventing or mitigating such effects.

"(b) SUBMISSION TO CONGRESS; COMMENTS; AUTHORIZATION.—(1) The report shall be transmitted to the Congress not later than 3 years after the date of enactment of the Clean Air Act Amendments of 1990 [Nov. 15, 1990].

"(2) At least 90 days before issuing a report the Administrator shall provide an opportunity for public comment on the proposed report. The Administrator shall include in the final report a summary of the comments received on the proposed report.

"(3) There are authorized to be appropriated such sums as are necessary to carry out this section."

§7410. State implementation plans for national primary and secondary ambient air quality standards

(a) Adoption of plan by State; submission to Administrator; content of plan; revision; new sources; indirect source review program; supplemental or intermittent control systems

(1) Each State shall, after reasonable notice and public hearings, adopt and submit to the Administrator, within 3 years (or such shorter period as the Administrator may prescribe) after the promulgation of a national primary ambient air quality standard (or any revision thereof) under section 7409 of this title for any air pollutant, a plan which provides for implementation, maintenance, and enforcement of such primary standard in each air quality control region (or portion thereof) within such State. In addition, such State shall adopt and submit to the Admin-

modified after November 15, 1990, in any manner unless the modification insures equivalent or greater emission reductions of such air pollutant.

(July 14, 1955, ch. 360, title I, §193, as added Pub. L. 101–549, title I, §108(*l*), Nov. 15, 1990, 104 Stat. 2469.)

SUBCHAPTER II—EMISSION STANDARDS FOR MOVING SOURCES

PART A—MOTOR VEHICLE EMISSION AND FUEL STANDARDS

§7521. Emission standards for new motor vehicles or new motor vehicle engines

(a) Authority of Administrator to prescribe by regulation

Except as otherwise provided in subsection (b) of this section—

(1) The Administrator shall by regulation prescribe (and from time to time revise) in accordance with the provisions of this section, standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare. Such standards shall be applicable to such vehicles and engines for their useful life (as determined under subsection (d) of this section, relating to useful life of vehicles for purposes of certification), whether such vehicles and engines are designed as complete systems or incorporate devices to prevent or control such pollution.

(2) Any regulation prescribed under paragraph (1) of this subsection (and any revision thereof) shall take effect after such period as the Administrator finds necessary to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance within such period.

(3)(A) IN GENERAL.—(i) Unless the standard is changed as provided in subparagraph (B), regulations under paragraph (1) of this subsection applicable to emissions of hydrocarbons, carbon monoxide, oxides of nitrogen, and particulate matter from classes or categories of heavy-duty vehicles or engines manufactured during or after model year 1983 shall contain standards which reflect the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the model year to which such standards apply, giving appropriate consideration to cost, energy, and safety factors associated with the application of such technology.

(ii) In establishing classes or categories of vehicles or engines for purposes of regulations under this paragraph, the Administrator may base such classes or categories on gross vehicle weight, horsepower, type of fuel used, or other appropriate factors.

(B) REVISED STANDARDS FOR HEAVY DUTY TRUCKS.—(i) On the basis of information available to the Administrator concerning the effects of air pollutants emitted from heavy-duty vehicles or engines and from other sources of mobile source related pollutants on the public health and welfare, and taking costs into account, the Administrator may promulgate regulations under paragraph (1) of this subsection revising any standard promulgated under, or before the date of, the enactment of the Clean Air Act Amendments of 1990 (or previously revised under this subparagraph) and applicable to classes or categories of heavy-duty vehicles or engines.

(ii) Effective for the model year 1998 and thereafter, the regulations under paragraph (1) of this subsection applicable to emissions of oxides of nitrogen (NO_x) from gasoline and diesel-fueled heavy duty trucks shall contain standards which provide that such emissions may not exceed 4.0 grams per brake horsepower hour (gbh).

(C) LEAD TIME AND STABILITY.—Any standard promulgated or revised under this paragraph and applicable to classes or categories of heavy-duty vehicles or engines shall apply for a period of no less than 3 model years beginning no earlier than the model year commencing 4 years after such revised standard is promulgated.

(D) REBUILDING PRACTICES.—The Administrator shall study the practice of rebuilding heavy-duty engines and the impact rebuilding has on engine emissions. On the basis of that study and other information available to the Administrator, the Administrator may prescribe requirements to control rebuilding practices, including standards applicable to emissions from any rebuilt heavy-duty engines (whether or not the engine is past its statutory useful life), which in the Administrator's judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare taking costs into account. Any regulation shall take effect after a period the Administrator finds necessary to permit the development and application of the requisite control measures, giving appropriate consideration to the cost of compliance within the period and energy and safety factors.

(E) MOTORCYCLES.—For purposes of this paragraph, motorcycles and motorcycle engines shall be treated in the same manner as heavy-duty vehicles and engines (except as otherwise permitted under section 7525(f)(1)[1] of this title) unless the Administrator promulgates a rule reclassifying motorcycles as light-duty vehicles within the meaning of this section or unless the Administrator promulgates regulations under subsection (a) of this section applying standards applicable to the emission of air pollutants from motorcycles as a separate class or category. In any case in which such standards are promulgated for such emissions from motorcycles as a separate class or category, the Administrator, in promulgating such standards, shall consider the need to achieve equivalency of emission reductions between motorcycles and other motor vehicles to the maximum extent practicable.

(4)(A) Effective with respect to vehicles and engines manufactured after model year 1978, no emission control device, system, or element of design shall be used in a new motor vehicle or new motor vehicle engine for purposes of complying with requirements prescribed under this subchapter if such device, system, or element of design will cause or contribute to an unreason-

[1] See References in Text note below.

able risk to public health, welfare, or safety in its operation or function.

(B) In determining whether an unreasonable risk exists under subparagraph (A), the Administrator shall consider, among other factors, (i) whether and to what extent the use of any device, system, or element of design causes, increases, reduces, or eliminates emissions of any unregulated pollutants; (ii) available methods for reducing or eliminating any risk to public health, welfare, or safety which may be associated with the use of such device, system, or element of design, and (iii) the availability of other devices, systems, or elements of design which may be used to conform to requirements prescribed under this subchapter without causing or contributing to such unreasonable risk. The Administrator shall include in the consideration required by this paragraph all relevant information developed pursuant to section 7548 of this title.

(5)(A) If the Administrator promulgates final regulations which define the degree of control required and the test procedures by which compliance could be determined for gasoline vapor recovery of uncontrolled emissions from the fueling of motor vehicles, the Administrator shall, after consultation with the Secretary of Transportation with respect to motor vehicle safety, prescribe, by regulation, fill pipe standards for new motor vehicles in order to insure effective connection between such fill pipe and any vapor recovery system which the Administrator determines may be required to comply with such vapor recovery regulations. In promulgating such standards the Administrator shall take into consideration limits on fill pipe diameter, minimum design criteria for nozzle retainer lips, limits on the location of the unleaded fuel restrictors, a minimum access zone surrounding a fill pipe, a minimum pipe or nozzle insertion angle, and such other factors as he deems pertinent.

(B) Regulations prescribing standards under subparagraph (A) shall not become effective until the introduction of the model year for which it would be feasible to implement such standards, taking into consideration the restraints of an adequate leadtime for design and production.

(C) Nothing in subparagraph (A) shall (i) prevent the Administrator from specifying different nozzle and fill neck sizes for gasoline with additives and gasoline without additives or (ii) permit the Administrator to require a specific location, configuration, modeling, or styling of the motor vehicle body with respect to the fuel tank fill neck or fill nozzle clearance envelope.

(D) For the purpose of this paragraph, the term "fill pipe" shall include the fuel tank fill pipe, fill neck, fill inlet, and closure.

(6) ONBOARD VAPOR RECOVERY.—Within 1 year after November 15, 1990, the Administrator shall, after consultation with the Secretary of Transportation regarding the safety of vehicle-based ("onboard") systems for the control of vehicle refueling emissions, promulgate standards under this section requiring that new light-duty vehicles manufactured beginning in the fourth model year after the model year in which the standards are promulgated and thereafter shall be equipped with such systems. The standards required under this paragraph shall apply to a percentage of each manufacturer's fleet of new light-duty vehicles beginning with the fourth model year after the model year in which the standards are promulgated. The percentage shall be as specified in the following table:

IMPLEMENTATION SCHEDULE FOR ONBOARD VAPOR RECOVERY REQUIREMENTS

Model year commencing after standards promulgated	Percentage*
Fourth	40
Fifth	80
After Fifth	100

*Percentages in the table refer to a percentage of the manufacturer's sales volume.

The standards shall require that such systems provide a minimum evaporative emission capture efficiency of 95 percent. The requirements of section 7511a(b)(3) of this title (relating to stage II gasoline vapor recovery) for areas classified under section 7511 of this title as moderate for ozone shall not apply after promulgation of such standards and the Administrator may, by rule, revise or waive the application of the requirements of such section 7511a(b)(3) of this title for areas classified under section 7511 of this title as Serious, Severe, or Extreme for ozone, as appropriate, after such time as the Administrator determines that onboard emissions control systems required under this paragraph are in widespread use throughout the motor vehicle fleet.

(b) Emissions of carbon monoxide, hydrocarbons, and oxides of nitrogen; annual report to Congress; waiver of emission standards; research objectives

(1)(A) The regulations under subsection (a) of this section applicable to emissions of carbon monoxide and hydrocarbons from light-duty vehicles and engines manufactured during model years 1977 through 1979 shall contain standards which provide that such emissions from such vehicles and engines may not exceed 1.5 grams per vehicle mile of hydrocarbons and 15.0 grams per vehicle mile of carbon monoxide. The regulations under subsection (a) of this section applicable to emissions of carbon monoxide from light-duty vehicles and engines manufactured during the model year 1980 shall contain standards which provide that such emissions may not exceed 7.0 grams per vehicle mile. The regulations under subsection (a) of this section applicable to emissions of hydrocarbons from light-duty vehicles and engines manufactured during or after model year 1980 shall contain standards which require a reduction of at least 90 percent from emissions of such pollutant allowable under the standards under this section applicable to light-duty vehicles and engines manufactured in model year 1970. Unless waived as provided in paragraph (5),[1] regulations under subsection (a) of this section applicable to emissions of carbon monoxide from light-duty vehicles and engines manufactured during or after the model year 1981 shall contain standards which require a reduction of at least 90 percent from emissions of such pollutant allowable

Pub. L. 95–95, title III, §305(e), Aug. 7, 1977, 91 Stat. 776; Pub. L. 101–549, title I, §§107(d), 108(i), Nov. 15, 1990, 104 Stat. 2464, 2467.)

CODIFICATION

Section was formerly classified to section 1857g of this title.

AMENDMENTS

1990—Subsec. (a)(1). Pub. L. 101–549, §108(i), inserted "subject to section 7607(d) of this title" after "regulations".

Subsec. (d). Pub. L. 101–549, §107(d), added subsec. (d).

1977—Subsec. (a). Pub. L. 95–95 designated existing provisions as par. (1) and added par. (2).

1970—Subsec. (a). Pub. L. 91–604, §15(c)(2), substituted "Administrator" for "Secretary" and "Environmental Protection Agency" for "Department of Health, Education, and Welfare".

Subsec. (b). Pub. L. 91–604, §3(b)(2), substituted "Environmental Protection Agency" for "Public Health Service" and struck out provisions covering the payment of salaries and allowances.

Subsec. (c). Pub. L. 91–604, §15(c)(2), substituted "Administrator" for "Secretary".

1967—Pub. L. 90–148 reenacted section without change.

EFFECTIVE DATE OF 1977 AMENDMENT

Amendment by Pub. L. 95–95 effective Aug. 7, 1977, except as otherwise expressly provided, see section 406(d) of Pub. L. 95–95, set out as a note under section 7401 of this title.

MODIFICATION OR RESCISSION OF RULES, REGULATIONS, ORDERS, DETERMINATIONS, CONTRACTS, CERTIFICATIONS, AUTHORIZATIONS, DELEGATIONS, AND OTHER ACTIONS

All rules, regulations, orders, determinations, contracts, certifications, authorizations, delegations, or other actions duly issued, made, or taken by or pursuant to act July 14, 1955, the Clean Air Act, as in effect immediately prior to the date of enactment of Pub. L. 95–95 [Aug. 7, 1977] to continue in full force and effect until modified or rescinded in accordance with act July 14, 1955, as amended by Pub. L. 95–95 [this chapter], see section 406(b) of Pub. L. 95–95, set out as an Effective Date of 1977 Amendment note under section 7401 of this title.

DISADVANTAGED BUSINESS CONCERNS; USE OF QUOTAS PROHIBITED

Title X of Pub. L. 101–549 provided that:

"SEC. 1001. DISADVANTAGED BUSINESS CONCERNS.

"(a) IN GENERAL.—In providing for any research relating to the requirements of the amendments made by the Clean Air Act Amendments of 1990 [Pub. L. 101–549, see Tables for classification] which uses funds of the Environmental Protection Agency, the Administrator of the Environmental Protection Agency shall, to the extent practicable, require that not less than 10 percent of total Federal funding for such research will be made available to disadvantaged business concerns.

"(b) DEFINITION.—

"(1)(A) For purposes of subsection (a), the term 'disadvantaged business concern' means a concern—

"(i) which is at least 51 percent owned by one or more socially and economically disadvantaged individuals or, in the case of a publicly traded company, at least 51 percent of the stock of which is owned by one or more socially and economically disadvantaged individuals; and

"(ii) the management and daily business operations of which are controlled by such individuals.

"(B)(i) A for-profit business concern is presumed to be a disadvantaged business concern for purposes of subsection (a) if it is at least 51 percent owned by, or in the case of a concern which is a publicly traded company at least 51 percent of the stock of the company is owned by, one or more individuals who are members of the following groups:

"(I) Black Americans.

"(II) Hispanic Americans.

"(III) Native Americans.

"(IV) Asian Americans.

"(V) Women.

"(VI) Disabled Americans.

"(ii) The presumption established by clause (i) may be rebutted with respect to a particular business concern if it is reasonably established that the individual or individuals referred to in that clause with respect to that business concern are not experiencing impediments to establishing or developing such concern as a result of the individual's identification as a member of a group specified in that clause.

"(C) The following institutions are presumed to be disadvantaged business concerns for purposes of subsection (a):

"(i) Historically black colleges and universities, and colleges and universities having a student body in which 40 percent of the students are Hispanic.

"(ii) Minority institutions (as that term is defined by the Secretary of Education pursuant to the General Education Provision Act (20 U.S.C. 1221 et seq.)).

"(iii) Private and voluntary organizations controlled by individuals who are socially and economically disadvantaged.

"(D) A joint venture may be considered to be a disadvantaged business concern under subsection (a), notwithstanding the size of such joint venture, if—

"(i) a party to the joint venture is a disadvantaged business concern; and

"(ii) that party owns at least 51 percent of the joint venture.

A person who is not an economically disadvantaged individual or a disadvantaged business concern, as a party to a joint venture, may not be a party to more than 2 awarded contracts in a fiscal year solely by reason of this subparagraph.

"(E) Nothing in this paragraph shall prohibit any member of a racial or ethnic group that is not listed in subparagraph (B)(i) from establishing that they have been impeded in establishing or developing a business concern as a result of racial or ethnic discrimination.

"SEC. 1002. USE OF QUOTAS PROHIBITED.—Nothing in this title shall permit or require the use of quotas or a requirement that has the effect of a quota in determining eligibility under section 1001."

§7602. Definitions

When used in this chapter—

(a) The term "Administrator" means the Administrator of the Environmental Protection Agency.

(b) The term "air pollution control agency" means any of the following:

(1) A single State agency designated by the Governor of that State as the official State air pollution control agency for purposes of this chapter.

(2) An agency established by two or more States and having substantial powers or duties pertaining to the prevention and control of air pollution.

(3) A city, county, or other local government health authority, or, in the case of any city, county, or other local government in which there is an agency other than the health authority charged with responsibility for enforcing ordinances or laws relating to the prevention and control of air pollution, such other agency.

(4) An agency of two or more municipalities located in the same State or in different States and having substantial powers or duties pertaining to the prevention and control of air pollution.

(5) An agency of an Indian tribe.

(c) The term "interstate air pollution control agency" means—

(1) an air pollution control agency established by two or more States, or

(2) an air pollution control agency of two or more municipalities located in different States.

(d) The term "State" means a State, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, and American Samoa and includes the Commonwealth of the Northern Mariana Islands.

(e) The term "person" includes an individual, corporation, partnership, association, State, municipality, political subdivision of a State, and any agency, department, or instrumentality of the United States and any officer, agent, or employee thereof.

(f) The term "municipality" means a city, town, borough, county, parish, district, or other public body created by or pursuant to State law.

(g) The term "air pollutant" means any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct material) substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term "air pollutant" is used.

(h) All language referring to effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants.

(i) The term "Federal land manager" means, with respect to any lands in the United States, the Secretary of the department with authority over such lands.

(j) Except as otherwise expressly provided, the terms "major stationary source" and "major emitting facility" mean any stationary facility or source of air pollutants which directly emits, or has the potential to emit, one hundred tons per year or more of any air pollutant (including any major emitting facility or source of fugitive emissions of any such pollutant, as determined by rule by the Administrator).

(k) The terms "emission limitation" and "emission standard" mean a requirement established by the State or the Administrator which limits the quantity, rate, or concentration of emissions of air pollutants on a continuous basis, including any requirement relating to the operation or maintenance of a source to assure continuous emission reduction, and any design, equipment, work practice or operational standard promulgated under this chapter..[1]

(*l*) The term "standard of performance" means a requirement of continuous emission reduction, including any requirement relating to the operation or maintenance of a source to assure continuous emission reduction.

(m) The term "means of emission limitation" means a system of continuous emission reduction (including the use of specific technology or fuels with specified pollution characteristics).

(n) The term "primary standard attainment date" means the date specified in the applicable implementation plan for the attainment of a national primary ambient air quality standard for any air pollutant.

(*o*) The term "delayed compliance order" means an order issued by the State or by the Administrator to an existing stationary source, postponing the date required under an applicable implementation plan for compliance by such source with any requirement of such plan.

(p) The term "schedule and timetable of compliance" means a schedule of required measures including an enforceable sequence of actions or operations leading to compliance with an emission limitation, other limitation, prohibition, or standard.

(q) For purposes of this chapter, the term "applicable implementation plan" means the portion (or portions) of the implementation plan, or most recent revision thereof, which has been approved under section 7410 of this title, or promulgated under section 7410(c) of this title, or promulgated or approved pursuant to regulations promulgated under section 7601(d) of this title and which implements the relevant requirements of this chapter.

(r) INDIAN TRIBE.—The term "Indian tribe" means any Indian tribe, band, nation, or other organized group or community, including any Alaska Native village, which is Federally recognized as eligible for the special programs and services provided by the United States to Indians because of their status as Indians.

(s) VOC.—The term "VOC" means volatile organic compound, as defined by the Administrator.

(t) PM–10.—The term "PM–10" means particulate matter with an aerodynamic diameter less than or equal to a nominal ten micrometers, as measured by such method as the Administrator may determine.

(u) NAAQS AND CTG.—The term "NAAQS" means national ambient air quality standard. The term "CTG" means a Control Technique Guideline published by the Administrator under section 7408 of this title.

(v) NO_x.—The term "NO_x" means oxides of nitrogen.

(w) CO.—The term "CO" means carbon monoxide.

(x) SMALL SOURCE.—The term "small source" means a source that emits less than 100 tons of regulated pollutants per year, or any class of persons that the Administrator determines, through regulation, generally lack technical ability or knowledge regarding control of air pollution.

[1] So in original.

(y) FEDERAL IMPLEMENTATION PLAN.—The term "Federal implementation plan" means a plan (or portion thereof) promulgated by the Administrator to fill all or a portion of a gap or otherwise correct all or a portion of an inadequacy in a State implementation plan, and which includes enforceable emission limitations or other control measures, means or techniques (including economic incentives, such as marketable permits or auctions of emissions allowances), and provides for attainment of the relevant national ambient air quality standard.

(z) STATIONARY SOURCE.—The term "stationary source" means generally any source of an air pollutant except those emissions resulting directly from an internal combustion engine for transportation purposes or from a nonroad engine or nonroad vehicle as defined in section 7550 of this title.

(July 14, 1955, ch. 360, title III, §302, formerly §9, as added Pub. L. 88–206, §1, Dec. 17, 1963, 77 Stat. 400, renumbered Pub. L. 89–272, title I, §101(4), Oct. 20, 1965, 79 Stat. 992; amended Pub. L. 90–148, §2, Nov. 21, 1967, 81 Stat. 504; Pub. L. 91–604, §15(a)(1), (c)(1), Dec. 31, 1970, 84 Stat. 1710, 1713; Pub. L. 95–95, title II, §218(c), title III, §301, Aug. 7, 1977, 91 Stat. 761, 769; Pub. L. 95–190, §14(a)(76), Nov. 16, 1977, 91 Stat. 1404; Pub. L. 101–549, title I, §§101(d)(4), 107(a), (b), 108(j), 109(b), title III, §302(e), title VII, §709, Nov. 15, 1990, 104 Stat. 2409, 2464, 2468, 2470, 2574, 2684.)

CODIFICATION

Section was formerly classified to section 1857h of this title.

PRIOR PROVISIONS

Provisions similar to those in subsecs. (b) and (d) of this section were contained in a section 1857e of this title, act July 14, 1955, ch. 360, §6, 69 Stat. 323, prior to the general amendment of this chapter by Pub. L. 88–206.

AMENDMENTS

1990—Subsec. (b)(1) to (3). Pub. L. 101–549, §107(a)(1), (2), struck out "or" at end of par. (3) and substituted periods for semicolons at end of pars. (1) to (3).

Subsec. (b)(5). Pub. L. 101–549, §107(a)(3), added par. (5).

Subsec. (g). Pub. L. 101–549, §108(j)(2), inserted at end "Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term 'air pollutant' is used."

Subsec. (h). Pub. L. 101–549, §109(b), inserted before period at end ", whether caused by transformation, conversion, or combination with other air pollutants".

Subsec. (k). Pub. L. 101–549, §303(e), inserted before period at end ", and any design, equipment, work practice or operational standard promulgated under this chapter."

Subsec. (q). Pub. L. 101–549, §101(d)(4), added subsec. (q).

Subsec. (r). Pub. L. 101–549, §107(b), added subsec. (r).

Subsecs. (s) to (y). Pub. L. 101–549, §108(j)(1), added subsecs. (s) to (y).

Subsec. (z). Pub. L. 101–549, §709, added subsec. (z).

1977—Subsec. (d). Pub. L. 95–95, §218(c), inserted "and includes the Commonwealth of the Northern Mariana Islands" after "American Samoa".

Subsec. (e). Pub. L. 95–190 substituted "individual, corporation" for "individual corporation".

Pub. L. 95–95, §301(b), expanded definition of "person" to include agencies, departments, and instrumentalities of the United States and officers, agents, and employees thereof.

Subsec. (g). Pub. L. 95–95, §301(c), expanded definition of "air pollutant" so as, expressly, to include physical, chemical, biological, and radioactive substances or matter emitted into or otherwise entering the ambient air.

Subsecs. (i) to (p). Pub. L. 95–95, §301(a), added subsecs. (i) to (p).

1970—Subsec. (a). Pub. L. 91–604, §15(c)(1), substituted definition of "Administrator" as meaning Administrator of the Environmental Protection Agency for definition of "Secretary" as meaning Secretary of Health, Education, and Welfare.

Subsecs. (g), (h). Pub. L. 91–604, §15(a)(1), added subsec. (g) defining "air pollutant", redesignated former subsec. (g) as (h) and substituted references to effects on soil, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate for references to injury to agricultural crops and livestock, and inserted references to effects on economic values and on personal comfort and well being.

1967—Pub. L. 90–148 reenacted section without change.

EFFECTIVE DATE OF 1977 AMENDMENT

Amendment by Pub. L. 95–95 effective Aug. 7, 1977, except as otherwise expressly provided, see section 406(d) of Pub. L. 95–95, set out as a note under section 7401 of this title.

§7603. Emergency powers

Notwithstanding any other provision of this chapter, the Administrator, upon receipt of evidence that a pollution source or combination of sources (including moving sources) is presenting an imminent and substantial endangerment to public health or welfare, or the environment, may bring suit on behalf of the United States in the appropriate United States district court to immediately restrain any person causing or contributing to the alleged pollution to stop the emission of air pollutants causing or contributing to such pollution or to take such other action as may be necessary. If it is not practicable to assure prompt protection of public health or welfare or the environment by commencement of such a civil action, the Administrator may issue such orders as may be necessary to protect public health or welfare or the environment. Prior to taking any action under this section, the Administrator shall consult with appropriate State and local authorities and attempt to confirm the accuracy of the information on which the action proposed to be taken is based. Any order issued by the Administrator under this section shall be effective upon issuance and shall remain in effect for a period of not more than 60 days, unless the Administrator brings an action pursuant to the first sentence of this section before the expiration of that period. Whenever the Administrator brings such an action within the 60-day period, such order shall remain in effect for an additional 14 days or for such longer period as may be authorized by the court in which such action is brought.

(July 14, 1955, ch. 360, title III, §303, as added Pub. L. 91–604, §12(a), Dec. 31, 1970, 84 Stat. 1705; amended Pub. L. 95–95, title III, §302(a), Aug. 7, 1977, 91 Stat. 770; Pub. L. 101–549, title VII, §704, Nov. 15, 1990, 104 Stat. 2681.)

CODIFICATION

Section was formerly classified to section 1857h–1 of this title.

lishes that such action is based on such a determination. Any petition for review under this subsection shall be filed within sixty days from the date notice of such promulgation, approval, or action appears in the Federal Register, except that if such petition is based solely on grounds arising after such sixtieth day, then any petition for review under this subsection shall be filed within sixty days after such grounds arise. The filing of a petition for reconsideration by the Administrator of any otherwise final rule or action shall not affect the finality of such rule or action for purposes of judicial review nor extend the time within which a petition for judicial review of such rule or action under this section may be filed, and shall not postpone the effectiveness of such rule or action.

(2) Action of the Administrator with respect to which review could have been obtained under paragraph (1) shall not be subject to judicial review in civil or criminal proceedings for enforcement. Where a final decision by the Administrator defers performance of any nondiscretionary statutory action to a later time, any person may challenge the deferral pursuant to paragraph (1).

(c) Additional evidence

In any judicial proceeding in which review is sought of a determination under this chapter required to be made on the record after notice and opportunity for hearing, if any party applies to the court for leave to adduce additional evidence, and shows to the satisfaction of the court that such additional evidence is material and that there were reasonable grounds for the failure to adduce such evidence in the proceeding before the Administrator, the court may order such additional evidence (and evidence in rebuttal thereof) to be taken before the Administrator, in such manner and upon such terms and conditions as to[5] the court may deem proper. The Administrator may modify his findings as to the facts, or make new findings, by reason of the additional evidence so taken and he shall file such modified or new findings, and his recommendation, if any, for the modification or setting aside of his original determination, with the return of such additional evidence.

(d) Rulemaking

(1) This subsection applies to—

(A) the promulgation or revision of any national ambient air quality standard under section 7409 of this title,

(B) the promulgation or revision of an implementation plan by the Administrator under section 7410(c) of this title,

(C) the promulgation or revision of any standard of performance under section 7411 of this title, or emission standard or limitation under section 7412(d) of this title, any standard under section 7412(f) of this title, or any regulation under section 7412(g)(1)(D) and (F) of this title, or any regulation under section 7412(m) or (n) of this title,

(D) the promulgation of any requirement for solid waste combustion under section 7429 of this title,

(E) the promulgation or revision of any regulation pertaining to any fuel or fuel additive under section 7545 of this title,

(F) the promulgation or revision of any aircraft emission standard under section 7571 of this title,

(G) the promulgation or revision of any regulation under subchapter IV–A of this chapter (relating to control of acid deposition),

(H) promulgation or revision of regulations pertaining to primary nonferrous smelter orders under section 7419 of this title (but not including the granting or denying of any such order),

(I) promulgation or revision of regulations under subchapter VI of this chapter (relating to stratosphere and ozone protection),

(J) promulgation or revision of regulations under part C of subchapter I of this chapter (relating to prevention of significant deterioration of air quality and protection of visibility),

(K) promulgation or revision of regulations under section 7521 of this title and test procedures for new motor vehicles or engines under section 7525 of this title, and the revision of a standard under section 7521(a)(3) of this title,

(L) promulgation or revision of regulations for noncompliance penalties under section 7420 of this title,

(M) promulgation or revision of any regulations promulgated under section 7541 of this title (relating to warranties and compliance by vehicles in actual use),

(N) action of the Administrator under section 7426 of this title (relating to interstate pollution abatement),

(O) the promulgation or revision of any regulation pertaining to consumer and commercial products under section 7511b(e) of this title,

(P) the promulgation or revision of any regulation pertaining to field citations under section 7413(d)(3) of this title,

(Q) the promulgation or revision of any regulation pertaining to urban buses or the clean-fuel vehicle, clean-fuel fleet, and clean fuel programs under part C of subchapter II of this chapter,

(R) the promulgation or revision of any regulation pertaining to nonroad engines or nonroad vehicles under section 7547 of this title,

(S) the promulgation or revision of any regulation relating to motor vehicle compliance program fees under section 7552 of this title,

(T) the promulgation or revision of any regulation under subchapter IV–A of this chapter (relating to acid deposition),

(U) the promulgation or revision of any regulation under section 7511b(f) of this title pertaining to marine vessels, and

(V) such other actions as the Administrator may determine.

The provisions of section 553 through 557 and section 706 of title 5 shall not, except as expressly provided in this subsection, apply to actions to which this subsection applies. This subsection shall not apply in the case of any rule or circumstance referred to in subparagraphs (A) or (B) of subsection 553(b) of title 5.

[5] So in original. The word "to" probably should not appear.

(2) Not later than the date of proposal of any action to which this subsection applies, the Administrator shall establish a rulemaking docket for such action (hereinafter in this subsection referred to as a ''rule''). Whenever a rule applies only within a particular State, a second (identical) docket shall be simultaneously established in the appropriate regional office of the Environmental Protection Agency.

(3) In the case of any rule to which this subsection applies, notice of proposed rulemaking shall be published in the Federal Register, as provided under section 553(b) of title 5, shall be accompanied by a statement of its basis and purpose and shall specify the period available for public comment (hereinafter referred to as the ''comment period''). The notice of proposed rulemaking shall also state the docket number, the location or locations of the docket, and the times it will be open to public inspection. The statement of basis and purpose shall include a summary of—

(A) the factual data on which the proposed rule is based;

(B) the methodology used in obtaining the data and in analyzing the data; and

(C) the major legal interpretations and policy considerations underlying the proposed rule.

The statement shall also set forth or summarize and provide a reference to any pertinent findings, recommendations, and comments by the Scientific Review Committee established under section 7409(d) of this title and the National Academy of Sciences, and, if the proposal differs in any important respect from any of these recommendations, an explanation of the reasons for such differences. All data, information, and documents referred to in this paragraph on which the proposed rule relies shall be included in the docket on the date of publication of the proposed rule.

(4)(A) The rulemaking docket required under paragraph (2) shall be open for inspection by the public at reasonable times specified in the notice of proposed rulemaking. Any person may copy documents contained in the docket. The Administrator shall provide copying facilities which may be used at the expense of the person seeking copies, but the Administrator may waive or reduce such expenses in such instances as the public interest requires. Any person may request copies by mail if the person pays the expenses, including personnel costs to do the copying.

(B)(i) Promptly upon receipt by the agency, all written comments and documentary information on the proposed rule received from any person for inclusion in the docket during the comment period shall be placed in the docket. The transcript of public hearings, if any, on the proposed rule shall also be included in the docket promptly upon receipt from the person who transcribed such hearings. All documents which become available after the proposed rule has been published and which the Administrator determines are of central relevance to the rulemaking shall be placed in the docket as soon as possible after their availability.

(ii) The drafts of proposed rules submitted by the Administrator to the Office of Management and Budget for any interagency review process prior to proposal of any such rule, all documents accompanying such drafts, and all written comments thereon by other agencies and all written responses to such written comments by the Administrator shall be placed in the docket no later than the date of proposal of the rule. The drafts of the final rule submitted for such review process prior to promulgation and all such written comments thereon, all documents accompanying such drafts, and written responses thereto shall be placed in the docket no later than the date of promulgation.

(5) In promulgating a rule to which this subsection applies (i) the Administrator shall allow any person to submit written comments, data, or documentary information; (ii) the Administrator shall give interested persons an opportunity for the oral presentation of data, views, or arguments, in addition to an opportunity to make written submissions; (iii) a transcript shall be kept of any oral presentation; and (iv) the Administrator shall keep the record of such proceeding open for thirty days after completion of the proceeding to provide an opportunity for submission of rebuttal and supplementary information.

(6)(A) The promulgated rule shall be accompanied by (i) a statement of basis and purpose like that referred to in paragraph (3) with respect to a proposed rule and (ii) an explanation of the reasons for any major changes in the promulgated rule from the proposed rule.

(B) The promulgated rule shall also be accompanied by a response to each of the significant comments, criticisms, and new data submitted in written or oral presentations during the comment period.

(C) The promulgated rule may not be based (in part or whole) on any information or data which has not been placed in the docket as of the date of such promulgation.

(7)(A) The record for judicial review shall consist exclusively of the material referred to in paragraph (3), clause (i) of paragraph (4)(B), and subparagraphs (A) and (B) of paragraph (6).

(B) Only an objection to a rule or procedure which was raised with reasonable specificity during the period for public comment (including any public hearing) may be raised during judicial review. If the person raising an objection can demonstrate to the Administrator that it was impracticable to raise such objection within such time or if the grounds for such objection arose after the period for public comment (but within the time specified for judicial review) and if such objection is of central relevance to the outcome of the rule, the Administrator shall convene a proceeding for reconsideration of the rule and provide the same procedural rights as would have been afforded had the information been available at the time the rule was proposed. If the Administrator refuses to convene such a proceeding, such person may seek review of such refusal in the United States court of appeals for the appropriate circuit (as provided in subsection (b) of this section). Such reconsideration shall not postpone the effectiveness of the rule. The effectiveness of the rule may be stayed during such reconsideration, however, by the Administrator or the court for a period not to exceed three months.

(8) The sole forum for challenging procedural determinations made by the Administrator under this subsection shall be in the United States court of appeals for the appropriate circuit (as provided in subsection (b) of this section) at the time of the substantive review of the rule. No interlocutory appeals shall be permitted with respect to such procedural determinations. In reviewing alleged procedural errors, the court may invalidate the rule only if the errors were so serious and related to matters of such central relevance to the rule that there is a substantial likelihood that the rule would have been significantly changed if such errors had not been made.

(9) In the case of review of any action of the Administrator to which this subsection applies, the court may reverse any such action found to be—

(A) arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law;

(B) contrary to constitutional right, power, privilege, or immunity;

(C) in excess of statutory jurisdiction, authority, or limitations, or short of statutory right; or

(D) without observance of procedure required by law, if (i) such failure to observe such procedure is arbitrary or capricious, (ii) the requirement of paragraph (7)(B) has been met, and (iii) the condition of the last sentence of paragraph (8) is met.

(10) Each statutory deadline for promulgation of rules to which this subsection applies which requires promulgation less than six months after date of proposal may be extended to not more than six months after date of proposal by the Administrator upon a determination that such extension is necessary to afford the public, and the agency, adequate opportunity to carry out the purposes of this subsection.

(11) The requirements of this subsection shall take effect with respect to any rule the proposal of which occurs after ninety days after August 7, 1977.

(e) Other methods of judicial review not authorized

Nothing in this chapter shall be construed to authorize judicial review of regulations or orders of the Administrator under this chapter, except as provided in this section.

(f) Costs

In any judicial proceeding under this section, the court may award costs of litigation (including reasonable attorney and expert witness fees) whenever it determines that such award is appropriate.

(g) Stay, injunction, or similar relief in proceedings relating to noncompliance penalties

In any action respecting the promulgation of regulations under section 7420 of this title or the administration or enforcement of section 7420 of this title no court shall grant any stay, injunctive, or similar relief before final judgment by such court in such action.

(h) Public participation

It is the intent of Congress that, consistent with the policy of subchapter II of chapter 5 of title 5, the Administrator in promulgating any regulation under this chapter, including a regulation subject to a deadline, shall ensure a reasonable period for public participation of at least 30 days, except as otherwise expressly provided in section[6] 7407(d), 7502(a), 7511(a) and (b), and 7512(a) and (b) of this title.

(July 14, 1955, ch. 360, title III, §307, as added Pub. L. 91–604, §12(a), Dec. 31, 1970, 84 Stat. 1707; amended Pub. L. 92–157, title III, §302(a), Nov. 18, 1971, 85 Stat. 464; Pub. L. 93–319, §6(c), June 22, 1974, 88 Stat. 259; Pub. L. 95–95, title III, §§303(d), 305(a), (c), (f)–(h), Aug. 7, 1977, 91 Stat. 772, 776, 777; Pub. L. 95–190, §14(a)(79), (80), Nov. 16, 1977, 91 Stat. 1404; Pub. L. 101–549, title I, §§108(p), 110(5), title III, §302(g), (h), title VII, §§702(c), 703, 706, 707(h), 710(b), Nov. 15, 1990, 104 Stat. 2469, 2470, 2574, 2681–2684.)

REFERENCES IN TEXT

Section 7521(b)(4) of this title, referred to in subsec. (a), was repealed by Pub. L. 101–549, title II, §230(2), Nov. 15, 1990, 104 Stat. 2529.

Section 7521(b)(5) of this title, referred to in subsec. (b)(1), was repealed by Pub. L. 101–549, title II, §230(3), Nov. 15, 1990, 104 Stat. 2529.

Section 1857c–10(c)(2)(A), (B), or (C) of this title (as in effect before August 7, 1977), referred to in subsec. (b)(1), was in the original "section 119(c)(2)(A), (B), or (C) (as in effect before the date of enactment of the Clean Air Act Amendments of 1977)", meaning section 119 of act July 14, 1955, ch. 360, title I, as added June 22, 1974, Pub. L. 93–319, §3, 88 Stat. 248, (which was classified to section 1857c–10 of this title) as in effect prior to the enactment of Pub. L. 95–95, Aug. 7, 1977, 91 Stat. 691, effective Aug. 7, 1977. Section 112(b)(1) of Pub. L. 95–95 repealed section 119 of act July 14, 1955, ch. 360, title I, as added by Pub. L. 93–319, and provided that all references to such section 119 in any subsequent enactment which supersedes Pub. L. 93–319 shall be construed to refer to section 113(d) of the Clean Air Act and to paragraph (5) thereof in particular which is classified to subsec. (d)(5) of section 7413 of this title. Section 7413(d) of this title was subsequently amended generally by Pub. L. 101–549, title VII, §701, Nov. 15, 1990, 104 Stat. 2672, and, as so amended, no longer relates to final compliance orders. Section 117(b) of Pub. L. 95–95 added a new section 119 of act July 14, 1955, which is classified to section 7419 of this title.

Part C of subchapter I of this chapter, referred to in subsec. (d)(1)(J), was in the original "subtitle C of title I", and was translated as reading "part C of title I" to reflect the probable intent of Congress, because title I does not contain subtitles.

CODIFICATION

In subsec. (h), "subchapter II of chapter 5 of title 5" was substituted for "the Administrative Procedures Act" on authority of Pub. L. 89–554, §7(b), Sept. 6, 1966, 80 Stat. 631, the first section of which enacted Title 5, Government Organization and Employees.

Section was formerly classified to section 1857h–5 of this title.

PRIOR PROVISIONS

A prior section 307 of act July 14, 1955, was renumbered section 314 by Pub. L. 91–604 and is classified to section 7614 of this title.

Another prior section 307 of act July 14, 1955, ch. 360, title III, formerly §14, as added Dec. 17, 1963, Pub. L. 88–206, §1, 77 Stat. 401, was renumbered section 307 by Pub. L. 89–272, renumbered section 310 by Pub. L. 90–148, and renumbered section 317 by Pub. L. 91–604, and is set out as a Short Title note under section 7401 of this title.

[6] So in original. Probably should be "sections".

regulatory program offices, while maintaining a high level of scientific quality. Such report shall be submitted on or before March 31, 1978.

(Pub. L. 95–155, §7, Nov. 8, 1977, 91 Stat. 1259.)

REFERENCES IN TEXT

This Act, referred to in subsec. (a), is Pub. L. 95–155, Nov. 8, 1977, 91 Stat. 1257, as amended, known as the Environmental Research, Development, and Demonstration Authorization Act of 1978, which to the extent classified to the Code enacted sections 300j–3a, 4361a, 4361b, and 4363 to 4367 of this title. For complete classification of this Act to the Code, see Tables.

CODIFICATION

Section was enacted as part of the Environmental Research, Development, and Demonstration Authorization Act of 1978, and not as part of the National Environmental Policy Act of 1969 which comprises this chapter.

§4365. Science Advisory Board

(a) Establishment; requests for advice by Administrator of Environmental Protection Agency and Congressional committees

The Administrator of the Environmental Protection Agency shall establish a Science Advisory Board which shall provide such scientific advice as may be requested by the Administrator, the Committee on Environment and Public Works of the United States Senate, or the Committee on Science, Space, and Technology, on Energy and Commerce, or on Public Works and Transportation of the House of Representatives.

(b) Membership; Chairman; meetings; qualifications of members

Such Board shall be composed of at least nine members, one of whom shall be designated Chairman, and shall meet at such times and places as may be designated by the Chairman of the Board in consultation with the Administrator. Each member of the Board shall be qualified by education, training, and experience to evaluate scientific and technical information on matters referred to the Board under this section.

(c) Proposed environmental criteria document, standard, limitation, or regulation; functions respecting in conjunction with Administrator

(1) The Administrator, at the time any proposed criteria document, standard, limitation, or regulation under the Clean Air Act [42 U.S.C. 7401 et seq.], the Federal Water Pollution Control Act [33 U.S.C. 1251 et seq.], the Resource Conservation and Recovery Act of 1976 [42 U.S.C. 6901 et seq.], the Noise Control Act [42 U.S.C. 4901 et seq.], the Toxic Substances Control Act [15 U.S.C. 2601 et seq.], or the Safe Drinking Water Act [42 U.S.C. 300f et seq.], or under any other authority of the Administrator, is provided to any other Federal agency for formal review and comment, shall make available to the Board such proposed criteria document, standard, limitation, or regulation, together with relevant scientific and technical information in the possession of the Environmental Protection Agency on which the proposed action is based.

(2) The Board may make available to the Administrator, within the time specified by the Administrator, its advice and comments on the adequacy of the scientific and technical basis of the proposed criteria document, standard, limitation, or regulation, together with any pertinent information in the Board's possession.

(d) Utilization of technical and scientific capabilities of Federal agencies and national environmental laboratories for determining adequacy of scientific and technical basis of proposed criteria document, etc.

In preparing such advice and comments, the Board shall avail itself of the technical and scientific capabilities of any Federal agency, including the Environmental Protection Agency and any national environmental laboratories.

(e) Member committees and investigative panels; establishment; chairmenship

The Board is authorized to constitute such member committees and investigative panels as the Administrator and the Board find necessary to carry out this section. Each such member committee or investigative panel shall be chaired by a member of the Board.

(f) Appointment and compensation of secretary and other personnel; compensation of members

(1) Upon the recommendation of the Board, the Administrator shall appoint a secretary, and such other employees as deemed necessary to exercise and fulfill the Board's powers and responsibilities. The compensation of all employees appointed under this paragraph shall be fixed in accordance with chapter 51 and subchapter III of chapter 53 of title 5.

(2) Members of the Board may be compensated at a rate to be fixed by the President but not in excess of the maximum rate of pay for grade GS–18, as provided in the General Schedule under section 5332 of title 5.

(g) Consultation and coordination with Scientific Advisory Panel

In carrying out the functions assigned by this section, the Board shall consult and coordinate its activities with the Scientific Advisory Panel established by the Administrator pursuant to section 136w(d) of title 7.

(Pub. L. 95–155, §8, Nov. 8, 1977, 91 Stat. 1260; Pub. L. 96–569, §3, Dec. 22, 1980, 94 Stat. 3337; Pub. L. 103–437, §15(*o*), Nov. 2, 1994, 108 Stat. 4593; Pub. L. 104–66, title II, §2021(k)(3), Dec. 21, 1995, 109 Stat. 728.)

REFERENCES IN TEXT

The Clean Air Act, referred to in subsec. (c)(1), is act July 14, 1955, ch. 360, 69 Stat. 322, as amended, which is classified generally to chapter 85 (§7401 et seq.) of this title. For complete classification of this Act to the Code, see Short Title note set out under section 7401 of this title and Tables.

The Federal Water Pollution Control Act, referred to in subsec. (c)(1), is act June 30, 1948, ch. 758, as amended generally by Pub. L. 92–500, §2, Oct. 18, 1972, 86 Stat. 816, which is classified generally to chapter 26 (§1251 et seq.) of Title 33, Navigation and Navigable Waters. For complete classification of this Act to the Code, see Short Title note set out under section 1251 of Title 33 and Tables.

The Resource Conservation and Recovery Act of 1976, referred to in subsec. (c)(1), is Pub. L. 94–580, Oct. 21, 1976, 90 Stat. 2796, as amended, which is classified generally to chapter 82 (§6901 et seq.) of this title. For

RESPONDENTS' CERTIFICATE OF COMPLIANCE WITH WORD LIMITATION AND TYPEFACE REQUIREMENTS

Respondents United States Environmental Protection Agency ("EPA") and Lisa P. Jackson, Administrator of EPA, hereby represent that this corrected final brief complies with the type-volume limitation of Fed. R. App. P. 32(a)(7)(B) and the briefing format adopted by the Court for this case because it contains 29,624 words, as counted by Microsoft Word, excluding the signature block and the parts of the brief exempted by Fed. R. App. P. 32(a)(7)(B)(iii), and that it complies with the typeface and type style requirements of Fed. R. App. P. 32(a)(5) and 32(a)(6) because it has been prepared in a proportionally spaced typeface using Microsoft Word in Times New Roman 14-point type.

DATED: November 14, 2011

/s/ Angeline Purdy
Counsel for Respondents

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing corrected Final Brief for Respondents have been served through the Court's CM/ECF system on all registered counsel this 14th day of November, 2011.

DATED: November 14, 2011

/s/ Angeline Purdy
Counsel for Respondents

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The committee believes it necessary and propitious for EPA to recognize and deal with the air pollution properties and propensities of all radioactive materials and elements, including source material, special nuclear material and byproduct material. The committee believes the EPA is specially qualified to assess and regulate, if necessary, the air pollution effects of the possession, storage, transport, use, and discharge of any and all radioactive materials.

Third, the committee believes that possible duplication of efforts and resources in the regulatory process can be eliminated or kept to a minimum through EPA-NRC consultation and cooperation. The two agencies presently share jurisdiction to some extent and are expected to continue to cooperate under this provision. In order to encourage proper coordination of efforts, the committee adopted subsection (c) of new section 120. This subsection requires the NRC and EPA to engage in appropriate consultation and to enter into an interagency agreement.

Of course, to the extent that existing EPA-NRC (substantive and procedural) requirements meet the requirements of the Clean Air Act, no further measures would be required. To the extent, however, that NRC measures do not conform to Clean Air Act requirements or authorities, changes will be necessary. Thus, for example, under the Clean Air Act, emission limitations may be enforced by citizen suit and State and local governments may adopt and enforce more stringent standards than the Federal emission or ambient air standards.[8] These authorities and requirements, under the new section 101 of the bill, would apply equally to radioactive pollutants, including nuclear-related emissions from nuclear powerplants.

It is recognized that this provision may necessitate extra caution in the construction, operation, and maintenance of nuclear facilities than presently exists. However, the specially hazardous nature of radioactive pollutants requires an extra degree of protection. The costs of protecting the public health under the Clean Air Act must be considered a cost of doing business for the nuclear power industry, just as is the cost of meeting clean air requirements for coal-fired generating stations.

Finally, in the committee's view, public confidence in nuclear power will be assured only with adequate health safeguards. Providing such safeguards is likely ultimately to lead to greater public confidence, and that, in turn, may reduce public resistance to the generation of needed energy by nuclear powerplants.

SECTION 102—BASIS OF ADMINISTRATIVE STANDARDS

Background

In *Ethyl Corp.* v. *EPA*, No. 73-2205 (D.C. Cir. Jan. 28, 1975), a three-judge panel of the U.S. Court of Appeals was called upon to review the regulations promulgated by the Administrator to phase down the lead concentrations in gasoline as a measure to protect the public health from what he found was "a significant risk." The court,

[8] Thus, the committee would not preempt States from setting and enforcing stricter air pollution standards for radiation than the Federal standards and would not follow the holding of *Northern States Power Co.* v. *State of Minnesota*, 447 F. 2d 1143 (8th Cir. 1971), aff'd 405 U.S. 1035 (1972), in the context of radioactive air pollution.

by a 2-to-1 vote, held that the Administrator's regulations were invalid on two grounds.

First, according to the court, section 211 of the act imposes a stricter burden of proof on the Agency than other sections of the act. The court specifically held that in order to take action under section 211 (d) (1) (A) "he must find that the lead from auto emissions by itself or alone contributes a measurable increment of lead to the human body, and that this measurable increment causes a significant health hazard". (Slip. op. at 8.)

Second, the court held that even if EPA's less stringent interpretation of section 211 had been legally correct, the lead phase down regulations would still have to be invalidated because the Administrator "failed in his analysis of and reliance on inconclusive facts". (Slip op. at p. 50, nt. 89.)

On the other hand, the Administrator had argued that the standard in section 211(c) (1) (A) requires no more direct or certain proof of harm than is required for the imposition of emission standards under other provisions of the act. Furthermore, the Administrator maintained that conclusive proof of harm was an unattainable objective in the new sciences of air pollution epidemiology and toxicology. The Administrator indicated that, in his view, the Agency was authorized to base its emission standards on a "reasoned judgment on a border area of scientific knowledge and policy choice." (Slip op, at 11.)

The dissenting opinion of the three-judge panel in the *Ethyl* case agreed with the Administrator.

> * * * the majority proceeds to distort its reading of the statutory standard into a requirement that lead emissions cause *actual harm*, not merely the threat of harm, before the public health is endangered within the meaning of section 211(c) (1) (A). And, having transformed the required showing from one of risk to one of fact, the majority takes the next risks in making his determination .(Slip op. at 9, dissenting opinion.)
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> A statute allowing for regulation in the face of danger is, necessarily, a precautionary statute. Regulatory action may be taken before the threatened harm occurs; indeed, the very existence of such precautionary legislation would seem to demand that regulatory action precede, and optimally, prevent the perceived harm. As should be apparent, the 'will endanger' language of section 211(c)(1)(A) makes it a precautionary statute. (Slip op. at 11, dissenting opinion.)
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> The majority position flows inexorably from its transformation of the 'will endanger' determination from one of risk into one of fact. Indeed the majority's willingness to disregard the plain meaning of 'endanger' may be explained by its desire to make its 'factual' argument. (Slip op. at 24-25, dissenting opinion.)
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> * * * * * * *
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> All this is not to say that Congress left the Administrator to set policy on his own terms. To the contrary, the policy guidelines are largely prescribed, both in the statutory term

> 'will endanger' and in the relationship of that term with other sections of the Clean Air Act. Thus, as has been discussed extensively above, . . . 'will endanger' contemplates regulation of emissions 'present[ing] a significant risk of harm.' . . . But while Congress has made the basic policy decision, the Administrator is left, in his judgment, to interpret and apply it. That is, the Administrator's delegated duty under section 211(c)(1)(A) is to assess the risks to the public health posed by the automotive emissions of lead particulates.
>
> Of course risks are not assessed in thin air. Assessment of risk, beyond all doubt, is based on fact. The point the majority cannot quite grasp, however, is that it is not based on fact alone. Rather, a risk may be assessed from suspected, but not completely substantiated, relationships between facts, from trends among facts, from theoretical projections from imperfect data, or from probative preliminary data, not yet certifiable as 'fact.' . . . By allowing regulation in the absence of proof of actual harm, Congress has made a policy judgment in favor of overprotection rather than underprotection. . . . Such a cautious policy can be implemented only if the Administrator is empowered to assess risks. Of course, this power does not permit him to act on hunches or wild guesses; Amoco makes it quite clear that his conclusions must be rationally justified. But the command of Congress is that the Administrator act to prevent harm. He cannot wait, as the majority would have him, until he can point, with factually indisputable precision, to the poisoning effect of lead automobile emissions in the past. (Slip op. at 32–33, dissenting opinion.)

The dissenting judge's critique of the majority opinion in the Ethyl case has been echoed by several commentators. Thus, in note, "Judicial Review of the Facts in Informal Rulemaking: A Proposed Standard," 84 Yale L.J. 1750, 1976, 1764 (1975), it was argued that "the required factual proof should vary directly with the potential for factual certainty" and that "the [Clean Air Act's] statutory policy preference for protection of . . . health should also reduce the level of factual certainty required". As the author explained:

> Regulatory statutes requiring preventative or curative action to be undertaken on the basis of predictions of future harm necessarily conflict with the court's predisposition to require evidence of past events as a basis for intervention in the private sector. The . . . reviewing court's responsibility [should be] to assure that the available evidence used in making predictions is adequately adduced and rationally applied. But factual certainty in the sense of presently complete information on the impact of future events [should] not be required.

Similarly, in Karstadt, "Protecting Public Health from Hazardous Substances: Federal Regulations of Environmental Contaminants," 5 E.L.R. 50165 (1975), the author criticized the majority opinion in the three judge panel decision in *Ethyl:*

> In *Ethyl* . . . the real judgment is whether it is appropriate to wait for bodies on the street' before a regulatory agency

can act to protect the public interest. (Id. at 50167.)

Regulators often are faced with the difficult choice of making a decision on the basis of admittedly imperfect data, or postponing regulation until a better data base is assembled. "Regulation now or later" becomes an especially sharp dilemma whenever a substance which may have very severe effects on human health but whose effects on health may only appear many years after exposure has occurred. If the decision is made to defer regulation until it can be shown more definitely that a substance actually causes harm to humans, then regulation may occur too late to prevent harm to the population. 'Regulation later' as a regulatory approach really means using humans as guinea pigs, and should be considered socially unacceptable. . . . [W]hen faced with an imperfect or incomplete data base, a regulator should work with a heavy bias towards measures which will reduce exposure of humans to health. (Id. at 50165)

Karstadt's article then proceeds to explain in detail why data on environmental health will necessarily be limited, incomplete, or imperfect. Id. at 50167–9) For similar explanations, see "Health Basis for Preventing Significant Deterioration", supra; the dissenting opinion in *Ethyl* at nt. 87; Glepe and Tarlock, "The Uses of Scientific Information in Environmental Decisionmaking," in Environmental Law Review—1975; pp. 593–649.

The National Academy of Sciences and the National Academy of Engineering have agreed with the concerns expressed by Karstadt, et al.

[Several] factors are operating to make it possible, even likely that some environmental disruption will be experienced as sudden catastrophe rather than as a slowly moving and predictably growing shadow. One is the long time lag that often intervenes between an environmental insult and the appearance of harm—e.g. carcinogens and mutagens. The second factor is the irreversibility of some kinds of damage—e.g. the loss of genetic variability. . . . NAS–NAE, "Man, Materials, and Environment: A Report to the National Commission on Materials Policy," (March 1973), p. 8.

Ultimately, the three-judge panel's decision in the *Ethyl* case was vacated and the U.S. Court of Appeals granted a rehearing en banc.

On March 19, 1976, the U.S. Court of Appeals for the District of Columbia (en banc) handed down its decision on rehearing in the *Ethyl* case. The Court, by a 5–4 vote, upheld the EPA regulations and thus supported the position of the dissent in the original *Ethyl* case. *Ethyl Corporation* v. *EPA*, 541 F. 2d 1 (1976), cert. den. 96 S. Ct. 2263.

The Court began by pointing out an essential difficulty in regulating environmental pollution which may pose a significant risk to human health:

Man's ability to alter his environment has developed far more rapidly than his ability to foresee with certainty the effects of his alterations. It is only recently that we have begun to appreciate the danger posed by unregulated modification

of the world around us, and have created watch dog agencies whose task it is to warn us, and protect us, when technological "advances" present dangers unappreciated—or unrevealed—by their supporters. Such agencies, unequipped with crystal balls and unable to read the future, are nonetheless charged with evaluating the effects of unprecedented environmental modifications, often on a massive scale. Necessarily, they must deal with predictions and uncertainty, with developing evidence, [and] with conflicting evidence . . . Slip op. at 6.

The Court also explained some of the constraints which prevent conclusive before-the-fact proof of environmental harm.

> Certainty in the complexities of environmental medicine may be achievable only after the fact, when scientists have the opportunity for leisurely and isolated scrutiny of an entire mechanism. Awaiting certainty will often allow for only reactive, not preventive regulation. . . .
>
> The problems faced by EPA in deciding whether lead automotive emissions pose a threat to the public health highlight the limitations of awaiting certainty. First, lead concentrations are, even to date, essentially low-level, so that the feared adverse effects would not materialize until after a lifetime of exposure. Contrary to petitioners' suggestion, however, we have not yet suffered a lifetime of exposure to lead emissions. At best, emissions at present levels have been with us for no more than 15–20 years. Second, lead exposures from the ambient air is prevasive, so that valid control groups cannot be found against which the effects of lead on our population can be measured. Third, the sources of human exposure to lead are multiple, so that it is difficult to isolate the effect of automobile emissions. Last, significant exposure to lead is toxic, so that considerations of decency and morality limit the flexibility of experiments on humans that would otherwise accelerate lead exposure from years to months, and measure those results. Slip op. at 47–49.

In light of these problems and the precautionary nature and purpose of the statute's mandate to protect the public health, the Court rejected petitioners' claims that conclusive proof of harm would be required before the Administrator could regulate lead in gasoline. After reviewing in detail for 25 pages the rationale for the Administrator's judgment that lead in gasoline did present a significant risk of harm, the Court concluded that the Administrator had "handled an extraordinarily complicated problem with great care and candor." Slip Op. at 95. The Court pointed out that the Administrator's decision was reached.

> * * * [o]nly after hearings spread over several months, consideration of thousands of pages of documents, publication of three health documents, three formal comment periods, and receipt of hundreds of comments. Each study was considered independently; its worth was assessed only after it was measured against any critical comments. * * *
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> In tracking the [Administrator's] path through the evi-

dence we, in our appellate role, have also considered separately each study and the objections petitioners make thereto. In no case have we found the Administrator' use of the evidence to be arbitrary or capricious. Slip Op. at 96-97.

The three-judge panel decision in the *Ethyl* case formed the basis for, and was of critical importance to, the deliberations of the Subcommittee and the committee for several reasons. First, a prompt, final settlement of this important public health issue was felt to be desirable in its own right.[1] Second, the *Ethyl* case has important and direct implications for possible future regulatory actions of the Administrator to control fuel constituents, contaminants, or additives which may endanger public health. Of particular concern is possible regulation with respect to sulfur in gasoline or additives such as manganese. Third, the *Ethyl* case was deemed worthy of attention insofar as it interpreted most other provisions of the act in addition to section 211(c)(1)(A), albeit in dicta.

Fourth, the initial *Ethyl* decision formed the background for Administrator Train's testimony in 1975 on this subject. In particular, he testified (1) that he would favor a shift in the burden of proof, to show that the pollutants are not harmful; (2) that the standard of proof differs under different sections of the Act; (3) that "if the present [three-judge] court decision in the *Ethyl* case were to stand * * * I think the agency would foresee some overwhelming difficulties in carrying out its responsibilities to protect the public health"; and (4) that he would not object to Congress "acting now to deal with the problem". (H. 131)

Finally, and perhaps most importantly, the decision of the three-judge panel in the *Ethyl* case posed fundamental policy questions concerning the future of measures for protection of public health from environmental contaminants, which the committee felt required further congressional clarification. Among the crucial policy questions posed by the two *Ethyl* decisions are the following:

A. Should the Administrator act to prevent harm before it occurs or should he be authorized to regulate an air pollutant only if he finds actual harm has already occurred?

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[1] The committee's concern about lead in gasoline as potential danger to health arises from several factors. First, there is the Administrator's finding, and the evidence cited by him in support of that finding that lead in gasoline poses "a significant risk" to the public health. Second, there is the unambiguous "call to action" sounded by the National Academy of Sciences-National Academy of Engineering: "This toxic metal [lead] is ubiquitous and increasing in urban communities. Documentation exists citing increases in blood levels and other organs in individuals in urban centers exclusively. Because lead moves through many systems, and tends to be cumulative at all levels of intake, these multiple sources add to the total body burden and increase the potential hazard. This situation requires a serious call to action, such as the establishment of national ambient air quality standards for lead and the reduction of lead in automobile fuel even if it reduces engine efficiency. NAS-NAE "Man, Materials, and Environment: A Report for the National Commission on Materials Policy" (March 1973), p. 76.

A third basis for the committee's concern is the November 7, 1975, report by the U.S. Center for Disease Control, a unit of the Department of Health, Education, and Welfare, "Review Statement: Lead in Automotive Emissions." That report includes the following conclusions:

"Low-level absorption (blood lead levels of 40-80 ug/ml) is capable of causing subclinical neurologic dysfunction in exposed children. The potential of automotive lead for producing low-level increased lead absorption with such consequent impairment appears no different from that of particulate lead from other sources.

"Particulate lead of automotive origin is an important contributor to lead absorption in persons in the United States, and particularly in children. Further, such lead is very likely a contributing cause of damage to the neurologic and physiologic development of children in this country. The epidemiologic evidence developed to date is sufficiently convincing and the possible health consequence of continued exposure to particulate lead so grave that the levels of lead in automotive emissions ought to be lowered as soon as possible." Pp. 4-5.

B. Should the Administrator's duty include the assessment of risks or should his responsibility be exclusively to make findings of past fact?

C. Should the Administrator be required to prove endangerment is caused by emissions of a pollutant from a single class of sources without respect to other sources of the pollutant or should the Administrator consider the cumulative risk to public health from multiple sources of the pollutant, including consideration of the total body burden of the contaminant resulting from exposures to the pollutant in food, water, other ingestion sources, as well as inhalation?

D. Should a more stringent standard of proof apply to regulation of a fuel or fuel additive than to emissions from motor vehicles or should the standard of proof be the same? Should a more stringent standard of proof apply to regulation of emission of any pollutant from mobile sources than would apply to regulation of such emissions from stationary sources?

E. Should protection of the public health be limited to protection of healthy normal adults or should it extend to protection of susceptible individuals within the exposed population?

F. Should the Court's standard of review of informal rulemaking by the Administrator to protect public health be whether he has relied on conclusive or indisputable facts or whether he has reached reasonable conclusions which are rationally justified?

The committee's action in adopting section 102 of the bill is intended to answer these questions, not only for the purpose of section 211(c)(1)(A) of the act, but for the entire proposal. In summary, the committee's action is intended to support the views expressed in the majority opinion of the en banc panel on rehearing and in the dissenting opinion of the three-judge panel in the *Ethyl* case with respect to its interpretation of section 211 of the act. The committee's bill would also apply this interpretation to all other sections of the act relating to public health protection.

Committee proposal

The committee's purposes in adopting section 102 may be summarized as follows:

A. To emphasize the preventive or precautionary nature of the act, i.e., to assure that regulatory action can effectively prevent harm before it occurs; to emphasize the predominant value of protection of public health;

B. To authorize the Administrator to weigh risks and make reasonable projections of future trends; thus, to find a middle road between those who would impose a nearly impossible standard of proof on the Administrator before he may move to protect public health and those who would shift the burden of proof for all pollutants to make the pollution source prove the safety of its emissions as a condition of operation; [2]

C. To assure consideration of the cumulative impact of all sources of a pollutant in setting ambient and emission standards, not just the

[2] This determination of the committee is consistent with, and supportive of, the views expressed by the Court in *Amoco Oil Co.* v. *EPA*, 501 F. 2d 722, (D.C. Cir.1974). While projections, estimates, and assessment of risks are authorized, they are "subject to the restraints of reasonableness and cannot be based on 'crystal ball' inquiry." *Portland Cement Association* v. *Ruckelshaus*, 486 F. 2d 375, 391 (D.C. Cir. 1973).

extent of the risk from the emissions from a single source or class of sources of the pollutant; to require consideration of cumulative or synergistic effects of multiple pollutants to mandate evaluations of total body burden of contaminants; [3]

D. To provide the same standard of proof for regulation of any air pollutant, whether that pollutant comes from stationary or mobile sources, or both, and to make the vehicle and fuel industries equally responsible for cleaning up vehicle exhaust emissions;

E. To assure that the health of susceptible individuals, as well as healthy adults, will be encompassed in the term "public health," regardless of the section of the act under which the Administrator proceeds;

F. To reflect awareness of the uncertainties and limitations in the data which will be available to the Administrator in the foreseeable future to enable him to execute his rulemaking duties under this act, because of the limitations on research resources and the fact that decisionmaking about the risks to public health from air pollution falls on "the frontiers of scientific and medical knowledge"; to provide for adequate judicial review of the reasonableness of the Administrator's judgment in assessing risks, while restraining the courts from attempting to act "as the equivalent of a combined Ph. D. in chemistry, biology, and statistics" or from applying a standard of review which is appropriate only to review of adjudications or formal fact finding.

To achieve these purposes, the committee has used a standardized basis for future rulemaking to protect the public health: the Administrator may regulate a pollutant, emissions of "which in his judgment cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare."

This same basic formula is used in proposed new sections 108 (criteria for national ambient air quality standards); 111 (new source standards of performance); 112 (hazardous emission standards, although nature of risk must be more serious); 202 (new motor vehicle emission standards); 211 (regulation of fuels and fuel additives); and 231 (aircraft emission standards) of the act. Furthermore, subtitle B of title I (ozone and stratosphere protection) uses the same formula.

In upholding the majority opinion in the en banc rehearing in *Ethyl*, the committee is moving in a direction which is consistent with most judicial interpretations of the act. Most other courts have held that a substantial element of judgment, including making comparative assessment of risks, projections of future possibilities, establishing margins of safety and margins of error, extrapolating from limited data, etc., are necessary and permissible under the act in order

[3] The committee's determination to require application of these factors to standard-setting under all sections of the act again reflects the recommendations of the National Academy of Sciences—National Academy of Engineering: "The concept of total body burden should be the significant indicator of exposure, rather than burden acquired in one or another part of the environment or from one or another toxic material. People who work in a factory in which dangerous substances are handled in high concentration, may live in an adjacent area in which the same or other substances are dispersed, thus increasing overall exposure. More than one organ may be attacked because the offending substance is transported by two or more media. Synergistic effects among two or more substances, by which the combined effect is more than the sum of the separate effects, should be considered. NASNAE, "Man, Materials, and Environment: A Report to the National Commission on Materials Policy," (March 1973), p. 12. See also pp. 25, 35, 73, 80."

to protect public health and encourage development of new technology. See *South Terminal Corp.* v. *EPA*, 504 F.2d 646 (1st Cir. 1974); *Amoco Oil Co.* v. *EPA*, 501 F.2d 722 (D.C. Cir. 1974); *Texas* v. *EPA*, 499 F.2d 289 (5th Cir. 1974).

In order to affirm this view of the Administrator's function under the act, the committee included the words "in the judgment of the Administrator" or "in his judgment" in each of the foregoing sections. In 1975, the committee expressly rejected an amendment which would have deleted these words and required a finding by the Administrator instead. Thus, the committee language is intended to emphasize the necessarily judgmental element in the task of predicting future health risks of present action and to confer upon the Administrator the requisite authority to exercise such judgment.

On the other hand, the committee does not intend this language as a license for "crystal ball" speculation. The Administrator's judgment must, of course, remain subject to restraints of reasoned decision-making. See *Portland Cement Association* v. *Ruckelshaus*, 486 F.2d 375, 391 (D.C. Cir. 1973). In addition, of course, the Administrator's exercise of judgment will be subject to the careful and thorough procedural safeguards contained in section 305 of the bill.

In order to emphasize the precautionary or preventive purpose of the act (and, therefore, the Administrator's duty to assess risks rather than wait for proof of actual harm), the committee not only retained the concept of endangerment to health; the committee also added the words "may reasonably be anticipated". In evaluating what "may reasonably be anticipated", the limitations and difficulties inherent in environmental medical research referred to above must be considered.

By its use of the words "cause or contribute to air pollution", the committee intends to require the Administrator to consider all sources of the contaminant which contribute to air pollution and to consider all sources of exposure to the contaminant—food, water, air, etc.—in determining health risk.

Finally, the term "in the judgment of the Administrator" is intended to modify both the "cause or contribute to" phrase and the "reasonably may be anticipated" phrase.

SECTION 102A—ECONOMIC IMPACT STATEMENT

Background

When H.R. 10498, last year's bill to amend the Clean Air Act, was considered on the floor of the House, an amendment was adopted which would require the Administrator to prepare an economic impact statement prior to the proposal of non-health-related regulations under the Clean Air Act. This statement would be published prior to notice of proposed rulemaking and would be available for public scrutiny and comment as provided in section 305 of the bill (Administrative procedures and judicial review). This year's bill contains the same provision.

The committee's primary purpose in adopting this section was to assure that the Administrator and the public would have before them adequate analyses of the economic impacts of alternative courses of action or inaction under the act. The availablity of such information is expected to help shape wiser policy and to permit the public to participate in rulemaking in a more informed and effective way.

Questioned
As of: Nov 01, 2016

MASSACHUSETTS, et al., Petitioners v. ENVIRONMENTAL PROTECTION AGENCY et al.

No. 05-1120

SUPREME COURT OF THE UNITED STATES

549 U.S. 497; 127 S. Ct. 1438; 167 L. Ed. 2d 248; 2007 U.S. LEXIS 3785; 75 U.S.L.W. 4149; 37 ELR 20075; 63 ERC (BNA) 2057; 20 Fla. L. Weekly Fed. S 128

November 29, 2006, Argued
April 2, 2007, Decided

SUBSEQUENT HISTORY: On remand at *Mass. v. Epa, 2007 U.S. App. LEXIS 11282 (D.C. Cir., May 9, 2007)*

PRIOR HISTORY: ON WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT.
Massachusetts v. EPA, 367 U.S. App. D.C. 282, 415 F.3d 50, 2005 U.S. App. LEXIS 14311 (2005)

DISPOSITION: Reversed and remanded.

DECISION:

[***248] Group of states, local governments, and private organizations held to have standing to challenge Environmental Protection Agency (EPA) denial of petition alleging that EPA had abdicated responsibility to regulate emission of greenhouse gases; EPA held to (1) have statutory authority to regulate such emission from new motor vehicles; and (2) have presented impermissible basis for failing to do so.

SUMMARY:

Some private organizations filed a rulemaking petition asking the Environmental Protection Agency (EPA) to begin regulating emission of four "greenhouse gases," including carbon dioxide, under *§ 202(a)(1) of the Clean Air Act* (*42 U.S.C.S. § 7521(a)(1)*), which required the EPA to prescribe standards applicable to emission of "any air pollutant" from any class of new motor vehicles which in the EPA Administrator's judgment caused or contributed to air pollution reasonably anticipated to endanger public health or welfare. The Act (*42 U.S.C.S. §§ 7401 et seq.*), in *42 U.S.C.S. § 7602(g)*, defined "air pollutant" to include "any

air pollution agent . . ., including any physical, chemical . . . substance . . . emitted into . . . the ambient air."

The EPA (1) concluded that (a) the Act did not authorize the EPA to issue mandatory regulations to address global climate change, and (b) even if the EPA had authority to set greenhouse-gas emission standards, it would have been unwise to do so at that time because a causal link between greenhouse gases and global warming could not be unequivocally established; and (2) issued an order denying the petition.

The private organizations, joined by some intervenor states and local governments, sought review of the EPA's order in the United States Court of [***249] Appeals for the District of Columbia Circuit, which denied review (*367 U.S. App. D.C. 282, 415 F. 3d 50, 2005 U.S. App. LEXIS 14311*).

On certiorari, the United States Supreme Court reversed and remanded. In an opinion by Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ., it was held that:

o The group of states, local governments, and private organizations that were seeking review had standing under the *Federal Constitution's Article III* to challenge the EPA's denial of the rulemaking petition, where (1) at least according to the group's uncontested affidavits, the rise in sea levels associated with global warming had already harmed and would continue to harm a particular state in the group; and (2) the risk of catastrophic harm (a) was real, and (b) would be reduced if the group received the relief that the group sought.

o The EPA had statutory authority to regulate emission of greenhouse gases from new motor vehicles, because such gases fit well within the Act's capacious definition of "air pollutant."

o The EPA's action was arbitrary, capricious, or otherwise not in accordance with law under *42 U.S.C.S. § 7607(d)(9)(A)*, because the EPA had offered no reasoned explanation for its refusal to decide whether greenhouse gases caused or contributed to climate change.

Roberts, Ch. J., joined by Scalia, Thomas, and Alito, JJ., dissenting, expressed the view that the challenge by the group of states, local governments, and private organizations ought to be dismissed as nonjusticiable, for (1) such a conclusion would (a) involve no judgment on whether global warming existed, what caused it, or the extent of the problem, and (b) not render the group without recourse; and (2) the Supreme Court's standing jurisprudence recognized that redress of grievances of the sort at issue in the case at hand was the function of Congress and the Chief Executive, not the federal courts.

Scalia, J., joined by Roberts, Ch. J., and Thomas and Alito, JJ., dissenting, expressed the view that (1) the Supreme Court lacked jurisdiction to decide the case at hand because the group challenging the EPA lacked standing; and (2) the EPA's interpretation of the discretion conferred on the EPA by the Act was (a) reasonable, and (b) the most natural reading of the Act.

LAWYERS' EDITION HEADNOTES:

[***250]

PARTIES § 3

GREENHOUSE GASES -- ENVIRONMENTAL PROTECTION AGENCY'S DENIAL OF RULEMAKING PETITION -- STANDING TO CHALLENGE

Headnote:[1A][1B][1C][1D][1E]

A group of states, local governments, and private organizations had standing under the *Federal Constitution's Article III* to challenge the denial by the Environmental Protection Agency (EPA) of the group's rulemaking petition--asking the EPA to begin regulating emis-

sion of four "greenhouse gases," including carbon dioxide, under *§ 202(a)(1) of the Clean Air Act* (*42 U.S.C.S. § 7521(a)(1)*), which required the EPA to prescribe standards applicable to emission of "any air pollutant" from any class of new motor vehicles which in the EPA Administrator's judgment caused or contributed to air pollution reasonably anticipated to endanger public health or welfare, where "air pollutant" was defined by the Act, in *42 U.S.C.S. § 7602(g)*, to include "any air pollution agent . . ., including any physical, chemical . . . substance . . . emitted into . . . the ambient air"--as:

o The dispute turned on the proper construction of a congressional statute, a question eminently suitable to resolution in federal court.

o It was of critical importance that Congress, in *42 U.S.C.S. § 7607(b)(1)*, had authorized the type of challenge in question to EPA action.

o Only one party among the petitioners needed to have standing to permit the United States Supreme Court to consider the group's petition for review.

o The group's submissions as they pertained to a particular state in the group had satisfied the most demanding standards of the adversarial process--and the EPA's steadfast refusal to regulate greenhouse gas emission presented a risk of harm to this state that was both actual and imminent--where (1) at least according to the group's uncontested affidavits, the rise in sea levels associated with global warming had already harmed and would continue to harm this state; (2) the state's risk of catastrophic harm, though remote, was nevertheless real; and (3) that risk would be reduced to some extent if the group received the relief that the group sought.

(Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ.)

[***251]

ENVIRONMENTAL LAW § 24

CLEAN AIR ACT -- GREENHOUSE GASES -- ENVIRONMENTAL PROTECTION AGENCY'S AUTHORITY TO REGULATE

Headnote:[2A][2B]

The Environmental Protection Agency (EPA) had authority to regulate emission of four "greenhouse gases" (carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons) from new motor vehicles under the *Clean Air Act* (*42 U.S.C.S. §§ 7401 et seq.*)--which (1) in *§ 202(a)(1)* of the Act (*42 U.S.C.S. § 7521(a)(1)*), required the EPA to prescribe standards applicable to emission of "any air pollutant" from any class of new motor vehicles which in the EPA Administrator's judgment caused or contributed to air pollution reasonably anticipated to endanger public health or welfare, and (2) in *42 U.S.C.S. § 7602(g)*, defined "air pollutant" to include "any air pollution agent . . ., including any physical, chemical . . . substance . . . emitted into . . . the ambient air"--because greenhouse gases fit well within the Act's capacious definition of "air pollutant," as:

o Carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons were physical and chemical substances that were emitted into the ambient air.

o The circumstance that subsequent Congresses had eschewed enacting binding emission limitations to combat global warming told nothing about what Congress had meant when it had amended *§ 202(a)(1)* in 1970 and 1977.

o There was nothing counterintuitive to the notion that the EPA could curtail emission of substances that were putting the global climate out of kilter.

o The EPA had not identified any congressional action that conflicted with regulation of greenhouse gases from new motor vehicles.

o The circumstance that the Department of Transportation set mileage standards for new motor vehicles in no way licensed the EPA to shirk its environmental responsibility to protect public health and welfare.

o While the Congresses that had drafted *§ 202(a)(1)* might not have appreciated the possibility that burning fossil fuels could lead to global warming, they had understood that without regulatory flexibility, changing circumstances and scientific developments would soon have rendered the Act obsolete.

(Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ..)

ENVIRONMENTAL LAW § 24

CLEAN AIR ACT -- GREENHOUSE GASES -- ENVIRONMENTAL PROTECTION AGENCY'S REFUSAL TO REGULATE

Headnote:[3A][3B][3C][3D][3E]

The Environmental Protection Agency (EPA), in rejecting a rulemaking petition asking the EPA to regulate "greenhouse gases," thought to cause global warming, from new motor vehicles under the *Clean Air Act* (*42 U.S.C.S. §§ 7401 et seq.*), acted arbitrarily, capriciously, or otherwise not in accordance with law under *42 U.S.C.S. § 7607(d)(9)(A)* by basing the EPA's determination on a contention that even if the EPA had authority to regulate emission of such gases under the Act, it would have been unwise to do so at that time, because the EPA had offered no reasoned explanation for its refusal to decide whether greenhouse gases caused or contributed to climate change, as:

o Once the EPA responded to the petition, the EPA's reasons for action or inaction were required to conform to the authorizing statute.

o Under the Act's clear terms, the EPA could avoid taking further action only if it (1) determined that greenhouse gases did not contribute to climate change, or (2) provided some reasonable explanation as to why the EPA could not or would not exercise its discretion to determine whether they did.

o The EPA's laundry list of offered reasons--for example, that (1) a number of voluntary executive branch programs already provide an effective response to the threat of global warming; (2) regulating greenhouse gases might impair the President's ability to negotiate with "key developing nations" to reduce emissions; and (3) curtailing motor-vehicle emissions would reflect an inefficient, piecemeal approach to address the climate-change issue--had nothing to do with whether greenhouse gas emissions contributed to climate change.

o The EPA could not avoid its statutory obligation by noting the uncertainty surrounding various features of climate change and concluding that it would therefore be better not to regulate at that time.

o The circumstance that the EPA would prefer not to regulate greenhouse gases because of some residual uncertainty was irrelevant.

(Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ.)

[***252]

COURTS § 236

FEDERAL-COURT JURISDICTION -- CASE OR CONTROVERSY

Headnote:[4]

The *Federal Constitution's Article III* limitation of federal-court jurisdiction to "Cases" and "Controversies" confines the business of

federal courts to questions presented in an adversary context and in a form historically viewed as capable of resolution through the judicial process. It is therefore familiar learning that no justiciable controversy exists when (1) parties (a) seek adjudication of a political question, or (b) ask for an advisory opinion; or (2) the question sought to be adjudicated has been mooted by subsequent developments. (Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ.)

PARTIES § 2 PARTIES § 3

STANDING -- POWER OF CONGRESS -- INJURY

Headnote:[5]

With respect to standing, Congress has the power to define injuries and articulate chains of causation that will give rise to a case or controversy where none existed before. In exercising this power, however, Congress must at the very least (1) identify the injury it seeks to vindicate, and (2) relate the injury to the class of persons entitled to bring suit. (Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ.)

PARTIES § 22

CITIZEN STANDING

Headnote:[6]

The United States Supreme Court will not entertain citizen suits to vindicate the public's nonconcrete interest in the proper administration of the laws. (Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ.)

PARTIES § 3

STANDING -- PERSONAL STAKE IN OUTCOME -- INJURY

Headnote:[7]

The gist of the question of standing is whether parties have such a personal stake in the outcome of the controversy as to assure that concrete adverseness which sharpens the presentation of issues upon which the court so largely depends for illumination. While it does not matter how many persons have been injured by the challenged action, the party bringing suit must show that the action injures that party in a concrete and personal way. This requirement assures that (1) the parties before the court have an actual, as opposed to professed, stake in the outcome; and (2) the legal questions presented will be resolved in a concrete factual context conducive to a realistic appreciation of the consequences of judicial action. (Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ.)

PARTIES § 2

STANDING -- PROCEDURAL RIGHT

Headnote:[8]

A litigant to whom Congress has accorded a procedural right to protect that litigant's concrete interests can assert that right without meeting all the normal standards for redressability and immediacy. (Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ.)

PARTIES § 3

STANDING -- PROCEDURAL RIGHT

Headnote:[9]

When a litigant is vested by Congress with a procedural right to protect that litigant's interest, the litigant has standing if there is some possibility that the requested relief will prompt the injury-causing party to reconsider the decision that allegedly harmed the litigant. (Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ.)

[***253]

PARTIES § 3

STANDING -- STATE'S CHALLENGE TO ENVIRONMENTAL PROTECTION AGENCY'S INACTION

Headnote:[10]

For purposes of determining whether a particular state had standing to challenge the denial by the Environmental Protection Agency (EPA) of the state's rulemaking petition--asking the EPA to begin regulating emission of four "greenhouse gases," thought to create global warming, under *§ 202(a)(1) of the Clean Air Act* (*42 U.S.C.S. § 7521(a)(1)*), which required the EPA to prescribe standards applicable to emission of "any air pollutant" from any class of new motor vehicles which in the EPA Administrator's judgment caused or contributed to air pollution reasonably anticipated to endanger public health or welfare--the state was entitled to special solicitude in the United States Supreme Court's standing analysis, as:

o The Supreme Court had recognized that states were not normal litigants for the purposes of invoking federal jurisdiction.

o The well-founded desire of the state in question to preserve its sovereign territory from asserted injury by global warming supported federal jurisdiction.

o The circumstance that this state owned a great deal of the territory alleged to be affected by global warming reinforced the conclusion that the state's stake in the outcome of the case was sufficiently concrete to warrant the exercise of federal judicial power.

o The sovereign prerogatives given up by the state when it joined the Union were lodged in the Federal Government, and Congress had ordered the EPA to protect the state (among other entities) by prescribing standards described in *§ 7521(a)(1)*.

o In another provision of the Act (*42 U.S.C.S. § 7607(b)(1)*), Congress had recognized a concomitant procedural right to challenge the rejection of the state's rulemaking petition as arbitrary and capricious.

(Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ.)

[***254]

PARTIES § 3

STANDING -- STATE'S CHALLENGE TO ENVIRONMENTAL PROTECTION AGENCY'S INACTION

Headnote:[11]

For purposes of determining whether a state had standing to challenge the denial by the Environmental Protection Agency (EPA) of the state's rulemaking petition asking the EPA to begin regulating emission of four "greenhouse gases," thought to create global warming, under *§ 202(a)(1) of the Clean Air Act* (*42 U.S.C.S. § 7521(a)(1)*), which required the EPA to prescribe standards applicable to emission of "any air pollutant" from any class of new motor vehicles which in the EPA Administrator's judgment caused or contributed to air pollution reasonably anticipated to endanger public health or welfare:

o As to injury, (1) because the state owned a substantial portion of the state's coastal property, it had alleged a particularized injury in its capacity as a landowner; (2) if sea levels continued to rise as predicted, then the severity of that injury would increase during the next century; and (3) the state alleged that remediation costs alone might run into the hundreds of millions of dollars.

o As to causation, (1) the EPA did not dispute the existence of a causal connection between man-made greenhouse gas emissions and global warming; (2) the circumstance that a first step seeking to combat global warming might be tentative did not by itself support the notion that federal courts lacked jurisdiction to determine whether that step conformed to law;

and (3) judged by any standard, motor-vehicle emissions in the United States made a meaningful contribution to greenhouse gas concentrations.

o As to remedy, (1) even if regulating motor-vehicle emissions would not by itself reverse global warming, it did not follow that the United States Supreme Court lacked jurisdiction to decide whether the EPA had a duty to take steps to slow global warming; (2) the circumstance that the effectiveness of a remedy might be delayed during the relatively short time it would take for a new motor-vehicle fleet to replace an older one was essentially irrelevant; and (3) it was not dispositive that developing countries were poised to increase greenhouse gas emissions substantially over the next century.

(Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ.)

ADMINISTRATIVE LAW §238ADMINISTRATIVE LAW § 247

CLEAN AIR ACT -- INACTION OF ENVIRONMENTAL PROTECTION AGENCY -- SCOPE OF REVIEW

Headnote:[12]

The scope of the United States Supreme Court's review of a question--whether the Environmental Protection Agency (EPA), in rejecting a rulemaking petition asking the EPA to regulate four "greenhouse gases," thought to cause global warming, from new motor vehicles under the *Clean Air Act* (*42 U.S.C.S. §§ 7401 et seq.*), had acted arbitrarily, capriciously, or otherwise not in accordance with law under *42 U.S.C.S. § 7607(d)(9)(A)*--was narrow, as:

o A federal administrative agency had broad discretion to choose how best to marshal its limited resources and personnel to carry out its delegated responsibilities.

o That discretion was at its height when the agency decided not to bring an enforcement action.

o In contrast to nonenforcement decisions, agency refusals to initiate rulemaking were less frequent, more apt to involve legal as opposed to factual analysis, and subject to special formalities, including a public explanation.

o Refusals to promulgate rules were thus susceptible to judicial review, though such review was extremely limited and highly deferential.

(Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ.)

ENVIRONMENTAL LAW § 26

CLEAN AIR ACT -- REVIEW OF ENVIRONMENTAL PROTECTION AGENCY'S INACTION

Headnote:[13]

With respect to the Environmental Protection Agency (EPA) rejection of a rulemaking petition asking the EPA to regulate four "greenhouse gases," thought to cause global warming, from new motor vehicles under the *Clean Air Act* (*42 U.S.C.S. §§ 7401 et seq.*)--where the EPA concluded (1) that it lacked authority under *42 U.S.C.S. § 7521(a)(1)* to regulate new vehicle emissions because carbon dioxide was not an "air pollutant" as that term was defined in *42 U.S.C.S. § 7602*, and (2) alternatively, that even if the EPA possessed such authority, it would decline to regulate because regulation would conflict with other administration priorities--the United States Supreme Court had authority to reverse any such action found to be arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law under *42 U.S.C.S. § 7607(d)(9)*, as the Act expressly permitted review of such an action in *42 U.S.C.S. § 7607(b)(1)*. (Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ.)

UNITED STATES § 22

PRESIDENTIAL AUTHORITY

Headnote:[14]

While the President has broad authority in foreign affairs, that authority does not extend to the refusal to execute domestic laws. (Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ.)

[***255]

APPEAL § 1750.6

CLEAN AIR ACT -- ENVIRONMENTAL PROTECTION AGENCY -- ISSUE NOT DECIDED

Headnote:[15]

In holding, on certiorari, that the Environmental Protection Agency (EPA)--in rejecting a rulemaking petition asking the EPA to regulate four "greenhouse gases," thought to cause global warming, from new motor vehicles under the *Clean Air Act* (*42 U.S.C. S. §§ 7401 et seq.*)--had acted arbitrarily, capriciously, or otherwise not in accordance with law under *42 U.S.C.S. § 7607(d)(9)(A)*, because the EPA had offered no reasoned explanation for its refusal to decide whether greenhouse gases caused or contributed to climate change, the United States Supreme Court did not need to reach, and did not reach, the question whether on remand, (1) the EPA would be required to make an endangerment finding, or (2) policy concerns would be allowed to inform the EPA's actions if it made such a finding. (Stevens, J., joined by Kennedy, Souter, Ginsburg, and Breyer, JJ.)

SYLLABUS

[***256] Based on respected scientific opinion that a well-documented rise in global temperatures and attendant climatological and environmental changes have resulted from a significant increase in the atmospheric concentration of "greenhouse gases," a group of private organizations petitioned the Environmental Protection Agency (EPA) to begin regulating the emissions of four such gases, including carbon dioxide, under *§ 202(a)(1) of the Clean Air Act*, which requires that EPA "shall by regulation prescribe . . . standards applicable to the emission of any air pollutant from any class . . . of new motor vehicles . . . which in [the EPA Administrator's] judgment cause[s], or contribute[s] to, air pollution . . . reasonably . . . anticipated to endanger public health or welfare," *42 U.S.C. § 7521(a)(1)*. The Act defines "air pollutant" to include "any air pollution agent . . ., including any physical, chemical . . . substance . . . emitted into . . . the ambient air." *§ 7602(g)*. EPA ultimately denied the petition, reasoning that (1) the Act does not authorize it to issue mandatory regulations to address global climate change, and (2) even if it had the authority to set greenhouse gas emission standards, it would have been unwise to do so at that time because a causal link between greenhouse gases and the increase in global surface air temperatures was not unequivocally established. The Agency further characterized any EPA regulation of motor-vehicle emissions as a piecemeal approach to climate change that would conflict with the President's comprehensive approach involving additional support for technological innovation, the creation of nonregulatory programs to encourage voluntary private-sector reductions in greenhouse gas emissions, and further research on climate change, and might hamper the President's ability to persuade key developing nations to reduce emissions.

Petitioners, now joined by intervenor Massachusetts and other state and local governments, sought review in the D. C. Circuit. Although each of the three judges on the panel wrote separately, two of them agreed that the EPA Administrator properly exercised his discretion in denying the rulemaking petition. One judge concluded that the Administrator's exercise of "judgment" as to whether a pollu-

tant could "reasonably be anticipated to endanger public health or welfare," *§ 7521(a)(1)*, could be based on scientific uncertainty as well as other factors, including the concern that unilateral U. S. regulation of motor-vehicle emissions could weaken efforts to reduce other countries' greenhouse gas emissions. The second judge opined that petitioners had failed to demonstrate the particularized injury to them that is necessary to establish standing under *Article III*, but accepted the contrary view as the law of the case and joined the judgment on the merits as the closest to that which he preferred. The court therefore denied review.

Held:

1. Petitioners have standing to challenge EPA's denial of their rulemaking petition.

(a) This case suffers from none of the defects that would preclude it from being a justiciable *Article III* "Controvers[y]." See, *e.g., Luther v. Borden, 48 U.S. 1, 7 How. 1, 12 L. Ed. 581*. Moreover, the proper construction of a congressional statute is an eminently suitable question for federal-court [***257] resolution, and Congress has authorized precisely this type of challenge to EPA action, see *42 U.S.C. § 7607(b)(1)*. Contrary to EPA's argument, standing doctrine presents no insuperable jurisdictional obstacle here. To demonstrate standing, a litigant must show that it has suffered a concrete and particularized injury that is either actual or imminent, that the injury is fairly traceable to the defendant, and that a favorable decision will likely redress that injury. See *Lujan v. Defenders of Wildlife, 504 U.S. 555, 560-561, 112 S. Ct. 2130, 119 L. Ed. 2d 351*. However, a litigant to whom Congress has "accorded a procedural right to protect his concrete interests," *id., at 573, n. 7, 112 S. Ct. 2130, 119 L. Ed. 2d 351* --here, the right to challenge agency action unlawfully withheld, *§ 7607(b)(1)* --"can assert that right without meeting all the normal standards for redressability and immediacy," *ibid.* Only one petitioner needs to have standing to authorize review. See *Rumsfeld v. Forum for Academic and Institutional Rights, Inc., 547 U.S. 47, 52, n. 2, 126 S. Ct. 1297, 164 L. Ed. 2d 156*. Massachusetts has a special position and interest here. It is a sovereign State and not, as in Lujan, a private individual, and it actually owns a great deal of the territory alleged to be affected. The sovereign prerogatives to force reductions in greenhouse gas emissions, to negotiate emissions treaties with developing countries, and (in some circumstances) to exercise the police power to reduce motor-vehicle emissions are now lodged in the Federal Government. Because Congress has ordered EPA to protect Massachusetts (among others) by prescribing applicable standards, *§ 7521(a)(1)*, and has given Massachusetts a concomitant procedural right to challenge the rejection of its rulemaking petition as arbitrary and capricious, *§ 7607(b)(1)*, petitioners' submissions as they pertain to Massachusetts have satisfied the most demanding standards of the adversarial process. EPA's steadfast refusal to regulate greenhouse gas emissions presents a risk of harm to Massachusetts that is both "actual" and "imminent," *Lujan, 504 U.S., at 560, 112 S. Ct. 2130, 119 L. Ed. 2d 351*, and there is a "substantial likelihood that the judicial relief requested" will prompt EPA to take steps to reduce that risk, *Duke Power Co. v. Carolina Environmental Study Group, Inc., 438 U.S. 59, 79, 98 S. Ct. 2620, 57 L. Ed. 2d 595* Pp. 12-17..

(b) The harms associated with climate change are serious and well recognized. The Government's own objective assessment of the relevant science and a strong consensus among qualified experts indicate that global warming threatens, *inter alia,* a precipitate rise in sea levels, severe and irreversible changes to natural ecosystems, a significant reduction in winter snowpack with direct and important economic consequences, and increases in the spread of disease and the ferocity of weather events. That these changes are widely shared does not minimize Massachusetts' interest in the outcome of this litigation. See *FEC v. Akins, 524*

U.S. 11, 24, 118 S. Ct. 1777, 141 L. Ed. 2d 10. According to petitioners' uncontested affidavits, global sea levels rose between 10 and 20 centimeters over the 20th century as a result of global warming and have already begun to swallow Massachusetts' coastal land. Remediation costs alone, moreover, could reach hundreds of millions of dollars. Pp. 17-19.

[***258] (c) Given EPA's failure to dispute the existence of a causal connection between manmade greenhouse gas emissions and global warming, its refusal to regulate such emissions, at a minimum, "contributes" to Massachusetts' injuries. EPA overstates its case in arguing that its decision not to regulate contributes so insignificantly to petitioners' injuries that it cannot be haled into federal court, and that there is no realistic possibility that the relief sought would mitigate global climate change and remedy petitioners' injuries, especially since predicted increases in emissions from China, India, and other developing nations will likely offset any marginal domestic decrease EPA regulation could bring about. Agencies, like legislatures, do not generally resolve massive problems in one fell swoop, see *Williamson v. Lee Optical of Okla., Inc., 348 U.S. 483, 489, 75 S. Ct. 461, 99 L. Ed. 563*, but instead whittle away over time, refining their approach as circumstances change and they develop a more nuanced understanding of how best to proceed, cf. *SEC v. Chenery Corp., 332 U.S. 194, 202-203, 67 S. Ct. 1575, 91 L. Ed. 1995*. That a first step might be tentative does not by itself negate federal-court jurisdiction. And reducing domestic automobile emissions is hardly tentative. Leaving aside the other greenhouse gases, the record indicates that the U. S. transportation sector emits an enormous quantity of carbon dioxide into the atmosphere. Pp. 20-21.

(d) While regulating motor-vehicle emissions may not by itself *reverse* global warming, it does not follow that the Court lacks jurisdiction to decide whether EPA has a duty to take steps to *slow* or *reduce* it. See *Larson v. Valente, 456 U.S. 228, 243, n. 15, 102 S. Ct. 1673, 72 L. Ed. 2d 33*. Because of the enormous potential consequences, the fact that a remedy's effectiveness might be delayed during the (relatively short) time it takes for a new motor-vehicle fleet to replace an older one is essentially irrelevant. Nor is it dispositive that developing countries are poised to substantially increase greenhouse gas emissions: A reduction in domestic emissions would slow the pace of global emissions increases, no matter what happens elsewhere. The Court attaches considerable significance to EPA's espoused belief that global climate change must be addressed. Pp. 21-23.

2. The scope of the Court's review of the merits of the statutory issues is narrow. Although an agency's refusal to initiate enforcement proceedings is not ordinarily subject to judicial review, *Heckler v. Chaney, 470 U.S. 821, 105 S. Ct. 1649, 84 L. Ed. 2d 714*, there are key differences between nonenforcement and denials of rulemaking petitions that are, as in the present circumstances, expressly authorized. EPA concluded alternatively in its petition denial that it lacked authority under *§ 7521(a)(1)* to regulate new vehicle emissions because carbon dioxide is not an "air pollutant" under *§ 7602*, and that, even if it possessed authority, it would decline to exercise it because regulation would conflict with other administration priorities. Because the Act expressly permits review of such an action, *§ 7607(b)(1)*, this Court "may reverse [it if it finds it to be] arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law," *§ 7607(d)(9)*. Pp. 24-25.

3. Because greenhouse gases fit well within the Act's capacious definition of "air pollutant," EPA has statutory authority to regulate emission of [***259] such gases from new motor vehicles. That definition--which includes "*any* air pollution agent . . ., including *any* physical, chemical, . . . substance . . . emitted into . . . the

ambient air . . .," *§ 7602(g)* (emphasis added)--embraces all airborne compounds of whatever stripe. Moreover, carbon dioxide and other greenhouse gases are undoubtedly "physical [and] chemical . . . substance[s]." *Ibid.* EPA's reliance on postenactment congressional actions and deliberations it views as tantamount to a command to refrain from regulating greenhouse gas emissions is unavailing. Even if postenactment legislative history could shed light on the meaning of an otherwise-unambiguous statute, EPA identifies nothing suggesting that Congress meant to curtail EPA's power to treat greenhouse gases as air pollutants. The Court has no difficulty reconciling Congress' various efforts to promote interagency collaboration and research to better understand climate change with the Agency's pre-existing mandate to regulate "any air pollutant" that may endanger the public welfare. *FDA v. Brown & Williamson Tobacco Corp., 529 U.S. 120, 133, 120 S. Ct. 1291, 146 L. Ed. 2d 121*, distinguished. Also unpersuasive is EPA's argument that its regulation of motor-vehicle carbon dioxide emissions would require it to tighten mileage standards, a job (according to EPA) that Congress has assigned to the Department of Transportation. The fact that DOT's mandate to promote energy efficiency by setting mileage standards may overlap with EPA's environmental responsibilities in no way licenses EPA to shirk its duty to protect the public "health" and "welfare," *§ 7521(a)(1)*. Pp. 25-30.

4. EPA's alternative basis for its decision--that even if it has statutory authority to regulate greenhouse gases, it would be unwise to do so at this time--rests on reasoning divorced from the statutory text. While the statute conditions EPA action on its formation of a "judgment," that judgment must relate to whether an air pollutant "cause[s], or contribute[s] to, air pollution which may reasonably be anticipated to endanger public health or welfare." *§ 7601(a)(1)*. Under the Act's clear terms, EPA can avoid promulgating regulations only if it determines that greenhouse gases do not contribute to climate change or if it provides some reasonable explanation as to why it cannot or will not exercise its discretion to determine whether they do. It has refused to do so, offering instead a laundry list of reasons not to regulate, including the existence of voluntary Executive Branch programs providing a response to global warming and impairment of the President's ability to negotiate with developing nations to reduce emissions. These policy judgments have nothing to do with whether greenhouse gas emissions contribute to climate change and do not amount to a reasoned justification for declining to form a scientific judgment. Nor can EPA avoid its statutory obligation by noting the uncertainty surrounding various features of climate change and concluding that it would therefore be better not to regulate at this time. If the scientific uncertainty is so profound that it precludes EPA from making a reasoned judgment, it must say so. The statutory question is whether sufficient information exists for it to make an endangerment finding. Instead, EPA rejected the rulemaking petition based on impermissible considerations. Its action was therefore "arbitrary, capricious, or otherwise not in [***260] accordance with law," *§ 7607(d)(9)*. On remand, EPA must ground its reasons for action or inaction in the statute. Pp. 30-32.

367 U.S. App. D.C. 282, 415 F.3d 50, reversed and remanded.

COUNSEL: James R. Milkey argued the cause for petitioners.

Gregory G. Garre argued the cause for respondents.

JUDGES: Stevens, J., delivered the opinion of the Court, in which Kennedy, Souter, Ginsburg, and Breyer, JJ., joined. Roberts, C. J., filed a dissenting opinion, in which Scalia, Thomas, and Alito, JJ., joined, *post*, p. 535. Scalia, J., filed a dissenting opinion, in which Roberts, C.

J., and Thomas and Alito, JJ., joined, *post*, p. 549.

OPINION BY: STEVENS

OPINION

[*504] [**1446] Justice **Stevens** delivered the opinion of the Court.

[***LEdHR1A] [***LEdHR2A] [***LEdHR3A] A well-documented rise in global temperatures has coincided with a significant increase in the concentration of carbon [*505] dioxide in the atmosphere. Respected scientists believe the two trends are related. For when carbon dioxide is released into the atmosphere, it acts like the ceiling of a greenhouse, trapping solar energy and retarding the escape of reflected heat. It is therefore a species--the most important species--of a "greenhouse gas."

Calling global warming "the most pressing environmental challenge of our time,"[1] a group of States,[2] local governments,[3] and private organizations[4] alleged in a petition for certiorari that the Environmental Protection Agency (EPA) has abdicated its responsibility under the *Clean Air Act* to regulate the emissions of four greenhouse gases, including carbon dioxide. Specifically, petitioners asked us to answer two questions concerning the meaning of *§ 202(a)(1)* of the Act: whether EPA has the statutory authority to regulate greenhouse gas emissions from new motor vehicles; and if so, whether its stated reasons for refusing to do so are consistent with the statute.

1 Pet. for Cert. 22.

2 California, Connecticut, Illinois, Maine, Massachusetts, New Jersey, New Mexico, New York, Oregon, Rhode Island, Vermont, and Washington.

3 District of Columbia, American Samoa, New York City, and Baltimore.

4 Center for Biological Diversity, Center for Food Safety, Conservation Law Foundation, Environmental Advocates, Environmental Defense, Friends of the Earth, Greenpeace, International Center for Technology Assessment, National Environmental Trust, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists, and U. S. Public Interest Research Group.

In response, EPA, supported by 10 intervening States[5] and six trade associations,[6] correctly argued that we may not address those two questions unless at least one petitioner has standing to invoke our jurisdiction under *Article III of the Constitution*. [**1447] Notwithstanding the serious character of [*506] that jurisdictional argument and the absence of any conflicting decisions construing *§ 202(a)(1)*, the unusual importance of the underlying issue persuaded us to grant the writ. [***261] *548 U.S. 903, 126 S. Ct. 2960, 165 L. Ed. 2d 949 (2006).*

5 Alaska, Idaho, Kansas, Michigan, Nebraska, North Dakota, Ohio, South Dakota, Texas, and Utah.

6 Alliance of Automobile Manufacturers, National Automobile Dealers Association, Engine Manufacturers Association, Truck Manufacturers Association, CO [2] Litigation Group, and Utility Air Regulatory Group.

I

Section 202(a)(1) of the Clean Air Act, as added by Pub. L. 89-272, § 101(8), 79 Stat. 992, and as amended by, *inter alia*, 84 Stat. 1690 and 91 Stat. 791, *42 U.S.C. § 7521(a)(1)*, provides:

> "The [EPA] Administrator shall by regulation prescribe (and from time to time revise) in accordance with the provisions of this section, standards applicable to the emission of any air pollutant from any class or classes of new motor vehi-

> cles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare . . . ."[7]

The Act defines "air pollutant" to include "any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive . . . substance or matter which is emitted into or otherwise enters the ambient air." *§ 7602(g)*. "Welfare" is also defined broadly: among other things, it includes "effects on . . . weather . . . and climate." *§ 7602(h)*.

7 The 1970 version of *§ 202(a)(1)* used the phrase "which endangers the public health or welfare" rather than the more protective "which may reasonably be anticipated to endanger public health or welfare." See § 6(a) of the Clean Air Amendments of 1970, 84 Stat. 1690. Congress amended *§ 202(a)(1)* in 1977 to give its approval to the decision in *Ethyl Corp. v. EPA, 176 U.S. App. D.C. 373, 541 F.2d 1, 25 (CADC 1976)* (en banc), which held that the *Clean Air Act* "and common sense . . . demand regulatory action to prevent harm, even if the regulator is less than certain that harm is otherwise inevitable." See § 401(d)(1) of the Clean Air Act Amendments of 1977, 91 Stat. 791; see also H. R. Rep. No. 95-294, p 49 (1977).

[*507] When Congress enacted these provisions, the study of climate change was in its infancy.[8] In 1959, shortly after the U. S. Weather Bureau began monitoring atmospheric carbon dioxide levels, an observatory in Mauna Loa, Hawaii, recorded a mean level of 316 parts per million. This was well above the highest carbon dioxide concentration--no more than 300 parts per million--revealed in the 420,000-year-old ice-core record.[9] By the time Congress drafted *§ 202(a)(1)* in 1970, carbon dioxide levels had reached 325 parts per million.[10]

8 The Council on Environmental Quality had issued a report in 1970 concluding that "[m]an may be changing his weather." Environmental Quality: The First Annual Report 93. Considerable uncertainty remained in those early years, and the issue went largely unmentioned in the congressional debate over the enactment of the *Clean Air Act*. But see 116 Cong. Rec. 32914 (1970) (statement of Sen. Boggs referring to Council's conclusion that "[a]ir pollution alters the climate and may produce global changes in temperature").

9 See Intergovernmental Panel on Climate Change, Climate Change 2001: Synthesis Report, pp 202-203 (2001). By drilling through thick Antarctic ice sheets and extracting "cores," scientists can examine ice from long ago and extract small samples of ancient air. That air can then be analyzed, yielding estimates of carbon dioxide levels. *Ibid.*

10 A more dramatic rise was yet to come: In 2006, carbon dioxide levels reached 382 parts per million, see Dept. of Commerce, National Oceanic & Atmospheric Administration, Mauna Loa CO [2] Monthly Mean Data, http://www.esrl.noaa.gov/gmd/ccgg/trends/co2_mm_mlo.dat (all Internet materials as visited Mar. 29, 2007, and available in Clerk of Court's case file), a level thought to exceed the concentration of carbon dioxide in the atmosphere at any point over the past 20-million years. See Intergovernmental Panel on Climate Change, Technical Summary of Working Group I Report 39 (2001).

[**1448] In the late 1970's, the Federal Government began devoting serious attention to the possibility that carbon dioxide emissions associated with human [***262] activity could provoke climate change. In 1978, Congress enacted the National Climate Program Act, 92 Stat. 601, which required the President to establish a program to "assist the Nation and the world to [*508] understand and respond to natural and man-induced climate processes and their implications," *id.,* § 3. President Carter, in turn, asked the National Research Council, the working arm of the National Academy of Sciences, to investigate the subject. The Council's response was unequivocal: "If carbon dioxide continues to increase, the study group finds no reason to doubt that climate changes will result and no reason to believe that these changes will be negligible. . . . A wait-and-see policy may mean waiting until it is too late."[11]

11 Climate Research Board, Carbon Dioxide and Climate: A Scientific Assessment, p viii (1979).

Congress next addressed the issue in 1987, when it enacted the Global Climate Protection Act, Title XI of Pub. L. 100-204, 101 Stat. 1407, note following *15 U.S.C. § 2901.* Finding that "manmade pollution--the release of carbon dioxide, chlorofluorocarbons, methane, and other trace gases into the atmosphere--may be producing a long-term and substantial increase in the average temperature on Earth," § 1102(1), 101 Stat. 1408, Congress directed EPA to propose to Congress a "coordinated national policy on global climate change," § 1103(b), and ordered the Secretary of State to work "through the channels of multilateral diplomacy" and coordinate diplomatic efforts to combat global warming, § 1103(c). Congress emphasized that "ongoing pollution and deforestation may be contributing now to an irreversible process" and that "[n]ecessary actions must be identified and implemented in time to protect the climate." § 1102(4).

Meanwhile, the scientific understanding of climate change progressed. In 1990, the Intergovernmental Panel on Climate Change (IPCC), a multinational scientific body organized under the auspices of the United Nations, published its first comprehensive report on the topic. Drawing on expert opinions from across the globe, the IPCC concluded that "emissions resulting from human activities are substantially [*509] increasing the atmospheric concentrations of . . . greenhouse gases [which] will enhance the greenhouse effect, resulting on average in an additional warming of the Earth's surface."[12]

12 IPCC, Climate Change: The IPCC Scientific Assessment, p xi (J. Houghton, G. Jenkins, & J. Ephraums eds. 1991).

Responding to the IPCC report, the United Nations convened the "Earth Summit" in 1992 in Rio de Janeiro. The first President Bush attended and signed the United Nations Framework Convention on Climate Change (UNFCCC), a nonbinding agreement among 154 nations to reduce atmospheric concentrations of carbon dioxide and other greenhouse gases for the purpose of "prevent[ing] dangerous anthropogenic [*i.e.*, human-induced] interference with the [Earth's] climate system."[13] S. Treaty Doc. No. 102-38, Art. 2, p 5, 1771 U.N.T.S. 107 (1992). The Senate unanimously ratified the treaty.

13 The industrialized countries listed in Annex I to the UNFCCC undertook to reduce their emissions of greenhouse gases to 1990 levels by the year 2000. No immediate restrictions were imposed on developing countries, including China and India. They could choose to become Annex I countries when sufficiently developed.

[***263] [**1449] Some five years later--after the IPCC issued a second comprehensive report in 1995 concluding that "[t]he bal-

ance of evidence suggests there is a discernible human influence on global climate"[14]--the UNFCCC signatories met in Kyoto, Japan, and adopted a protocol that assigned mandatory targets for industrialized nations to reduce greenhouse gas emissions. Because those targets did not apply to developing and heavily polluting nations such as China and India, the Senate unanimously passed a resolution expressing its sense that the United States should not enter into the Kyoto Protocol. See S. Res. 98, 105th Cong., 1st Sess. (July 25, 1997) (as passed). President Clinton did not submit the protocol to the Senate for ratification.

14 IPCC, Climate Change 1995, The Science of Climate Change, p 4.

[*510] II

On October 20, 1999, a group of 19 private organizations[15] filed a rulemaking petition asking EPA to regulate "greenhouse gas emissions from new motor vehicles under *§ 202* of the Clean Air Act." App. 5. Petitioners maintained that 1998 was the "warmest year on record"; that carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons are "heat trapping greenhouse gases"; that greenhouse gas emissions have significantly accelerated climate change; and that the IPCC's 1995 report warned that "carbon dioxide remains the most important contributor to [manmade] forcing of climate change." *Id., at 13* (internal quotation marks omitted). The petition further alleged that climate change will have serious adverse effects on human health and the environment. *Id., at 22-35*. As to EPA's statutory authority, the petition observed that the Agency itself had already confirmed that it had the power to regulate carbon dioxide. See *id., at 18, n 21*. In 1998, Jonathan Z. Cannon, then EPA's general counsel, prepared a legal opinion concluding that "CO [2] emissions are within the scope of EPA's authority to regulate," even as he recognized that EPA had so far declined to exercise that authority. *Id., at 54* (memorandum to Carol M. Browner, Administrator (Apr. 10, 1998) (hereinafter Cannon memorandum)). Cannon's successor, Gary S. Guzy, reiterated that opinion before a congressional committee just [*511] two weeks before the rulemaking petition was filed. See *id., at 61*.

15 Alliance for Sustainable Communities; Applied Power Technologies, Inc.; Bio Fuels America; The California Solar Energy Industries Assn.; Clements Environmental Corp.; Environmental Advocates; Environmental and Energy Study Institute; Friends of the Earth; Full Circle Energy Project, Inc.; The Green Party of Rhode Island; Greenpeace USA; International Center for Technology Assessment; Network for Environmental and Economic Responsibility of the United Church of Christ; New Jersey Environmental Watch; New Mexico Solar Energy Assn.; Oregon Environmental Council; Public Citizen; Solar Energy Industries Assn.; The SUN DAY Campaign. See App. 7-11.

Fifteen months after the petition's submission, EPA requested public comment on "all the issues raised in [the] petition," adding a "particular" request for comments on "any scientific, technical, legal, economic or other aspect of these issues that may be relevant to EPA's consideration of this petition." *66 Fed. Reg. 7486, 7487 (2001)*. EPA received more than 50,000 comments over the next five months. See *68 Fed. Reg. 52924 (2003)*.

Before the close of the comment period, the White House sought "assistance [***264] in identifying the areas in the science of climate change where there are the greatest certainties and uncertainties" from the National Research Council, asking for a response "as soon as possible." App. 213. [**1450] The result was a 2001 report titled Climate Change Science: An Analysis of Some Key Questions (NRC Report), which, drawing heavily on the 1995

IPCC report, concluded that "[g]reenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. Temperatures are, in fact, rising." NRC Report 1.

On September 8, 2003, EPA entered an order denying the rulemaking petition. *68 Fed. Reg. 52922*. The Agency gave two reasons for its decision: (1) that contrary to the opinions of its former general counsels, the *Clean Air Act* does not authorize EPA to issue mandatory regulations to address global climate change, see *id., at 52925-52929*; and (2) that even if the Agency had the authority to set greenhouse gas emission standards, it would be unwise to do so at this time, *id., at 52929-52931*.

In concluding that it lacked statutory authority over greenhouse gases, EPA observed that Congress "was well aware of the global climate change issue when it last comprehensively amended the [*Clean Air Act*] in 1990," yet it declined to adopt a proposed amendment establishing binding [*512] emissions limitations. *Id., at 52926*. Congress instead chose to authorize further investigation into climate change. *Ibid.* (citing §§ 103(g) and *602(e) of the Clean Air Act Amendments of 1990*, 104 Stat. 2652, 2703, *42 U.S.C. §§ 7403(g)(1)* and *7671a(e)*). EPA further reasoned that Congress'"specially tailored solutions to global atmospheric issues," *68 Fed. Reg. 52926* --in particular, its 1990 enactment of a comprehensive scheme to regulate pollutants that depleted the ozone layer, see Title VI, 104 Stat. 2649, *42 U.S.C. §§ 7671-7671q* --counseled against reading the general authorization of *§ 202(a)(1)* to confer regulatory authority over greenhouse gases.

EPA stated that it was "urged on in this view," *68 Fed. Reg. 529*. by this Court's decision in *FDA v. Brown & Williamson Tobacco Corp., 529 U.S. 120, 120 S. Ct. 1291, 146 L. Ed. 2d 121 (2000)*. In that case, relying on "tobacco['s] unique political history," *id., at 159, 120 S. Ct. 1291, 146 L. Ed. 2d 121*, we invalidated the Food and Drug Administration's reliance on its general authority to regulate drugs as a basis for asserting jurisdiction over an "industry constituting a significant portion of the American economy," *ibid.*

EPA reasoned that climate change had its own "political history": Congress designed the original *Clean Air Act* to address *local* air pollutants rather than a substance that "is fairly consistent in its concentration throughout the *world's* atmosphere," *68 Fed. Reg. 52927*; declined in 1990 to enact proposed amendments to force EPA to set carbon dioxide emission standards for motor vehicles, *ibid.* (citing H. R. 5966, 101st Cong., 2d Sess. (1990)); and addressed global climate change in other legislation, *68 Fed. Reg. 52927*. Because of this political history, and because imposing emission limitations on greenhouse gases would have even greater economic and political repercussions than regulating tobacco, EPA was persuaded that it lacked the power to do so. *Id., at 52928*. In essence, EPA concluded that climate change was so important [***265] that unless Congress spoke with exacting specificity, it could not have meant the Agency to address it.

[*513] Having reached that conclusion, EPA believed it followed that greenhouse gases cannot be "air pollutants" within the meaning of the Act. See *ibid.* ("It follows from this conclusion, that [greenhouse gases], as such, are not air pollutants under the [*Clean Air Act's*] regulatory provisions . . ."). The Agency bolstered this conclusion [**1451] by explaining that if carbon dioxide were an air pollutant, the only feasible method of reducing tailpipe emissions would be to improve fuel economy. But because Congress has already created detailed mandatory fuel economy standards subject to Department of Transportation (DOT) administration, the Agency concluded that EPA regulation would either con-

flict with those standards or be superfluous. *Id., at 52929.*

Even assuming that it had authority over greenhouse gases, EPA explained in detail why it would refuse to exercise that authority. The Agency began by recognizing that the concentration of greenhouse gases has dramatically increased as a result of human activities, and acknowledged the attendant increase in global surface air temperatures. *Id., at 52930.* EPA nevertheless gave controlling importance to the NRC Report's statement that a causal link between the two "'cannot be unequivocally established.'" *Ibid.* (quoting NRC Report 17). Given that residual uncertainty, EPA concluded that regulating greenhouse gas emissions would be unwise. *68 Fed. Reg. 52930.*

The Agency furthermore characterized any EPA regulation of motor-vehicle emissions as a "piecemeal approach" to climate change, *id., at 52931*, and stated that such regulation would conflict with the President's "comprehensive approach" to the problem, *ibid.*. That approach involves additional support for technological innovation, the creation of nonregulatory programs to encourage voluntary private-sector reductions in greenhouse gas emissions, and further research on climate change--not actual regulation. *Id., at 52932-52933.* According to EPA, unilateral EPA regulation of motor-vehicle greenhouse gas emissions might also [*514] hamper the President's ability to persuade key developing countries to reduce greenhouse gas emissions. *Id., at 52931.*

III

Petitioners, now joined by intervenor States and local governments, sought review of EPA's order in the United States Court of Appeals for the District of Columbia Circuit.[16] Although each of the three judges on the panel wrote a separate opinion, two judges agreed "that the EPA Administrator properly exercised his discretion under *§ 202(a)(1)* in denying the petition for rule making." *367 U.S. App. D.C. 282, 415 F.3d 50, 58 (2005).* The court therefore denied the petition for review.

16 See *42 U.S.C. § 7607(b)(1)* ("A petition for review of action of the Administrator in promulgating any . . . standard under *section 7521* of this title . . . or final action taken, by the Administrator under this chapter may be filed only in the United States Court of Appeals for the District of Columbia").

In his opinion announcing the court's judgment, Judge Randolph avoided a definitive ruling as to petitioners' standing, *id., at 56*, reasoning that it was permissible to proceed to the merits because the standing and the merits inquiries "overlap[ped]," [***266] *ibid.* Assuming without deciding that the statute authorized the EPA Administrator to regulate greenhouse gas emissions that "in his judgment" may "reasonably be anticipated to endanger public health or welfare," *42 U.S.C. § 7521(a)(1)*, Judge Randolph concluded that the exercise of that judgment need not be based solely on scientific evidence, but may also be informed by the sort of policy judgments that motivate congressional action. *415 F.3d at 58.* Given that framework, it was reasonable for EPA to base its decision on scientific uncertainty as well as on other factors, including the concern that unilateral regulation of U. S. motor-vehicle emissions could weaken efforts to reduce [**1452] greenhouse gas emissions from other countries. *Ibid.*

Judge Sentelle wrote separately because he believed petitioners failed to "demonstrat[e] the element of injury necessary [*515] to establish standing under *Article III.*" *Id., at 59* (opinion dissenting in part and concurring in judgment). In his view, they had alleged that global warming is "harmful to humanity at large," but could not allege "particularized injuries" to themselves. *Id., at 60* (citing *Lujan v. Defenders of Wildlife, 504 U.S. 555, 562,*

112 S. Ct. 2130, 119 L. Ed. 2d 351 (1992)). While he dissented on standing, however, he accepted the contrary view as the law of the case and joined Judge Randolph's judgment on the merits as the closest to that which he preferred. *415 F.3d at 60-61*.

Judge Tatel dissented. Emphasizing that EPA nowhere challenged the factual basis of petitioners' affidavits, *id., at 66*, he concluded that at least Massachusetts had "satisfied each element of *Article III* standing--injury, causation, and redressability," *id., at 64*. In Judge Tatel's view, the "'substantial probability,'" *id., at 66*, that projected rises in sea level would lead to serious loss of coastal property was a "far cry" from the kind of generalized harm insufficient to ground *Article III* jurisdiction. *Id., at 65*. He found that petitioners' affidavits more than adequately supported the conclusion that EPA's failure to curb greenhouse gas emissions contributed to the sea level changes that threatened Massachusetts' coastal property. *Ibid.* As to redressability, he observed that one of petitioners' experts, a former EPA climatologist, stated that "'[a]chievable reductions in emissions of CO [2] and other [greenhouse gases] from U. S. motor vehicles would . . . delay and moderate many of the adverse impacts of global warming.'" *Ibid.* (quoting declaration of Michael MacCracken, former Executive Director, U. S. Global Change Research Program P 5(e) (hereinafter MacCracken Decl.), available in 2 Petitioners' Standing Appendix in No. 03-1361 etc. (CADC), p 209 (Stdg. App.)). He further noted that the one-time director of EPA's motor-vehicle pollution control efforts stated in an affidavit that enforceable emission standards would lead to the development of new technologies that "'would gradually be mandated by other countries around [*516] the world.'" *415 F.3d at 66* (quoting declaration of Michael Walsh PP 7-8, 10, Stdg. App. 309-310, 311). On the merits, Judge Tatel explained at length why he believed the text of the statute provided EPA with authority to regulate greenhouse gas emissions, and why its policy concerns did not justify its refusal to exercise that authority. *415 F.3d at 67-82*.

IV

[***LEdHR4] *Article III of the Constitution* [***267] limits federal-court jurisdiction to "Cases" and "Controversies." Those two words confine "the business of federal courts to questions presented in an adversary context and in a form historically viewed as capable of resolution through the judicial process." *Flast v. Cohen, 392 U.S. 83, 95, 88 S. Ct. 1942, 20 L. Ed. 2d 947 (1968)*. It is therefore familiar learning that no justiciable "controversy" exists when parties seek adjudication of a political question, *Luther v. Borden, 48 U.S. 1, 7 How. 1, 12 L. Ed. 581 (1849)*, when they ask for an advisory opinion, *Hayburn's Case, 2 U.S. 409, 2 Dall. 409, 1 L. Ed. 436 (1792)*, see also *Clinton v. Jones, 520 U.S. 681, 700, n. 33, 117 S. Ct. 1636, 137 L. Ed. 2d 945 (1997)*, or when the question sought to be adjudicated has been mooted by subsequent developments, *California v. San Pablo & Tulare R. Co., 149 U.S. 308, 13 S. Ct. 876, 37 L. Ed. 747 (1893)*. This case suffers from none of these defects.

[***LEdHR1A] [***LEdHR5] [5] [***LEdHR6] [6] [**1453] The parties' dispute turns on the proper construction of a congressional statute, a question eminently suitable to resolution in federal court. Congress has moreover authorized this type of challenge to EPA action. See *42 U.S.C. § 7607(b)(1)*. That authorization is of critical importance to the standing inquiry: "Congress has the power to define injuries and articulate chains of causation that will give rise to a case or controversy where none existed before." *Lujan, 504 U.S., at 580, 112 S. Ct. 2130, 119 L. Ed. 2d 351* (Kennedy, J., concurring in part and concurring in judgment). "In exercising this power, however, Congress must at the very least identify the injury it seeks to vindicate and relate the injury to the class of persons entitled to bring suit." *Ibid.* We will not, therefore,

"entertain citizen [*517] suits to vindicate the public's nonconcrete interest in the proper administration of the laws." *Id., at 581, 112 S. Ct. 2130, 119 L. Ed. 2d 351.*

[***LEdHR7] [7] EPA maintains that because greenhouse gas emissions inflict widespread harm, the doctrine of standing presents an insuperable jurisdictional obstacle. We do not agree. At bottom, "the gist of the question of standing" is whether petitioners have "such a personal stake in the outcome of the controversy as to assure that concrete adverseness which sharpens the presentation of issues upon which the court so largely depends for illumination." *Baker v. Carr, 369 U.S. 186, 204, 82 S. Ct. 691, 7 L. Ed. 2d 663 (1962).* As Justice Kennedy explained in his *Lujan* concurrence:

> "While it does not matter how many persons have been injured by the challenged action, the party bringing suit must show that the action injures him in a concrete and personal way. This requirement is not just an empty formality. It preserves the vitality of the adversarial process by assuring both that the parties before the court have an actual, as opposed to professed, stake in the outcome, and that the legal questions presented . . . will be resolved, not in the rarified atmosphere of a debating society, but in a concrete factual context conducive to a realistic appreciation of the consequences of judicial action." *504 U.S., at 581, 112 S. Ct. 2130, 119 L. Ed. 2d 351* (internal quotation marks omitted).

[***LEdHR8] [8] [***LEdHR9] [9] To ensure the proper adversarial presentation, *Lujan* holds that a litigant must demonstrate that it has suffered a concrete and particularized injury that is either actual or imminent, that the injury is fairly [***268] traceable to the defendant, and that it is likely that a favorable decision will redress that injury. See *id., at 560-561, 112 S. Ct. 2130, 119 L. Ed. 2d 351.* However, a litigant to whom Congress has "accorded a procedural right to protect his concrete interests," *id., at 572, n. 7, 112 S. Ct. 2130, 119 L. Ed. 2d 351* --here, the right to challenge agency action unlawfully withheld, *§ 7607(b)(1)* --"can assert that right without meeting all the normal standards for redressability [*518] and immediacy," *ibid.* When a litigant is vested with a procedural right, that litigant has standing if there is some possibility that the requested relief will prompt the injury-causing party to reconsider the decision that allegedly harmed the litigant. *Ibid.;* see also *Sugar Cane Growers Cooperative of Fla. v. Veneman, 351 U.S. App. D.C. 214, 289 F.3d 89, 94-95 (CADC 2002)* ("A [litigant] who alleges a deprivation of a procedural protection to which he is entitled never has to prove that if he had received the procedure the substantive result would have been altered. All that is necessary is to show that the procedural step was connected to the substantive result").

[***LEdHR1A] Only one of the petitioners needs to have standing to permit us to consider the petition for review. See *Rumsfeld v. Forum for Academic and Institutional Rights, Inc., 547 U.S. 47, 52, n. 2, 126 S. Ct.* [**1454] *1297, 164 L. Ed. 2d 156 (2006).* We stress here, as did Judge Tatel below, the special position and interest of Massachusetts. It is of considerable relevance that the party seeking review here is a sovereign State and not, as it was in *Lujan*, a private individual.

[***LEdHR10] [10] Well before the creation of the modern administrative state, we recognized that States are not normal litigants for the purposes of invoking federal jurisdiction. As Justice Holmes explained in *Georgia*

v. Tennessee Copper Co., 206 U.S. 230, 237, 27 S. Ct. 618, 51 L. Ed. 1038 (1907), a case in which Georgia sought to protect its citizens from air pollution originating outside its borders:

> "The case has been argued largely as if it were one between two private parties; but it is not. The very elements that would be relied upon in a suit between fellow-citizens as a ground for equitable relief are wanting here. The State owns very little of the territory alleged to be affected, and the damage to it capable of estimate in money, possibly, at least, is small. This is a suit by a State for an injury to it in its capacity of *quasi*-sovereign. In that capacity the State has an interest independent of and behind the titles of its citizens, [*519] in all the earth and air within its domain. It has the last word as to whether its mountains shall be stripped of their forests and its inhabitants shall breathe pure air."

Just as Georgia's independent interest "in all the earth and air within its domain" supported federal jurisdiction a century ago, so too does Massachusetts' well-founded desire to preserve its sovereign territory today. Cf. *Alden v. Maine, 527 U.S. 706, 715, 119 S. Ct. 2240, 144 L. Ed. 2d 636 (1999)* (observing that in the federal system, the States "are not relegated to the role of mere provinces or political corporations, but retain the dignity, though not the full authority, of sovereignty"). That Massachusetts does in fact own a great deal of the "territory alleged to be affected" only reinforces the conclusion that its stake in the outcome of this case is sufficiently concrete to warrant the exercise of federal judicial power.

[***269] When a State enters the Union, it surrenders certain sovereign prerogatives. Massachusetts cannot invade Rhode Island to force reductions in greenhouse gas emissions, it cannot negotiate an emissions treaty with China or India, and in some circumstances the exercise of its police powers to reduce in-state motor-vehicle emissions might well be pre-empted. See *Alfred L. Snapp & Son, Inc. v. Puerto Rico ex rel. Barez, 458 U.S. 592, 607, 102 S. Ct. 3260, 73 L. Ed. 2d 995 (1982)* ("One helpful indication in determining whether an alleged injury to the health and welfare of its citizens suffices to give the State standing to sue *parens patriae* is whether the injury is one that the State, if it could, would likely attempt to address through its sovereign lawmaking powers").

These sovereign prerogatives are now lodged in the Federal Government, and Congress has ordered EPA to protect Massachusetts (among others) by prescribing standards applicable to the "emission of any air pollutant from any class or classes of new motor vehicle engines, which in [the Administrator's] judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public [*520] health or welfare." *42 U.S.C. § 7521(a)(1)*. Congress has moreover recognized a concomitant procedural right to challenge the rejection of its rulemaking petition as arbitrary and capricious. *§ 7607(b)(1)*. Given that procedural right and Massachusetts' stake in protecting its quasi-sovereign interests, the Commonwealth [**1455] is entitled to special solicitude in our standing analysis.[17]

17 The Chief Justice accuses the Court of misreading *Georgia v. Tennessee Copper Co., 206 U.S. 230, 27 S. Ct. 618, 51 L. Ed. 1038 (1907)*, see *post, at 537-538, 167 L. Ed. 2d, at 280* (dissenting opinion), and "devis[ing] a new doctrine of state standing," *post, at 548, 167 L. Ed. 2d, at 287*. But no less an authority than Hart & Wechsler's The Federal

Courts and the Federal System understands *Tennessee Copper* as a standing decision. R. Fallon, D. Meltzer, & D. Shapiro, Hart & Wechsler's The Federal Courts and the Federal System 290 (5th ed. 2003). Indeed, it devotes an entire section to chronicling the long development of cases permitting States "to litigate as *parens patriae* to protect quasi-sovereign interests--*i.e.*, public or governmental interests that concern the state as a whole." *Id., at 289*; see, *e.g., Missouri v. Illinois, 180 U.S. 208, 240-241, 21 S. Ct. 331, 45 L. Ed. 497 (1901)* (finding federal jurisdiction appropriate not only "in cases involving boundaries and jurisdiction over lands and their inhabitants, and in cases directly affecting the property rights and interests of a State," but also when the "substantial impairment of the health and prosperity of the towns and cities of the state" are at stake).

Drawing on *Massachusetts v. Mellon, 262 U.S. 447, 43 S. Ct. 597, 67 L. Ed. 1078 (1923)*, and *Alfred L. Snapp & Son, Inc. v. Puerto Rico ex rel. Barez, 458 U.S. 592, 102 S. Ct. 3260, 73 L. Ed. 2d 995 (1982)* (citing *Missouri v. Illinois, 180 U.S. 208, 21 S. Ct. 331, 45 L. Ed. 497 (1901))*, The Chief Justice claims that we "overloo[k] the fact that our cases cast significant doubt on a State's standing to assert a quasi-sovereign interest . . . against the Federal Government." *Post, at 539, 167 L. Ed. 2d, at 281*. Not so. Mellon itself disavowed any such broad reading when it noted that the Court had been "called upon to adjudicate, not rights of person or property, not rights of dominion over physical domain, [and] not quasi sovereign rights actually invaded or threatened." *262 U.S., at 484-485, 43 S. Ct. 597, 67 L. Ed. 1078* (emphasis added). In any event, we held in *Georgia v. Pennsylvania R. Co., 324 U.S. 439, 447, 65 S. Ct. 716, 89 L. Ed. 1051 (1945)*, that there is a critical difference between allowing a State "to protect her citizens from the operation of federal statutes" (which is what Mellon prohibits) and allowing a State to assert its rights under federal law (which it has standing to do). Massachusetts does not here dispute that the *Clean Air Act* applies to its citizens; it rather seeks to assert its rights under the Act. See also *Nebraska v. Wyoming, 515 U.S. 1, 20, 115 S. Ct. 1933, 132 L. Ed. 2d 1 (1995)* (holding that Wyoming had standing to bring a cross-claim against the United States to vindicate its "'quasi-sovereign' interests which are 'independent of and behind the titles of its citizens, in all the earth and air within its domain'" (quoting *Tennessee Copper, 206 U.S., at 237, 27 S. Ct. 618, 51 L. Ed. 1038*)).

[*521] [***LEdHR1A] With that in mind, it is clear that petitioners' submissions as they pertain to Massachusetts have satisfied the most demanding standards of [***270] the adversarial process. EPA's steadfast refusal to regulate greenhouse gas emissions presents a risk of harm to Massachusetts that is both "actual" and "imminent." *Lujan, 504 U.S., at 560, 112 S. Ct. 2130, 119 L. Ed. 2d 351* (internal quotation marks omitted). There is, moreover, a "substantial likelihood that the judicial relief requested" will prompt EPA to take steps to reduce that risk. *Duke Power Co. v. Carolina Environmental Study Group, Inc., 438 U.S. 59, 79, 98 S. Ct. 2620, 57 L. Ed. 2d 595 (1978).*

The Injury

[***LEdHR11] [11] The harms associated with climate change are serious and well recognized. Indeed, the NRC Report itself--which EPA regards as an "objective and independent assessment of the relevant science," *68 Fed. Reg. 52930* --identifies a number of environmental changes that have already inflicted significant harms, including "the glob-

al retreat of mountain glaciers, reduction in snow-cover extent, the earlier spring melting of ice on rivers and lakes, [and] the accelerated rate of rise of sea levels during the 20th century relative to the past few thousand years . . . ." NRC Report 16.

Petitioners allege that this only hints at the environmental damage yet to come. According to the climate scientist Michael [**1456] MacCracken, "qualified scientific experts involved in climate change research" have reached a "strong consensus" that global warming threatens (among other things) a precipitate rise in sea levels by the end of the century, MacCracken Decl. P 5, Stdg. App. 207, "severe and irreversible changes to natural ecosystems," *id., P 5(d), at 209*, a "significant reduction in water storage in winter snowpack in mountainous regions with direct and important economic consequences," *ibid.*, and an increase in the spread of disease, *id., P 28, at 218-219*. He also observes that rising ocean temperatures [*522] may contribute to the ferocity of hurricanes. *Id., PP 23-25, at 216-217*.[18]

18 In this regard, MacCracken's 2004 affidavit--drafted more than a year in advance of Hurricane Katrina--was eerily prescient. Immediately after discussing the "particular concern" that climate change might cause an "increase in the wind speed and peak rate of precipitation of major tropical cyclones (i.e., hurricanes and typhoons)," MacCracken noted that "[s]oil compaction, sea level rise and recurrent storms are destroying approximately 20-30 square miles of Louisiana wetlands each year. These wetlands serve as a 'shock absorber' for storm surges that could inundate New Orleans, significantly enhancing the risk to a major urban population." PP 24-25, Stdg. App. 217.

That these climate-change risks are "widely shared" does not minimize Massachusetts' interest in the outcome of this litigation. See *Federal Election Comm'n v. Akins, 524 U.S. 11, 24,118 S. Ct. 1777, 141 L. Ed. 2d 10 (1998)* ("[W]here a harm is concrete, though widely shared, the Court has found 'injury in fact'"). According to petitioners' unchallenged affidavits, global sea levels rose somewhere between 10 and 20 centimeters over the 20th century as a result of global warming. MacCracken Decl. P 5(c), Stdg. App. 208. These rising seas have already begun to swallow Massachusetts' coastal land. *Id., at 196* (declaration of Paul H. Kirshen P 5), 216 (MacCracken Decl. P 23). Because the Commonwealth "owns a substantial portion of the state's coastal property," *id., at 171* (declaration of Karst R. Hoogeboom [***271] P 4),[19] it has alleged a particularized injury in its capacity as a landowner. The severity of that injury will [*523] only increase over the course of the next century: If sea levels continue to rise as predicted, one Massachusetts official believes that a significant fraction of coastal property will be "either permanently lost through inundation or temporarily lost through periodic storm surge and flooding events." *Id.,* P 6, at 172.[20] Remediation costs alone, petitioners allege, could run well into the hundreds of millions of dollars. *Id.,* P 7, at 172; see also Kirshen Decl. P 12, at 198.[21]

19 "For example, the [Massachusetts Department of Conservation and Recreation] owns, operates and maintains approximately 53 coastal state parks, beaches, reservations, and wildlife sanctuaries. [It] also owns, operates and maintains sporting and recreational facilities in coastal areas, including numerous pools, skating rinks, playgrounds, playing fields, former coastal fortifications, public stages, museums, bike trails, tennis courts, boathouses and boat ramps and landings. Associated with these coastal properties and facilities is a sig-

nificant amount of infrastructure, which the Commonwealth also owns, operates and maintains, including roads, parkways, stormwater pump stations, pier[s], sea wal[l] revetments and dams." Hoogeboom Decl. P 4, at 171.

20 See also *id., at 179* (declaration of Christian Jacqz) (discussing possible loss of roughly 14 acres of land per miles of coastline by 2100); Kirshen Decl. P 10, at 198 (alleging that "[w]hen such a rise in sea level occurs, a 10-year flood will have the magnitude of the present 100-year flood and a 100-year flood will have the magnitude of the present 500-year flood").

21 In dissent, The Chief Justice dismisses petitioners' submissions as "conclusory," presumably because they do not quantify Massachusetts' land loss with the exactitude he would prefer. *Post, at 542, 167 L. Ed. 2d, at 283.* He therefore asserts that the Commonwealth's injury is "conjectur[al]." See *ibid.* Yet the likelihood that Massachusetts' coastline will recede has nothing to do with whether petitioners have determined the precise metes and bounds of their soon-to-be-flooded land. Petitioners maintain that the seas are rising and will continue to rise, and have alleged that such a rise will lead to the loss of Massachusetts' sovereign territory. No one, save perhaps the dissenters, disputes those allegations. Our cases require nothing more.

[**1457] *Causation*

EPA does not dispute the existence of a causal connection between manmade greenhouse gas emissions and global warming. At a minimum, therefore, EPA's refusal to regulate such emissions "contributes" to Massachusetts' injuries.

EPA nevertheless maintains that its decision not to regulate greenhouse gas emissions from new motor vehicles contributes so insignificantly to petitioners' injuries that the Agency cannot be haled into federal court to answer for them. For the same reason, EPA does not believe that any realistic possibility exists that the relief petitioners seek would mitigate global climate change and remedy their injuries. That is especially so because predicted increases in greenhouse [*524] gas emissions from developing nations, particularly China and India, are likely to offset any marginal domestic decrease.

But EPA overstates its case. Its argument rests on the erroneous assumption that a small incremental step, because it is incremental, can never be attacked in a federal judicial forum. Yet accepting that premise would doom most challenges to regulatory action. Agencies, like legislatures, do not generally resolve massive problems in one fell regulatory swoop. See *Williamson v. Lee Optical of Okla., Inc., 348 U.S. 483, 489, 75 S. Ct. 461, 99 L. Ed. 563 (1955)* ("[A] reform may take one step at a time, addressing itself to the phase of the problem which seems most acute to [***272] the legislative mind"). They instead whittle away at them over time, refining their preferred approach as circumstances change and as they develop a more nuanced understanding of how best to proceed. Cf. *SEC v. Chenery Corp., 332 U.S. 194, 202, 67 S. Ct. 1575, 91 L. Ed. 1995 (1947)* ("Some principles must await their own development, while others must be adjusted to meet particular, unforeseeable situations"). That a first step might be tentative does not by itself support the notion that federal courts lack jurisdiction to determine whether that step conforms to law.

And reducing domestic automobile emissions is hardly a tentative step. Even leaving aside the other greenhouse gases, the United States transportation sector emits an enormous quantity of carbon dioxide into the atmosphere--according to the MacCracken affidavit, more than 1.7 billion metric tons in 1999 alone.

P 30, Stdg. App. 219. That accounts for more than 6% of worldwide carbon dioxide emissions. *Id., at 232 (Oppenheimer Decl. P 3)*; see also MacCracken Decl. P 31, at 220. To put this in perspective: Considering just emissions from the transportation sector, which represent less than one-third of this country's total carbon dioxide emissions, the United States would still rank as the third-largest emitter of carbon dioxide in the world, [*525] outpaced only by the European Union and China.[22] Judged by any [**1458] standard, U. S. motor-vehicle emissions make a meaningful contribution to greenhouse gas concentrations and hence, according to petitioners, to global warming.

22 See UNFCCC, National Greenhouse Gas Inventory Data for the Period 1990-2004 and Status of Reporting 14 (2006) (reflecting emissions from Annex I countries); UNFCCC, Sixth Compilation and Synthesis of Initial National Communications from Parties not Included in Annex I to the Convention 7-8 (2005) (reflecting emissions from non-Annex I countries); see also Dept. of Energy, Energy Information Admin., International Energy Annual 2004, H.1co2 World Carbon Dioxide Emissions from the Consumption and Flaring of Fossil Fuels, 1980-2004 (Table), http://www.eia.doe.gov/pub/international/iealf/tableh1co2.xls.

The Remedy

While it may be true that regulating motor-vehicle emissions will not by itself *reverse* global warming, it by no means follows that we lack jurisdiction to decide whether EPA has a duty to take steps to *slow* or *reduce* it. See also *Larson v. Valente, 456 U.S. 228, 244, n. 15, 102 S. Ct. 1673, 72 L. Ed. 2d 33 (1982)* ("[A] plaintiff satisfies the redressability requirement when he shows that a favorable decision will relieve a discrete injury to himself. He need not show that a favorable decision will relieve his *every* injury"). Because of the enormity of the potential consequences associated with manmade climate change, the fact that the effectiveness of a remedy might be delayed during the (relatively short) time it takes for a new motor-vehicle fleet to replace an older one is essentially irrelevant.[23] Nor is it dispositive that developing countries such as China and India are poised to increase greenhouse gas emissions [*526] substantially over the next century: A reduction in domestic [***273] emissions would slow the pace of global emissions increases, no matter what happens elsewhere.

23 See also *Mountain States Legal Foundation v. Glickman, 320 U.S. App. D.C. 87, 92 F.3d 1228, 1234 (CADC 1996)* ("The more drastic the injury that government action makes more likely, the lesser the increment in probability to establish standing"); *Village of Elk Grove Village v. Evans, 997 F.2d 328, 329 (CA7 1993)* ("[E]ven a small probability of injury is sufficient to create a case or controversy--to take a suit out of the category of the hypothetical--provided of course that the relief sought would, if granted, reduce the probability").

We moreover attach considerable significance to EPA's "agree[ment] with the President that 'we must address the issue of global climate change,'" *68 Fed. Reg. 52929* (quoting remarks announcing Clear Skies and Global Climate Initiatives, 2002 Public Papers of George W. Bush, Vol. 1, Feb. 14, p 227 (2004)), and to EPA's ardent support for various voluntary emission-reduction programs, *68 Fed. Reg. 52932*. As Judge Tatel observed in dissent below, "EPA would presumably not bother with such efforts if it thought emissions reductions would have no discernable impact on future global warming." *415 F.3d at 66*.

[***LEdHR1A] In sum--at least according to petitioners' uncontested affidavits--the rise in sea levels associated with global warming has already harmed and will continue to harm Massachusetts. The risk of catastrophic harm, though remote, is nevertheless real. That risk would be reduced to some extent if petitioners received the relief they seek. We therefore hold that petitioners have standing to challenge EPA's denial of their rulemaking petition.[24]

24 In his dissent, The Chief Justice expresses disagreement with the Court's holding in *United States v. Students Challenging Regulatory Agency Procedures (SCRAP), 412 U.S. 669, 687-688, 93 S. Ct. 2405, 37 L. Ed. 2d 254 (1973)*. He does not, however, disavow this portion of Justice Stewart's opinion for the Court:

"Unlike the specific and geographically limited federal action of which the petitioner complained in *Sierra Club [v. Morton, 405 U.S. 727, 92 S. Ct. 1361, 31 L. Ed. 2d 636 (1972)]*, the challenged agency action in this case is applicable to substantially all of the Nation's railroads, and thus allegedly has an adverse environmental impact on all the natural resources of the country. Rather than a limited group of persons who used a picturesque valley in California, all persons who utilize the scenic resources of the country, and indeed all who breathe its air, could claim harm similar to that alleged by the environmental groups here. But we have already made it clear that standing is not to be denied simply because many people suffer the same injury. Indeed some of the cases on which we relied in Sierra Club demonstrated the patent fact that persons across the Nation could be adversely affected by major governmental actions. To deny standing to persons who are in fact injured simply because many others are also injured, would mean that the most injurious and widespread Government actions could be questioned by nobody. We cannot accept that conclusion." *Ibid.* (citations omitted and emphasis added).

It is moreover quite wrong to analogize the legal claim advanced by Massachusetts and the other public and private entities who challenge EPA's parsimonious construction of the *Clean Air Act* to a mere "lawyer's game." See *post, at 548, 167 L. Ed. 2d, at 286*.

[**1459] [*527] V

[***LEdHR12] [12] The scope of our review of the merits of the statutory issues is narrow. As we have repeated time and again, an agency has broad discretion to choose how best to marshal its limited resources and personnel to carry out its delegated responsibilities. See *Chevron U.S.A. Inc. v. NRDC, 467 U.S. 837, 842-845, 104 S. Ct. 2778, 81 L. Ed. 2d 694 (1984)*. That discretion is at its height when the agency decides not to bring an enforcement action. Therefore, in *Heckler v. Chaney, 470 U.S. 821, 105 S. Ct. 1649, 84 L. Ed. 2d 714 (1985)*, we held that an agency's refusal to initiate enforcement proceedings is not ordinarily subject to judicial review. Some debate remains, however, as to the rigor with which we review an agency's denial of a petition for rulemaking.

There are key differences between a denial of a petition for rulemaking and an agency's decision not to initiate an enforcement action. See [***274] *American Horse Protection Asso. v. Lyng, 258 U.S. App. D.C. 397, 812 F.2d 1, 3-4 (CADC 1987)*. In contrast to nonenforcement decisions, agency refusals to initiate rulemaking "are less frequent, more apt to involve legal as opposed to factual analysis, and subject to special formalities, including a public explanation." *Id., at 4*; see also *5 U.S.C. § 555(e)*. They moreover arise out of denials of

petitions for rulemaking which (at least in the circumstances here) the affected party had an undoubted procedural right to file in the first instance. Refusals to promulgate rules are thus susceptible to judicial review, though such review is "extremely [*528] limited" and "highly deferential." *National Customs Brokers & Forwarders Ass'n. v. United States, 280 U.S. App. D.C. 21, 883 F.2d 93, 96 (CADC 1989).*

[***LEdHR13] [13] EPA concluded in its denial of the petition for rulemaking that it lacked authority under *42 U.S.C. § 7521(a)(1)* to regulate new vehicle emissions because carbon dioxide is not an "air pollutant" as that term is defined in *§ 7602*. In the alternative, it concluded that even if it possessed authority, it would decline to do so because regulation would conflict with other administration priorities. As discussed earlier, the *Clean Air Act* expressly permits review of such an action. *§ 7607(b)(1)*. We therefore "may reverse any such action found to be . . . arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." *§ 7607(d)(9)*.

VI

[***LEdHR2A] On the merits, the first question is whether *§ 202(a)(1)* of the Clean Air Act authorizes EPA to regulate greenhouse gas emissions from new motor vehicles in the event that it forms a "judgment" that such emissions contribute to climate change. We have little trouble concluding that it does. In relevant part, *§ 202(a)(1)* provides that EPA "shall by regulation [**1460] prescribe . . . standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in [the Administrator's] judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare." *42 U.S.C. § 7521(a)(1)*. Because EPA believes that Congress did not intend it to regulate substances that contribute to climate change, the agency maintains that carbon dioxide is not an "air pollutant" within the meaning of the provision.

The statutory text forecloses EPA's reading. The *Clean Air Act's* sweeping definition of "air pollutant" includes "*any* air pollution agent or combination of such agents, including *any* physical, chemical . . . substance or matter which is emitted [*529] into or otherwise enters the ambient air . . . ." *§ 7602(g)* (emphasis added). On its face, the definition embraces all airborne compounds of whatever stripe, and underscores that intent through the repeated use of the word "any."[25] Carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons are without a doubt "physical [and] chemical [***275] . . . substance[s] which [are] emitted into . . . the ambient air." The statute is unambiguous.[26]

25 See *Department of Housing and Urban Development v. Rucker, 535 U.S. 125, 131, 122 S. Ct. 1230, 152 L. Ed. 2d 258 (2002)* (observing that "'any' . . . has an expansive meaning, that is, one or some indiscriminately of whatever kind" (some internal quotation marks omitted)).

26 In dissent, Justice Scalia maintains that because greenhouse gases permeate the world's atmosphere rather than a limited area near the earth's surface, EPA's exclusion of greenhouse gases from the category of air pollution "agent[s]" is entitled to deference under *Chevron U.S.A. Inc. v. NRDC, 467 U.S. 837, 104 S. Ct. 2778, 81 L. Ed. 2d 694 (1984)*. See *post, at 558-560, 167 L. Ed. 2d, at 293*. EPA's distinction, however, finds no support in the text of the statute, which uses the phrase "the ambient air" without distinguishing between atmospheric layers. Moreover, it is a plainly unreasonable reading of a sweeping statutory provision designed to capture "*any* physical, chemical . . . substance or matter which is emitted into or otherwise enters the ambient air." *42 U.S.C. § 7602(g)*.

Justice Scalia does not (and cannot) explain why Congress would define "air pollutant" so carefully and so broadly, yet confer on EPA the authority to narrow that definition whenever expedient by asserting that a particular substance is not an "agent." At any rate, no party to this dispute contests that greenhouse gases both "ente[r] the ambient air" and tend to warm the atmosphere. They are therefore unquestionably "agent[s]" of air pollution.

Rather than relying on statutory text, EPA invokes postenactment congressional actions and deliberations it views as tantamount to a congressional command to refrain from regulating greenhouse gas emissions. Even if such postenactment legislative history could shed light on the meaning of an otherwise-unambiguous statute, EPA never identifies any action remotely suggesting that Congress meant to curtail its power to treat greenhouse gases as air pollutants. That subsequent Congresses have eschewed enacting binding [*530] emissions limitations to combat global warming tells us nothing about what Congress meant when it amended *§ 202(a)(1)* in 1970 and 1977.[27] And unlike EPA, we have no difficulty reconciling Congress' various efforts to promote interagency collaboration and research to better understand [**1461] climate change[28] with the Agency's pre-existing mandate to regulate "any air pollutant" that may endanger the public welfare. See *42 U.S.C. § 7601(a)(1)*. Collaboration and research do not conflict with any thoughtful regulatory effort; they complement it.[29]

27 See *United States v. Price, 361 U.S. 304, 313, 80 S. Ct. 326, 4 L. Ed. 2d 334, 1960-1 C.B. 701 (1960)* (holding that "the views of a subsequent Congress form a hazardous basis for inferring the intent of an earlier one"); see also *Cobell v. Norton, 368 U.S. App. D.C. 249, 428 F.3d 1070, 1075 (CADC 2005)* ("[P]ost-enactment legislative history is not only oxymoronic but inherently entitled to little weight").

28 See, *e.g.*, National Climate Program Act, § 5, 92 Stat. 601, *15 U.S.C. § 2901 et seq.* (calling for the establishment of a National Climate Program and for additional climate change research); Global Climate Protection Act of 1987, § 1103, 101 Stat. 1408-1409, note following *15 U.S.C. § 2901* (directing EPA and the Secretary of State to "jointly" develop a "coordinated national policy on global climate change" and report to Congress); *Global Change Research Act of 1990*, Tit. I, 104 Stat. 3097, *15 U.S.C. §§ 2921-2938* (establishing for the "development and coordination of a comprehensive and integrated United States research program" to aid in "understand[ing] . . . human-induced and natural processes of climate change"); Global Climate Change Prevention Act of 1990, 104 Stat. 4058, *7 U.S.C. § 6701 et seq.* (directing the Dept. of Agriculture to study the effects of climate change on forestry and agriculture); Energy Policy Act of 1992, §§ 1601-1609, 106 Stat. 2999, *42 U.S.C. §§ 13381-13388* (requiring the Secretary of Energy to report on information pertaining to climate change).

29 We are moreover puzzled by EPA's roundabout argument that because later Congresses chose to address stratospheric ozone pollution in a specific legislative provision, it somehow follows that greenhouse gases cannot be air pollutants within the meaning of the *Clean Air Act*.

EPA's reliance on *Brown & Williamson Tobacco Corp., 529 U.S. 120, 120 S. Ct. 1291, 146 L. Ed. 2d 121*, is similarly misplaced. In holding that [***276] tobacco products are not "drugs" or "devices" subject to Food and Drug Administration (FDA) regulation pursuant to the Food, Drug and Cosmetic Act

(FDCA), see *529 U.S., at 133, 120 S. Ct. 1291, 146 L. Ed. 2d 121*, we [*531] found critical at least two considerations that have no counterpart in this case.

First, we thought it unlikely that Congress meant to ban tobacco products, which the FDCA would have required had such products been classified as "drugs" or "devices." *Id., at 135-137, 120 S. Ct. 1291, 146 L. Ed. 2d 121*. Here, in contrast, EPA jurisdiction would lead to no such extreme measures. EPA would only *regulate* emissions, and even then, it would have to delay any action "to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance," *§ 7521(a)(2)*. However much a ban on tobacco products clashed with the "common sense" intuition that Congress never meant to remove those products from circulation, *Brown & Williamson, 529 U.S., at 133, 120 S. Ct. 1291, 146 L. Ed. 2d 121*, there is nothing counterintuitive to the notion that EPA can curtail the emission of substances that are putting the global climate out of kilter.

Second, in *Brown & Williamson* we pointed to an unbroken series of congressional enactments that made sense only if adopted "against the backdrop of the FDA's consistent and repeated statements that it lacked authority under the FDCA to regulate tobacco." *Id., at 144, 120 S. Ct. 1291, 146 L. Ed. 2d 121*. We can point to no such enactments here: EPA has not identified any congressional action that conflicts in any way with the regulation of greenhouse gases from new motor vehicles. Even if it had, Congress could not have acted against a regulatory "backdrop" of disclaimers of regulatory authority. Prior to the order that provoked this litigation, EPA had never disavowed the authority to regulate greenhouse gases, and in 1998 it in fact affirmed that it *had* such authority. See App. 54 (Cannon memorandum). There is no reason, much less a compelling reason, to accept EPA's invitation to read ambiguity into a clear statute.

EPA finally argues that it cannot regulate carbon dioxide emissions from [**1462] motor vehicles because doing so would require it to tighten mileage standards, a job (according to [*532] EPA) that Congress has assigned to DOT. See *68 Fed. Reg. 52929*. But that DOT sets mileage standards in no way licenses EPA to shirk its environmental responsibilities. EPA has been charged with protecting the public's "health" and "welfare," *42 U.S.C. § 7521(a)(1)*, a statutory obligation wholly independent of DOT's mandate to promote energy efficiency. See Energy Policy and Conservation Act, § 2(5), 89 Stat. 874, *42 U.S.C. § 6201(5)*. The two obligations may overlap, but there is no reason to think the two agencies cannot both administer their obligations and yet avoid inconsistency.

While the Congresses that drafted *§ 202(a)(1)* might not have appreciated the possibility that burning fossil fuels could lead to global warming, they did understand that without regulatory flexibility, changing circumstances and scientific developments would soon render the *Clean Air Act* obsolete. The broad language of *§ 202(a)(1)* reflects an intentional effort to confer the flexibility necessary to forestall such obsolescence. See *Pennsylvania Dep't of Corrections v. Yeskey, 524 U.S. 206, 212, 118 S.* [***277] *Ct. 1952, 141 L. Ed. 2d 215 (1998)* ("[T]he fact that a statute can be applied in situations not expressly anticipated by Congress does not demonstrate ambiguity. It demonstrates breadth" (internal quotation marks omitted)). Because greenhouse gases fit well within the *Clean Air Act's* capacious definition of "air pollutant," we hold that EPA has the statutory authority to regulate the emission of such gases from new motor vehicles.

VII

[***LEdHR3A] The alternative basis for EPA's decision--that even if it does have statutory authority to regulate greenhouse gases, it would be unwise to do so at this

time--rests on reasoning divorced from the statutory text. While the statute does condition the exercise of EPA's authority on its formation of a "judgment," *42 U.S.C. § 7521(a)(1)*, that judgment must relate to whether an air pollutant "cause[s], or contribute[s] to, air pollution which may reasonably be anticipated to endanger [*533] public health or welfare," *ibid.* Put another way, the use of the word "judgment" is not a roving license to ignore the statutory text. It is but a direction to exercise discretion within defined statutory limits.

If EPA makes a finding of endangerment, the *Clean Air Act* requires the Agency to regulate emissions of the deleterious pollutant from new motor vehicles. *Ibid.* (stating that "[EPA] shall by regulation prescribe . . . standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles"). EPA no doubt has significant latitude as to the manner, timing, content, and coordination of its regulations with those of other agencies. But once EPA has responded to a petition for rulemaking, its reasons for action or inaction must conform to the authorizing statute. Under the clear terms of the *Clean Air Act*, EPA can avoid taking further action only if it determines that greenhouse gases do not contribute to climate change or if it provides some reasonable explanation as to why it cannot or will not exercise its discretion to determine whether they do. *Ibid.* To the extent that this constrains agency discretion to pursue other priorities of the Administrator or the President, this is the congressional design.

EPA has refused to comply with this clear statutory command. Instead, it has offered a laundry list of reasons not to regulate. For example, EPA said that a number of voluntary Executive Branch programs already provide an effective response to the threat of global warming, *68 Fed. Reg. 52932,* [**1463] that regulating greenhouse gases might impair the President's ability to negotiate with "key developing nations" to reduce emissions, *id., at 52931*, and that curtailing motor-vehicle emissions would reflect "an inefficient, piecemeal approach to address the climate change issue," *ibid.*

[***LEdHR3A] [***LEdHR14] [14] Although we have neither the expertise nor the authority to evaluate these policy judgments, it is evident they have nothing to do with whether greenhouse gas emissions contribute to climate change. Still less do they amount to a [*534] reasoned justification for declining to form a scientific judgment. In particular, while the President has broad authority in foreign affairs, that authority does not extend to the refusal to execute domestic laws. In the *Global Climate Protection Act of 1987*, Congress authorized the State Department--not EPA--to formulate United States foreign policy with reference to environmental [***278] matters relating to climate. See § 1103(c), 101 Stat. 1409. EPA has made no showing that it issued the ruling in question here after consultation with the State Department. Congress did direct EPA to consult with other agencies in the formulation of its policies and rules, but the State Department is absent from that list. § 1103(b).

[***LEdHR3A] Nor can EPA avoid its statutory obligation by noting the uncertainty surrounding various features of climate change and concluding that it would therefore be better not to regulate at this time. See *68 Fed. Reg. 52930*-52931. If the scientific uncertainty is so profound that it precludes EPA from making a reasoned judgment as to whether greenhouse gases contribute to global warming, EPA must say so. That EPA would prefer not to regulate greenhouse gases because of some residual uncertainty--which, contrary to Justice Scalia's apparent belief, *post, at 553-555, 167 L. Ed. 2d, at 290-291*, is in fact all that it said, see *68 Fed. Reg. 52929* ("We do not believe . . . that it would be either effective or appropriate for EPA *to establish [greenhouse gas] standards for motor vehicles* at this time" (emphasis added))--is irrelevant. The statutory question is

whether sufficient information exists to make an endangerment finding.

[***LEdHR3A] [***LEdHR15] [15] In short, EPA has offered no reasoned explanation for its refusal to decide whether greenhouse gases cause or contribute to climate change. Its action was therefore "arbitrary, capricious, . . . or otherwise not in accordance with law." *42 U.S.C. § 7607(d)(9)(A)*. We need not and do not reach the question whether on remand EPA must make an endangerment finding, or whether policy concerns can inform [*535] EPA's actions in the event that it makes such a finding. Cf. *Chevron U.S.A. Inc. v. NRDC, 467 U.S. 837, at 843-844, 104 S. Ct. 2778, 81 L. Ed. 2d 694 (1984)*. We hold only that EPA must ground its reasons for action or inaction in the statute.

VIII

The judgment of the Court of Appeals is reversed, and the case is remanded for further proceedings consistent with this opinion.

It is so ordered.

DISSENT BY: ROBERTS; SCALIA

DISSENT

Chief Justice **Roberts**, with whom Justice **Scalia,** Justice **Thomas,** and Justice **Alito** join, dissenting.

Global warming may be a "crisis," even "the most pressing environmental problem of our time." Pet. for Cert. 26, 22. Indeed, it may ultimately affect nearly everyone on the planet in some potentially adverse way, and it may be that governments have done too little to address it. It is not a problem, however, that has escaped the attention of policymakers in the Executive [**1464] and Legislative Branches of our Government, who continue to consider regulatory, legislative, and treaty-based means of addressing global climate change.

Apparently dissatisfied with the pace of progress on this issue in the elected branches, petitioners have come to the courts claiming broad-ranging injury, and attempting to tie that injury to the Government's alleged failure to comply with a rather narrow statutory provision. I would [***279] reject these challenges as nonjusticiable. Such a conclusion involves no judgment on whether global warming exists, what causes it, or the extent of the problem. Nor does it render petitioners without recourse. This Court's standing jurisprudence simply recognizes that redress of grievances of the sort at issue here "is the function of Congress and the Chief Executive," not the federal courts. *Lujan v. Defenders of Wildlife, 504 U.S. 555, 576, 112 S. Ct. 2130, 119 L. Ed. 2d 351 (1992)*. I would vacate the judgment [*536] below and remand for dismissal of the petitions for review.

I

Article III, § 2, of the Constitution limits the federal judicial power to the adjudication of "Cases" and "Controversies." "If a dispute is not a proper case or controversy, the courts have no business deciding it, or expounding the law in the course of doing so." *DaimlerChrysler Corp. v. Cuno, 547 U.S. 332, 341, 126 S. Ct. 1854, 164 L. Ed. 2d 589 (2006)* "Standing to sue is part of the common understanding of what it takes to make a justiciable case," *Steel Co. v. Citizens for Better Environment, 523 U.S. 83, 102, 118 S. Ct. 1003, 140 L. Ed. 2d 210 (1998)*, and has been described as "an essential and unchanging part of the case-or-controversy requirement of *Article III*," *Defenders of Wildlife, supra, at 560, 112 S. Ct. 2130, 119 L. Ed. 2d 351*.

Our modern framework for addressing standing is familiar: "A plaintiff must allege personal injury fairly traceable to the defendant's allegedly unlawful conduct and likely to be redressed by the requested relief." *DaimlerChrysler, supra, at 342, 126 S. Ct. 1854, 164 L. Ed. 2d 589* ; (quoting *Allen v. Wright, 468*

U.S. 737, 751, 104 S. Ct. 3315, 82 L. Ed. 2d 556 (1984)). Applying that standard here, petitioners bear the burden of alleging an injury that is fairly traceable to the Environmental Protection Agency's failure to promulgate new motor vehicle greenhouse gas emission standards, and that is likely to be redressed by the prospective issuance of such standards.

Before determining whether petitioners can meet this familiar test, however, the Court changes the rules. It asserts that "States are not normal litigants for the purposes of invoking federal jurisdiction," and that given "Massachusetts' stake in protecting its quasi-sovereign interests, the Commonwealth is entitled to *special solicitude* in our standing analysis." *Ante, at 518, 520, 167 L. Ed. 2d, at 268, 269* (emphasis added).

Relaxing *Article III* standing requirements because asserted injuries are pressed by a State, however, has no basis in our jurisprudence, and support for any such "special solicitude" is conspicuously absent from the Court's opinion. The general judicial review provision cited by the Court, *42 U.S.C. § 7607(b)(1)*, [*537] affords States no special rights or status. The Court states that "Congress has ordered EPA to protect Massachusetts (among others)" through the statutory provision at issue, *§ 7521(a)(1)*, and that "Congress has . . . recognized a concomitant procedural right to challenge the rejection of its rulemaking petition as arbitrary and capricious." *Ante, at 519, 520, 167 L. Ed. 2d, at 257*. The reader might think from this unfortunate phrasing that Congress said something about the rights [**1465] of States in this particular provision of the statute. Congress knows how to do that when it wants to, see, *e.g.*, [***280] *§ 7426(b)* (affording States the right to petition EPA to directly regulate certain sources of pollution), but it has done nothing of the sort here. Under the law on which petitioners rely, Congress treated public and private litigants exactly the same.

Nor does the case law cited by the Court provide any support for the notion that *Article III* somehow implicitly treats public and private litigants differently. The Court has to go back a full century in an attempt to justify its novel standing rule, but even there it comes up short. The Court's analysis hinges on *Georgia v. Tennessee Copper Co., 206 U.S. 230, 27 S. Ct. 618, 51 L. Ed. 1038 (1907)* --a case that did indeed draw a distinction between a State and private litigants, but solely with respect to available remedies. The case had nothing to do with *Article III* standing.

In *Tennessee Copper*, the State of Georgia sought to enjoin copper companies in neighboring Tennessee from discharging pollutants that were inflicting "a wholesale destruction of forests, orchards and crops" in bordering Georgia counties. *Id., at 236, 27 S. Ct. 618, 51 L. Ed. 1038*. Although the State owned very little of the territory allegedly affected, the Court reasoned that Georgia--in its capacity as a "*quasi*-sovereign"--"has an interest independent of and behind the titles of its citizens, in all the earth and air within its domain." *Id., at 237, 27 S. Ct. 618, 51 L. Ed. 1038*. The Court explained that while "[t]he very elements that would be relied upon in a suit between fellow-citizens as a ground for equitable relief [were] wanting," a State "is not lightly to be required [*538] to give up *quasi*-sovereign rights for pay." *Ibid.* Thus while a complaining private litigant would have to make do with a *legal* remedy--one "for pay"--the State was entitled to *equitable* relief. See *id., at 237-238, 27 S. Ct. 618, 51 L. Ed. 1038*.

In contrast to the present case, there was no question in *Tennessee Copper* about *Article III* injury. See *id., at 238-239, 27 S. Ct. 618, 51 L. Ed. 1038*. There was certainly no suggestion that the State could show standing where the private parties could not; there was no dispute, after all, that the private landowners had "an action at law." *Id., at 238, 27 S. Ct. 618, 51 L. Ed. 1038*. *Tennessee Copper* has since

stood for nothing more than a State's right, in an original jurisdiction action, to sue in a representative capacity as [**1466] *parens patriae.* See, *e.g., Maryland v. Louisiana, 451 U.S. 725, 737, 101 S. Ct. 2114, 68 L. Ed. 2d 576 (1981).* Nothing about a State's ability to sue in that capacity dilutes the bedrock requirement of showing injury, causation, and redressability to satisfy *Article III.*

A claim of *parens patriae* standing is distinct from an allegation of direct injury. See *Wyoming v. Oklahoma, 502 U.S. 437, 448-449, 451, 112 S. Ct. 789, 117 L. Ed. 2d 1 (1992).* Far from being a substitute for *Article III* injury, *parens patriae* actions raise an additional hurdle for a state litigant: the articulation of a "quasi-sovereign interest" "*apart* from the interests of particular private parties." *Alfred L. Snapp & Son, Inc. v. Puerto Rico ex rel. Barez, 458 U.S. 592, 607, 102 S. Ct. 3260, 73 L. Ed. 2d 995 (1982)* (emphasis added) (cited *ante, at 519, 167 L. Ed. 2d, at 269*). Just as an association suing on behalf of its members must show not only that it represents the members but that at least one satisfies *Article III* requirements, so too a State asserting quasi-sovereign [***281] interests as *parens patriae* must still show that its citizens satisfy *Article III.* Focusing on Massachusetts's interests as quasi-sovereign makes the required showing here harder, not easier. The Court, in effect, takes what has always been regarded as a *necessary* condition for *parens patriae* standing--a quasi-sovereign interest--and converts it into a *sufficient* showing for purposes of *Article III.*

[*539] What is more, the Court's reasoning falters on its own terms. The Court asserts that Massachusetts is entitled to "special solicitude" due to its "quasi-sovereign interests," *ante, at 520, 167 L. Ed. 2d, at 269*, but then applies our *Article III* standing test to the asserted injury of the Commonwealth's loss of coastal property. See *ante, at 522, 167 L. Ed. 2d, at 271* (concluding that Massachusetts "has alleged a particularized injury *in its capacity as a landowner*" (emphasis added)). In the context of *parens patriae* standing, however, we have characterized state ownership of land as a "nonsovereign interes[t]" because a State "is likely to have the same interests as other similarly situated proprietors." *Alfred L. Snapp & Son, supra, at 601, 102 S. Ct. 3260, 73 L. Ed. 2d 995.*

On top of everything else, the Court overlooks the fact that our cases cast significant doubt on a State's standing to assert a quasi-sovereign interest--as opposed to a direct injury--against the Federal Government. As a general rule, we have held that while a State might assert a quasi-sovereign right as *parens patriae* "for the protection of its citizens, it is no part of its duty or power to enforce their rights in respect of their relations with the Federal Government. In that field it is the United States, and not the State, which represents them." *Massachusetts v. Mellon, 262 U.S. 447, 485-486, 43 S. Ct. 597, 67 L. Ed. 1078 (1923)* (citation omitted); see also *Alfred L. Snapp & Son, supra, at 610, n. 16, 102 S. Ct. 3260, 73 L. Ed. 2d 995.*

All of this presumably explains why petitioners never cited *Tennessee Copper* in their briefs before this Court or the D. C. Circuit. It presumably explains why not one of the legion of *amici* supporting petitioners ever cited the case. And it presumably explains why not one of the three judges writing below ever cited the case either. Given that one purpose of the standing requirement is "'to assure that concrete adverseness which sharpens the presentation of issues upon which the court so largely depends for illumination,'" *ante, at 517, 167 L. Ed. 2d, at 267* (quoting *Baker v. Carr, 369 U.S. 186, 204, 82 S. Ct. 691, 7 L. Ed. 2d 663 (1962))*, it is ironic that the Court today adopts a new theory [*540] of *Article III* standing for States without the benefit of briefing or argument on the point.[1]

1 The Court seems to think we do not recognize that *Tennessee Copper* is a case about *parens patriae* standing, *ante, at 520-521, n 17, 167 L. Ed. 2d, at 269-270*, but we have no doubt about that. The point is that nothing in our cases (or Hart & Wechsler) suggests that the prudential requirements for *parens patriae* standing, see *Republic of Venezuela v. Philip Morris Inc., 351 U.S. App. D.C. 108, 287 F.3d 192, 199, n. (CADC 2002)* (observing that "*parens patriae* is merely a species of prudential standing" (internal quotation marks omitted)), can somehow substitute for, or alter the content of, the "irreducible constitutional minimum" requirements of injury in fact, causation, and redressability under *Article III. Lujan v. Defenders of Wildlife, 504 U.S. 555, 560, 112 S. Ct. 2130, 119 L. Ed. 2d 351 (1992). Georgia v. Pennsylvania R. Co., 324 U.S. 439, 65 S. Ct. 716, 89 L. Ed. 1051 (1945)*, is not to the contrary. As the caption makes clear enough, the fact that a State may assert rights under a federal statute as parens patriae in no way refutes our clear ruling that "[a] State does not have standing as parens patriae to bring an action against the Federal Government." *Alfred L. Snapp & Son, Inc. v. Puerto Rico ex rel. Barez, 458 U.S. 592, 610, n. 16, 102 S. Ct. 3260, 73 L. Ed. 2d 995 (1982).*

[***282] II

It is not at all clear how the Court's "special solicitude" for Massachusetts plays out in the standing analysis, except as an implicit concession that petitioners cannot establish standing on traditional terms. But the status of Massachusetts as [**1467] a State cannot compensate for petitioners' failure to demonstrate injury in fact, causation, and redressability.

When the Court actually applies the three-part test, it focuses, as did the dissent below, see *367 U.S. App. D.C. 282, 415 F.3d 50, 64 (CADC 2005)* (opinion of Tatel, J.), on the Commonwealth's asserted loss of coastal land as the injury in fact. If petitioners rely on loss of land as the *Article III* injury, however, they must ground the rest of the standing analysis in that specific injury. That alleged injury must be "concrete and particularized," *Defenders of Wildlife, 504 U.S., at 560, 112 S. Ct. 2130, 119 L. Ed. 2d 351*, and "distinct and palpable," *Allen, 468 U.S., at 751, 104 S. Ct. 3315, 82 L. Ed. 2d 556* (internal quotation marks omitted). Central to this concept of "particularized" injury is the requirement that a plaintiff be affected in a "personal and individual way," *Defenders of Wildlife, 504 U.S., at 560, n. 1,* [*541] *112 S. Ct. 2130, 119 L. Ed. 2d 351*, and seek relief that "directly and tangibly benefits him" in a manner distinct from its impact on "the public at large," *id., at 573-574, 112 S. Ct. 2130, 119 L. Ed. 2d 351*. Without "particularized injury, there can be no confidence of 'a real need to exercise the power of judicial review' or that relief can be framed 'no broader than required by the precise facts to which the court's ruling would be applied.'" *Warth v. Seldin, 422 U.S. 490, 508, 95 S. Ct. 2197, 45 L. Ed. 2d 343 (1975)* (quoting *Schlesinger v. Reservists Comm. to Stop the War, 418 U.S. 208, 221-222, 94 S. Ct. 2925, 41 L. Ed. 2d 706 (1974))*.

The very concept of global warming seems inconsistent with this particularization requirement. Global warming is a phenomenon "harmful to humanity at large," *415 F.3d at 60* (Sentelle, J., dissenting in part and concurring in judgment), and the redress petitioners seek is focused no more on them than on the public generally--it is literally to change the atmosphere around the world.

If petitioners' particularized injury is loss of coastal land, it is also that injury that must be "actual or imminent, not conjectural or hypothetical," *Defenders of Wildlife, supra, at 560, 112 S. Ct. 2130, 119 L. Ed. 2d 351* (internal quotation marks omitted), "real and immedi-

ate," *Los Angeles v. Lyons, 461 U.S. 95, 102, 103 S. Ct. 1660, 75 L. Ed. 2d 675 (1983)* (internal quotation marks omitted), and "certainly impending," *Whitmore v. Arkansas, 495 U.S. 149, 158, 110 S. Ct. 1717, 109 L. Ed. 2d 135 (1990)* (internal quotation marks omitted).

As to "actual" injury, the Court observes that "global sea levels rose somewhere between 10 and 20 centimeters over the 20th century as a result of global warming" and that "[t]hese rising seas have already begun to swallow Massachusetts' coastal land." *Ante, at 522, 167 L. Ed.* [***283] *2d, at 270.* But none of petitioners' declarations supports that connection. One declaration states that "a rise in sea level due to climate change is occurring on the coast of Massachusetts, in the metropolitan Boston area," but there is no elaboration. Petitioners' Standing Appendix in No. 03-1361, etc. (CADC), p 196 (Stdg. App.). And the declarant goes on to identify a "significan[t]" *non*-global-warming cause of Boston's rising sea level: land [*542] subsidence. *Id., at 197*; see also *id., at 216.* Thus, aside from a single conclusory statement, there is nothing in petitioners' 43 standing declarations and accompanying exhibits to support an inference of actual loss of Massachusetts coastal land from 20th-century global sea level increases. It is pure conjecture.

The Court's attempts to identify "imminent" or "certainly impending" loss of Massachusetts coastal land fares no better. See *ante, at 522-523, 167 L. Ed. 2d, at 270-271.* One of petitioners' declarants predicts global warming will cause sea level to rise by 20 to 70 centimeters *by the year 2100.* Stdg. App. 216. Another uses a computer modeling [**1468] program to map the Commonwealth's coastal land and its current elevation, and calculates that the high-end estimate of sea level rise would result in the loss of significant state-owned coastal land. *Id., at 179.* But the computer modeling program has a conceded average error of about 30 centimeters and a maximum observed error of 70 centimeters. *Id., at 177-178.* As an initial matter, if it is possible that the model underrepresents the elevation of coastal land to an extent equal to or in excess of the projected sea level rise, it is difficult to put much stock in the predicted loss of land. But even placing that problem to the side, accepting a century-long time horizon and a series of compounded estimates renders requirements of imminence and immediacy utterly toothless. See *Defenders of Wildlife, supra, at 565, n. 2, 112 S. Ct. 2130, 119 L. Ed. 2d 351* (while the concept of "'imminence'" in standing doctrine is "somewhat elastic," it can be "stretched beyond the breaking point"). "Allegations of possible future injury do not satisfy the requirements of *Art. III.* A threatened injury must be *certainly impending* to constitute injury in fact." *Whitmore, supra, at 158, 110 S. Ct. 1717, 109 L. Ed. 2d 135* (internal quotation marks omitted; emphasis added).

III

Petitioners' reliance on Massachusetts's loss of coastal land as their injury in fact for standing purposes creates insurmountable [*543] problems for them with respect to causation and redressability. To establish standing, petitioners must show a causal connection between that specific injury and the lack of new motor vehicle greenhouse gas emission standards, and that the promulgation of such standards would likely redress that injury. As is often the case, the questions of causation and redressability overlap. See *Allen, 468 U.S., at 753, n. 19, 104 S. Ct. 3315, 82 L. Ed. 2d 556* (observing that the two requirements were "initially articulated by this Court as two facets of a single causation requirement" (internal quotation marks omitted)). And importantly, when a party is challenging the Government's allegedly unlawful regulation, or lack of regulation, of a third party, satisfying the causation and redressability requirements becomes "substantially more difficult." *Defenders of Wildlife, 504 U.S. at 562, 112 S. Ct. 2130, 119 L. Ed.*

2d 351 (internal quotation marks omitted); see also *Warth, supra, at 504-505,95 S. Ct. 2197, 45 L. Ed. 2d 343.*

Petitioners view the relationship between their injuries and EPA's failure to promulgate new motor vehicle greenhouse gas emission standards as simple and direct: Domestic motor vehicles emit carbon dioxide and other greenhouse gases. Worldwide emissions of greenhouse gases contribute to global warming and therefore also to petitioners' alleged injuries. Without the new vehicle standards, greenhouse gas emissions--and therefore global warming and its attendant harms--have been higher than they otherwise would have been; once EPA changes course, the trend will be reversed.

The Court ignores the complexities of global warming, and does so by now disregarding the "particularized" injury it relied on in step one, and using the dire nature of global warming itself as a bootstrap for finding causation and redressability. First, it is important to recognize the extent of the emissions at issue here. Because local greenhouse gas emissions disperse throughout the atmosphere and remain there for anywhere from 50 to 200 years, it is global emissions data that are relevant. See App. to Pet. for Cert. A-73. [*544] According to one of petitioners' declarations, domestic motor vehicles contribute about 6 percent of global carbon dioxide emissions and 4 percent of global greenhouse gas emissions. Stdg. App. 232. The amount of global emissions at issue here is [**1469] smaller still; *§ 202(a)(1)* of the Clean Air Act covers only *new* motor vehicles and *new* motor vehicle engines, so petitioners' desired emission standards might reduce only a fraction of 4 percent of global emissions.

This gets us only to the relevant greenhouse gas emissions; linking them to global warming and ultimately to petitioners' alleged injuries next requires consideration of further complexities. As EPA explained in its denial of petitioners' request for rulemaking,

> "predicting future climate change necessarily involves a complex web of economic and physical factors including: our ability to predict future global anthropogenic emissions of [greenhouse gases] and aerosols; the fate of these emissions once they enter the atmosphere (e.g., what percentage are absorbed by vegetation or are taken up by the oceans); the impact of those emissions that remain in the atmosphere on the radiative properties of the atmosphere; changes in critically important climate feedbacks (e.g., changes in cloud cover and ocean circulation); changes in temperature characteristics (e.g., average temperatures, shifts in daytime and evening temperatures); changes in other climatic parameters (e.g., shifts in precipitation, storms); and ultimately the impact of such changes on human health and welfare (e.g., increases or decreases in agricultural productivity, human health impacts)." App. to Pet. for Cert. A-83 through A-84.

Petitioners are never able to trace their alleged injuries back through this complex web to the fractional amount of global emissions that might have been limited with EPA standards. In light of the bit-part domestic new motor vehicle [*545] greenhouse gas emissions have played in what petitioners describe as a 150-year global [***285] phenomenon, and the myriad additional factors bearing on petitioners' alleged injury--the loss of Massachusetts coastal land--the connection is far too speculative to establish causation.

IV

Redressability is even more problematic. To the tenuous link between petitioners' alleged injury and the indeterminate fractional domestic emissions at issue here, add the fact that petitioners cannot meaningfully predict what will come of the 80 percent of global greenhouse gas emissions that originate outside the United States. As the Court acknowledges, "developing countries such as China and India are poised to increase greenhouse gas emissions substantially over the next century," *ante, at 525-526, 167 L. Ed. 2d, at 272*, so the domestic emissions at issue here may become an increasingly marginal portion of global emissions, and any decreases produced by petitioners' desired standards are likely to be overwhelmed many times over by emissions increases elsewhere in the world.

Petitioners offer declarations attempting to address this uncertainty, contending that "[i]f the U. S. takes steps to reduce motor vehicle emissions, other countries are very likely to take similar actions regarding their own motor vehicles using technology developed in response to the U. S. program." Stdg. App. 220; see also *id., at 311-312*. In other words, do not worry that other countries will contribute far more to global warming than will U. S. automobile emissions; someone is bound to invent something, and places like the People's Republic of China or India will surely require use of the new technology, regardless of cost. The Court previously has explained that when the existence of an element of standing "depends on the unfettered choices made by independent actors not before the courts and whose [**1470] exercise of broad and legitimate discretion the courts cannot presume [*546] either to control or to predict," a party must present facts supporting an assertion that the actor will proceed in such a manner. *Defenders of Wildlife, 504 U.S., at 562, 112 S. Ct. 2130, 119 L. Ed. 2d 351* (quoting *ASARCO Inc. v. Kadish, 490 U.S. 605, 615, 109 S. Ct. 2037, 104 L. Ed. 2d 696 (1989)* (opinion of Kennedy, J.); internal quotation marks omitted). The declarations' conclusory (not to say fanciful) statements do not even come close.

No matter, the Court reasons, because *any* decrease in domestic emissions will "slow the pace of global emissions increases, no matter what happens elsewhere." *Ante, at 526, 167 L. Ed. 2d, at 273*. Every little bit helps, so Massachusetts can sue over any little bit.

The Court's sleight of hand is in failing to link up the different elements of the three-part standing test. What must be *likely* to be redressed is the particular injury in fact. The injury the Court looks to is the asserted loss of land. The Court contends that regulating domestic motor vehicle emissions will reduce carbon dioxide in the atmosphere, *and therefore* redress Massachusetts's injury. But even if regulation *does* reduce emissions--to some indeterminate degree, given events elsewhere in the world--the Court never explains why that makes it *likely* that the injury in fact--the loss of land--will be redressed. Schoolchildren know that a kingdom might be lost "all for the want of a horseshoe nail," but "likely" [***286] redressability is a different matter. The realities make it pure conjecture to suppose that EPA regulation of new automobile emissions will *likely* prevent the loss of Massachusetts coastal land.

V

Petitioners' difficulty in demonstrating causation and redressability is not surprising given the evident mismatch between the source of their alleged injury--catastrophic global warming--and the narrow subject matter of the *Clean Air Act* provision at issue in this suit. The mismatch suggests [*547] that petitioners' true goal for this litigation may be more symbolic than anything else. The constitutional role of the courts, however, is to decide concrete cases--not to serve as a convenient forum for policy debates. See *Valley Forge*

Christian College v. Americans United for Separation of Church and State, Inc., 454 U.S. 464, 472, 102 S. Ct. 752, 70 L. Ed. 2d 700 (1982) ("[Standing] tends to assure that the legal questions presented to the court will be resolved, not in the rarified atmosphere of a debating society, but in a concrete factual context conducive to a realistic appreciation of the consequences of judicial action").

When dealing with legal doctrine phrased in terms of what is "fairly" traceable or "likely" to be redressed, it is perhaps not surprising that the matter is subject to some debate. But in considering how loosely or rigorously to define those adverbs, it is vital to keep in mind the purpose of the inquiry. The limitation of the judicial power to cases and controversies "is crucial in maintaining the tripartite allocation of power set forth in the Constitution." *DaimlerChrysler, 547 U. S., at 341, 126 S. Ct. 1854, 164 L. Ed. 2d 589*(internal quotation marks omitted). In my view, the Court today--addressing *Article III*'s "core component of standing," *Defenders of Wildlife, supra, at 560, 112 S. Ct. 2130, 119 L. Ed. 2d 351* --fails to take this limitation seriously.

To be fair, it is not the first time the Court has done so. Today's decision recalls the previous high-water mark of diluted standing requirements, *United States v. Students Challenging Regulatory Agency Procedures (SCRAP), 412 U.S. 669, 93 S. Ct. 2405, 37 L. Ed. 2d 254 (1973)*. [**1471] *SCRAP* involved "[p]robably the most attenuated injury conferring *Art. III* standing" and "surely went to the very outer limit of the law"--until today. *Whitmore, 495 U.S., at 158-159, 110 S. Ct. 1717, 109 L. Ed. 2d 135*; see also *Lujan v. Nat'l Wildlife Fed'n, 497 U.S. 871, 889, 110 S. Ct. 3177, 111 L. Ed. 2d 695 (1990)* (*SCRAP* "has never since been emulated by this Court"). In *SCRAP*, the Court based an environmental group's standing to challenge a railroad freight rate surcharge on the group's allegation that [*548] increases in railroad rates would cause an increase in the use of nonrecyclable goods, resulting in the increased need for natural resources to produce such goods. According to the group, some of these resources might be taken from the Washington area, resulting in increased refuse that might find its way into area parks, harming the group's members. *412 U.S., at 688, 93 S. Ct. 2405, 37 L. Ed. 2d 254*.

Over time, *SCRAP* became emblematic not of the looseness of *Article III* standing requirements, but of how utterly manipulable they are if not taken seriously as a matter of judicial self-restraint. *SCRAP* made standing seem a lawyer's game, rather than a [***287] fundamental limitation ensuring that courts function as courts and not intrude on the politically accountable branches. Today's decision is *SCRAP* for a new generation.[2]

2 The difficulty with *SCRAP*, and the reason it has not been followed, is not the portion cited by the Court. See *ante, at 526-527, n 24, 167 L. Ed. 2d, at 273*. Rather, it is the *attenuated* nature of the injury there, and here, that is so troubling. Even in *SCRAP*, the Court noted that what was required was "something more than an ingenious academic exercise in the conceivable," *412 U.S., at 688, 93 S. Ct. 2405, 37 L. Ed. 2d 254*, and we have since understood the allegation there to have been "that the string of occurrences alleged would happen *immediately*," *Whitmore v. Arkansas, 495 U.S. 149, 159, 110 S. Ct. 1717, 109 L. Ed. 2d 135 (1990)* (emphasis added). That is hardly the case here. The Court says it is "quite wrong" to compare petitioners' challenging "EPA's parsimonious construction of the *Clean Air Act* to a mere 'lawyer's game.'" *Ante, at 527, n 24, 167 L. Ed. 2d, at 273*. Of course it is not the legal challenge that is merely "an ingenious academic exercise in the conceivable," *SCRAP, supra, at 688, 93 S.*

Ct. 2405, 37 L. Ed. 2d 254, but the assertions made in support of standing.

Perhaps the Court recognizes as much. How else to explain its need to devise a new doctrine of state standing to support its result? The good news is that the Court's "special solicitude" for Massachusetts limits the future applicability of the diluted standing requirements applied in this case. The bad news is that the Court's self-professed relaxation of those *Article III* requirements has caused us to transgress "the proper--and properly limited--role of the courts in a [*549] democratic society." *Allen, 468 U.S., at 750, 104 S. Ct. 3315, 82 L. Ed. 2d 556* (internal quotation marks omitted).

I respectfully dissent.

Justice **Scalia,** with whom The **Chief Justice,** Justice **Thomas,** and Justice **Alito** join, dissenting.

I join The Chief Justice's opinion in full, and would hold that this Court has no jurisdiction to decide this case because petitioners lack standing. The Court having decided otherwise, it is appropriate for me to note my dissent on the merits.

I

A

The provision of law at the heart of this case is *§ 202(a)(1)* of the Clean Air Act (CAA or Act), which provides that the Administrator of the Environmental Protection Agency (EPA) "shall by regulation prescribe . . . standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which *in his* [**1472] *judgment* cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare." *42 U.S.C. § 7521(a)(1)* (emphasis added). As the Court recognizes, the statute "condition[s] the exercise of EPA's authority on its formation of a 'judgment.'" *Ante, at 532, 167 L. Ed. 2d, at 277.* There is no dispute that the Administrator has made no such judgment in this case. See *ante, at 534, 167 L. Ed. 2d, at 278* ("We need not and do not reach the question whether on remand EPA must make an endangerment finding"); *68 Fed. Reg. 52929 (2003)* ("[N]o Administrator has made a finding under any of the CAA's regulatory provisions that CO [2] meets the applicable statutory criteria for regulation").

The question thus arises: Does anything *require* the Administrator to make a "judgment" whenever a petition for rulemaking is filed? Without [***288] citation of the statute or any other authority, the Court says yes. Why is that so? When [*550] Congress wishes to make private action force an agency's hand, it knows how to do so. See, *e.g., Brock v. Pierce County, 476 U.S. 253, 254-255, 106 S. Ct. 1834, 90 L. Ed. 2d 248 (1986)* (discussing the Comprehensive Employment and Training Act (CETA), 92 Stat. 1926, *29 U.S.C. § 816(b) (1976 ed., Supp. V)*, which "provide[d] that the Secretary of Labor 'shall' issue a final determination as to the misuse of CETA funds by a grant recipient within 120 days after receiving a complaint alleging such misuse"). Where does the CAA say that the EPA Administrator is required to come to a decision on this question whenever a rulemaking petition is filed? The Court points to no such provision because none exists.

Instead, the Court invents a multiple-choice question that the EPA Administrator must answer when a petition for rulemaking is filed. The Administrator must exercise his judgment in one of three ways: (a) by concluding that the pollutant *does* cause, or contribute to, air pollution that endangers public welfare (in which case EPA is required to regulate); (b) by concluding that the pollutant *does not* cause, or contribute to, air pollution that endangers public welfare (in which case EPA is *not* required to regulate); or (c) by "provid[ing] some rea-

sonable explanation as to why it cannot or will not exercise its discretion to determine whether" greenhouse gases endanger public welfare, *ante, at 533, 167 L. Ed. 2d, at 277* (in which case EPA is *not* required to regulate).

I am willing to assume, for the sake of argument, that the Administrator's discretion in this regard is not entirely unbounded--that if he has no reasonable basis for deferring judgment he must grasp the nettle at once. The Court, however, with no basis in text or precedent, rejects all of EPA's stated "policy judgments" as not "amount[ing] to a reasoned justification," *ante, at 533-534, 167 L. Ed. 2d, at 277*, effectively narrowing the universe of potential reasonable bases to a single one: Judgment can be delayed *only* if the Administrator concludes that "the scientific uncertainty is [too] profound." *Ibid.* The Administrator is precluded from concluding *for other reasons* "that it would . . . be better not to regulate [*551] at this time." *Ibid.*[1] Such other reasons--perfectly valid reasons--were set forth in the Agency's statement.

> "We do not believe . . . that it would be either effective or appropriate for EPA to establish [greenhouse gas] standards for motor vehicles at this time. As described in detail below, the President has laid out a comprehensive approach [**1473] to climate change that calls for near-term voluntary actions and incentives along with programs aimed at reducing scientific uncertainties and encouraging technological development so that the government may effectively and efficiently address the climate change issue over the long term.
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> . . . . .
>
> "[E]stablishing [greenhouse gas] emission standards for U. S. motor vehicles at this time would . . . result in an inefficient, piecemeal approach to addressing the climate change issue. The U. S. motor vehicle [***289] fleet is one of many sources of [greenhouse gas] emissions both here and abroad, and different [greenhouse gas] emission sources face different technological and financial challenges in reducing emissions. A sensible regulatory scheme would require that all significant sources and sinks of [greenhouse gas] emissions be considered in deciding how best to achieve any needed emission reductions.
>
> "Unilateral EPA regulation of motor vehicle [greenhouse gas] emissions could also weaken U. S. efforts to persuade developing countries to reduce the [greenhouse gas] intensity of their economies. Considering the large populations and growing economies of some developing countries, increases in their [greenhouse gas] emissions could quickly overwhelm the effects of [greenhouse [*552] gas] reduction measures in developed countries. Any potential benefit of EPA regulation could be lost to the extent other nations decided to let their emissions significantly increase in view of U. S. emissions reductions. Unavoidably, climate change raises important foreign policy issues, and it is the President's prerogative to address them." *68 Fed. Reg. 52929*-52931 (footnote omitted).

1 The Court's way of putting it is, of course, not quite accurate. The issue is whether it would be better *to defer the decision about whether to exercise judgment.* This has the *effect* of deferring regulation but is quite a different determination.

The Court dismisses this analysis as "rest[ing] on reasoning divorced from the statutory text." *Ante, at 532, 167 L. Ed. 2d, at 277.* "While the statute does condition the exercise of EPA's authority on its formation of a 'judgment,' . . . that judgment must relate to whether an air pollutant 'cause[s], or contribute[s] to, air pollution which may reasonably be anticipated to endanger public health or welfare.'" *Ibid.* True but irrelevant. When the Administrator *makes* a judgment whether to regulate greenhouse gases, that judgment must relate to whether they are air pollutants that "cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare." *42 U.S.C. § 7521(a)(1).* But the statute says *nothing at all* about the reasons for which the Administrator may *defer* making a judgment--the permissible reasons for deciding not to grapple with the issue at the present time. Thus, the various "policy" rationales, *ante, at 532-533, 167 L. Ed. 2d, at 277*, that the Court criticizes are not "divorced from the statutory text," *ante, at 532, 167 L. Ed. 2d, at 277*, except in the sense that the statutory text is silent, as texts are often silent about permissible reasons for the exercise of agency discretion. The reasons EPA gave are surely considerations executive agencies *regularly* take into account (and *ought* to take into account) when deciding whether to consider entering a new field: the impact such entry would have on other Executive Branch programs and on foreign policy. There is no basis in law for the Court's imposed limitation.

EPA's interpretation of the discretion conferred by the statutory reference to "its judgment" is not only reasonable, [*553] it is the most natural reading of the text. The Court nowhere explains why this interpretation is incorrect, let alone why it is not entitled to deference under *Chevron U.S.A. Inc. v. NRDC, 467 U.S. 837,* [**1474] *104 S. Ct. 2778, 81 L. Ed. 2d 694 (1984).* As the Administrator acted within the law in declining to make a "judgment" for the policy reasons above set forth, I would uphold the decision to deny the rulemaking petition on that ground alone.

[***290] B

Even on the Court's own terms, however, the same conclusion follows. As mentioned above, the Court gives EPA the option of determining that the science is too uncertain to allow it to form a "judgment" as to whether greenhouse gases endanger public welfare. Attached to this option (on what basis is unclear) is an essay requirement: "If," the Court says, "the scientific uncertainty is so profound that it precludes EPA from making a reasoned judgment as to whether greenhouse gases contribute to global warming, EPA must say so." *Ante, at 534, 167 L. Ed. 2d, at 278.* But EPA *has* said precisely that--and at great length, based on information contained in a 2001 report by the National Research Council (NRC) entitled Climate Change Science: An Analysis of Some Key Questions:

> "As the NRC noted in its report, concentrations of [greenhouse gases (GHGs)] are increasing in the atmosphere as a result of human activities (pp. 9-12). It also noted that '[a] diverse array of evidence points to a warming of global surface air temperatures' (p. 16). The report goes on to state, however, that '[b]ecause of the large and still uncertain level of natural variability inherent in the climate record and the uncertainties in the time histories of the

various forcing agents (and particularly aerosols), a [causal] linkage between the buildup of [GHGs] in the atmosphere and the observed climate changes during the 20th century cannot be unequivocally established. The fact that the [*554] magnitude of the observed warming is large in comparison to natural variability as simulated in climate models is suggestive of such a linkage, but it does not constitute proof of one because the model simulations could be deficient in natural variability on the decadal to century time scale' (p. 17).

"The NRC also observed that 'there is considerable uncertainty in current understanding of how the climate system varies naturally and reacts to emissions of [GHGs] and aerosols' (p. 1). As a result of that uncertainty, the NRC cautioned that 'current estimate of the magnitude of future warming should be regarded as tentative and subject to future adjustments (either upward or downward).' *Id.* It further advised that '[r]educing the wide range of uncertainty inherent in current model predictions of global climate change will require major advances in understanding and modeling of both (1) the factors that determine atmospheric concentrations of [GHGs] and aerosols and (2) the so-called "feedbacks" that determine the sensitivity of the climate system to a prescribed increase in [GHGs].' *Id.*

"The science of climate change is extraordinarily complex and still evolving. Although there have been substantial advances in climate change science, there continue to be important uncertainties in our understanding of the factors that may affect future climate change and how it should be addressed. As the NRC explained, predicting future climate change necessarily involves a complex web of economic and physical factors including: Our ability to predict future global anthropogenic emissions of GHGs and aerosols; the fate of these emissions once they enter the atmosphere (*e.g.,* what percentage are absorbed [**1475] by vegetation or are taken up by the [***291] oceans); the impact of those emissions that remain in the atmosphere on the radiative properties of the atmosphere; [*555] changes in critically important climate feedbacks (*e.g.,* changes in cloud cover and ocean circulation); changes in temperature characteristics (*e.g.,* average temperatures, shifts in daytime and evening temperatures); changes in other climatic parameters (*e.g.,* shifts in precipitation, storms); and ultimately the impact of such changes on human health and welfare (*e.g.,* increases or decreases in agricultural productivity, human health impacts). The NRC noted, in particular, that '[t]he understanding of the relationships between weather/climate and human health is in its infancy and therefore the health consequences of climate change are poorly understood' (p. 20). Substantial scientific uncertainties limit our ability to assess each of these factors and to separate out those changes resulting from natural variability from those that are

directly the result of increases in anthropogenic GHGs.

"Reducing the wide range of uncertainty inherent in current model predictions will require major advances in understanding and modeling of the factors that determine atmospheric concentrations of [GHGs] and aerosols, and the processes that determine the sensitivity of the climate system." *68 Fed. Reg. 52930.*

I simply cannot conceive of what else the Court would like EPA to say.

II

A

Even before reaching its discussion of the word "judgment," the Court makes another significant error when it concludes that "*§ 202(a)(1)* of the Clean Air Act *authorizes* EPA to regulate greenhouse gas emissions from new motor vehicles in the event that it forms a 'judgment' that such emissions contribute to climate change." *Ante, at 528, 167 L. Ed. 2d, at 274* (emphasis added). For such authorization, the Court relies on [*556] what it calls "the *Clean Air Act's* capacious definition of 'air pollutant.'" *Ante, at 532, 167 L. Ed. 2d, at 277.*

"Air pollutant" is defined by the Act as "any air pollution agent or combination of such agents, including any physical, chemical, . . . substance or matter which is emitted into or otherwise enters the ambient air." *42 U.S.C. § 7602(g).* The Court is correct that "[c]arbon dioxide, methane, nitrous oxide, and hydrofluorocarbons," *ante, at 529, 167 L. Ed. 2d, at 274*, fit within the second half of that definition: They are "physical, chemical, . . . substance[s] or matter which [are] emitted into or otherwise ente[r] the ambient air." But the Court mistakenly believes this to be the end of the analysis. In order to be an "air pollutant" under the Act's definition, the "substance or matter [being] emitted into . . . the ambient air" must also meet the *first* half of the definition--namely, it must be an "air pollution agent or combination of such agents." The Court simply pretends this half of the definition does not exist.

The Court's analysis faithfully follows the argument advanced by petitioners, which focuses on the word "including" in the statutory definition of "air pollutant." See Brief for Petitioners 13-14. As that argument goes, anything that *follows* the word "including" must necessarily be a subset of whatever *precedes* it. Thus, if [***292] greenhouse gases qualify under the phrase following the word "including," they must qualify under the phrase preceding it. Since greenhouse gases come within the capacious phrase "any physical, chemical, . . . substance or matter which is emitted into or otherwise enters the ambient air," [**1476] they must also be "air pollution agent[s] or combination[s] of such agents," and therefore meet the definition of "air pollutant[s]."

That is certainly one possible interpretation of the statutory definition. The word "including" can indeed indicate that what follows will be an "illustrative" sampling of the general category that precedes the word. *Federal Land Bank of St. Paul v. Bismarck Lumber Co., 314 U.S. 95, 100, 62 S. Ct. 1, 86 L. Ed. 65* [*557] *(1941).* Often, however, the examples standing alone are broader than the general category, and must be viewed as limited in light of that category. The Government provides a helpful (and unanswered) example: "The phrase 'any American automobile, including any truck or minivan,' would not naturally be construed to encompass a foreign-manufactured [truck or] minivan." Brief for Federal Respondent 34. The general principle enunciated--that the speaker is talking about *American* automobiles--carries forward

to the illustrative examples (trucks and minivans), and limits them accordingly, even though in isolation they are broader. Congress often uses the word "including" in this manner. In *28 U.S.C. § 1782(a)*, for example, it refers to "a proceeding in a foreign or international tribunal, including criminal investigations conducted before formal accusation." Certainly this provision would not encompass criminal investigations underway in a *domestic* tribunal. See also, *e.g.*, *2 U.S.C. § 54(a)* ("The Clerk of the House of Representatives shall, at the request of a Member of the House of Representatives, furnish to the Member, for official use only, one set of a privately published annotated version of the United States Code, including supplements and pocket parts"); *22 U.S.C. § 2304(b)(1)* ("the relevant findings of appropriate international organizations, including nongovernmental organizations").

In short, the word "including" does not require the Court's (or the petitioners') result. It is perfectly reasonable to view the definition of "air pollutant" in its entirety: An air pollutant *can* be "any physical, chemical, . . . substance or matter which is emitted into or otherwise enters the ambient air," but only if it retains the general characteristic of being an "air pollution agent or combination of such agents." This is precisely the conclusion EPA reached: "[A] substance does not meet the CAA definition of 'air pollutant' simply because it is a 'physical, chemical, . . . substance or matter which is emitted into or otherwise enters the ambient air.' It must [*558] also be an 'air pollution agent.'" *68 Fed. Reg. 52929, n. 3*. See also *id., at 52928* ("The root of the definition indicates that for a substance to be an 'air pollutant,' it must be an 'agent' of 'air pollution'"). Once again, in the face of textual ambiguity, the Court's application of *Chevron* deference to EPA's interpretation of the word "including" is nowhere to be found.[2] Evidently, the Court defers only to those reasonable interpretations that it favors.

2 Not only is EPA's interpretation reasonable, it is far more plausible than the Court's alternative. As the Court correctly points out, "all airborne compounds of whatever stripe," *ante, at 529, 167 L. Ed. 2d, at 274*, would qualify as "physical, chemical, . . . substance[s] or matter which [are] emitted into or otherwise ente[r] the ambient air," *42 U.S.C. § 7602(g)*. It follows that *everything* airborne, from Frisbees to flatulence, qualifies as an "air pollutant." This reading of the statute defies common sense.

[***293] B

Using (as we ought to) EPA's interpretation of the definition of "air pollutant," we must next determine whether greenhouse gases are "agent[s]" of "air pollution." If so, the statute would authorize [**1477] regulation; if not, EPA would lack authority.

Unlike "air pollutants," the term "air pollution" is not itself defined by the CAA; thus, once again we must accept EPA's interpretation of that ambiguous term, provided its interpretation is a "permissible construction of the statute." *Chevron, 467 U.S., at 843, 104 S. Ct. 2778, 81 L. Ed. 2d 694*. In this case, the petition for rulemaking asked EPA for "regulation of [greenhouse gas] emissions from motor vehicles to reduce the risk of global climate change." *68 Fed. Reg. 52925*. Thus, in deciding whether it had authority to regulate, EPA had to determine whether the concentration of greenhouse gases assertedly responsible for "global climate change" qualifies as "air pollution." EPA began with the commonsense observation that the "[p]roblems associated with atmospheric concentrations [*559] of CO [2] ," *id., at 52927*, bear little resemblance to what would naturally be termed "air pollution":

> "EPA's prior use of the CAA's general regulatory provisions provides an important context. Since

> the inception of the Act, EPA has used these provisions to address air pollution problems that occur primarily at ground level or near the surface of the earth. For example, national ambient air quality standards (NAAQS) established under CAA section 109 address concentrations of substances in the ambient air and the related public health and welfare problems. This has meant setting NAAQS for concentrations of ozone, carbon monoxide, particulate matter and other substances in the air near the surface of the earth, not higher in the atmosphere. . . . CO [2] , by contrast, is fairly consistent in concentration throughout the world's atmosphere up to approximately the lower stratosphere." *Id., at 52926-52927.*

In other words, regulating the buildup of CO [2] and other greenhouse gases in the upper reaches of the atmosphere, which is alleged to be causing global climate change, is not akin to regulating the concentration of some substance that is *polluting* the *air.*

We need look no further than the dictionary for confirmation that this interpretation of "air pollution" is eminently reasonable. The definition of "pollute," of course, is "[t]o make or render impure or unclean." Webster's New International Dictionary 1910 (2d ed. 1949). And the first three definitions of "air" are as follows: (1) "[t]he invisible, odorless, and tasteless mixture of gases which surrounds the earth"; (2) "[t]he body of the earth's atmosphere; esp., the part of it near the earth, as distinguished from the upper rarefied part"; (3) "[a] portion of air or of the air considered with respect to physical characteristics or as affecting the [*560] senses." *Id., at 54.* EPA's conception of "air pollution"--focusing on impurities in the "ambient air" "at ground level or [***294] near the surface of the earth"--is perfectly consistent with the natural meaning of that term.

In the end, EPA concluded that since "CAA authorization to regulate is generally based on a finding that an air pollutant causes or contributes to air pollution," *68 Fed. Reg. 52928*, the concentrations of CO [2] and other greenhouse gases allegedly affecting the global climate are beyond the scope of CAA's authorization to regulate. "[T]he term 'air pollution' as used in the regulatory provisions cannot be interpreted to encompass global climate change." *Ibid.* Once again, the Court utterly fails to explain why this interpretation is incorrect, let alone so unreasonable as to be unworthy of *Chevron* deference.

* * *

The Court's alarm over global warming may or may not be justified, but it ought [**1478] not distort the outcome of this litigation. This is a straightforward administrative-law case, in which Congress has passed a malleable statute giving broad discretion, not to us but to an executive agency. No matter how important the underlying policy issues at stake, this Court has no business substituting its own desired outcome for the reasoned judgment of the responsible agency.

REFERENCES

U.S.C.S., Constitution, Art. III; *42 U.S.C.S. §§ 7401 et seq.*

2A Environmental Law Practice Guide § 15.02 (Matthew Bender)

3 Environmental Law Practice Guide §§ 17.10, 17.10A, 17.12 (Matthew Bender)

1 *Treatise on Environmental Law §§ 2.04, 2*:06 (Matthew Bender)

6 Treatise on Environmental Law §§ 13:03, 13:04 (Matthew Bender)

L Ed Digest, Environmental Law § 24; Parties § 3

L Ed Index, Pollution

Validity, construction, and application of Clean Air Act, as amended (CAA) (*42 U.S.C.S. §§ 7401 et seq.*)--Supreme Court cases. *157 L. Ed. 2d 1285*.

Requirements of *Article III of Federal Constitution* as affecting standing to challenge particular conduct as violative of federal law--Supreme Court cases. *70 L. Ed. 2d 941*.

Supreme Court's view as to what is a "case or controversy" within the meaning of *Article III of the Federal Constitution* or an "actual controversy" within the meaning of the Declaratory Judgment Act (*28 U.S.C.S. § 2201*). *40 L. Ed. 2d 783*.

United States Environmental Protection Agency

EPA's Response to the Petitions to Reconsider the Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act

Volume 1: Climate Science and Data Issues Raised by Petitioners

U.S. Environmental Protection Agency
Office of Atmospheric Programs
Climate Change Division
Washington, D.C.

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ACRONYMS

°C	degrees Celsius
°F	degrees Fahrenheit
AIRS	Atmospheric Infrared Sounder
AMS	American Meteorological Society
AOGCM	Atmosphere-Ocean General Circulation Models
AR4	IPCC Fourth Assessment Report
BOM	Australian Bureau of Meteorology
CCSP	U.S. Climate Change Science Program
CH_4	methane
cm	centimeter
CDIAC	Carbon Dioxide Information Analysis Center
CMIP	Coupled Model Intercomparison Project
CO_2	carbon dioxide
CRU	Climatic Research Unit
EPA	U.S. Environmental Protection Agency
FOIA	Freedom of Information Act
GHCN	Global Historical Climatology Network
GHG	greenhouse gases
GISS	Goddard Institute for Space Studies (NASA)
GSL	Global Snow Laboratory (Rutgers Universitry)
IAC	InterAcademy Council
IEA	Institute of Economic Analysis
IISD	International Institute for Sustainable Development
IJC	International Journal of Climatology
IPCC	Intergovernmental Panel on Climate Change
IQA	Information Quality Act
LIA	Little Ice Age
MET	United Kingdom Meteorological Office
MWP	Medieval Warm Period
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NIWA	National Institute of Water & Atmospheric Research
NMS	National Meteorological Station
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NSIDC	U.S. National and Snow and Ice Data Center
ORNL	Oak Ridge National Laboratory
PBL	Netherlands Environmental Assessment Agency
RTC	Response to Comments
RTP	Response to Petitions
SAB	Scientific Advisory Board
SALR	saturated adiabatic lapse rate
TSD	Technical Support Document

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UAH	University of Alabama–Huntsville
UCAR	University Corporation for Atmospheric Research
UHI	urban heat island
UK	United Kingdom
USGCRP	U.S. Global Change Research Program
USHCN	United States Historical Climatology Network
W/m^2	watts per meter squared
WMO	World Meteorological Organization
WWR	World Weather Reports

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1.0 Climate Science and Data Issues Raised by Petitioners

1.1. Validity of Paleoclimate Temperature Reconstructions and Related Issues

1.1.1 The "Divergence Issue" in Paleoclimate Reconstructions

A number of petitioners (the Coalition for Responsible Regulation, Peabody Energy, the Southeastern Legal Foundation, the State of Texas, and the Competitive Enterprise Institute) challenge the validity of the paleoclimate reconstructions of the temperatures of the past 1,000 and 10,000 years, as summarized in the assessment literature.[1] Many of the issues they raise are similar to comments EPA received on the proposed Endangerment Finding, although in some cases the petitioners draw additional support from more recent information released in the media. In particular, several petitioners use e-mails involving scientists at the Climatic Research Unit (CRU) of the University of East Anglia in the United Kingdom that were made public in November 2009. Based on statements in these e-mails, along with other sources, petitioners specifically raise the possibility that the Medieval Warm Period (MWP) or the early Holocene (about 10,000 to 8,000 years ago) may have been warmer than the present. Additionally, they claim that the e-mails demonstrate deliberate, inappropriate manipulation of the data. Petitioners claim that by showing that recent warmth may not have been "unprecedented," that the attribution of recent warming to human causes is undermined, and therefore, the Findings are flawed.

EPA's review of the arguments raised by the petitioners, as well as EPA's review of the totality of the CRU e-mails and other documents, finds that the uncertainties about paleoclimate reconstructions highlighted by the petitioners were recognized and appropriately discussed in the Intergovernmental Panel on Climate Change (IPCC) and other assessment documents, as well as in the EPA Technical Support Document (TSD). EPA addressed the uncertainties involved in historical temperature reconstructions in the Response to Comments (RTC) document, as this was an issue raised by a number of commenters. Petitioners fail to acknowledge or engage substantively with the scope and comprehensiveness of the discussion of this issue, both in the assessment literature and by EPA. Further, they fail to recognize or discuss the other evidence relied on in assessing the conclusions drawn from the entire body of paleoclimate evidence. As a result, the petitioners' arguments rely on innuendo and speculation with little scientific support or argumentation.

When viewed as a whole, the paleoclimate analysis contributes to our understanding of the climate system. These analyses provide supporting evidence that current warming is attributable to anthropogenic greenhouse gases (GHGs). The uncertainties concerning the precise temperature and climatic influences in the paleoclimate reconstructions are clearly recognized, acknowledged, and taken into account in the conclusions of the

[1] Paleoclimatology is the study of climates of time periods prior to the widespread use of direct measurement instruments.

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assessment literature and in EPA's Endangerment Finding. Contrary to petitioners' claims, EPA has not treated this evidence as "compelling" but has instead weighed it appropriately given the uncertainties involved. Whether previous warm historical episodes were possibly slightly warmer globally than the present or, as the majority of the science suggests, slightly cooler on a global average than the present, does not materially change the understanding of the climate provided by the paleoclimate evidence.

We respond to petitioners' arguments in the following subsections. Subsection 1.1.2 provides background on paleoclimate temperature reconstructions as context for the more technical responses that follow. Subsection 1.1.3 addresses issues including the "divergence issue" concerning recent tree ring data. Subsection 1.1.4 addresses the arguments over manipulation of data including tree ring data. Section 1.1.5 addresses arguments regarding the relative warmth of the MWP and the present day. Section 1.1.6 addresses arguments on the issue of the role of paleoclimate reconstructions in attribution of observed temperature changes to GHGs. Subsection 1.1.7 summarizes EPA's conclusions on the petitioners' arguments

1.1.2 Background

To evaluate the technical details of the petitioners' arguments, it is useful to describe what paleoclimate temperature reconstructions are and how they are used to improve understanding of past and present climate change. Direct observation of surface temperature records have global coverage over approximately the last 130 to 150 years. To determine temperatures in time periods before the instrumental record, climate scientists need to use indirect methods ("proxies"). These indirect methods include examining tree rings; sediment cores for pollen and plankton records; atomic isotope and chemical compound ratios in corals and other marine organisms; glacier extent and oxygen isotope ratios in the glacial ice; and subsurface ground temperatures. Determining temperatures from these proxies is not always straightforward. For example, tree growth is dependent not only on temperature but also water availability, CO_2 concentrations in the air, and pollution exposure. Marine organism records can be influenced by salinity changes, glacier records can be influenced by precipitation changes, and so forth. Many of these proxies (including tree rings) are calibrated against the instrumental temperature record for the period where datasets overlap. The statistical relationship found between the proxy and regional temperatures over the past 150 years is then used to extrapolate over the hundreds or thousands of years before instrumental records. Examining more data sources and more proxies provides more certainty in the reconstructions than would be achieved using a single proxy study with fewer data sources, even if some of the included proxies have only a weak relationship with temperature.

Researchers combine a number of different proxies from around the world to develop their temperature reconstructions of the past. Different researchers use different subsets of data—some rely on only one proxy, others use multi-proxy reconstructions. Fewer proxies are available for examination as scientists extend their research further back in the past, and the uncertainty of conclusions about past surface temperatures becomes

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larger. These reconstructions contribute to our understanding of historical temperatures and variability and enable comparison of present day changes to changes in the past 1,000 years, as well as allowing testing of climate models and our understanding of how the climate system responded to historical conditions.

The "divergence" issue refers to a certain subset of the tree ring records whose growth has not correlated with temperature change in recent decades. Basically, in recent years, where the regional instrumental record shows warming, some tree ring proxies do not show a corresponding growth rate. This is not a new issue; one of the earliest papers on divergence was published by CRU researchers in 1998 in the journal *Nature* (Briffa et al., 1998). More recently, reports of the IPCC (Jansen et al., 2007) and National Research Council (NRC) (2006) cite a number of studies that have explored this topic, assessing potential explanations ranging from ozone depletion to specific regional changes in drought and precipitation. EPA's TSD discusses this issue and includes the NRC (2006) multiproxy reconstruction in Figure 4.3. As discussed in the TSD, and in more detail in Volume 2 in the RTC document, NRC (2006) found divergence in some trees north of 55 degrees latitude. The TSD summarizes the NRC (2006) and IPCC conclusions on paleoclimate, including important discussions of the uncertainty in the reconstructions, stating on page 32, "Considering this study and additional research, the IPCC (2007d) concluded: "Paleoclimatic information supports the interpretation that the warmth of the last half century is unusual in at least the previous 1,300 years." However, like NRC (2006b), IPCC cautions that uncertainty is significant prior to 1600 (Jansen et al., 2007)."

Some researchers are concerned about the implications of this divergence in the use of tree rings for reconstructing historical warm periods; other researchers note that because the divergence only applies to trees north of 55 degrees latitude, and a similar difference in behavior between northern and southern trees was not seen before the last few decades, it is reasonable to conclude that the divergence is a unique phenomenon of the last few decades.

Placing the paleoclimate work into the broader climate science context, the TSD cites the U.S. Global Change Research Program (USGCRP) statement that "The second line of evidence arises from indirect, historical estimates of past climate changes that suggest that the changes in global surface temperature over the last several decades are unusual (Karl et al, 2009)." The phrase in Karl et al. regarding "indirect historical estimates" refers to the paleoclimate reconstructions based on proxies. Following Karl's statement, the unusual nature of the current warming in the context of the past 1,000 years contributes to one of the lines of evidence supporting the attribution of current warming to human activities. Note that "unusual" does not mean unprecedented, and past warming must be considered in the light of what we know about past climatic forcings such as solar and volcanic activity. Additionally, in the IPCC chapter on attribution, Hegerl et al. (2007) states that "[a]nalyses of palaeoclimate data have increased confidence in the role of external influences on climate." Hegerl et al. are stating that paleoclimate information improves our understanding of the difference between how the climate responds to external changes, such as changes in solar radiation, orbital

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characteristics, GHG concentrations, or atmospheric loadings of aerosols (such as from volcanic eruptions), compared to internal changes such as el Niño events.

1.1.3 Assessment of the Evidence Provided by Petitioners Regarding the Climate Reconstructions

Comment (1-1):
Several petitioners (the Coalition for Responsible Regulation, Peabody Energy, the Southeastern Legal Foundation, the State of Texas, and Competitive Enterprise Institute) argue that the "divergence" issue in the tree ring records "makes comparing the temperatures during the MWP [Medieval Warm Period] with recent observed temperatures virtually impossible" and that these concerns were suppressed in IPCC reports.

Response (1-1):
As noted in the background on paleoclimate above, the divergence issue (between certain tree rings and recent temperature changes) is not yet a fully explained phenomenon, and the e-mails quoted by the petitioners recognize these uncertainties. However, these uncertainties are not new. The science community has long been aware of the tree ring divergence issue, as well as other issues on the certainty of proxy reconstructions. After thorough evaluations, both the IPCC and NRC properly recognized these issues and appropriately reflected the uncertainty in their scientific conclusions, as did EPA. Thus, these uncertainties were fully presented in the assessment literature. In Response 2-64 and 2-67 of the RTC document, EPA addressed divergence and uncertainty in paleoclimate reconstructions, stating:

> Some temperature reconstructions end in 1980 or earlier because of a well-recognized (in the assessment literature) "divergence" problem, where some tree ring records present temperature trends that do not correlate well with the instrumental (thermometer) records. Explanations for the divergence discussed in NRC (2006b) include water (i.e., drought stress) becoming a limiting factor, increasing winter precipitation (leading to delaying snowmelt), greater ultraviolet radiation (resulting from ozone depletion) or bias in instrumental temperature. However, NRC (2006b) notes a number of tree-ring records have not been impacted by divergence, and it is primarily concentrated north of 55° latitude. The IPCC (Jansen et al., 2007) notes it is not even ubiquitous in that region.

Specifically, the NRC also found that "Elevational treeline sites in Mongolia (D'Arrigo et al., 2001) and the European Alps (Büntgen et al., 2005) are not affected by "divergence." This geographic separation was confirmed by Cook et al. (2004)" (NRC, 2006). The significance of these studies is that they demonstrate that divergence is not an issue with all tree ring proxies, much less the many non-tree ring proxies, such as retreating glaciers, sediment cores, corals, and other data sources.

It is important to recognize that the assessment reports looked at all of the proxy evidence (e.g., see Fig 4.3 in the TSD [U.S. EPA, 2009]) as well as other paleoclimate evidence, such as the clear record that warmer periods in the past coincide with periods with higher levels of CO_2. The assessment reports rely on this entire body of evidence to support

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their conclusions, correctly reflecting any uncertainty expressed in the literature, while petitioners discuss only one part of this evidence—the tree ring divergence for trees in some locations—and do not contest any of the other parts of the entire body of evidence. Petitioners also do not attempt to show that the entire body of evidence supports a different conclusion than that drawn by the assessment reports and by EPA.

Comment (1-2):
Peabody Energy cites papers by D'Arrigo et al. (2008), Esper and Frank (2009), and Loehle (2009) on the subject of divergence. Loehle (2009) presents an analysis on the implications of divergence being a result of non-linear responses to temperature. Peabody Energy quotes D'Arrigo's paper as stating that the divergence issues impede "a robust comparison of recent warming during the anthropogenic period with past natural climate episodes such as the Medieval Warm Period," and states that the Esper and Frank paper "concluded that the divergence problem 'is of importance…'"

Response (1-2):
EPA has reviewed the petitioners' submission of D'Arrigo et al. (2008), Esper and Frank (2009), and Loehle (2009) and finds that it was not impracticable to raise the objection during the public comment period and that the reasons for the objection did not arise between June 24, 2009, and February 16, 2010. Petitioners could have submitted these studies during the comment period on the proposed Endangerment Finding. Although, in most cases, the petitioners provide excerpts from the CRU e-mails in support of their assertions, EPA's review has determined that this evidence does not support their allegations, and that the information submitted by petitioners on these topics was available before the comment period for the Endangerment Finding. Petitioners have not shown why it would have been impractical for them to have submitted these studies then. Indeed, similar points were already raised, and responded to, in the RTC. Despite the fact that these objections fail to meet the statutory timeframe for evidence supporting a petition for reconsideration, we briefly explain why, contrary to petitioners' allegation, they fail to call into question the Finding.

Though the petitioners cite D'Arrigo et al. (2008) to support their contention that the divergence problem undermines paleoclimate reconstructions, D'Arrigo et al. (2008) recognize the possibility that divergence is a uniquely modern phenomena, though they do include caveats on that conclusion: "Although limited evidence suggests that the divergence may be anthropogenic in nature and restricted to the recent decades of the 20th century, more research is needed to confirm these observations." Similarly, the quote from Esper and Frank (2009) that the petitioners select comes from a context-setting paragraph and is not a conclusion of the paper, despite the contention of the petitioner. Esper and Frank also note that the divergence phenomena is "widely perceived" and the "potential consequences discussed (e.g., IPCC, 2007)," providing confirmation that the researchers in the field approve of the assessment literature conclusions. Indeed, more recent work by Esper (Esper et al., 2010) may have found that some analysis methods do not show the same divergence phenomena when used with high latitude Siberian trees.

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Loehle (2009) is a more theoretical study examining the implications for reconstructions if the reason for "divergence" results from a non-linear response of trees to warming. He shows that if the trees respond quadratically to warming rather than linearly, then it is possible that reconstructions using these trees would not reproduce some historical warm periods. However, these questions are not new: the possibility of such non-linear response was addressed in a qualitative form by the NRC (2006). Additionally, some reconstructions have examined the effect of not including any tree rings whatsoever and still find that modern warming is slightly larger than other events in the past millenium (Mann et al., 2008).

This is an area of ongoing research, but petitioners present no evidence that demonstrates that the treatment of this issue by EPA failed to address the uncertainties involved in these reconstructions.

Comment (1-3):
Peabody Energy raises objections to the IPCC Fourth Assessment Report (AR4) treatment of Holocene temperature variation, to the sentence in the TSD referring to reconstructions of this period, and to the discussion in the RTC document on the subject. Peabody Energy claims that certain e-mails raise doubts about IPCC conclusions regarding the early Holocene (about 10,000 to 8,000 years ago). Peabody Energy states that "Obviously, warmer temperatures in the early Holocene when GHG concentrations were lower than those today would seem to further undermine the conclusion that today's temperatures are unprecedented and, therefore, must be the result of anthropogenic GHG emissions." Peabody Energy quotes several e-mails from IPCC authors discussing two papers (Porter, 2000 and Thompson et al., 2006) that were not included in the AR4. Peabody Energy states that these e-mails support its claims that the IPCC omitted references and skewed the discussion of this issue in the AR4, and that the two papers demonstrate that there was simultaneous warmth in the tropics and the Southern Hemisphere during the early Holocene, in contrast to the IPCC conclusions.

For example, a petitioner quotes the following from Olga Solomina from July 2006:

> I attach here a version of glacier box and suggestions (in red) how to include there the reference to the new Thompson et al., 2006 paper.
>
> In this relation - I am getting more and more concern about our statement that the Early Holocene was cool in the tropics - this paper shows that it was, actually, warm - ice core evidences+glaciers were smaller than now in the tropical Andes. The glaciers in the Southern Hemisphere (Porter, 2000, review paper) were also smaller than at least in the Neoglacial. We do not cite Porter's paper for the reason that we actually do not know how to explain this - orbital reason does not work for the SH, but if we do cite it (which is fair) we have to say that during the Early to Mid Holocene glaciers were smaller than later in both Northern, and Southern Hemisphere, including the tropics, which would contradict

> to our statement in the Holocene chapter and the bullet. It is probably too late to rise these questions, but still just to draw your attention.[2]

The petitioner further quotes Valerie Masson-Delmotte on uncertainties in Holocene land reconstructions:

> It seems to me that there is still a large uncertainty about the temperature versus precipitation effect on these tropical glaciers. Other indications from South America are related to lake levels with contrasted views in the low versus highlands.
>
> Several references suggest that there is the end of a wet period after the early Holocene in tropical south America; this is expected to induce an increase of 18O signals. One review was conducted several years ago within the PEPI project (http://wwwpaztcn.wr.usgs.gov/pcaw/ and references herein).
>
> I think that the state of the art is that we have no reliable proxy record that is sensivite to temperature only on the tropical lands for the Holocene; therefore the statement that was written for the Holocene was based on areas of the tropical oceans where SST reconstructions were published.
>
> Do we have to write more explicitely about the uncertainty?[3]

The petitioner objects that "Ultimately, the Coordinating Lead Author of Chapter 6, Eystein Jansen, decided, *contrary to the contentions of Thompson et al. and Foster,* that the early Holocene evidence from the tropics and Southern Hemisphere is not a reliable temperature indicator, and to just leave the text the way it was – that is, without including the published evidence from Thompson et al. (2006), Foster (2000), or any discussion surrounding these studies that runs contrary to the orbital hypothesis," including Jansen's e-mail:

> I agree with Valerie that the ice core evidence is ambiguous. I would personally place more weight on the alkenone data, which is a reasonable well calibrated SST proxy. Foraminifer transfer function based SSTs and some Mg/Ca results that are available suggest a similar picture as far as I know. Of course it is possible and plausible that the tropical oceans are behaving in a non consistent manner and not all areas are showing the same signal, but a sizeable portion appear to do so in order to conclude as we do in the chapter in my opinion. Some signals may be due to changes in in trade wind induced coastal upwelling strength, but there are enough cores with alkenone data outside of these areas. If we were to say more about the uncertainties it may be the fact that proxies are seasonally skewed.
>
> My conclusion is to let the chapter say what we say at the moment.[4]

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[2] E-mail file 1154353922.txt, (July 31, 2006), page 1189, lines 9-19 of PDF version entitled: CRU Emails 1996-2009.pdf

[3] E-mail file 1154353922.txt, (July 31, 2006), page 1188, lines 35-45 of PDF version entitled: CRU Emails 1996-2009.pdf

[4] E-mail file 1154353922.txt, (July 31, 2006), page 1188, lines 25-34 of PDF version entitled: CRU Emails 1996-2009.pdf

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Response (1-3):
The petitioner raises three main claims: that the e-mails demonstrate bias in writing the IPCC chapters, that the omitted references demonstrate global early Holocene warmth, and that early Holocene warmth raises doubt about attribution of current warming. On the first claim, our analysis finds that the e-mails are examples of legitimate scientific discussion between the authors trying to determine what is appropriate for inclusion in a chapter and that several of the issues discussed in these e-mails were indeed included in the final chapter even if the two papers in question were not directly referenced. On the second claim, we note that there is uncertainty regarding early Holocene warmth, that this is still an area of ongoing research, and that EPA made no claims about Holocene warmth in the TSD or the Finding. On the third claim, early Holocene temperature reconstructions are not central to arguments regarding attribution. Additionally, the Thompson paper in question makes statements consistent with the EPA TSD regarding the effects of human activities.

With regard to Peabody Energy's assertions about the Holocene based on glacier literature from Porter (2000) and Thompson et al (2006), the final version of the IPCC chapter (Jansen et al., 2007) discusses early Holocene reconstructions without referring to either paper. Thompson et al. (2006) finds that glacier data suggests tropical Pacific warmth between 11,000 and 8,000 years ago, in apparent contrast to Figure 6.9 in the IPCC chapter, which shows a cooler tropical Pacific in that time period. The e-mail discussion between Eystein Jansen (Professor of Marine Biology, University of Bergen, Norway), Olga Solomina (Senior Scientist, Institute of Geology, Russian Academy of Sciences), and Valérie Masson-Delmotte (Laboratoire des Sciences du Climat et de l'Environnement, France) cited by the petitioners includes the reasoning of the e-mail authors that there is more confidence in using marine sediment and shell data for determining ocean temperatures than there is using glacier oxygen isotope data relied upon in the Thompson paper, because the glacier data can also be influenced by changes in precipitation. This kind of ongoing discussion regarding which data best reflects past temperatures is appropriate for lead authors of a scientific assessment, and reflects scientific dialogue attempting to determine the most appropriate answer.

A very recent paper (Leduc et al., 2010) finds cool early Holocene tropical oceans based on alkenone data but an apparently contradictory result based on Mg/Ca data. A possible explanation suggested by this paper was that one proxy was capturing winter trends, and the other proxy summer trends, and there are orbital reasons to think that the trends might be different. Interestingly, this is consistent with Jansen's statement in the quoted e-mail that the proxies may be seasonally skewed. This is clearly an area of ongoing research.

Contrary to the assertion of the petitioners that there was no discussion included in the chapter that "runs contrary to the orbital hypothesis," Chapter 6 of Working Group I (Jansen et al., 2007) discusses that there are some Holocene results that are not fully explained by the orbital hypothesis, stating: "At high southern latitudes, the early warm period cannot be explained by a linear response to local summer insolation changes (see Box 6.1), suggesting large-scale reorganization of latitudinal heat transport." Similarly,

Box 6.3 discusses tropical glacier retreat stating "tropics indicate short, or in places even absent, glaciers between 11 and 5 ka," consistent with both Porter and Thompson.

Therefore, the quoted e-mails demonstrate that the authors were appropriately attempting to explore this issue and use their best scientific reasoning to determine which proxies were most appropriate for use in their assessment. One of the e-mails even presciently identified a possible source of seasonal skew which was a core finding of a paper published four years later. Evidence that "runs contrary to the orbital hypothesis" was in fact included in the final version of the chapter, as was the issue about absent glaciers.

The Endangerment Finding does not directly address the early Holocene. The TSD statement that "current data limitations limit the ability to determine if there were multi-decadal periods of global warmth compared to the last half of the 20th century prior to about 1,000 years ago" remains accurate after considering these two papers on Holocene glaciers. The RTC document (RTC Response 3-55) also quotes this statement from the TSD in response to a comment regarding early Holocene temperatures. The TSD also stated (quoting the NRC report) that "Very little confidence can be assigned to statements concerning the hemispheric mean or global mean surface temperature prior to about 900 A.D. because of sparse data coverage and because the uncertainties associated with proxy data and the methods used to analyze and combine them are larger than during more recent time periods." Again, nothing that the petitioner has provided suggests that this statement about uncertainty regarding early Holocene data is incorrect. Therefore, the issues raised by the petitioner do not cast doubt on or change any of the reasoning or the scientific basis for the Administrator's Findings.

With regard to the implications of early Holocene temperature reconstructions to attribution of recent temperature changes to human influences, we quote the NRC again:

> Surface temperature reconstructions have the potential to provide independent information about climate sensitivity and about the natural variability of the climate system that can be compared with estimates based on theoretical calculations and climate models, as well as other empirical data. However, large-scale surface temperature reconstructions for the last 2,000 years are not the primary evidence for the widely accepted views that global warming is occurring, that human activities are contributing, at least in part, to this warming, and that the Earth will continue to warm over the next century. (NRC, 2006)

Just as temperature reconstructions of the last 2,000 years are not the primary evidence for anthropogenic climate change, neither are temperature reconstructions of 8,000 years ago. Because climate forcings in the early Holocene were very different from present, whether the early Holocene was slightly warmer or cooler than today (an uncertainty recognized in the TSD and assessment literature) does not prove or disprove the anthropogenic nature of recent warming. Additionally, the major conclusions of Thompson et al. (2006) are consistent with those of the TSD on attribution. In fact, with regard to recent glacier retreat, the conclusion of the paper states:

> "These observations suggest that within a century human activities may have nudged global-scale climate conditions closer to those that prevailed before 5,000 yr ago, during the early Holocene. If this is the case, then Earth's currently retreating glaciers may signal that the climate system has exceeded a critical threshold…"

Therefore, the e-mails quoted by the petitioners demonstrate that the authors were making deliberate and appropriate choices in writing their chapter that reflected their ongoing dialogue over the best understanding of the science. Several of the issues identified by petitioners were indeed included in the chapter. While there is continuing uncertainty in reconstructions of early Holocene temperatures, as reflected even in the most recent papers, the EPA TSD makes no statements inconsistent with this uncertainty. Finally, early Holocene reconstructions are not central to the determination of attribution.

Comment (1-4):
Referring to previous discussions about Holocene temperatures, the petitioner states "Thus, it is clear that the IPCC AR4 is not an accurate assessment of the scientific literature, but instead includes only a selection of the literature that supports a particular viewpoint – one either held by the chapter IPCC authors, or which had been dictated to them by more influential IPCC authorities. This is perhaps the type of behavior that Chapter 6 Lead Author Briffa was referring to when he told a colleague 'I tried hard to balance the needs of the science and the IPCC, which were not always the same.'"

Response (1-4):
Response 1-3 above demonstrates that the e-mail authors were engaging in a dialogue over the best understanding of the science, and that the chapter did include uncertainties and conclusions consistent with the omitted papers. Response 2-30 in Subsection 2.2 of this Response to Petitions (RTP) document shows how the quote on the "needs of the science" was taken out of context by the petitioners, and that the work by Briffa was complimented on how it managed to "convey the the science accurately".

Comment (1-5):
The Competitive Enterprise Institute refers to a presentation by Don Easterbrook at the Geological Society of America (Easterbrook, 2009), stating Professor Easterbrook "demonstrated how tree ring data from Russia, which show a cooling after 1961, were artfully truncated in graphs presented in IPCC publications." The petitioner claims "This truncation gave the false impression that the tree ring data agree with reported late 20th Century surface temperature data, when in fact they did not. This artful deceit, now exposed, indicates that the IPCC Assessment Report 4 (AR4) is scientifically questionable. The CRU e-mails leaked in November confirmed that this deception was deliberate."

Response (1-5):
EPA has reviewed the petitioner's information and has determined that the graph provided by the petitioner from Professor Easterbrook's talk is not from the AR4, but rather from the Third Assessment Report, which was published in 2001 and is no longer the most recent IPCC assessment report. In the AR4, the latest data on this issue was assessed and depicted in Figure 6.10. In this figure, three out of the 12 reconstructions

terminate in 1960 (as noted in Table 6.1 in the same chapter), because the reconstructions in the underlying papers also terminate in 1960. Six of the 12 reconstructions extend to 1990 or later, again based on the time period covered by the relevant dataset.

EPA's TSD actually uses a figure from the NRC (2006), which shows six reconstructions, one of which terminates in 1960. Because these assessment reports are showing the entirety of the data represented in the underlying literature, there is no evidence of any "artful deceit," nor is this evidence that the AR4 is "scientifically questionable."

Comment (1-6):
Peabody Energy also quotes e-mail exchanges by Richard Alley and by John Mitchell before the release of the NRC (2006) report regarding divergence. For example, Peabody Energy cites the following excerpt from an e-mail by Richard Alley of Penn State to Jonathan Overpeck of the University of Arizona, written on March 11, 2006:

> My impression is that, for good reasons, the US NRC panel looking at the record of temperatures over the last millennium or two is not going to strongly endorse the ability of proxies to detect warming above the level of a millennium ago, and that a careful re-examination of the Chapter 6 wording and its representation in the TS and SPM would be wise. . .
>
> These considerations do somewhat affect the confidence that can be attached to the best estimate of recent warmth versus that of a millennium ago. If the paleoclimatic data could be confidently be interpreted as paleotemperatures, then joining the paleoclimatic and instrumental records would be appropriate, and the recent warmth would clearly be anomalous over the last millennium and beyond. By demonstrating that some tree-ring series chosen for temperature sensitivity are not fully reflecting temperature changes, the divergence issue widens the error bars and so reduces confidence in the comparison between recent and earlier warmth[5]

Peabody Energy also quotes Professor John Mitchell from the UK Met Office as stating:

> There needs to be a clear statement of why the instrumental and proxy data are shown on the same graph. The issue of why we dont show the proxy data for the last few decades (they dont show continued warming) but assume that they are valid for early warm periods needs to be explained

and

> I have not had time to check the original chapter, but the comments give the impression that the recent 50 yr warming is unprecedented over the last 500years (seems reasonable) and elsewhere over the last 1000years (less clear).[6]

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[5] E-mail file 1142108839.txt, (March 11, 2006), pages 1103-1104, lines 9-13 and 37-44 of PDF version entitled: CRU Emails 1996-2009.pdf
[6] E-mail file 1150923423.txt, (March 11, 2006), pages 1141-1142, lines 45-46 and 16-17 of PDF version entitled: CRU Emails 1996-2009.pdf

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Finally, Peabody Energy quotes an e-mail by Keith Briffa which stated "I know there is pressure to present a nice tidy story as regards 'apparent unprecedented warming in a thousand years or more in the proxy data' but in reality the situation is not quite so simple."[7]

Peabody Energy claims that "Taken together, the foregoing emails present a record of serious and sustained doubt about the validity of the proxy record, and particularly, as developed from tree rings. The divergence problem plainly concerned a number of respected researchers leading them to question not only the continued use of tree ring data in the science of paleoclimatology, but also the key theory based on that data: that recent warming of the 20th century is truly unprecedented and unmatched over a period of at least 1000 years."

Response (1-6):
The petitioner's arguments are flawed for several reasons, previously discussed. First, not all tree ring records demonstrate divergence, only a subset mainly in far northern latitudes. Second, while this divergence does raise potential issues about the applicability of those trees for reconstructions of warm eras, there are also a number of potential reasons for this divergence that are due to anthropogenic influences and that therefore would not reduce the value of these tree rings for reconstructions. Third, the TAR and AR4 do not solely rely on tree ring records in their assessment of temperatures in the past 1000 years. There are a number of other proxies that have been used. Mann et al. (2008) shows proxy reconstructions that do not use any tree rings at all.

Finally, the EPA TSD quotes both the NRC and the AR4 on the significant uncertainties involved in reconstructions before 1600. The TSD never claims that the current warming is "truly unprecedented in 1000 years," and neither does the AR4. What the IPCC AR4 says (Jansen et al., 2007) is:

> The TAR pointed to the 'exceptional warmth of the late 20th century, relative to the past 1,000 years'. Subsequent evidence has strengthened this conclusion. It is very likely that average Northern Hemisphere temperatures during the second half of the 20th century were higher than for any other 50-year period in the last 500 years. It is also likely that this 50-year period was the warmest Northern Hemisphere period in the last 1.3 kyr, and that this warmth was more widespread than during any other 50-year period in the last 1.3 kyr. These conclusions are most robust for summer in extratropical land areas, and for more recent periods because of poor early data coverage.

The AR4 does not use the term "unprecedented" in this statement, nor with respect to temperature in its Summary for Policymakers, and discusses that there is increased uncertainty before the "more recent periods".

In addition to these issues, the petitioners do not quote the full context of the e-mails and instead cherry-pick only segments. For example, in the above e-mail quoted from

[7] E-mail files 0938018124.txt, (September 22, 1999), page 205, line 22 of PDF version entitled: CRU Emails 1996-2009.pdf

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Richard Alley, he provides a long and detailed assessment of many of the issues involved in divergence. The petitioners do not, for example, quote his statement that "[t]hese considerations do not affect the best estimate that recent warmth is greater than that of a millennium ago; the central estimate from proxy data of latter-twentieth-century warmth is still above that of a millennium ago, with greater spatial coherence recently in the signal."[8] John Mitchell and Jonathan Overpeck are discussing how to address issues of uncertainty: Jonathan Overpeck forwarded these concerns from Mitchell to Keith Briffa and Tim Osborn so that they would be addressed in the IPCC chapter, and as noted above, the IPCC chapter includes a discussion of the relevant uncertainties and the divergence issue. Michael Mann's response to Briffa's arguments was that "Keith and Phil have both raised some very good points" [9], and many of Briffa's arguments were included in the final version of the IPCC AR4 chapter. For example, Keith Briffa argues in his e-mail that "I prefer a Figure that shows a multitude of reconstructions", and the figure in the chapter includes a multitude of reconstructions. The discussion of the MWP in the IPCC AR4 chapter (Jansen et al. 2007) heavily referenced and was consistent with Briffa's own research, concluding that:

> The evidence currently available indicates that NH mean temperatures during medieval times (950–1100) were indeed warm in a 2-kyr context and even warmer in relation to the less sparse but still limited evidence of widespread average cool conditions in the 17th century (Osborn and Briffa, 2006). However, the evidence is not sufficient to support a conclusion that hemispheric mean temperatures were as warm, or the extent of warm regions as expansive, as those in the 20th century as a whole, during any period in medieval times (Jones et al., 2001; Bradley et al., 2003a,b; Osborn and Briffa, 2006).

Therefore, the petitioners do not appropriately characterize the e-mails which they are excerpting, and the fundamental issues of uncertainty related to historical reconstructions were properly reflected in the EPA TSD and the Endangerment Findings.

Comment (1-7):

Peabody Energy quotes a 1999 e-mail in which Cook (Professor at the Lamont-Dohert Earth Observatory) asks Briffa (Professor at CRU), "Also, there is no evidence for a decline or loss of temperature response in your data in the post-1950s (I assume that you didn't apply a bodge here)"[10] in relation to a discrepancy between a *Nature* paper published at that time by Vaganov (1999) and an earlier *Nature* paper by Briffa (1998). Peabody Energy states that "By saying he assumed Briffa had not applied a "bodge," he seemed to be asking Briffa to confirm that Briffa had not masked divergence in the data through statistical legerdemain."

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[8] E-mail file 1142108839.txt, (March 11, 2006), page 1104, lines 34-37 of PDF version entitled: CRU Emails 1996-2009.pdf

[9] E-mail files 0938018124.txt, (September 22, 1999), page 205, line 22 of PDF version entitled: CRU Emails 1996-2009.pdf

[10] E-mail file 0932158667.txt, (July 16, 1999), page 180, lines 27-29 of PDF version entitled: CRU Emails 1996-2009.pdf

ED_001612_00028342-00018

Response (1-7):
In this 1999 e-mail, two scientists are discussing the results of papers that are now more than a decade old. The earlier *Nature* paper by Briffa (1998) (on which Vaganov was also a co-author) clearly stated in its abstract, "During the second half of the twentieth century, the decadal-scale trends in wood density and summer temperatures have increasingly diverged as wood density has progressively fallen." This statement is clearly flagging the divergence issue and rebuts the petitioner's claim that Briffa et al. "masked divergence" in their paper.

The paper by Vaganov explores the possibility that later spring snowmelt due to increased winter precipitation might explain the divergence observed in the data. In the e-mail discussion with Cook, Briffa is doubtful that this is the answer (though he does not rule it out) because his data do not show an effect of high precipitation and because the precipitation data in the region is "dubious." Cook notes that Vaganov used a different, more distant city from the tree ring site for the meteorological data for his paper than Briffa had used in the original, which may explain this difference.

This e-mail chain is clearly a professional discussion between colleagues attempting to understand the implications of newer literature. There is no evidence of any inappropriate behavior on the part of the scientists involved.

The Independent Climate Change E-Mail Review (The Independent Climate Change Email Inquiry, 2010) discussed the term "bodge" in their report, finding that the term referred to an ad hoc adjustment that was later validated:

> The term "bodging" has been used, including by Briffa himself, to refer to a procedure he adopted in 1992. The 'bodge' refers to the upward adjustment of the low-frequency behaviour of the density signal after 1750, to make it agree with the width signal. This *ad hoc* process was based on the conjecture that the width signal was correct. There is nothing whatsoever underhand or unusual with this type of procedure, and it was fully described in the paper. The interpretation of the results is simply subject to this caveat. The conjecture was later validated when it was shown to be an effect due to the standardisation technique adopted in 1992. Briffa referred to it as a "bodge" in a private e-mail in the way that many researchers might have done when corresponding with colleagues. We find it unreasonable that this issue, pertaining to a publication in 1992, should continue to be misrepresented widely to imply some sort of wrongdoing or sloppy science.

Comment (1-8):
Peabody Energy quotes from a July 2000 discussion between Bradley (Professor at UMass Amherst) and Frank Oldfield (Executive Director of the International Geosphere-Biosphere Programme Past Global Changes Core Project), in which they express concern that the divergence issue could "become a foothold for climate change skeptics."

The petitioner highlights part of the e-mail from Bradley, "Indeed, in the verification period, the biggest 'miss' was an apparently very warm year in the late 19th century that

we did not get right at all. This makes criticisms of the 'antis' difficult to respond to (they have not yet risen to this level of sophistication, but they are 'on the scent'). Furthermore, it may be that Mann et al simply don't have the long-term trend right, due to underestimation of low frequency info."[11]

The petitioner states that this quote shows "complete disregard of objective science in Bradley's statement that the 'antis' had not yet realized a possible flaw in the reconstructions but were 'on the scent.' Bradley appears much more interested in preserving the views of himself and his colleagues than in an objective and transparent scientific process."

Additionally, the petitioner highlights another July 2000 quote from Bradley that stated "The results were good, giving me confidence that if we had a comparable proxy data set for post-1980 (we don't!) our proxy-based reconstruction would capture that period well. Unfortunately, the proxy network we used has not been updated, and furthermore there are many/some/tree ring sites where there has been a 'decoupling' between the long-term relationship between climate and tree growth, so that things fall apart in recent decades.... this makes it very difficult to demonstrate what I just claimed."[12]

Response (1-8):
As noted in the latter quote provided by the petitioner, Bradley postulated that if more data for the period post-1980 existed, it would support his existing conclusions. This suggests that he believed that his conclusions are sound, though he recognized that the divergence issue limits the number of useable sites where his theory could be tested. Regarding discussion of the "antis," there is no evidence of any attempt to hide or ignore uncertainties by Bradley or his colleagues.

To the contrary, the quote from the petitioner is embedded in a larger paragraph that begins, "But there are real questions to be asked of the paleo reconstruction." Furthermore, the e-mail ends, "In Ch 7 we will try to discuss some of these issues, in the limited space available. Perhaps the best thing at this stage is to simply point out the inherent uncertainties and point the way towards how these uncertainties can be reduced."[13] Neither of these statements suggests that Bradley was merely "interested in preserving the views of himself and his colleagues," and both support the contention that he was indeed interested in "an objective and transparent scientific process." The petitioner selectively lifts words or phrases from e-mail correspondence to make unsupported, discrediting accusations.

Comment (1-9):
Peabody Energy claims that "The bona fides of McIntyre and McKitrick should have become evident after their 2003 paper and follow-up papers were published in peer-

[11]E-mail file 0963233839.txt, (July 10, 2000), page 263, line 9-13 of PDF version entitled: CRU Emails 1996-2009.pdf
[12] E-mail file 0963233839.txt, (July 10, 2000), page 262-263, line 43-46 and 1-3 of PDF version entitled: CRU Emails 1996-2009.pdf
[13] E-mail file 0963233839.txt, (July 10, 2000), page 262-263, lines 41-42 and 24-27 of PDF version entitled: CRU Emails 1996-2009.pdf

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reviewed scientific journals. Moreover, the independent Wegman Report subsequently confirmed the validity of their critiques of the hockey stick analysis and the methodological errors in that analysis that they brought to light, and the NRC report also confirmed that it was not confident of the central conclusions of the hockey stick paper." The Southeastern Legal Foundation also cites McIntyre, McKitrick, and the Wegman Report in order to criticize the "hockey stick affair".

Response (1-9):
The petitioners are critiquing a 1998 paper by Michael Mann ("the hockey stick paper"). This paper broke new ground in terms of temperature reconstructions of the past several hundred years and therefore attracted a lot of attention. Indeed, the petitioners focus on this 1998 paper despite the fact that many other reconstructions have been published in the decade since the original paper and several additional assessments have been conducted (including NRC [2006], which focused specifically on the divergence issue and new literature since Mann's paper). The TSD relied on the NRC (2006) report and the IPCC AR4, which were comprehensive assessments of the published literature, not only the early papers examined by the ad hoc Wegman report (2006) and McIntyre and McKitrick (2003).

We also note that there have been a number of peer-reviewed critiques and discussions of the McIntyre and McKitrick analyses (e.g., Rutherford et al. 2005, Juckes et al. 2007, von Storch and Zorita 2005, Huybers 2005, Wahl and Amman 2007). These papers question the validity of some aspects of the McIntyre and McKitrick critiques and find that correcting for other valid aspects of the critiques have "no significant effects on the reconstruction itself" (Wahl and Amman, 2007).

Therefore, the petitioners have overstated the implications of the "hockey stick" critiques, in terms of both the validity of the critiques and the reliance of EPA on the original "hockey stick" papers.

Comment (1-10):
Peabody Energy states that "In the fall of last year [2009], as a result of McIntyre's requests for data, the authors of a paper published in *Science* were forced to admit that they had flipped a data set upside down," referring to Kaufman et al. (2009).

Response (1-10):
A correction to Kaufman et al. (2009) was recently published in *Science* (Kaufman, 2010). This correction updated some of the proxies to "conform to the interpretations of the original authors" and acknowledged the contributions of "H. McCulloch and others who have pointed out errors and have offered suggestions."

However, the correction also stated that "[t]he original conclusions of the paper have been strengthened as a result," and "[t]he primary trends of the Arctic temperature reconstruction, however, are not changed, including the millennial-scale summer cooling that was reversed by strong warming during the 20th century and (on the basis of the instrumental record) continued through the last decade."

1.1.4 Assessment of the Evidence Provided by the Petitioners of Intentional Data Manipulation Regarding Tree Ring Data and the MWP

Comment (1-11):
Petitioners cite a statement in an e-mail written in November 1999 by Dr. Phil Jones (then co-director of the CRU), which states:

> "I've just completed Mike's Nature trick of adding in the real temps to each series for the last 20 years (ie from 1981 onwards) and from 1961 for Keith's to hide the decline."[14]

The petitioners claim that this e-mail "evidences CRU staff's effort to deliberately manipulate data to yield desired results." The Southeastern Legal Foundation states that some responses to this text reached the conclusion that the statement shows "an attempt to cook the books to conceal the fact that the famous 'hockey stick' is a manipulated, misleading barrel of scientific nonsense."

Response (1-11):
Based on our review of this string of e-mails, it appears that the quote citing "Mike's Nature Trick" referred to a graph prepared for the front cover of a WMO report, "WMO Statement on the Status of the Global Climate in 1999," which was under development at the time (WMO, 2000). While few details were provided about the cover graphic, the caption and text box referring to it discussed the uncertainties involved in historical temperature reconstructions. The figure developed for this WMO report is unrelated to the IPCC process. While it would have been clearer about its sources if the graph had overlaid the instrumental record using a separate color rather than merging the instrumental and proxy records together, this is an issue for WMO to address, considering the purpose of the report and the role of the graph on the cover. However, the graph and the method used to prepare the graph bear no relationship to the detailed technical discussion found in the assessment reports which EPA relied upon in the development of the TSD, which addressed all of the evidence and discussed the issue of tree ring data in the context of the entire body of paleoclimate evidence.

In fact, the evidence shows that the research community was fully aware of these issues and was not hiding or concealing them. The figure as developed for the WMO report was not used by the IPCC. Rather, the Third Assessment Report, published in 2001 (IPCC, 2001), had a full paragraph on "important caveats to be kept in mind" regarding paleoclimate reconstructions that use tree rings. The paragraph included a discussion of the divergence and concluded that tree rings were best used as one of multiple proxies rather than being the sole source for a climate reconstruction. The AR4, published in 2007, addressed the divergence issue in a paragraph that began "Several analyses of ring width and ring density chronologies, with otherwise well established sensitivity to temperature, have shown that they do not emulate the general warming trend evident in instrumental temperature records over recent decades…." Figure 6.10 in the AR4 and

[14] E-mail file 0942777075.txt, (November 16, 1999), page 243, lines 39-41 of PDF version entitled: CRU Emails 1996-2009.pdf

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Figure S-1 in the NRC report (which was replicated in Figure 4.3 in the EPA TSD) both clearly show a separate line for the instrumental temperature record and the lines provided by proxy reconstructions, unlike the WMO figure. Hence, the IPCC and additional assessment literature relied on by EPA transparently document, illustrate, and discuss the divergence issue, as did EPA in Volume 2 of the RTC document. The evidence (the CRU e-mails) the petitioners cite on this issue have no relevance on the Administrator's Findings.

The petitioners highlight the use of the word "trick." Contrary to the responses described by the Southeastern Legal Foundation, more formal reviews did not find that this phrase indicated an "attempt to cook the books". The UK Science & Technology Committee (2010) reviewed this specific e-mail in its investigation of the disclosure of climate data from the CRU. This investigation concluded: "We are content that the phrases such as 'trick' or 'hiding the decline' were colloquial terms used in private e-mails, and the balance of evidence is that they were not part of a systematic attempt to mislead."

Comment (1-12):
As part of a set of e-mails that purportedly "confirm certain scientists' efforts to 'artificially adjust' data," the Coalition for Responsible Regulation quotes from a 1996 e-mail by Gary Funkhouser of the University of Arizona: "I really wish I could be more positive about the Kyrgyzstan material, but I swear I pulled every trick out of my sleeve trying to milk something out of that."

Response (1-12):
The Funkhouser quote regarding "trying to milk something out of that" does not appear to be an example of an effort to "artificially adjust" data. The full e-mail contains quotes such as "The data's tempting but there's too much variation even within stands" and "Not having seen the sites I can only speculate, but I'd be optimistic if someone could get back there and spend more time collecting samples, particularly at the upper elevations."[15] Thus, this e-mail is most likely an example of a researcher being who is aware of the limits of the data, is committed to data that are of high quality, and did not draw stronger conclusions than the data warranted. We further note that this email is almost 14 years old, and has no relevance to the literature assessed in the reports upon which EPA relied or the Finding.

Comment (1-13):
As part of a set of e-mails that purportedly "confirm certain scientists' efforts to 'artificially adjust' data," the Coalition for Responsible Regulation quotes from a 2006 e-mail from Keith Briffa (a scientist at CRU) noting that "the PC1 time series in the Mann et al. analysis was adjusted to reduce the positive slope in the last 150 years," and that "this adjustment was arbitrary and the link between Bristlecone pine growth and CO_2 is, at the very least, arguable."[16]

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[15] E-mail file 0843161829.txt, (September 19, 1996), page 11, lines 13-14,16, and 19-21 of PDF version entitled: CRU Emails 1996-2009.pdf
[16] E-mail file 1163715685.txt, (November 16, 2006), page 1239, lines 9-10 and 15-16 of PDF version entitled: CRU Emails 1996-2009.pdf

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Response (1-13):
The Briffa e-mail does not appear to raise questions about artificially adjusting the data in the analysis. While Briffa appears to disagree with the adjustments used by Mann, he does note that the Mann adjustment was "following an earlier paper by Lamarche et al."[17] based on CO_2 fertilization estimates and therefore is consistent with the literature. Disagreement among scientists is part of the normal scientific process and is not evidence of deceit.

Comment (1-14):
As part of a set of e-mails that purportedly "confirm certain scientists' efforts to 'artificially adjust' data," the Coalition for Responsible Regulation quotes from a 2003 e-mail from Michael Mann (then of the University of Virginia) stating that "it would be nice to try to 'contain' the putative 'MWP' [Medieval Warm Period]."[18]

Response (1-14):
With regard to the Mann quote about containing the MWP, petitioners do not explain why the word "contain" is not a reference to timeframe rather than, as they imply, data manipulation. The full quote is: "I think that trying to adopt a timeframe of 2K [2000 years], rather than the usual 1K [1000 years], addresses a good earlier point that Peck made w/ regard to the memo, that it would be nice to try to 'contain' the putative 'MWP.'"[19] A 1,000-year-long reconstruction would only cover (i.e., "contain") part of the MWP, whereas 2,000 years would contain the entire MWP. In sum, although petitioners read into the quotes evidence of artificial adjustment of data, when examined in their entirety the quotes do not support this conclusion.

1.1.5 Assessment of Petitioners' Argument That the MWP May Have Been Warmer Than Present Temperatures

Comment (1-15):
Petitioners make a number of arguments claiming that the MWP may have been warmer than present temperatures. For example, petitioners claim that the divergence issue undermines our understanding of climate change, because "if tree rings missed the warming of the latter half of the 20th century, they may also have missed the warming in the MWP." They claim that all proxy data are unreliable for use in any time period. For example, Peabody Energy states that the effect of the divergence between tree ring proxy data and recent temperature data is to "reduce the mean and range of reconstructed values compared to what they actually were," thereby making comparisons between the MWP and recent observed temperatures "virtually impossible."

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[17] E-mail file 1163715685.txt, (November 16, 2006), page 1239, lines 10-11 of PDF version entitled: CRU Emails 1996-2009.pdf
[18] E-mail file 1054736277.txt, (June 4, 2003), page 510, lines 26-27 of PDF version entitled: CRU Emails 1996-2009.pdf
[19] E-mail file 1054736277.txt, (June 4, 2003), page 510, lines 25-27 of PDF version entitled: CRU Emails 1996-2009.pdf

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Petitioners ascribe great significance to the reconstructions of paleoclimate and their importance to our understanding of anthropogenic global warming and claim this evidence was misused by the IPCC. For example, Peabody Energy states that because both the IPCC Third and Fourth Assessment Reports relied on tree rings "to significantly downplay the MWP and LIA [Little Ice Age]," this casts doubt on "their conclusions that current warming is likely unprecedented in 1000 years." Southeastern Legal Foundation claims that "[p]rior naturally occurring episodes of warming and cooling present a problem of proof for the promoters of catastrophic anthropogenic global warming ("AGW"), namely how to explain that modern warming is caused by man when prior episodes of equal or greater warming self-evidently were not."

Response (1-15):
The Finding states that "We agree there was a Medieval Warm Period in many regions but find the evidence is insufficient to assess whether it was globally coherent. Our review of the available evidence suggests that Northern Hemisphere temperatures in the MWP were probably between 0.1°C and 0.2°C below the 1961–1990 mean and significantly below the level shown by instrumental data after 1980. However, we note significant uncertainty in the temperature record prior to 1600 A.D."

The TSD addresses paleoclimate in more depth, finding that "Less confidence can be placed in large-scale surface temperature reconstructions for the period from 900 to 1600 A.D" based on the NRC (2006) report, and further stating that "Considering this study and additional research, the IPCC (2007c) concluded: 'Paleoclimatic information supports the interpretation that the warmth of the last half century is unusual in at least the previous 1,300 years.' However, like NRC (2006), IPCC cautions that uncertainty is significant prior to 1600 (Jansen et al., 2007)."

With regard to the claim that the IPCC AR4 "downplays" the MWP and LIA, Jansen et al. (2007) clearly acknowledge the existence of and analyze the best estimates of the magnitude of both periods, noting the uncertainty due to limitations of past data, and conclude that

> The evidence currently available indicates that NH mean temperatures during medieval times (950–1100) were indeed warm in a 2-kyr context and even warmer in relation to the less sparse but still limited evidence of widespread average cool conditions in the 17th century (Osborn and Briffa, 2006). However, the evidence is not sufficient to support a conclusion that hemispheric mean temperatures were as warm, or the extent of warm regions as expansive, as those in the 20th century as a whole, during any period in medieval times (Jones et al., 2001; Bradley et al., 2003a,b; Osborn and Briffa, 2006).

Therefore, the TSD appropriately highlighted the uncertainty that was reflected in both the NRC report and the IPCC statements. The NRC and IPCC assessed the best available science and came to conclusions that appropriately reflected the underlying literature. The petitioners raise nothing new that was not already addressed by existing characterizations of the uncertainties involved in paleoclimate reconstructions made by the IPCC, NRC, and EPA in the TSD.

Comment (1-16):
Petitioners present a study by Loehle and McCulloch (2008) that calculated a 2,000-year reconstruction without using tree rings. Petitioners claim that this study shows that the MWP was as warm as the late 20th century.

Response (1-16):
EPA has reviewed the petitioners' submission of Loehle and McCulloch (2008) and finds that it was not impracticable to raise the objection during the public comment period and that the reasons for the objection did not arise between June 24, 2009, and February 16, 2010. Petitioners could have submitted this study during the comment period on the proposed Endangerment Finding. Although, in most cases, the petitioners provide excerpts from the CRU e-mails in support of their assertions, EPA's review has determined that this evidence does not support their allegations, and that the information submitted by petitioners on these topics was available well before the comment period for the Endangerment Finding. Petitioners have not shown why it would have been impractical for them to have submitted this study then. Indeed, similar points were already raised, and responded to, in the RTC. Despite the fact that these objections fail to meet the statutory timeframe for evidence supporting a petition for reconsideration, we briefly explain why, contrary to petitioners' allegation, they fail to call into question the Finding.

The petitioners presented a reconstruction from Loehle and McCulloch (2008) that claimed that without using tree rings they could show that the average of the warmest three decades of the MWP was a little warmer (though not in a statistically significant sense) than the three decades ending in 2006. The paper uses the straight average of 18 proxies, apparently with no attempt to weight the proxies to take into account the geographic distribution of the sites or the strength of their ability to detect temperature changes. In contrast, Mann et al. (2008) presented reconstructions both with and without tree rings, using geographic and other weighting corrections, and unlike Loehle (2008), they found that "Recent warmth appears anomalous for at least the past 1,300 years whether or not tree-ring data are used." We acknowledge that this is an area of ongoing research and that disagreements among researchers are to be expected, and as noted, the assessment literature and the TSD appropriately characterize the Medieval Warm Period and the uncertainties associated with reconstructing temperatures prior to 1600.

1.1.6 Assessment of the Petitioners' Argument that Questions About the MWP and Paleoclimate Reconstructions Limit Current Ability to Attribute Present Warming to Humans

Comment (1-17):
The Southeastern Legal Foundation claims that "The importance of these proxy reconstructions to the AGW conjecture can hardly be overstated. Since the Climategate documents gravely impeach the validity and reliability of these reconstructions, they are obviously of central relevance to the Endangerment Finding." Peabody Energy claims that the doubts raised in the CRU e-mails would make it harder to attribute recent warmth to human activity. The petitioners claim that if the current warming is not unprecedented,

this undermines our ability to determine that the recent warming is due to human influences.

Peabody Energy suggests that EPA relies on reconstructions of historic temperatures over the last 1,000 to 2,000 years as one of the three lines of evidence supporting the statement that GHGs are the root cause of recently observed climate change, but that neither the IPCC nor NRC provide "compelling" evidence that the temperatures of the last several decades are unusual in that context. Peabody Energy further refers to the CRU e-mails discussing uncertainties in historic temperatures, including the divergence in the tree-ring temperature reconstruction in the late part of the 20th century.

Response (1-17):
The assertions that proxy reconstructions are of "central relevance to the Endangerment Finding" and that the importance of these reconstructions "can hardly be overstated" are inconsistent with the scientific literature on attribution. On this issue, the TSD states that the unusual nature of global surface temperature changes in the past decades are one line of evidence contributing to the confidence in statements about attribution (pg. 47), relying on Karl et al. (2009). The Finding makes the same argument (page 66523). The TSD also notes in Box 5.1 that the IPCC AR4 found that paleoclimate analyses increased confidence in the role of external influences on climate, relying on Hegerl et al. (2007). However, the relative warmth of the MWP and Holocene are just part of the paleoclimate data referred to by Karl et al. and Hegerl et al., and historical paleoclimate data is only one line, and not the primary line, of evidence supporting attribution.

According to Hegerl et al. (2007), paleoclimate data is used to "test understanding of the climate response to external forcings" (where external forcings include volcanic eruptions, solar variability, and changes in GHGs, but not internal variability such as El Niño events). Hegerl et al. note that the past 1,000 years of analyses focus on responses to changes in solar radiation and volcanism. The other time periods mentioned in the chapter are the mid-Holocene (6,000 years ago) and the last glacial maximum (21,000 years ago). Hegerl et al. state that the similarity between modeled and reconstructed temperatures over the past 1,000 years increases confidence that the inability to simulate modern warming without anthropogenic forcing shows the impact of human activity. However, they also note that the uncertainty in both temperature reconstructions and the solar and volcanic forcings makes it difficult to fully assess models in this way. For example, a reconstruction that showed a colder MWP simultaneous with a warmer sun would be harder to explain than a warmer MWP.

The NRC (2006) explicitly addressed this issue at length:

> Surface temperature reconstructions have the potential to provide independent information about climate sensitivity and about the natural variability of the climate system that can be compared with estimates based on theoretical calculations and climate models, as well as other empirical data. However, large-scale surface temperature reconstructions for the last 2,000 years are not the primary evidence for the widely accepted views that global warming is occurring, that human activities are contributing,

at least in part, to this warming, and that the Earth will continue to warm over the next century. The primary evidence for these conclusions (see, e.g., NRC 2001) includes:

- Measurements showing large increases in carbon dioxide and other greenhouse gases beginning in the middle of the 19th century, instrumental measurements of upward temperature trends and concomitant changes in a host of proxy indicators over the last century.

- Simple radiative transfer calculations of the forcing associated with increasing greenhouse gas concentrations together with reasonable assumptions about the sign and magnitude of climate feedbacks.

- Numerical experiments performed with state-of-the-art climate models.

Supporting evidence includes:

- The observed global cooling in response to volcanic eruptions is consistent with sensitivity estimates based on climate models.

- Proxy evidence concerning the atmospheric cooling in response to the increased ice cover and the decreased atmospheric carbon dioxide concentrations at the time of the last glacial maximum is consistent with sensitivity estimates based on climate models.

- Documentation that the recent warming has been a nearly worldwide phenomenon.

- The stratosphere has cooled and the oceans have warmed in a manner that is consistent with the predicted spatial and temporal pattern of greenhouse warming.

Surface temperature reconstructions for the last 2,000 years are consistent with other evidence of global climate change and can be considered as additional supporting evidence. In particular, the numerous indications that recent warmth is unprecedented for at least the last 400 years and potentially the last several millennia, in combination with estimates of external climate forcing variations over the same period, support the conclusion that human activities are responsible for much of the recent warming. However, the uncertainties in the reconstructions of surface temperature and external forcings for the period prior to the instrumental record render this evidence less conclusive than the other lines of evidence cited above. It should also be noted that the scientific consensus regarding human-induced global warming would not be substantively altered if, for example, the global mean surface temperature 1,000 years ago was found to be as warm as it is today.

It is important to point out that, in drawing the conclusion that multiple lines of evidence indicate GHGs are the root cause of recently observed climate change, EPA does not claim that any individual line of evidence by itself necessarily forms the "compelling" evidence of human-induced climate change. Rather, the multiple lines of evidence collectively form the compelling evidence.

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EPA did not state that the reconstructions of prior temperatures alone provide evidence that the recent warming is unusual, nor that the evidence that recent warming is unusual is "compelling" as stated by the petitioners. Instead, EPA appropriately reflected the uncertainty raised in the scientific literature in its statements, as described in Subsection 1.1.2 and many responses to comments in Subsection 1.1.3 of this Response to Petitions (RTP) document. The TSD appropriately highlighted the uncertainty that was in both the NRC report and the IPCC statements. EPA properly found that this evidence "supports" the interpretation that the recent warming is unusual. The arguments raised by Petitioners about the MWP and about other issues related to temperature reconstructions do not change or undermine the basis for this conclusion.

In addition, even if the global mean temperature was as warm or warmer during the MWP as it is today (which is not consistent with the best estimates of the scientific assessments, nor supported by petitioners' arguments), recent warming would still be "unusual," even if not "unprecedented". EPA never stated that recent warming was "unprecedented." In fact, the TSD reserved the use of the term "unprecedented" for the rate of increase of radiative forcing in the past 10,000 years and for the likely impacts on ecosystems due to a combination of changes in climate and other global change drivers over the next 100 years, should GHG emissions continue at or above current rates.

Additionally, uncertainty over the exact temperatures in the MWP does not change the fact that other critical lines of evidence strongly support the view that GHGs are the root cause of recent warming, such as our basic physical understanding of how GHGs trap heat, how the climate system responds to an increase in GHGs, and how other human and natural factors influence climate and the broad, qualitative consistency between observed changes in climate and the computer model simulations of how climate would be expected to change in response to human activities. The NRC report "Advancing the Science of Climate Change" (NRC, 2010) summarizes the many lines of evidence that support the conclusion that most of the observed warming over at least the last several decades is due to human activities:

- Both the basic physics of the greenhouse effect and more detailed calculations using sophisticated models of atmospheric radiative transfer indicate that increase in atmospheric GHGs should lead to warming of the Earth's surface and lower atmosphere.

- Earth's surface temperature has unequivocally risen over the past 100 years, to levels not seen in at least several hundred years and possibly much longer, at the same time that human activities have resulted in sharp increases in CO_2 and other GHGs [as discussed above].

- Detailed observations of temperatures, GHG increases, and other climate forcing factors from an array of instruments, including Earth-orbiting satellites, reveal an unambiguous correspondence between human-induced GHG increases and planetary warming over at least the past three decades, in addition to substantial year-to-year climate variability.

- The vertical pattern of atmospheric temperature change over the past few decades, with warming in the lower atmosphere and cooling in the stratosphere, is consistent with the pattern expected due to GHG increases and inconsistent with the pattern expected if other climate forcing agents (e.g., changes in solar activity) were responsible.

- Estimates of changes in temperature and forcing factors over the first seven decades of the 20th century are slightly more uncertain and also reveal significant decadal-scale variability, but nonetheless indicate a consistent relationship between long-term temperature trends and estimated forcing by human activities.
- The horizontal pattern of observed temperature change over the past century, with stronger warming over land areas and higher latitudes, is consistent with the pattern of change expected from a persistent positive climate forcing.

- Detailed numerical model simulations of the climate system are able to reproduce the observed spatial and temporal pattern of warming when anthropogenic GHG emissions and aerosols are included in the simulation, but not when only natural climate forcing factors are included.

- Both climate model simulations and reconstructions of temperature variations over the past several centuries indicate that the current warming trend cannot be attributed to natural variability in the climate system

- Estimates of the climate forcing and temperature changes on a range of timescales, from the several years following volcanic eruptions to the 100,000+ year Ice Age cycles, yield estimates of climate sensitivity that are consistent with the observed magnitude of observed climate change and estimated climate forcing.

- Finally, there is not any compelling evidence for other possible explanations of the observed warming, such as changes in solar activity, changes in cosmic ray flux, natural climate variability, or release of heat stored in the deep ocean or their climate system components.

Another example of evidence supporting human influence on recent warming given by the TSD is that observations of natural influences such as solar variability and historical volcanism over the past century are not consistent with the pattern of observed temperature trends. In general, Karl et al. (2009) found that a number of aspects of modeled and theoretically predicted responses to human-induced climate change were consistent with observations. As Karl et al. state:

> This conclusion rests on multiple lines of evidence. Like the warming "signal" that has gradually emerged from the "noise" of natural climate variability, the scientific evidence for a human influence on global climate has accumulated over the past several decades,

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from many hundreds of studies. No single study is a "smoking gun." Nor has any single study or combination of studies undermined the large body of evidence supporting the conclusion that human activity is the primary driver of recent warming.

1.1.7 Summary

The IPCC, NRC, and TSD appropriately reflected the uncertainty involved in temperature reconstructions, including those for the MWP and the early Holocene. This involved considering the entire body of evidence, including the kinds of evidence and arguments presented by petitioners. Petitioners' evidence and arguments do not warrant any revisions to these conclusions and their related caveats on degree of certainty. In general, petitioners have not considered the breadth of evidence on these issues and the clear recognition and documentation of the uncertainty concerning temperature reconstructions of the past. They have instead relied upon a limited selection of e-mails, studies, and other evidence that does not warrant the broad conclusions they have drawn.

The issue of divergence of some tree ring records was discussed in depth in the assessment literature and in the RTC document, and the petitioners have not shown that these discussions were incorrect or incomplete. While the graph used for the cover of a 1999 World Meteorological Organization (WMO) report did not disclose this divergence, the graph is both outdated and unrelated to any of the assessment reports or the Findings. The quotes provided by the petitioners as examples of "deliberate manipulation" or "artificial adjustments" are taken out of context and do not support this view.

The petitioners have not shown that the uncertainty concerning the temperature during historical time periods is any different or higher than the degree of uncertainty clearly recognized in the assessment reports and considered by the Administrator in the Endangerment Finding. EPA stated that "We agree there was a Medieval Warm Period in many regions but find the evidence is insufficient to assess whether it was globally coherent. Our review of the available evidence suggests that Northern Hemisphere temperatures in the MWP were probably between 0.1°C and 0.2°C below the 1961–1990 mean and significantly below the level shown by instrumental data after 1980. However, we note significant uncertainty in the temperature record prior to 1600 A.D." The assessment literature did not conclude that the current warming is definitively unique or unprecedented, but that it is unusual, properly accounting for the uncertainty associated with temperature reconstructions. The petitioners have provided no evidence that indicates a different conclusion is appropriate in light of all of the scientific evidence, or that the Administrator failed to properly account for this uncertainty. The broad conclusions drawn by petitioners are not warranted by the limited evidence they rely upon.

The CRU e-mails and other evidence do not materially change or warrant any less reliance on the paleoclimate temperature reconstructions. Petitioners' objections to certain aspects of the science behind paleoclimate reconstructions are without merit, as discussed above. Petitioners fail to consider or contest the other scientific bases for the temperature reconstructions, and fail to provide arguments that take into consideration the entire body of evidence. Petitioners also mischaracterize the limited role that

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paleoclimate temperature reconstructions play in attributing recent warming to atmospheric concentrations of GHGs. EPA and the assessment literature consider this one of three lines of evidence, and largely as supporting evidence, in light of the recognized uncertainties in this area of science. Petitioners' arguments do not support changing the degree of reliance EPA properly placed on this one line of evidence.

The CRU e-mails and other evidence also do not materially change or warrant any less reliance on the other important lines of evidence linking GHGs and climate change: our basic physical understanding of the effects of changing GHG concentrations and other factors; the broad, qualitative consistency between observed changes in climate and the computer model simulations of how climate would be expected to change in response to human activities; and other important evidence of an anthropogenic fingerprint in the observed warming. All of the lines of evidence cited in the TSD concerning attribution, including paleolcimate temperature reconstructions, properly reflect the literature as far as the degree of certainty involved in each, and the scientific conclusion on attribution that is drawn from them is based on consideration of the entire body of evidence and not from any single element. Petitioners do not attempt to assess this entire body of evidence and do not show that when considered as a whole, it leads to a different conclusion on attribution from that found by EPA.

1.2 Attribution of Recent Temperature Trends and Models

1.2.1 The Validity of the Human "Fingerprint" in the Vertical Temperature Structure of the Atmosphere Over the Tropics

1.2.1.1 Background

Supporting the attribution of GHGs to climate change is the vertical pattern of temperature change that has been observed in recent decades, as briefly described in Subsection 1.1.2.5 and discussed in Section 5 of the TSD. "Fingerprint studies" are often used to assess and identify the human contribution to observed changes in the vertical temperature structure of the atmosphere. Fingerprint studies compare the patterns of observed temperature changes with results from models that account for GHG levels and determine whether or not similarities could have occurred by chance. The assessment literature documents the identification of these fingerprints—where observations and models match and similarities are not expected to have occurred by chance—which the TSD summarizes as follows:

> Fingerprint studies have identified GHG and sulfate aerosol signals in observed surface temperature records, a stratospheric ozone depletion signal in stratospheric temperatures, and the combined effects of these forcing agents in the vertical structure of atmospheric temperature changes (Karl et al., 2006).

In many parts of the world, the anthropogenic fingerprint has been unambiguous. However, the fingerprint in the tropics only recently has become apparent, as the TSD explains:

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> … However, an important inconsistency may have been identified in the tropics. In the tropics, most observational data sets show more warming at the surface than in the troposphere, while almost all model simulations have larger warming aloft than at the surface (Karl et al., 2006). Karl et al. (2009) state that when uncertainties in models and observations are properly accounted for, newer observational data sets are in agreement with climate model results.

EPA references Karl et al. (2009) (the USGCRP 2009 assessment), which synthesizes the results of several new studies to conclude that models are in general agreement with observations in the tropical troposphere. EPA referred to these same studies in Volume 3 of the RTC document, in response to public comment.

1.2.1.2 Assessment of the Arguments Regarding the Vertical Temperature Structure Over the Tropics

Comment (1-18):
Peabody Energy asserts that the CRU e-mails call into question the reliability of studies supporting the existence of a human (i.e., anthropogenic GHG) "fingerprint" in the vertical temperature structure of the atmosphere (i.e., in the troposphere) over the tropics. Peabody Energy claims that the CRU e-mails reveal that the authors of fingerprint studies published their results in an "inappropriate and indeed unethical way." Peabody Energy also suggests that the lack of an anthropogenic fingerprint in the tropics would challenge the assessment literature finding of consistency between models and observations, which supports a primary line of evidence linking GHGs and climate change.

Specifically, Peabody Energy claims the authors of a significant article—Santer et al., 2008—supporting the existence of an anthropogenic tropical fingerprint, along with some other scientists with whom Santer corresponded, exerted improper influence to delay the print publication of a paper by Douglass et al. (2007) that did not identify a tropical fingerprint. Peabody Energy's chief allegation is that the print publication of Douglass et al. in the *International Journal of Climatology* (IJC), a paper which was originally published online in December 2007, was stalled until November 2008 to coincide with publication of Santer et al. (2008), a paper which rebutted the Douglass et al. findings. According to Peabody Energy, the simultaneous print publication of Santer et al. (2008) and Douglass et al. (2007) prevented Douglass et al. from having an opportunity for a simultaneous response to Santer's paper. The petitioner claims, "The gamesmanship behind this strategy diverted the process of scientific inquiry from its proper path and tainted the material on which the Agency now seeks to rely." Peabody Energy claims that dozens of e-mails document inappropriate conduct on the part of the authors and editors of the journals that published the studies supporting the presence of a tropical fingerprint.

Response (1-18):
Peabody Energy does not offer any substantive basis for questioning the technical validity of the studies cited by EPA (and USGCRP), which rebut Douglass et al. The Santer et al. study convincingly detailed a number of errors in the Douglass et al. study, the most blatant of which was the inappropriate calculation of uncertainty range of model

estimates, which was off by a factor of almost five in Douglas et al. (2007). Peabody's claims of lack of reliability of the studies at issue are without scientific basis.

We also note that more than 18 months have passed since publication of Santer et al. (2008). Certainly, Douglass et al. have had ample opportunity to publish a rebuttal and defend their analysis during this time, either as a reply to Santer et al. in the IJC or as a new analysis in a different journal. Such a step is common in areas of active scientific discourse, where scientists go back and forth in the literature until the issues are resolved. However, to our knowledge, Douglass et al. have not responded with a scientific response that has been accepted for publication in a peer-reviewed journal.

Peabody instead relies upon an assertion of lack of scientific credibility because of the timing of the article, not the substance of the article. The timing of the study's publication bears no relationship to its scientific or technical validity. At most, Peabody is concerned that the paper publication of an article already available online occurred at the same time as a rebuttal. The lack of an opportunity for a simultaneous response is unrelated to the scientific merit of the study, especially when it appears no response has been forthcoming. There is no scientific merit to Peabody's argument.

Furthermore, Peabody Energy is incorrect in asserting that EPA relied solely on Santer et al. to rebut Douglass et al. (2007). In response to public comment, RTC (3-7) also cites studies by Haimberger et al. (2008) and Allen and Sherwood (2008), which were published in other journals (*Journal of Climate* and *Nature Geoscience*, respectively) and assessed by USGCRP.

Peabody Energy attempts to implicate several of the authors of the Haimberger et al. and Allen and Sherwood studies by linking them to the IJC dispute, because several of the authors were copied on some of the CRU e-mails in which the Douglass et al. (2007) results are discussed. However, Peabody Energy provides no evidence these authors were in any way involved in the publication timing of either the Douglass et al. or Santer et al. paper in the IJC.

In summary, questions raised by petitioners concerning the timing of the paper publication of papers in IJC do not provide any substantive basis for questioning the validity of the scientific conclusions of the studies at issue or the assessment literature (i.e., Karl et al., 2009) and EPA on this issue. For more detailed discussion of the CRU e-mails pertaining to the publication of studies on the existence of a human fingerprint in the vertical temperature structure of the atmosphere over the tropics and what the e-mails signify, refer to Subsection 3.3.3 in Volume 3 of this RTP document. .

Comment (1-19):
Peabody Energy suggests that Ben Santer, a research scientist at Lawrence Livermore Laboratory and lead author of the Santer et al. (2008) study discussed above, improperly accuses Douglass et al. of neglecting datasets that do not suggest a discrepancy between observations and models in the vertical structure of the atmosphere in the tropics. The petitioner quotes an e-mail from Melissa Free, co-author of a paper acknowledging the

existence of a discrepancy between observations and models, which was also the basic conclusion of Douglass et al. (2007). Free's e-mail states: "What about the implications of a real model-observation difference for upper-air trends? Is this really so dire?"[20]

Peabody Energy quotes Santer's response: "What is dire is Douglass et al.'s willful neglect of any observational datasets that do not support their arguments."[21] According to Peabody Energy, Santer was referring to two radiosonde datasets—RAOBCORE v1.3 and v1.4—that were excluded from the analysis in Douglass et al. (2007). Peabody Energy states that Douglass et al. (2007) explained in an addendum that these datasets are faulty.

Response (1-19):
The comment by Santer about Douglass' neglect of datasets was an informal communication with colleagues, which was written in December 2007, before Douglass et al. submitted the addendum to which Peabody Energy refers; the addendum was submitted in January 2008. We note that this addendum was not accepted for publication and seems to be available only via the author's personal website. The formal rebuttal to Douglass et al. remains the peer-reviewed paper by Santer et al., which states:

> Our results contradict a recent claim that all simulated temperature trends in the tropical troposphere and in tropical lapse rates are inconsistent with observations. This claim was based on use of older radiosonde and satellite datasets, and on two methodological errors: the neglect of observational trend uncertainties introduced by interannual climate variability, and application of an inappropriate statistical "consistency test."

As stated in the preceding response, to date, Douglass et al. have not published a rebuttal to Santer et al.'s formal critique. Furthermore, the quote from Melissa Free does not acknowledge the existence of a discrepancy between observations and models; it is raising the possibility as a hypothetical.

1.2.2 Global Temperature Trends Over the Last Decade and Implications for Attribution of These Trends to GHGs

1.2.2.1 Background

According to the latest National Oceanic and Atmospheric Administration (NOAA) data (NOAA, 2010a), the decade spanning 2000–2009 was substantially warmer than the prior decade (1990–1999). Every year from 2000 to 2009 was warmer than the 1990–1999 average. Using data available through 2008, the TSD in Box 4.1 states that "the warming rate in the last 10 30-year periods (averaging about 0.30°F [0.17°C] per decade) is the greatest in the observed record..." However, depending on one's choice of temperature record and the start and stop date chosen for computing a trend in that record, it is

[20] E-mail file 1196956362.txt, (December 6, 2007), page 1371, line 10-11 of PDF version entitled: CRU Emails 1996-2009.pdf
[21] E-mail file 1196956362.txt, (December 6, 2007), page 1371, line 5-6 of PDF version entitled: CRU Emails 1996-2009.pdf

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possible to demonstrate a slowdown in the rate of warming over the last 10 years or so relative to the rate of warming observed over the last several decades.

The assessment literature, as summarized in the TSD, emphasizes that "that year-to-year fluctuations in natural weather and climate patterns can produce a period that does not follow the long-term trend" (Karl et al., 2009). More recent assessment literature, not available for inclusion in the Endangerment TSD, states (NRC, 2010), "it is not appropriate to look at only a short period of the overall record (such as changes over just the last five or ten years) to infer major changes in the trajectory of global warming."

The responses in this section address petitioners' arguments about the meaning and implications of a possible slowdown in the rate of warming.

1.2.2.2 Assessment of Arguments Regarding Global Temperature Trends Over the Last Decade and Implications for Attribution of These Trends to GHGs

Comment (1-20):
Peabody Energy alleges that the "CRU material … contradicts EPA's assertion that the results of climate models constitute a third line of evidence that can be relied on to attribute climate change to anthropogenic GHG emissions." To support this conclusion, Peabody Energy refers to CRU e-mails in which scientists discuss the possible slowdown in warming over the last 10 years or so.

Response (1-20):
This issue is not new and was the subject of public comment during development of EPA's Findings. As discussed in the TSD, analysis of surface and lower tropospheric temperature data over the last 10 or so years indicates that the rate of warming may have temporarily slowed, although the magnitude of the slowdown varies depending on dataset analyzed and choice of start date. Contrary to the argument of the petitioner, such a possible slowdown does not "eviscerate" the scientific support for climate change, which is a long-term process. As explained in Box 4.1 of the TSD:

> It is important to recognize that year-to-year fluctuations in natural weather and climate patterns can produce a period that does not follow the long-term trend (Karl et al., 2009). Thus, each year will not necessarily be warmer than every year before it, though the long-term warming trend continues (Karl et al., 2009).

In addition, the recent NRC (2010) states: "Individual years, or even individual decades, can deviate from the long term trend due to natural climate variability. Thus, it is not appropriate to look at only a short period of the overall record (such as changes over just the last five or ten years) to infer major changes in the trajectory of global warming."

As demonstrated by the detailed responses below, the petitioner's evidence does not warrant the conclusion that current explanations for the possible slowdown in warming are invalid, or that this slowdown undermines our confidence in the utility of climate models for either attributing or projecting climate change over appropriately long timescales.

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Comment (1-21):
In support of the argument that the short-term slowdown in warming undermines the science supporting the Findings, Peabody Energy specifically highlights an e-mail from climate scientist Kevin Trenberth (Head of the Climate Analysis Section at the National Center for Atmospheric Research) stating, "The fact is that we can't account for the lack of warming at the moment and it is a travesty that we can't."[22] On this basis, Peabody Energy asserts that "Trenberth was unconvinced that the recent lack of warming was consistent with the scientific understanding of the climate system on which the models are based." Peabody Energy concludes that "Trenberth's statement eviscerates the grounds for EPA's Endangerment Finding" and posits that "…if, as Trenberth says, the science is too uncertain to determine whether GHG reductions will produce a measurable climate response, then there is no basis to regulate and no basis to express confidence that anthropogenic GHG emissions are primarily responsible for the warming of the last several decades."

Response (1-21):
Peabody Energy's interpretation of the Trenberth e-mail is a profound misinterpretation of the context and meaning of his statement. It is not in any sense an admission that the science underlying the climate models is compromised. In response to questions about the context of the quote, Trenberth provided the following clarification on the website of his employer, the University Center for Atmospheric Research (Trenberth, 2010):

> It is amazing to see this particular quote lambasted so often. It stems from a paper I published this year bemoaning our inability to effectively monitor the energy flows associated with short-term climate variability. It is quite clear from the paper that I was not questioning the link between anthropogenic greenhouse gas emissions and warming, or even suggesting that recent temperatures are unusual in the context of short-term natural variability.
>
> This paper tracks the effects of the changing Sun, how much heat went into the land, ocean, melting Arctic sea ice, melting Greenland and Antarctica, and changes in clouds, along with changes in greenhouse gases. We can track this well for 1993 to 2003, but not for 2004 to 2008. It does NOT mean that global warming is not happening…

Furthermore, the paper Trenberth references in this clarification states the following (Trenberth, 2009):

> The present-day climate is changing mainly in response to human-induced changes in the composition of the atmosphere as increases in greenhouse gases promote warming…

Peabody Energy's assertion that Trenberth was implying that the "science is too uncertain to determine whether GHG reductions will produce a measurable climate response," is a gross mischaracterization of the meaning and significance of both the quote and

[22] E-mail file 1255352257.txt, (October 12, 2009), page 1801, lines 26-27 of PDF version entitled: CRU Emails 1996-2009.pdf

Trenberth's position. Trenberth was not implying or questioning the validity of climate models used for attribution and projections. He was identifying a gap in the Earth-observing system, which if filled, would improve our understanding of short-term variations in climate.

Comment (1-22):
Petitioners (Competitive Enterprise Institute and Southeastern Legal Foundation) refer to a recent interview between CRU scientist Phil Jones and the BBC in which temperature trends are discussed, with an emphasis on the last seven to 15 years (Harribin, 2010). They highlight a question for CRU scientist Phil Jones - "Do you agree that from 1995 to the present there has been no statistically-significant global warming?" - to which he responds "Yes." The Competitive Enterprise Institute parenthetically mentions that Jones states that there had indeed been warming during the period but that it was not statistically significant. Based on this statement from Phil Jones, Southeastern Legal Foundation concludes: "Under the circumstances, it is apparent that there is no need to rush headlong into a potentially irrational and arbitrary decision [a reference to the need to regulate GHGs]." Additionally, the Competitive Enterprise Institute notes that, in this interview, Jones indicates that there has been statistically insignificant cooling since 2002, appearing to contradict a statement (Reuters, 2008[23]) he made on how the 2001–2007 period was warmer than the previous decade.

Response (1-22):
The Competitive Enterprise Institute and Southeastern Legal Foundation are not presenting new information or making a new argument. The Jones statement does not substantively add to what we have already responded to in the RTC (e.g., see RTC 2-41). The TSD is very clear that some datasets show a possible slowdown in the warming trend in the last decade or so. Box 4.1 of the TSD states:

> Though most of the warmest years on record have occurred in the last decade in all available datasets, according to an analysis of the HadCRUT dataset in the "State of the Climate in 2008" report (Peterson and Baringer, 2009), the rate of warming has, for a short time, slowed. The temperature trend calculated for January 1999 to December 2008 was about +0.13 ± 0.13°F (+0.07 ± 0.07°C) per decade, which is less than the 0.32°F (0.18°C) per decade trend recorded between 1979 and 2005 (or 0.30°F [0.17□C] per decade for 1980 to 2008 as stated above). However, NOAA [the National Oceanic and Atmospheric Administration] (NOAA, 2009a) and NASA [the National Aeronautics and Space Administration] (NASA, 2009) trends do not show the same marked slowdown for the 1999-2008 period. The NOAA trend was ~0.21°F (0.12□C) per decade while the NASA trend was ~0.34°F (0.19□C) per decade. The variability among datasets is a reflection of fewer data points and some differences in dataset methodologies. Analysis of trends for the years 2000, 2001, and 2002 through 2008 indicate a rather flat trend, with slight warming or cooling depending on choice of dataset

[23] CEI provided the following link in its petition, but this link does not seem to work: http://www.news24.com/Content/SciTech/News/1132/ 1249c274c6df42cca1302d82e4236ef6/11-01-2008-06-57/Earth_still_warming#. We believe an active link for the article cited is http://www.news24.com/SciTech/News/Earth-still-warming-20080111.

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> and start date. It is important to recognize that year-to-year fluctuations in natural weather and climate patterns can produce a period that does not follow the long-term trend (Karl et al., 2009). Thus, each year will not necessarily be warmer than every year before it, though the long-term warming trend continues (Karl et al., 2009).

In other words, the fact that the warming rate may have temporarily slowed was recognized and taken into full account in the endangerment record.

In addition, the petitioner only includes part of Jones' full response to BBC's interview question. Here is the question and complete response (Harribin, 2010):

> **[BBC] - Do you agree that from 1995 to the present there has been no statistically-significant global warming**
>
> [Jones] Yes, but only just. I also calculated the trend for the period 1995 to 2009. This trend (0.12C per decade) is positive, but not significant at the 95% significance level. The positive trend is quite close to the significance level. Achieving statistical significance in scientific terms is much more likely for longer periods, and much less likely for shorter periods.

As the complete response indicates, the Competitive Enterprise Institute and Southeastern Legal Foundation fail to mention that Jones found the warming nearly statistically significant and that he explains the limitations of analyzing temperature trends over short time periods. The petitioners' implication that the lack of statistically significant warming over a few years somehow negates the rationale for action is not supported by the science or Dr. Jones' statements.

Regarding the "cooling" Jones mentions since 2002, as the Competitive Enterprise Institute itself notes, it is statistically insignificant. Furthermore, it is analyzed over a completely inappropriate time period for discerning long-term trends, as stated in both the scientific literature and the endangerment record. The fact that Jones computed a negative temperature trend over this very short period does not contradict the statement he had made the year before (in 2008) about the 2001–2007 period, described by the news service Reuters accordingly (Reuters, 2008):

> Underscoring an underlying rise in temperatures, British forecaster Phil Jones said 2001-07, with an average of 0.44 Celsius above the 1961-90 world average of 14 degrees, was 0.21 degrees warmer than the corresponding values for 1991-2000.

In this Reuters article, Jones was referring to absolute temperature levels in 2001–2007 compared to absolute temperatures in 1991–2000, rather than the 2002–2009 time series discussed in the BBC interview. Further, a very recent analysis by NOAA's National Climatic Data Center (NCDC) (NOAA, 2010b)—using its own temperature record—corroborates Jones' statement. The NOAA analysis indicates that the 2000–2009 period was substantially warmer than the prior decade. Importantly, every year from 2000 to 2009 was warmer than the 1990–1999 average, as shown in the figure below.

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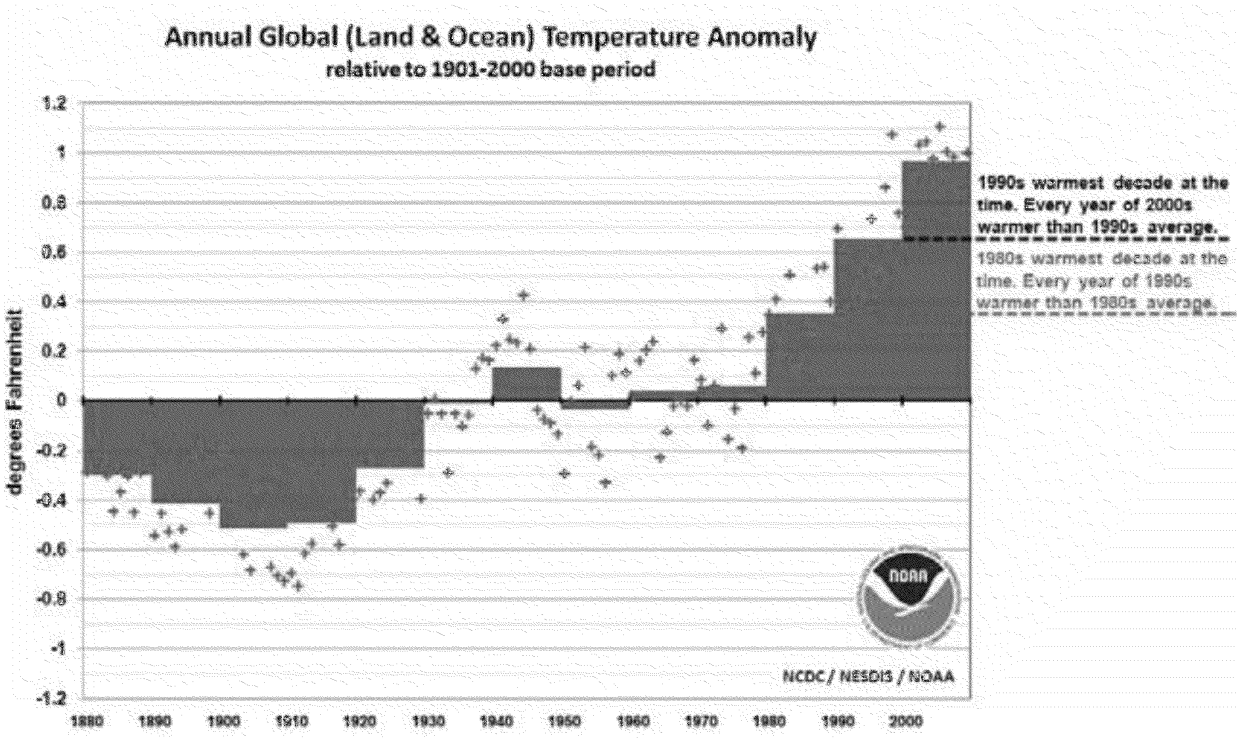

To summarize, the TSD and endangerment record address short-term trends in the temperature record in a manner that is entirely consistent with the statements in Jones' BBC interview. The petitioners have not provided any new information that alters our understanding of temperatures over the last 10 to 15 years—when temperatures have been the warmest in the instrumental record.

Comment (1-23):
From the BBC interview discussed in Response 1-22, the Competitive Enterprise Institute and Southeastern Legal Foundation also refer to Jones' statement that for the periods 1860 to 1880, 1910 to 1940, 1975 to 1998, and 1975 to 2009 "the warming rates … are similar and not statistically significantly different from each other." The Competitive Enterprise Institute concludes:

> If there has been no change in warming rates, this contradicts one of EPA's basic contentions. During this same period, atmospheric levels of carbon dioxide and other greenhouse gases levels dramatically increased-according to EPA, to "essentially unprecedented levels." 74 FR 66, 517. Yet if increasing levels of these gases did not produce a clear acceleration of warming, then the role of these gases as a major driver of temperature becomes even more dubious.

Response (1-23):
The warming rates for those four periods are similar, but it is important to note that these four periods are of different lengths (21, 31, 24, and 35 years), making trend comparisons incongruent. The TSD, comparing periods of equal lengths, notes that the recent warming rates are the greatest on record, though we note they are closely followed by (and therefore similar to) earlier periods (TSD Box 4.1):

> The warming rate in the last 10 30-year periods (averaging about 0.30°F [0.17°C] per decade) is the greatest in the observed record, followed closely by the warming rate (averaging about 0.25°F [0.14°C] per decade) observed during a number of 30-year periods spanning the 1910s to the 1940s.

The Competitive Enterprise Institute's assertion that similarity in warming rates between the present and past contradicts attribution of recent warming to anthropogenic GHGs is not supported by scientific analysis and ignores the scientific assessments on which EPA relied. In contrast to petitioners, the TSD accurately characterizes current scientific understanding, which does not look at GHGs in isolation but considers them in the context of other drivers of warming or cooling. For example, Section 5(a) of the TSD states:

> The IPCC (Hegerl et al., 2007) finds that anthropogenic GHG emissions were one of the influences contributing to temperature rise during the early part of the 20th century along with increasing solar output and a relative lack of volcanic activity. During the 1950s and 1960s, when temperature leveled off, increases in aerosols from fossil fuels and other sources are thought to have cooled the planet. For example, the eruption of Mt. Agung in 1963 put large quantities of reflective dust into the atmosphere. The rapid warming since the 1970s has occurred in a period when the increase in GHGs has dominated over all other factors (Hegerl et al., 2007).

Section 5 of the TSD provides substantial additional information to support this statement. Multiples responses (e.g., 1-24, 1-25, 1-27, 1-28, and 1-29) in this RTP discuss the possible slowing of the warming rate in the last decade and implications for attribution to anthropogenic GHGs.

Thus, the Competitive Enterprise Institute provides no new information to support its conclusion that the role of GHGs in temperature change is "dubious." The issues they raise are not new, their argument improperly looks at GHGs in isolation, and these issues were fully addressed in the Endangerment Finding, TSD, and RTC document.

Comment (1-24):
Peabody Energy contends that EPA's understanding of the causes of the warming in the latter part of the 20th century is contradicted by the lack of warming over the 1998–2008 period. They assert that EPA did not cite any natural forces (such as a volcanic eruption) that might explain the lack of warming during this period, a period when atmospheric GHG concentrations continued to increase.

Response (1-24):
The possible slowdown in warming from 1998 to 2008 does not contradict understanding of the causes of warming over the latter part of the 20th century. EPA is very clear about the well-known scientific limitations of taking a short snapshot of the temperature record and attempting to draw any conclusion from it—with respect to either natural variability or the human influence on climate. As stated in the RTC 3-4:

> … drawing conclusions from short time-scales is of limited value. Directly comparing global GHG emissions with global temperatures on decadal or shorter time-scales must consider all plausible variations and other existing non-linear inter-relationships.
>
> We note there are other 10-year periods in the temperature record that when extracted show no trend even though these periods are embedded within a longer period showing substantial overall warming (Easterling and Wehner, 2009). Therefore, it is clear that temperatures do not rise monotonically despite the continuing increase of GHG concentrations. Observations over such short periods examined in isolation may be misleading in the interpretation of the longer-term trend in temperatures.

In spite of the possible slowdown in warming over the last 10 or so years, TSD Box 4.1 documents that the overall rate of warming is about 0.29–0.30°F per decade over the last 30 years and 0.24–0.25°F per decade over the last 50 years.

Peabody Energy correctly states that EPA does not cite specific natural factors that might explain temperature trends over the last decade. This is because attribution of trends over short timescales is more difficult and is an emerging area of research. The paper by Solomon et al. (2009) discussed in Response 1-81 of this volume provides a plausible explanation related to changes in stratospheric water vapor to explain at least some of the trend, but concludes that more research is required for understanding temperature changes on short time scales. Additionally, in Response 1-27 for example, we acknowledge gaps in describing the causes of short-term variability but emphasize that these gaps do not undermine the case for linking longer term changes in temperature to GHGs.

The TSD—citing the assessment literature—summarizes the significant advances in scientific understanding that have been made in linking long-term temperature trends to GHGs in Section 5(a):

> The increased confidence in the GHG contribution to the observed warming results from (Hegerl. et al., 2007):
>
> - An expanded and improved range of observations allowing attribution of warming to be more fully addressed jointly with other changes in the climate system.
> - Improvements in the simulation of many aspects of present mean climate and its variability on seasonal to inter-decadal time scales.
> - More detailed representations of processes related to aerosol and other forcings in models.
> - Simulations of 20th-century climate change that use many more models and much more complete anthropogenic and natural forcings.
> - Multi-model ensembles that increase confidence in attribution results by providing an improved representation of model uncertainty.

To summarize, the possible slowdown in warming over the last decade or so does not undermine the linkage between GHGs and temperature over sufficiently long timescales.

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Comment (1-25):
Peabody Energy asserts that EPA's explanation for the slowdown in warming—that there is enough natural variability in the climate system to accommodate the lack of warming over a short time period—is not consistent with the following statement from the Academies of Science for the G8+5 countries, which EPA cites in RTC 1-43:

> … climate change is happening even faster than previously estimated; global CO_2 emissions since 2000 have been higher than even the highest predictions, Arctic sea ice has been melting at rates much faster than predicted, and the rise in the sea level has become more rapid. (National Academies, 2009)

Peabody Energy states:

> EPA cannot have it both ways. It cannot insist that the cessation of warming over the last eleven years must be the result of poorly understood natural variability; whereas, other climate phenomena during that period conclusively demonstrate man's impact on the climate and are not explained by the same variability.
>
> Moreover, EPA's discussion of the period over which warming must be sustained to provide confidence that the warming is not natural is confusing. According to EPA, "[b]oth the IPCC and the TSD note that 'difficulties remain in attributing temperature changes on smaller than continental scales and over time scales of less than fifty years,' and that with limited exceptions attribution at these scales has not yet been established." Since the warming of the second period lasted only about thirty years before it ceased, and since the plus-fifty year warming trend of the 20th century includes a period in which the warming did not result primarily from anthropogenic GHGs, it would appear that EPA cannot justify its conclusion that the warming of the last thirty years can be definitively attributed to anthropogenic GHGs.

Response (1-25):
The above statement from the Academies of Science for the G8+5 countries cited by EPA in RTC 1-43 (National Academies, 2009) describes trends in GHG emissions, Arctic sea ice, and sea level but does not address attribution, whether over a short time period or a longer time period. The statement is provided in the context of listing many major national and international scientific societies and academies that have endorsed or expressed support for the findings and conclusions of the assessment literature. It is not scientific information synthesized for the TSD or the Findings.

This Academies of Science statement does not address attribution and was not used to support arguments pertaining to attribution, and EPA is not "having it both ways". Peabody Energy correctly articulates our characterization of the attribution issue when it states:

> According to EPA, "[b]oth the IPCC and the TSD note that 'difficulties remain in attributing temperature changes on smaller than continental scales and over time scales of less than fifty years,' and that with limited exceptions attribution at these scales has not yet been established."

There is no contradiction or inconsistency in the view that the warming rate may have slowed in the last decade or so and the fact that the long-term warming trend has been attributed to anthropogenic GHGs—as described in Response 1-24. Our statements about temperature trends and their relationship to the observed increases in GHGs are internally consistent within the endangerment record, and consistent with the assessment literature.

Comment (1-26):
Peabody Energy refers to the following CRU e-mail, written by climate scientist Kevin Trenberth in October 2009, to suggest that the climate community could never demonstrate that reducing GHG emissions will reduce warming:

> [t]he fact that we can not account for what is happening in the climate system [the lack of warming] makes any consideration of geoengineering quite hopeless as we will never be able to tell if it is successful or not![24]

Peabody Energy asserts that Trenberth's reference to "geoengineering" includes reducing GHG emissions, citing a letter Trenberth wrote in *Physics Today* in February 2009 (Trenberth, 2009), stating:

> The ethical questions associated with climate manipulation loom so large that some forms of geoengineering are simply unacceptable. The forms that are acceptable include those that reduce emissions and mitigate the rates of change or reduce the amount of carbon dioxide in the atmosphere.

Based on Trenberth's expressed doubts about the ability to evaluate geoengineering, Peabody Energy claims:

> …Trenberth stated that the flaws in the climate community's understanding of climatic forces that are exposed by the lack of warming is so fundamental – and the extent of natural variability must be so great – that it could never be demonstrated that reducing GHG emissions will reduce warming.

Response (1-26):
Peabody Energy's conclusions are speculative and unsupportable, and are based on selectively linking disparate statements made at different times by Trenberth. Examining each statement in context makes clear that he does not agree with the views Peabody Energy ascribes to him.

Although Trenberth included GHG emissions reductions as an example of a geoengineering method in the *Physics Today* letter, that does not mean he is referring to GHG reductions as "geoengineering" within the context of the statement, "we will never be able to tell if it is successful or not," from the CRU material.

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[24] E-mail file 1255523796.txt, (October 14, 2009), page 1810, lines 9-11 of PDF version entitled: CRU Emails 1996-2009.pdf

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Generally, "geoengineering" does not refer to GHG emissions reductions achieved by lowering anthropogenic emissions, but rather, alternative options to counter the warming effects of GHGs. The IPCC's discussion (Barker et al., 2007) of geoengineering discusses options such as iron and nitrogen fertilization of the oceans (to take up CO_2) and deployment of technologies that reduce the amount of sunlight accepted by the Earth's system (e.g. injecting reflective aerosols into the stratosphere and installing a deflector system in space to block sunlight). In fact, in a recent paper in Science authored by Trenberth and a colleague (Trenberth and Fasullo, 2010), Trenberth describes geoengineering accordingly:

> Proposals for addressing global warming now include geoengineering, whereby tiny particles are injected into the stratosphere to emulate the cooling effects of stratospheric aerosol of a volcanic eruption.

Furthermore, as discussed in Response 1-21, Trenberth makes clear that his comments in this context are in reference to his frustration about gaps in the observing system that make it difficult to understand the Earth's energy balance, and hence climate variability, on short timescales. Trenberth and Fasullo (2010) specifically mention the importance of understanding the flow of energy in the Earth's system for tracking the effectiveness of potential geoengineering projects:

> Implicitly, such proposals assume understanding and control of the energy flow, which requires detailed tracking of energy within the climate system.

Thus, EPA finds no evidence to suggest that Trenberth intended to imply that reducing GHG emissions will not reduce warming. In fact, Trenberth's July 2008 testimony (Trenberth, 2008) before the U.S. Senate Committee on Environment and Public Works suggests the opposite:

> I believe that mitigation actions are certainly needed to significantly reduce the build-up of greenhouse gases in the atmosphere and lessen the magnitude and rate of climate change. Action taken now to reduce significantly the build-up of greenhouse gases in the atmosphere will lessen the magnitude and rates of climate change. In fact I believe there is a crisis of lack of adequate action in this regard.

Trenberth's public statements and recent published work very strongly suggest that the Trenberth statement cited by Peabody Energy does not mean it is impossible to know if GHG reductions will reduce warming, but simply that better understanding of the energy budget is needed if we are to track potential geoengineering projects (where "geoengineering" is referring to injecting particles into the atmosphere).

Comment (1-27):
Peabody Energy raises a number of methodological concerns with the Easterling and Wehner (2009) and Knight et al. (2009) analyses and concludes that "the models demonstrably do not take account of the current no-warming trend."

Response (1-27):
As discussed in Response 1-20, the NRC (2010) states "it is not appropriate to look at only a short period of the overall record (such as changes over just the last five or ten years) to infer major changes in the trajectory of global warming." See other prior discussions (e.g., Response 1-22) concerning whether there is a slowdown in the rate of warming over a limited number of recent years. Furthermore, in the TSD, EPA cites the NOAA "State of the Climate in 2008" report (Knight et al., 2009[25]), which finds that climate models possess internal mechanisms of variability capable of reproducing the possible current slowdown in global temperature rise. Further, in a response to public comments on the issue (2-41), we refer to Easterling and Wehner (2009), who find that short-term trends in long-term time series occasionally run counter to the overall trend.

As a general matter, the assessment literature is clear that the ability (or lack of ability) of climate models to reproduce a short-term slowdown in warming in no way invalidates or changes their reliability for attributing or projecting long-term changes in global climate variables resulting from sustained anthropogenic forcing of the climate system. The analysis of long-term trends is their primary purpose, rather than projecting year-to-year changes over a period of a decade or so or less. As the NRC (2010) states: "Robust analyses of global climate change thus tend to focus on trends of at least several decades." Our responses to the specific issues raised by Peabody Energy regarding Easterling and Wehner (2009), Knight et al. (2009), and related issues are discussed below.

Comment (1-28):
Peabody Energy contends that the failure of the planet to warm over the last 11 years raises serious questions about the accuracy of computer models, specifically challenging the reliance on the studies of Easterling and Wehner (2009) and Knight et al. (2009),[26] which support the notion that climate models can produce short periods of temperature trends that run counter to the overall long-term warming trend.

Peabody Energy expresses several concerns about Easterling and Wehner (2009), asserting that:

- The examples of pauses from warming in the past (running counter to the long-term trend) from 1977 to 1985 and from 1981 to 1989 are shorter than the pause in warming from 1998 to 2008. Peabody Energy writes that "no global warming during the eleven-year period 1998-2008 is a much more unlikely event than no global warming during the nine-year periods, 1975-1983 and 1981-1989."

- The period of no warming from 1977 to 1985 was driven by the eruption of El Chichon in 1981.

[25] In the TSD, we cite Knight et al. (2009) as Peterson and Baringer (2009)—the overarching report containing Knight et al.
[26] Knight et al. (2009) was cited as Peterson and Baringer, 2009 in EPA's TSD.

- Easterling and Wehner make a factual error, stating there was no warming from 1981 to 1989 because the Goddard Institute for Space Studies (GISS) and CRU datasets indicate warming of +0.08°C per decade.

- "…[T]he probability of a ten-year period of no warming, as determined by Easterling and Wehner from climate model projections as 10%, is too large. If the actual emissions were used to drive the climate models, the probability of occurrence of a ten year period of no trend would be smaller, and the mismatch between model expectations and observations would be higher."

- The distribution of models used in the study disproportionately included models that were more likely to simulate a pause in the warming, biasing the results.

Regarding Knight et al., Peabody Energy then contends that:

- Knight et al. did not compare observed trends with the results of the model when run with an emissions scenario that is closest to observed emissions.

- Knight et al. changed various parameters within the climate model that do not occur in nature; the actual variability is only produced by a single set of physics.

Peabody Energy concludes that these two studies were designed and conducted in such a way as to lead to an artificially inflated probability of occurrence of low (or no) trends in global temperatures over short time periods and thus, provide false confidence in the ability of the climate models to replicate temperature trends over such short time periods.

Response (1-28):
As we have discussed in previous responses (e.g., 1-24 and 1-25), the ability to project and attribute global trends in temperature over short time periods is limited, but this does not undermine their reliability in longer-term projection and attribution of temperature trends to GHGs. It is well recognized that climate models do a better job of simulating global changes over longer time scales, when short-term "noise" in the climate system due to year-to-year climate variability (e.g., El Niño or La Niña events[27]) tends to become smoothed.

However, some of the limitations of modeling short-term variations in global climate can be overcome by running multiple simulations in which the input parameters are altered slightly to produce a range of plausible results. This is exactly what Easterling and Wehner and Knight et al., relatively new studies published during and after the Proposed Endangerment Finding public comment period (refer to Response 1-29 for discussion on the timing of the publication of these studies), did to test whether models could simulate periods of no warming under a range of conditions.

[27] El Niño is characterized by unusually warm ocean temperatures in the Equatorial Pacific, as opposed to La Niña, which characterized by unusually cold ocean temperatures in the Equatorial Pacific. El Niño is an oscillation of the ocean-atmosphere system in the tropical Pacific having important consequences for weather around the globe.

With respect to Peabody Energy's criticisms of Easterling and Wehner, we note the following:

- When Peabody Energy asserts that an 11-year pause in warming (from 1998 to 2008) is much less likely than 9-year pauses in warming (from 1977 to 1985 and 1981 to 1989), Peabody Energy fails to mention that Easterling and Wehner indicate that the lack of warming from 1998 to 2008 is largely related to the start and end date chosen. Easterling and Wehner write: "if we drop 1998 and fit the trend to the period 1999-2008 we indeed get a strong, statistically significant positive trend."

- When Peabody Energy notes that the pause in warming from 1977 to 1985 was affected by the 1981 volcanic eruption of Mt. Chichon, it is well recognized that volcanoes are one kind of natural variability that can temporarily slow the rate of warming. Just as the 1981 eruption caused a slow down in warming, there are other drivers of variability within the Earth system such as La Niña (or El Niño) events that may slow (or steepen) GHG-induced warming over short time periods. Peabody Energy does not explain why this specific example of temporary slowdown in warming embedded within a longer-term warming trend is significant or why it represents any sort of flaw in the Easterling and Wehner study.

- Though Peabody Energy claims that Easterling and Wehner make a factual error in computing no warming from 1981 to 1989, Easterling and Wehner do not say there was no warming—just that there was no statistically significant warming (i.e., "no trend").

- In indicating that Easterling and Wehner did not use a sufficiently aggressive emissions scenario in its simulations, Peabody Energy fails to mention that Easterling and Wehner defend their choice of emissions scenario accordingly: "The A2 scenario postulates a 'business as usual' future with little reduction in anthropogenic emissions resulting in large greenhouse gas concentrations by the end of the 21st century." In other words, Easterling and Wehner chose an aggressive emissions scenario. While it may be true that the current rate of increase in GHG emissions is higher than that scenario, as discussed in Section 6 of the TSD, a range of future emissions scenarios are plausible and will depend on assumptions regarding population and economic growth, implementation of policies, technology change and adoption, and other factors.

- Peabody Energy's assertion that the models chosen by Easterling and Wehner disproportionately included models more likely to simulate a slowdown is not substantiated. Easterling and Wehner state that they used all available simulations in the Climate Model Intercomparison Project (CMIP) database. Peabody Energy states that "the models with the greater number of runs [in the database] – particularly those models with a large degree of internal noise – had a greater influence on the overall distribution" but provides no additional evidence to support this assertion.

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With respect to Peabody Energy's criticisms of Knight et al., we note the following:

- Just as in the Easterling and Wehner study, Peabody Energy criticizes the choice of the emissions scenario in the Knight et al. study as being too conservative. However, Knight et al. indicate that they use "several" scenarios from the IPCC Special Report on Emissions Scenarios, which is appropriate to reflect the range of plausible futures.

- Peabody Energy's claim that Knight et al.'s technique of varying model parameters is inappropriate because only a single set of physics applies in nature is based on the flawed assumption that modelers can perfectly replicate nature in its model settings. Modelers vary these parameters to capture the uncertainty in their modeling of the science. Through multiple model runs with these varying parameters, the model output can reflect the whole range of plausible results rather than a single value for which there would be limited confidence. Furthermore, Peabody Energy's assertion that producing multiple simulations artificially inflates the probability of the occurrence of low trends in global temperatures is false. Randomly increasing the number of simulations should equally increase the number of results that show both large and small trends.

To summarize, we find Peabody Energy's criticisms of the Easterling and Wehner and Knight et al. studies misplaced, unsubstantiated, and/or flawed. These studies demonstrate temporary slowdowns in the rate of warming have occurred in the recent past during a period of sustained long-term warming and conduct legitimate modeling experiments showing that models can and do produce sustained multi-year periods of reduced warming, no trend, and/or even slight cooling embedded within the longer term warming projected in the next century.

Comment (1-29):
Peabody Energy notes that the Easterling and Wehner study (discussed in Response 1-28) was published just before the public comment deadline, such that the public did not have an opportunity to fully comment on it. The petitioner also notes that the Knight et al. paper was published after the public comment deadline, so the public did not have an opportunity to comment on it. Finally, the petitioner notes that the Easterling and Wehner and Knight et al. studies were published too recently to have matured to the point that the issue has received extensive analysis.

Response (1-29):
Peabody Energy's fundamental concern about these studies—that they allegedly may overstate how well models simulate or explain short-term changes in temperature – does not undermine the basis for the Findings or justify their reconsideration. We have discussed above why EPA concluded that the Easterling and Wehner and Knight et al. results are legitimate. However, these studies are not materially important to the Findings. The TSD acknowledges there are "difficulties" in explaining the causes of short-term temperature change, stating in Section 5(a): "The IPCC (Hegerl et al., 2007) cautions that difficulties remain in attributing temperature changes … over time scales of less than 50 years." Thus, the amount of time the public had to comment on these studies

as well as the concerns raised about them are insignificant. The issue of the ability of the models to project temperatures over short time periods was in fact highlighted in the TSD and subject to public comment. EPA's response to comments included an appropriate discussion of studies that are relevant to these issues.

Finally, while the Easterling and Wehner and Knight et al. studies are relatively recent, they have been highly visible and subject to significant scrutiny. The Easterling and Wehner study was cited in the 2009 report, *Global Climate Change Impacts in the United States* (published in June 2009)—a major assessment report of the USGCRP (Karl et al, 2009). The Knight et al. study was incorporated into NOAA's peer-reviewed *State of the Climate* 2008 report (issued in August 2009), published as a special supplement to the *Bulletin of the American Meteorological Society* (AMS) and disseminated to all AMS members (NOAA, 2009). Most recently, Easterling and Wehner and Knight et al. were cited in the NRC assessment, "Advancing the Science of Climate Change" (NRC, 2010). We are not aware of any published criticisms of these studies.

These studies, and the petitioner's criticisms of them, do not change the degree of uncertainty expressed in the assessment reports and identified by EPA as associated with the use of temperature data over these kinds of short time periods. Confidence in linking observed climate change to GHGs is not based on modeling analysis of short-term temperature trends but rather modeling analysis of longer-term temperature trends and additional lines of evidence. In summary, the results of these studies are not central to the Findings, and do not change the scientific position expressed in both the proposed and final Findings that temperatures over time periods as short as those at issue have only limited relevance to determining the existence of long-term temperature trends or attributing such trends to their causes.

1.2.3 Climate Model Issues Raised by Petitions

Comment (1-30):
Petitioner Arthur Randol states that the CRU e-mails "reveal serious questions about the validity of the IPCC models and the modelers," and therefore, EPA's reliance upon models. Arthur Randol also quotes a number of EPA and IPCC sources discussing model uncertainties (e.g., "What does the accuracy of a climate model's simulation of past or contemporary climate say about the accuracy of its projections of climate change? This question is just beginning to be addressed…") (Randall, 2007).

Response (1-30):
EPA responded to comments on computer modeling issues at length in the RTC document (Volume 4.1), in terms of both their uses and limitations. Response 4-1 of the RTC is provided here, as it is the general response to the petitioner's issues already contained within the RTC document. Responses to specific information provided by the petitioner are provided below. Response 4-1 stated:

> First, models are not the foundation of climate science, rather they are the tools used to better understand information and data from multiple sources and disciplines. Paleoclimate data, basic theory, observations of climate changes, and other branches of

climate science together have provided (and continue to provide) the basis for key findings in the assessment literature. Indeed, research long before the advent of the computer found that the climate should respond to increased CO_2 concentrations. Recently, scientists have used paleoclimate data about historical analogues such as the last interglacial and glacial maximum to estimate climate sensitivity, sea level response to temperature change, and other important climatic variables (Jansen et al., 2007, Hegerl et al., 2007). Computer modeling is, of course, important because it improves refinement of predictions, attributions, and analysis of non-linear interactions of a complex system, and thus climate models will continue to play a major role in understanding and projecting the future of the climate system. However, the characterization of a number of commenters that the projection and attribution findings of the IPCC, the U.S. Global Change Research Program (USGCRP), and others are supported only by the output of models is not accurate.

With respect to the issues commenters raised concerning flaws in the models used for projections and attribution studies, it is well recognized that models are representations of complex systems and may not be able to perfectly represent all interactions in the system being modeled. For example, clouds are too difficult to model computationally because the physics involved in cloud formation occurs at scales smaller than the resolution of most climate models. Although model-based results are subject to some degree of inherent uncertainty, as reflected in the assessment literature and in the TSD, these uncertainties are acknowledged; uncertainties do not mean that the models are fatally flawed or unreliable representations of the climate system. Climate models have been demonstrated to successfully simulate a number of climatic properties, as documented in the IPCC, CCSP, NRC, and USGCRP reports on which the TSD primarily relies.

Absolute certainty is not required, and in fact, the TSD summarizes both the important role and the limitations of models in Section 6(b), quoting Meehl et al. (2007):

> [C]onfidence in models comes from their physical basis, and their skill in representing observed climate and past climate changes. Models have proven to be extremely important tools for simulating and understanding climate, and there is considerable confidence that they are able to provide credible quantitative estimates of future climate change, particularly at larger scales. Models continue to have significant limitations, such as in their representation of clouds, which lead to uncertainties in the magnitude and timing, as well as regional details, of predicted climate change. Nevertheless, over several decades of model development, they have consistently provided a robust and unambiguous picture of significant climate warming in response to increasing greenhouse gases.

Karl et al. (2009) reaches a similar conclusion, stating:

> All of the models used in this work [Karl et al., 2009] have imperfections in their representation of the complexities of the "real world" climate system. These are due to both limits in our understanding of the climate system, and in our ability to represent its complex behavior with available computer resources. Despite this, models are extremely useful, for a number of reasons.
>
> First, despite remaining imperfections, the current generation of climate models accurately portrays many important aspects of today's weather patterns and

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> climate. Models are constantly being improved, and are routinely tested against many observations of Earth's climate system. Second, the fingerprint work shows that models capture not only our present-day climate, but also key features of the observed climate changes over the past century. Third, many of the large-scale observed climate changes (such as the warming of the surface and troposphere, and the increase in the amount of moisture in the atmosphere) are driven by very basic physics, which is well-represented in models. Fourth, climate models can be used to predict changes in climate that can be verified in the real world. Examples include the short-term global cooling subsequent to the eruption of Mount Pinatubo and the stratospheric cooling with increasing carbon dioxide. Finally, models are the only tools that exist for trying to understand the climate changes likely to be experienced over the course of this century. No period in Earth's geological history provides an exact analogue for the climate conditions that will unfold in the coming decades.

A CCSP report (2008a) assessed model strengths and limitations in detail, and the introduction states:

> Scientists extensively use mathematical models of Earth's climate, executed on the most powerful computers available, to examine hypotheses about past and present-day climates. Development of climate models is fully consistent with approaches being taken in many other fields of science dealing with very complex systems. These climate simulations provide a framework within which enhanced understanding of climate relevant processes, along with improved observations, are merged into coherent projections of future climate change…
>
> The science of climate modeling has matured through finer spatial resolution, the inclusion of a greater number of physical processes, and comparison to a rapidly expanding array of observations. These models have important strengths and limitations. They successfully simulate a growing set of processes and phenomena; this set intersects with, but does not fully cover, the set of processes and phenomena of central importance for attribution of past climate changes and the projection of future changes.

The consensus of the assessment literature is that models serve a useful purpose within the field of climate science, successfully modeling a number of processes. This is true despite the complexity of the system that was mentioned by one commenter. Although there are a number of limitations and uncertainties, they are accounted for, on a global scale, by providing a range of global mean temperature estimations for any given emission scenario (e.g., Figure 10.26, Meehl et al., 2007). This range, though important, still enables robust conclusions about the impact of GHGs on temperature.

A number of specific comments on model flaws are addressed by responses within this volume. It is EPA's conclusion that the models have demonstrated the ability to accurately simulate many key aspects of climate, and in light of the key conclusions of the IPCC, CCSP, and USGCRP in regard to model skill and limitations, we have determined that it is fully appropriate to report model-based projections and attribution studies in the TSD.

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Comment (1-31):
Arthur Randol quotes an e-mail from Tom Wigley to support his contention that the CRU e-mails "reveal serious questions about the validity of the IPCC models and the modelers":

> Mike[Mann],
> The Figure you sent is very deceptive. As an example, historical runs with PCM look as though they match observation—but the match is a fluke. PCM has no indirect aerosol forcing and a low climate sensitivity—compensating errors. In my (perhaps too harsh) view, there have been a number of dishonest presentations of model results by individual authors and by IPCC. This is why I still use results from MAGICC to compare with observed temperatures. At least here I can assess how sensitive matches are to sensitivity and forcing assumptions/uncertainties. Tom[Wigley].[28]

Response (1-31):
The figure referred to in this e-mail is an informal figure developed by Gavin Schmidt for posting at the blog "realclimate" and is related to the perception that the climate was warming more slowly than the models had predicted. This figure does not appear in the IPCC or even the published literature. Gavin Schmidt replies later in the e-mail chain that the reason for using the full CMIP3 archive (including the PCM historical runs referred to by Wigley) as the basis for the figure, rather than the MAGICC model developed by Wigley, is because the behavior being explored by this figure is related to unforced variability, which requires the more complex models. MAGICC, a simpler model, does not display unforced variability. This is a normal discussion between scientists about how best to explore a given question. While Wigley objects to one specific model (PCM), the reasoning behind using the full ensemble of different models (including PCM) is that the ensemble often demonstrates better attributes overall than any of the individual models within the ensemble (each of which have their own strengths and weaknesses). This feature of model ensembles was discussed in the paper "How well do coupled model simulate today's climate?" (Reichler and Kim, 2008). The paper concluded, based on the authors' analysis of the CMIP3 model ensemble compared to earlier efforts, that "Both improved performance and more physical formulation suggest that an increasing level of confidence can be placed in model-based predictions of climate."

In the e-mail discussion, Wigley also promotes a couple of different methods of his own to explain the observed variability in the rate of warming. One method used by Wigley involves comparing an artificial distribution of unforced variability to the difference between the observed trend and the best estimate of a trend without variability, rather than using the CMIP3 archive to determine the variability. Another method involves using known sources of variability like the solar cycle, ENSO, or volcanoes to explain recent temperature trends. Using both these methods, Wigley also finds that the recent rate of warming is consistent with the models:

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[28] E-mail file 1255553034.txt, (October 14, 2009), page 1824, lines 39-45 of PDF version entitled: CRU Emails 1996-2009.pdf

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> At the risk of overload, here are some notes of mine on the recent lack of warming. I look at this in two ways. The first is to look at the difference between the observed and expected anthropogenic trend relative to the pdf for unforced variability. The second is to remove ENSO, volcanoes and TSI variations from the observed data. Both methods show that what we are seeing is not unusual. The second method leaves a significant warming over the past decade. These sums complement Kevin‘s energy work. Kevin [Trenberth] says ... "The fact is that we can‘t account for the lack of warming at the moment and it is a travesty that we can’t". I do not agree with this.[29]

This e-mail from Tom Wigley does not reveal serious questions about the validity of models as a whole, nor does it demonstrate that the PCM model should not be used. It reflects a discussion over alternate ways to analyze one specific question.

Comment (1-32):
Arthur Randol quotes one of the CRU e-mails from Susan Solomon, claiming that the questions raised regarding the use of models are “enough to seriously challenge the IPCC results.”

> The question I want to raise is not related to the very important dialogue on how to handle the errors and the statistics, but rather how to think about the models. The attached paper by Forster et al. appeared recently in GRL. It taught me something I didn’t realize, namely that ozone losses and accompanying temperature trends at higher altitudes can strongly affect low altitudes, through the influence of downwelling longwave.
>
> No global general circulation model can possibly be expected to simulate this correctly unless it has interactive ozone, or prescribes an observed tropical ozone trend. The AR4 models did not include this, and any “discrepancies” are not relevant at all to the issue of the fidelity of those models for global warming.[30]

Response (1-32):
We note, with respect to this e-mail from Susan Solomon, that she specifically stated that the issues raised were “not relevant at all to the issue of the fidelity of those models for global warming.”[31] This means that this issue does not raise doubts about conclusions based on using these models for long-term global warming studies. In addition, the fact that there are phenomena not captured by the models should not be surprising, as described above. The question is, how much will the inclusion of these phenomena alter the conclusions reached from using the model? The particular phenomena described by Solomon is the possibility that cooling of the stratosphere due to ozone depletion may also lead to cooling of some parts of the troposphere: Solomon suggests that this could further explain any discrepancies between the observed warming in the tropical

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[29] E-mail file 1255496484.txt, (October 14, 2009), page 1807, lines 37-43 of PDF version entitled: CRU Emails 1996-2009.pdf

[30] E-mail file 1199027884.txt, (December 30, 2007), page 1397-1398, lines 35-40 and 18-22 of PDF version entitled: CRU Emails 1996-2009.pdf

[31] E-mail file 1199027884.txt, (December 30, 2007), page 1398, lines 21-22 of PDF version entitled: CRU Emails 1996-2009.pdf

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troposphere and theoretically predicted warming (the "hot spot"). The comment at the start of this e-mail fragment about "the errors and the statistics" is a reference to the Douglass (2007) paper on the "hot spot". The errors in the Douglass paper were the subject of a paper (Santer, 2008) that is discussed in Responses 1-18 and 1-19 of this RTP document. Our review finds that the petitioner may have misunderstood the e-mail. The e-mail does not challenge the IPCC results; if anything, it suggests a way in which some existing discrepancies might be further narrowed.

Comment (1-33):
Arthur Randol quotes an e-mail from Peter Thorne in support of his contention that models are flawed:

> Maybe we need to step back and rephrase the question in terms of the physics rather than aiming solely to rebutt Douglass et al? In this case the key physical questions in my view would be:
>
> Is there really a stratospheric radiative influence? If so, how low does it go? What is the cause? Are the numbers consistent with the underlying governing physics or simply an artifact of residual obs errors?
>
> Can any models show trend behaviour that deviates from a SALR on multi-decadal timescales? If so, what is it about the model that causes this effect? Physics? Forcings? Phasing of natural variability? Is it also true on shorter timescales in this model?
>
> I think in the future the Forster et al paper may be seen as the more scientifically significant result when Douglass et al is no longer cared about ...[32]

Response (1-33):
This quote is also related to discussion about the "hot spot" in the troposphere, as was the quote discussed in Response 1-32. The e-mail's author indicates that there are more significant scientific questions involved on this topic than would be addressed merely by rebutting Douglass et al. (2007). The discrepancy that scientists are interested in is the possible difference between the theory of saturated adiabatic lapse rate (SALR) and the observations of the tropical tropospheric temperatures. While the Santer (2008) rebuttal of the Douglass et al. study resolved this discrepancy in large part, there is still the interesting question of whether a model could demonstrate a way in which the troposphere would not warm as much as the surface, in contradiction to the basic theory. The Santer (2008) paper is discussed in Responses 1-18 and 1-19 of this RTP document. This quote is not about flawed models, but rather, about determining whether models can be used to explore potentially interesting behavior about the vertical temperature structure of the troposphere.

[32] E-mail file 1199286511.txt, (January 2, 2008), page 1400, lines 13-15, 18-23 and 27-29 of PDF version entitled: CRU Emails 1996-2009.pdf

Comment (1-34):
Arthur Randol quotes a 2008 e-mail from Jagadish Shukla critiquing some aspects of regional climate change projections. The petitioner underlines two portions of this e-mail:

> For example, we can not advise the policymakers about re-building the city of New Orleans - or more generally about the habitability of the Gulf-Coast - using climate models which have serious deficiencies in simulating the strength, frequency and tracks of hurricanes.

and

> It is not without precedent that quite deficient climate models are used by large communities simply because it is convenient to use them. It is self-evident that if a coarse resolution IPCC model does not correctly capture the large-scale mean and transient response, a high-resolution regional model, forced by the lateral boundary conditions from the coarse model, can not improve the response. Considering the important role of multi-scale interactions and feedbacks in the climate system, it is essential that the IPCC-class global models themselves be run at sufficiently high resolution.[33]

The petitioner also quotes the EPA TSD, underlining, among other statements, the following sentence:

> Uncertainty also increases as the temporal scales move away from present, either backward, but more importantly forward in time.

Response (1-34):
In the e-mail from Shukla quoted by the petitioner there is also the statement "in fact many of us were arguing for stronger language with a higher level of confidence at the last meetings of the Las [i.e. at the previous IPCC AR4 lead author meeting],"[34] and a note that Shukla was not objecting to the use of model results for discussions of mitigation, but rather for providing information that is useful for adaptation. The statement on hurricanes is consistent with the assessment of hurricane projections in Section 6(e) of the TSD. Moreover, that the "chaotic variability" of weather (required for predicting hurricane tracks) is different from climatic changes is well understood (see Response 4-2 of the RTC document). The uncertainties in regional modeling are well understood and summarized in the TSD (as quoted by the petitioner).

The TSD does not rely on downscaled modeling (where a high resolution model is run for a small area within a larger lower resolution model), including the kind critiqued in the e-mail. However, we note that within the quote provided by the petitioner, there is no

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[33] E-mail file 1202939193.txt, (February 13, 2008), page 1460, lines 3-6 and 28-34 of PDF version entitled: CRU Emails 1996-2009.pdf
[34] E-mail file 1202939193.txt, (February 13, 2008), page 1459, lines 44-45 of PDF version entitled: CRU Emails 1996-2009.pdf

statement that downscaling cannot work, merely that the global models in which the downscaled models are embedded should be run at an appropriate resolution.

The quoted e-mail argued for stronger language with a higher level of confidence, the uncertainties involved with regional modeling were well represented in the TSD, and specific issues highlighted in the e-mail by the petitioner were both consistent with the TSD and not germane to the Findings. Therefore we find that the petitioner has not raised any issues that would result in a change of any conclusions in the TSD or the RTCs.

Comment (1-35):
Arthur Randol claims that "the CRU email reveal serious questions about the validity of the IPCC models and the modelers," based on the e-mails discussed above and also on an e-mail from Ben Santer. The Santer e-mail discusses using a subset of models to examine certain climatic features, stating:

> We've had fun computing a whole range of metrics that might be used to define such a subset of "better" models. The ultimate goal is to determine the sensitivity of our water vapor D&A results to model quality. I think that this kind of analysis will be unavoidable in the multi-model world in which we now live. Given substantial inter-model differences in simulation quality, "one model, one vote" is probably not the best policy for D&A work![35]

The e-mail concludes with "The results are fascinating, and show (at least for water vapor and SST) that every model has its own individual strengths and weaknesses. It is difficult to identify a subset of models that CONSISTENTLY does well in many different regions and over a range of different timescales."[36]

Response (1-35):
That different models have different strengths and weaknesses is well-understood and as described above was discussed in the assessment reports and the Findings. This is why conclusions in the literature are considered more robust when multiple models exhibit similar behavior and the conclusions don't rely on just one model or one line of evidence. Parallel to the conclusions of Santer in this e-mail, Reichler and Kim (2008) published a paper which showed that it is often difficult to identify one best model, and that using the average of multiple models often produces better results than any model individually over a range of metrics. Therefore, the issue that models have differential abilities to simulate different processes is well documented in the literature and the assessment reports, and was taken into consideration when considering model results for purposes of developing an Endangerment Finding. The commenter does not explain how these recognized differences between models impacts the validity of the conclusions drawn in the

[35] E-mail file 1196882357.txt, (December 5, 2007), page 1368, lines 36-41 of PDF version entitled: CRU Emails 1996-2009.pdf
[36] E-mail file 1196882357.txt, (December 5, 2007), page 1369, lines 16-19 of PDF version entitled: CRU Emails 1996-2009.pdf

assessment reports and in EPA's Endangerment Finding, which recognized and took into account the differences, strengths, and weaknesses of the various climate models.

1.2.4 Summary

Petitioners attempt to challenge key scientific information supporting the Endangerment Finding pertaining to temperature trends in the vertical structure of the atmosphere, the rate of warming over the last 10 or so years at the surface, the ability to attribute observed temperature trends (both in the vertical structure of the atmosphere and at the surface) to increasing GHG concentrations, and the general ability of models to replicate what has been observed and then make valid projections. Petitioners refer to material in the CRU e-mails in some cases to support their assertions.

We find the following:

- The claim that the CRU e-mails provide evidence that there is no human fingerprint in the vertical structure of the atmosphere in the tropics is not supported by scientific evidence but rather speculative assertions pertaining the timing of the publication of a journal article.
- Petitioners' overstate the significance of a possible slowdown in the rate of warming in the last 10 or so years; misinterpret statements on the issue from prominent scientists, as well as published literature; and rely upon an inappropriate examination of a short period of the temperature record to draw broad, conclusive statements about global warming and the ability to attribute it to human activities, an issue which requires analysis of data over several decades and consideration of a wide body of evidence.
- The discussions among scientists in the CRU e-mails do not undermine the validity of climate models or raise any new issues of their reliability. The discussions revolve around the strengths and weaknesses of individual models, which have been long understood by the scientific community and were reflected in and taken into account in the assessment literature and in EPA's endangerment record. The e-mails do not change the appropriate degree of certainty that should be associated with the results obtained from such models, including the increased degree of certainty when multiple different models are used to evaluate an issue, as reflected in the assessment reports and EPA's Endangerment Finding.

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1.3. Validity of the HadCRUT Temperature Record

1.3.1 Overview

A number of petitioners challenge the validity of the surface temperature record developed by scientists at CRU. Many of their issues were raised during notice and comment on the Endangerment Findings, although in some cases the petitioners claim additional support from more recent information released in the media. In particular, several petitioners reference the CRU e-mails that were made public in November 2009. Based on statements in the e-mails, petitioners question the validity of the HadCRUT temperature record and other associated temperature records.

As described in more detail in this section, the petitioners make a number of claims involving the HadCRUT temperature record, including alleged destruction of data; inappropriate data manipulation; selective use of data from Russian weather stations to create a biased global temperature record; and inappropriate corrections for urban heat island (UHI) effect, particularly in China.

The petitioners argue that these errors demonstrate that the CRU datasets in general, and the HadCRUT temperature record in particular, are flawed and unreliable. In some cases, they argue that errors in unrelated datasets maintained by CRU also undermine the HadCRUT temperature record. They then argue that these datasets and temperature records are a critical underpinning of the IPCC assessment reports, and that questions about the quality of the CRU datasets must inevitably raise questions about the validity of the IPCC's conclusions. Finally, they argue that EPA's Endangerment Finding must be reconsidered as a result of these questions, because EPA relied on the IPCC findings in reaching its conclusions.

EPA's analysis indicates that the issues and evidence presented by the petitioners do not support the conclusions they draw. First, we note that many of the issues raised by petitioners were already addressed in EPA's RTC document, such as the alleged destruction of data and the alleged problems involving Chinese UHI analyses. As explained in more detail below, other issues identified by the petitioners involve codes that have not been shown to be used in a public product; speculative analyses of Russian data that do not have any effect on modern temperature trends;, and objections to logs of quality control efforts (related to another CRU dataset, but not the HadCRUT temperature record that is the main issue in the petitioners' allegations), with no showing of any bias of the final products.

We note that the HadCRUT temperature record is one of three surface temperature records relied on by the AR4 or the EPA Findings. There are also many other records of warming, such as satellite and other records of atmospheric temperatures, as well as evidence of warming in many aspects of the environment. These multiple and independent sources of physical evidence of warming provide a comprehensive and consistent picture of warming. Petitioners fail to address this body of evidence, and

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instead, as discussed below, make inappropriate and exaggerated claims concerning one of the three surface temperature records.

For all of the temperature records referenced in the IPCC's AR4 and the TSD, including the HadCRUT temperature record, there are known to be both strengths and uncertainties with respect to data coverage, instrumental error, and other issues. There is no assertion that historical temperatures are precisely known. The size of the error ranges shown in one paper (Brohan et al. 2006) on the HadCRUT temperature record, for example, appropriately indicates the certainty of that temperature reconstruction. The petitioners have not shown that the existing error range was too small, nor have the petitioners presented any analysis indicating these error bounds should be adjusted. In addition, as described in responses throughout this section, their accusations of bias are unfounded.

In reaching the Endangerment Finding, the Administrator took the recognized degree of certainty of the underlying scientific evidence into consideration when making her decision. For many reasons that we discuss below, EPA strongly disputes the arguments that the HadCRUT temperature record or the CRU datasets serve as "the only" or "the most important" basis for 1) determinations pertaining to warming in recent decades, 2) all analyses of anthropogenic global warming, and 3) IPCC's models of future warming.

EPA's review indicates that neither the claims of error or bias nor their broad and unfounded conclusions about the validity of EPA scientific findings are supported by the evidence that they present.

Note: petitioners' arguments regarding the three surface temperature records together are addressed in Section 1.4 of this document.

1.3.2 Scientific Background on Surface Temperature Records and Underlying Datasets

Before the detailed response to petitioners' arguments, we provide some background on the development and use of the major surface temperature records and datasets. We list the records and datasets in the following text boxes. The CRU temperature record and datasets are described in this section, and the NOAA and NASA temperature records and datasets are described in Section 1.4 of this document.

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At CRU (University of East Anglia)	
CRUTEM3	Temperature record; land only, based on multiple sources including unadjusted GHCN (see below)
HadCRUT	Temperature record: land and ocean, based on CRUTEM3 plus ocean data
CRU TS2.1 and TS3.0	Multiple climate elements (temperature, rainfall, cloudiness) at a high resolution

At NOAA (NCDC)	
GHCN (Global Historical Climate Network)	Unadjusted: Data collected from a number of weather stations, used by NASA and CRU in developing their temperature record. Adjusted: Uses various techniques to correct for station moves and other issues in the raw data. This is the temperature record most commonly presented by NOAA.
USHCN (U.S. Historical Climate Network)	Adjusted: Uses various techniques to correct for time of observation and corrections based on neighboring stations.

At NASA GISS	
NASA temperature record	Referred to in other documents as the GISS temperature record, or GISTEMP. Available as a land only temperature record or as land plus ocean. Based on unadjusted GHCN, adjusted USHCN, and Antarctic station records.

Other data sources	
CLIMAT	Monthly reports from national meteorological stations organized through WMO
World Weather Records (WWR)	Station data from around the world, published decadally for most of the century. WWR was originally published by the Smithsonian Institution, later by the U.S. Weather Bureau and other organizations, and was digitized by the National Center for Atmospheric Research (NCAR).

Monitoring the changes in the surface temperature of the Earth is one of several key components of studying climate change. Surface temperature is not the only metric of a changing climate. Receding glaciers, sea level rise, changes in Arctic ice, tropospheric and stratospheric temperatures, ocean heat content, changes in precipitation and hurricanes, movement of plants, and a number of other indicators are also valuable physical parameters to monitor and evaluate observed changes of the Earth's climate. The surface temperature record is but one of many sources of evidence leading to the conclusion that global warming is occurring.

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Surface temperature records are built on the data collected from thousands of weather stations around the globe, as well as sea surface temperature records taken by ships crossing the ocean on different routes. Some of this data goes back for well over 100 years. These weather stations and the data collected by the stations were not originally intended to be used for climate monitoring, and therefore, a number of adjustments often have to be made to the data they have collected over time. Typical adjustments include corrections for the introduction of artificial biases, such as changes in the time of day that observations were made, changes in station locations, changes in the type of measurement instrument or temperature recording method, and addressing the effects of UHIs (the increased temperature observed within cities compared to rural locations). For example, sea surface temperatures used to be recorded by dipping a canvas or wooden bucket into the sea and checking the temperature after the bucket had been brought on board the ship. More recently, these temperatures are recorded in intake valves of ships. Studies have shown that these two methods result in different temperatures for measurements made at the same time and place. Thus, a long-term climate record that includes a transition from one method to the other requires an adjustment so that the whole time series consistently reflects the actual changes in temperature trends, rather than artifacts of different data collection methodologies.

We note that the petitioners have raised no objections concerning the sea surface temperature record, despite the fact that the oceans cover about 70% of the Earth's surface, and therefore, ocean surface temperature trends are the dominant component of any global temperature trend analyses. The corrections described above to adjust for the bucket to intake valve transition (documented in Rayner et al., 2005 and Folland and Parker, 1995) result in a dataset that shows less warming than the raw data would suggest. Folland and Parker noted that the first, crude attempts to correct for this bias in the 1980s involved adding 0.3 degrees to all data before 1940; this is the largest single source of bias correction involved in the global surface temperature record. Even after this correction, the sea surface temperature record shows a clear warming signal over both the past several decades and the past century. Petitioners ignore this aspect of the surface temperature record.

Other routine quality control measures involve checking for and deleting data that are shown to be duplicative. This can occur, for example, when data are obtained from different sources, and some stations are included in both datasets. Often, such duplicate stations are identified because two records have the same WMO identifier. In some cases, weather stations in different countries, or at different points in time, will have inconsistent measurement methodologies or formats for reporting data. When this occurs, the data must be adjusted to ensure that the observed results reflect actual temperature change and not methodological differences. Further, the recording stations are not evenly distributed around the planet. The methodology for building up a global average temperature record must ensure that areas with many stations are not overrepresented in the record and areas with few stations are not underrepresented. In this case, available data from existing recording stations need to be averaged in areas with high station coverage and extrapolated for areas with poorer coverage. Overall, the

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kinds of adjustments made to the underlying raw data are designed so that the results of analyses of the dataset reflect as much as possible the actual direction and magnitude of any change in surface temperature and do not reflect other changes, such as in measurement devices or in the location of stations, as if they were changes in surface temperature.

In general, the method for estimating temperature trends does not attempt to determine the average surface temperature of the Earth, but rather, to determine if temperatures have changed over time, both regionally and globally. The difference between the temperatures at a given time period compared to a reference period is known as the temperature "anomaly." Anomalies or equivalent methods are used for long-term trend analyses that combine multiple stations. Temperature anomalies are superior to absolute temperatures for climate analysis because absolute temperatures can vary significantly over small distances, whereas anomalies are better correlated with large regional changes. For example, two nearby stations—one on top of a mountain and one in the neighboring valley—will likely have different absolute temperatures but similar anomalies (changes in temperature) over time, as a shift in climate will cause both temperatures to drop or both temperatures to rise in concert. Additionally, use of anomalies, rather than absolute temperatures, allows for determination of temperature trends, even when the data availability changes (see Subsection 1.4.3.1 on "station drop-out" for an explanation of why this matters).

The process by which the HadCRUT global surface temperature record is collected and computed is described in a series of publications from CRU scientists, such as Jones (1988), Jones (1994), Jones and Moberg (2003), and Brohan et al. (2006). The earliest versions of these temperature records primarily relied on the World Weather Records. The Jones (1988) work included 1,873 stations (mostly in the Northern Hemisphere), plus 16 stations in Antarctica. The 1994 update added a number of additional stations that had been collected through the efforts of Karl et al. (1993) and incorporated some methodological improvements. Even with these improvements in spatial coverage and accuracy, the hemispheric averages were nearly unchanged. Jones attributed this to the robustness of the hemispheric mean temperature series and the high correlation of anomaly measurements over large areas. He estimated that for a hemispheric average, only 100 well-placed stations would be necessary to give a robust result. However, for estimating continental or smaller regional-scale temperature trends, more temperature records would be necessary.

The Jones and Moberg (2003) paper reported the inclusion of the GHCN dataset (described in Subsection 1.4.2 of this document on NOAA and NCDC data); improved 18th and 19th century records; and integrated data from individual National Meteorological Services (NMSs) in countries around the world, data exchanged over the WMO CLIMAT network and other global datasets covering the years after 1981, and data from Antarctica. The 2003 temperature record was based on data from 5,159 stations. Jones and Moberg (2003) describes the "laborious and time consuming" analysis that was required when certain stations existed in both the original Jones temperature record and in the new data that was acquired from other sources, and the

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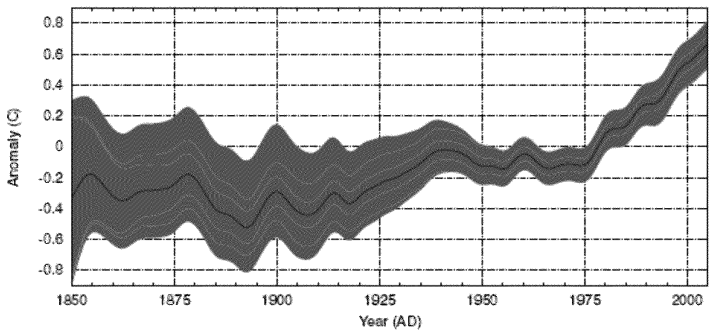
approach taken in such cases to determine how to appropriately "homogenize" the data. This "homogenization" involves adjusting data to correct for discontinuities in the data due to nonclimatic effects. For example, in 1994 the Australian NMS switched from reporting a "daily mean" temperature, which was the average of the maximum and minimum temperature each day, to a "daily mean" temperature, which was the average of every temperature recorded over the day on a three-hour basis. These two methods yield different results for the same date, and without an adjustment to correct for the change in average temperature before and after the switch, the apparent temperature trends would reflect the change in methodology in addition to any actual climatic change. Other quality control methods involved examining every outlier (defined as five standard deviations from the mean) and determining if there was a reason that the data point was so far off from the other data from that station. Jones and Moberg (2003) compared the CRU analysis to the NOAA and NASA analyses as well as the older Jones study (1994), and found that the Northern Hemisphere patterns remained remarkably similar in all four series. There were some larger differences in the Southern Hemisphere because fewer stations were located there, and therefore, differences in methodologies used for the different temperature records (in terms of how to include Antarctica and South Pacific islands) could lead to more differences in the Southern Hemispheric record than were seen in the Northern Hemisphere.

The final published update (Brohan et al., 2006) added a few more stations, deleted some stations where there were duplicates, and performed additional quality control checks. This update also describes three kinds of errors that are incorporated into an error analysis: station error due to bad measurements or adjustments to an individual station, sampling error because of too little coverage, and large-scale bias error due to changes in methodologies (like the Australian NMS switch or the bucket to ship intake switch) (see Brohan et al. Figure). We note that while bad measurements or adjustments to an individual station can lead to incorrect assessments of very local trends, on a large scale, these kinds of random errors will, on average, cancel out. Large-scale bias errors have the potential to be more important for large-scale trends, but the major sources of biases have all been examined, and corrections for these biases have been incorporated into the temperature records and uncertainty estimations. Petitioners have not identified new sources of large-scale bias that are not already considered and addressed by the scientific literature.



Brohan et al. (2006) Figure: Land component of HadCRUT3: The solid black line is the best estimate value, the red band gives the 95% uncertainty range caused by station, sampling and measurement errors; the green band adds the 95% error range due to limited coverage; and the blue band adds the 95% error range due to bias errors.

Another graph is included in Brohan et al. (2006) that summarizes all the homogenization adjustments that were made to the data, showing a fairly symmetric distribution, although with slightly more adjustments that cooled older data (attributed to a number of stations moving from inside a city to an out of town airport). The paper also discusses how the uncertainty estimates take into account the potential magnitude of the effects of urbanization (UHIs) and changes in thermometer methodologies. Continued updates to the HadCRUT methodology, along with links to the data, are reported on the UK Met office website (UK Met Office, 2010a).

These data, along with a number of other temperature records (such as the NOAA and NCDC temperature records), are used to analyze long-term trends to compare to both model simulations and satellite trends. The recent warming shown in HadCRUT and other temperature records has contributed to statements by the IPCC that "warming in the climate system is unequivocal" (IPCC 2007a), among other statements.

In addition to the HadCRUT temperature record, CRU also maintains a dataset whose current version is known as TS3.0. TS2.1, also referred to in some of the CRU e-mails, is the older version of this dataset. The TS datasets include various temperature metrics and data on precipitation, wet-day frequency, frost-day frequency, vapour pressure, and cloud cover. The gridding of these data is at a high resolution (half a degree) compared to the 5-degree resolution of the HadCRUT temperature record, and is described in Mitchell and Jones (2005). These data have been used by many researchers, in combination with other datasets that measure the same variables, to analyze long-term trends and compare to model simulations. The TS2.1 dataset is referred to twice in the IPCC AR4 in relation to historical precipitation data. However, almost all of the references to global temperatures over time that refer to CRU data refer to the HadCRUT temperature record. The HadCRUT temperature record is distinct from the TS datasets. Compared to HadCRUT, the TS datasets include many more climatic variables than temperature, are gridded at a finer resolution, and are updated only once every several years rather than every month. While the TS2.1 dataset did use the CRUTEM dataset from Jones and Moberg (2003) for temperature data, it also included temperature data from five other sources. Arguments made by petitioners about the TS datasets are not relevant to the HadCRUT temperature record.

1.3.3 Responses to Petitioners' Arguments Regarding the Validity of CRU Data

Petitioners, including the Competitive Enterprise Institute, the Pacific Legal Foundation, Peabody Energy, the Southeastern Legal Foundation, the State of Texas, and the Coalition for Responsible Regulation, raise a number of concerns regarding the data held and analyzed by CRU. The petitioners present five major arguments regarding the validity of the CRU data. The first argument is that alleged destruction of raw data for the HadCRUT temperature record renders the scientific data on surface temperature worthless and makes replication of temperature trends impossible. The second argument alleges that comments within code and log files are evidence of manipulation that "undercuts the credibility of CRU databases." The third argument refers to a report from the Moscow-based Institute of Economic Analysis (IEA) (Pivovarova, 2009) that claims

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to show that the Russian stations used in the HadCRUT temperature record were selectively chosen to show increased warming. The fourth argument refers to a dispute about a 1990 paper coauthored by Phil Jones (Jones et. al, 1990) and claims that the IPCC improperly relied on this study for its conclusions about the magnitude of the UHI effect. Finally, petitioners argue that the CRU data is the primary basis for the conclusion of "unprecedented" warming and the foundation of anthropogenic global warming analyses.

The following subsections address each of these five arguments. The alleged data destruction was addressed in the RTC document. No original raw data were destroyed, the original raw data are and remain the property of the NMS that collected them and can be obtained from the original stations (or national meteorological offices), subject to their procedures. With respect to the code and log files, the quotes selected by the petitioners are not evidence of deliberate data manipulation and are mainly the result of quality control processes determining how to best address the vast quantities of data collected from different sources. The IEA analysis of Russian temperature stations shows little divergence between the HadCRUT dataset and its own analysis after 1950, and while there is some divergence in the pre-1950 timeframe, the IEA analysis is not credible because it uses improper methodologies to do the comparison. Jones et al. (1990) was addressed in the RTC document and is not a central component of the IPCC analysis of UHI effects. Finally, the HadCRUT temperature record does not serve as the only or most important basis for recent warming or other anthropogenic global warming analyses. It is one of several temperature records used in analyses of global warming, along with numerous other analyses of physical evidence of warming.

1.3.3.1 Alleged Destruction of Raw Data

Comment (1-36):
Several petitioners claim that CRU has not kept raw data collected from the surface weather stations, only the homogenized and value-added data (e.g., the data corrected for station moves and measurement changes), and that therefore, the evidence for warming in the past century is questionable. For example, the Competitive Enterprise Institute objects that CRU has been involved in "data dumping" the original raw data for its datasets and claims that this action "renders independent review and verification of the 150-plus year temperature trends published by the Hadley Center-CRU impossible - a clear violation of basic principles of science and was found by the British Information Commissioner's Office to be a violation of the British Freedom of Information Act." Along similar lines, the State of Texas argues that "revelations that CRU data was destroyed, lost, or simply withheld indicate a different, but equally serious, problem: that the data can neither confirm nor deny how quickly, how far, for how long, or even, in some cases, whether, temperatures have risen." The Southeastern Legal Foundation cited a newspaper article claiming that "Shortly after the Climategate documents became public, CRU was forced to admit on or about November 29, 2009 that much of their original data has been destroyed…" (Leake, 2009).

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Petitioners assert that these alleged actions by CRU make EPA's "claim of warming trends scientifically indefensible" (Competitive Enterprise Institute) and render the CRU data "scientifically worthless" (State of Texas).

Peabody Energy states:

> EPA was aware at the time it published the Endangerment Finding that some of the raw data used in HadCRUT3 had been destroyed but dismissed concerns about the reliability of these records on essentially three grounds. First, it uncritically adopted CRU's public position that since (a) ninety-five percent of the raw data has long been available to researchers on the Global Historical Climatology Network ("GHCN") and (b) CRU's adjustment methodology is available, then (c) researchers could independently replicate and confirm the appropriateness of CRU's adjustments.[243] But as shown in section VI(E) below, the reason CRU and independent researchers cannot replicate CRU's adjustments is because CRU can no longer determine which data from the GHCN it used. EPA's unwillingness to make its own assessment of this issue further illustrates that EPA has ceded its own judgment to third parties.

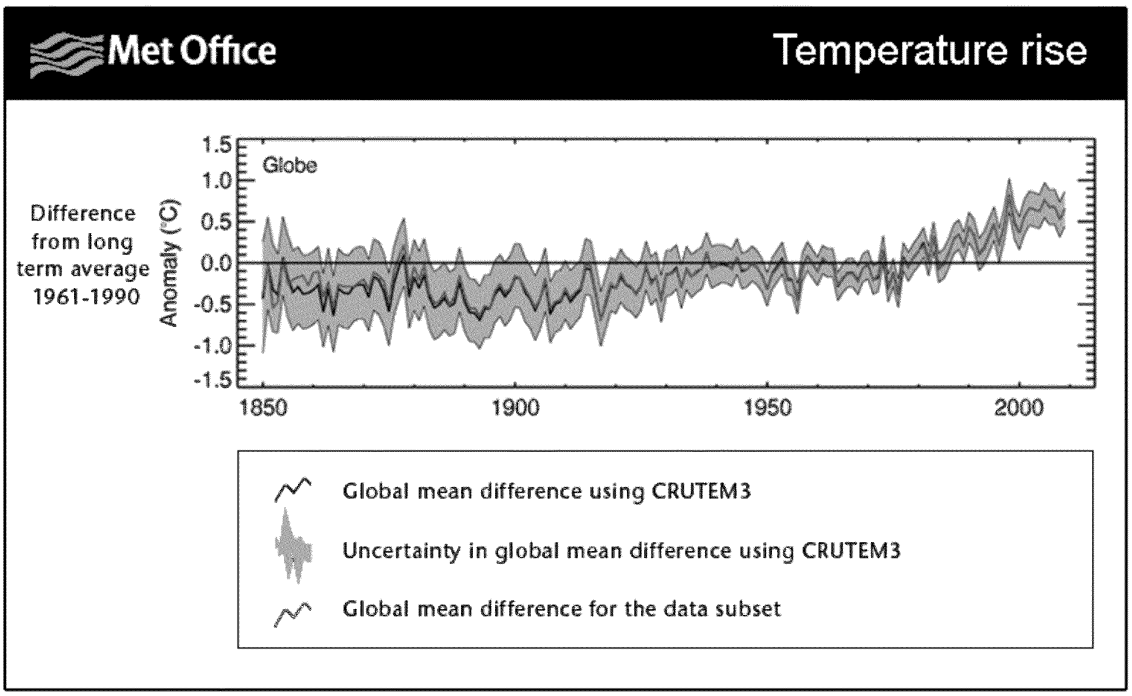
Response (1-36):
CRU has not retained all of the raw weather station data collected during development of the HadCRUT temperature record, and CRU has openly acknowledged this point and provided a detailed explanation for its handling of the data. In fact, this issue was raised in public comment on the proposed Endangerment Finding and is addressed at length in Volume 2 (Response 2-39) of the EPA RTC document. In that response, we explained that:

> CRU has stated (see Appendix B) that they do not hold the original raw data but only the value added (i.e., quality-controlled and homogenized) data for "some sites," and refers readers to a long list of peer-reviewed references that describe how the value-added data were generated. To the extent possible, CRU has made all data for the HadCRUT record available (see Appendix A). In certain instances, data may be unavailable to the public due to constraints of the arrangements made in obtaining the data between CRU and other governments/organizations, as described in Appendix B.

CRU's statement on this issue is available on their website (CRU, 2010).

The fact that CRU has not retained all the raw data does not interfere in any way with replication of or development of independent estimates of global or regional surface temperature history. The vast majority of the raw global weather station data is available from the GHCN and other public data sources. It is therefore possible to generate an independent estimate of global temperatures, as GISS, NCDC, and other groups have done. While attempting an exact replication of a particular analysis could be useful in understanding how it works and possibly identify minor bugs, this kind of exact replication is certainly not necessary. Indeed, for a result to be robust, it should yield a very similar answer, even if there are differences in the method of the underlying analysis. As discussed in Section 1.4 of this document, NOAA and NASA analyses of global surface temperature records provide such evidence. These analyses find temperature increases of similar magnitude and thus, strongly support the conclusion that the CRU analysis is robust. Similarly, as described in the background above, the major

conclusions about warming based on the HadCRUT temperature record have remained robust, even as more data were integrated and methodologies refined over a period of two decades. Additionally, CRU has posted a graph showing that there is very little difference in global average surface temperatures resulting from using the 80% of the station data that is publicly available compared to the full dataset (MetOffice Data Subset Figure; UK Met Office, 2010c). At smaller spatial scales there may be differences between the full and partial datasets, but at the global scale, this confirms the trend is very robust and reliable.



UK Met Office Data Subset Figure: The temperature reconstruction from the full dataset is in black, and the temperature reconstruction from the publically available dataset is in red. (UK Met Office, 2010c)

Petitioners have not conducted an independent analysis to determine global temperature trends, although the data are available, and they do not provide any global analysis that yields a different result. They have provided no evidence that an additional or different analysis using the publicly available temperature data would yield a result that differs substantively from the warming over the century reflected in the HadCRUT and other analyses of global surface temperature.

In contrast, the recent Independent Climate Change E-mails Review (2010) managed to write computer code from scratch in a space of two days that produced results similar to the HadCRUT temperature record and other independent analyses, working with publicly accessible data. This independent effort included the two key characteristics of any global temperature analysis: use of anomalies (or equivalent method) in order to focus on the change in temperature rather than the absolute temperature, and use of gridding (or

equivalent method) to take into account the spatial distribution of the data. In the process, the Review determined that:

> The exercise and comparison of all figures demonstrates that:
>
> 1. Any independent researcher may freely obtain the primary station data. It is impossible for any group to withhold data.
> 2. It is impossible for any group to tamper improperly with data unless they have done so to the GHCN and NCAR (and presumably the NMO [National Meteorological Office]) sources themselves.
> 3. The steps needed to create a temperature trend are straightforward to implement.
> 4. The computer code necessary is straightforward to write from scratch and could easily be done by any competent programmer.
> 5. The shape obtained in all cases is very similar; in other words, if one does the same thing with the same data one gets very similar results.
> 6. The result does not depend significantly on the exact list of stations.
> 7. Adjustments make little difference.

Studies that use consistent methods for determining annual anomalies and spatial interpolation weighting factors produce results broadly consistent with the HadCRUT temperature record. Contrary to the assertions of petitioners, EPA has not ceded its judgment to third parties or uncritically adopted positions by other organizations; it has assessed the major surface temperature records and the methodologies of creating them and determined that the global trends found in these temperature records are robust. Contrary to the implications by the petitioners, it is not necessary to perfectly duplicate the HadCRUT temperature record to the precise decimal point in order to make scientifically useful conclusions from replication exercises.

In addition, the limited amount of raw data that is no longer in CRU's possession does not adversely affect the scientific usefulness of the surface temperature analyses and results prepared by CRU. There is a long record of peer-reviewed publications explaining the process of preparing the raw data for analysis, presenting the results of the analyses, and evaluating the magnitude of various possible sources of error. It is an unwarranted leap in logic to assume these analyses have no merit just because a small percentage of the underlying raw data is no longer in CRU's possession.

In summary, we find that the petitioners arguments were previously addressed in EPA's RTC document, and they have shown no evidence that CRU's lack of a small portion of the raw temperature data impedes the ability to check if the publicly available data give results consistent with the HadCRUT temperature record, or that it changes the scientific validity of the analyses performed by CRU.

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1.3.3.2 Alleged Data Manipulation

Comment (1-37):
The Coalition for Responsible Regulation claims that "According to CRU's own programming staff, the CRU temperature data were 'fudged,'" noting that "the file BRIFFA_SEPT98_E.PRO reveals that the programmer 'Appl[ied] a VERYARTIFICIAL correction for decline!!,' and literally labeled several of the adjustments as 'fudge factors.'"

Response (1-37):
Based on the comments in the code, BRIFFA_SEPT98_E.PRO appears to be a provisional test program, with comments in capital letters to remind the programmer to replace the temporary fudge factors with more valid adjustments before the code is used for public products. Additionally, although the petitioners claim that this code shows that "CRU temperature data were 'fudged,'" it appears that the fudge factor in question is related to the divergence issue discussed in Section 1.1 of this document, and therefore the fudge factor is not related to the HadCRUT temperature record. There is no evidence or reason to believe that the BRIFFA_SEPT98_E.PRO code was actually used for any public final product. On its face the "Artificial Correction" was designed as a temporary adjustment.

Comment (1-38):
The State of Texas refers to "one notable email" in which "a CRU staff member discuss a 'trick' to 'hide the decline' in CRU temperature data sets from 1981-2000", and concludes that "Such emails show that the CRU did not simply gather raw temperature data, enter it into computer programs, and produce conclusions based on collated raw data. Instead, the CRU gathered temperature data and manipulated it to produce a result that was sometimes different from the result that the raw data would have produced." The State of Texas states that "Consequently, the British Meteorological Office (the 'MET') has announced that it will reexamine 160 years of climate data, attributing the need to reexamine the data to a *'lack of public confidence based on the leaked e-mails.'"* The Southeastern Legal Foundation also brought up the MET reexamination in its petition.

Response (1-38):
The State of Texas is referring to an e-mail that addressed paleoclimate temperature reconstructions, not the modern surface temperature record. As discussed in Subsection 1.1.4, the "decline" referenced in this e-mail was a reference to the divergence between some tree ring records and the instrumental record. This divergence was recognized in the published literature, and in some cases the authors of these publications were the same people who were the authors of the e-mails. This is unrelated to the HadCRUT temperature record.

In addition, the petitioner objects to the "manipulation" of raw temperature data but has produced no evidence or argument that CRU made any inappropriate adjustments to the data in the process of producing the HadCRUT temperature record. The adjustments to

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the raw data are made in order to make the resulting temperature record a more accurate representation of the actual large-scale historical temperature changes. There is no scientific merit to petitioners' allegations that the adjusted data is faulty because it gives different results than the unadjusted data. That ignores the scientific basis for making the adjustments. EPA addresses these issues in Subsection 1.3.2 on the Scientific Background on the HadCRUT Temperature Record.

The MET announced a reexamination of climate data, but creating an investigative body to reexamine the data is not evidence that the original conclusions are in error. Indeed, the proposal from the MET (UK Met Office, 2010b) stated, "[i]t is important to emphasize that we do not anticipate any substantial changes in the resulting global and continental-scale multi-decadal trends. This effort will ensure that the datasets are completely robust and that all methods are transparent." There have been several investigations of CRU and other climate researchers, and to date, none of the released conclusions of these investigations have found evidence of inappropriate data manipulation, nor has any evidence been shown that the HadCRUT temperature record is not robust. The existence of similar trends in the NASA and NOAA records, along with other physical signs of warming, such as glacial melt, satellite records, and ocean heating, strongly supports the robustness of the HadCRUT temperature record, and it is all of these sources that provide the comprehensive evidence that has led to the conclusion that warming in the climate system is unequivocal.

Comment (1-39):
The State of Texas also references the investigation into CRU by the British House of Commons, stating "On December 2, 2009, Science and Technology Committee Chairman Phil Willis wrote to the Vice Chancellor of East Anglia University asking for an explanation of CRU's conduct and expressing concern about allegations that CRU 'data may have been manipulated or deleted in order to produce evidence on global warming.'"

Response (1-39):
The UK House of Commons Science and Technology Committee has released the report (2010) from its independent investigation and found no evidence of manipulations or deletions to produce evidence on global warming. See the Decision Document, as well as Subsections 1.3.5 and 1.4.3.5.

Additionally, the "Report of the International Panel set up by the University of East Anglia to examine the research of the Climatic Research Unit" was issued recently (University of East Anglia, 2010a), and found that:

> We saw no evidence of any deliberate scientific malpractice in any of the work of the Climatic Research Unit and had it been there we believe that it is likely that we would have detected it. Rather we found a small group of dedicated if slightly disorganised researchers who were ill-prepared for being the focus of public attention. As with many small research groups their internal procedures were rather informal.

Comment (1-40):
The Pacific Legal Foundation claims that "The e-mails may suggest that the authors manipulated and "massaged" the data to strengthen the case in favor of unprecedented global warming, and to suppress their own data if it called global warming into question. *See* e-mails 0938018124, 0843161829, 0939154709, 0942777075, and 1059664704."[37]

Response (1-40):
The petitioners do not state what portions of these selected e-mails are evidence for their claim of manipulation. All of these e-mails were written in 1999. The first e-mail (0938018124)[38], for example, is from Michael Mann to Keith Briffa, Chris Folland, and Phil Jones and includes in the first paragraph a statement that is directly contrary to the assertion of the petitioners. This paragraph demonstrates appropriate acknowledgment of limitations and avoidance of overconfidence:

> And I should point out that Chris, through no fault of his own, but probably through ME not conveying my thoughts very clearly to the others, definitely overstates any singular confidence I have in my own (Mann et al) series. I believe strongly that the strength in our discussion will be the fact that certain key features of past climate estimates are robust among a number of quasi-independent and truly independent estimates, each of which is not without its own limitations and potential biases. And I certainly don't want to abuse my lead authorship by advocating my own work.[39]

E-mail 0843161829[40] is from Gary Funkhouser, about a certain Kyrgyzstan tree ring dataset from which he was unable to make robust conclusions. We respond to the issues in this e-mail in Response 1-12 in Subsection 1.1.4 of this RTP document, and find that the scientist is following proper procedures and not using data unless the data meets statistical requirements. The e-mail ends with Funkhouser hoping that someone will take some more data from the site to get better statistics.

E-mail 0939154709[41] contains data from a temperature reconstruction from Tim Osborn to Mike Mann and others. This e-mail contains a discussion of the post-1960 non-temperature signal that has been discussed in Section 1.1 on "divergence", but again this e-mail contains no evidence of improperly massaging data:

> Keith has asked me to send you a timeseries for the IPCC multi-proxy reconstruction figure, to replace the one you currently have. The data are attached to this e-mail. They

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[37] E-mail files 0938018124.txt (September 22, 1999) page 203 line 12, 0843161829.txt (September 19, 2006) page 11 line 4, 0939154709.txt (October 5, 1999) page 229 line 32, 0942777075.txt (November 16, 1999) page 243 line 31, and 1059664704.txt (July 31, 2003) page 558 line 6 of PDF version entitled: CRU Emails 1996-2009.pdf
[38] E-mail files 0938018124.txt, (September 22, 1999), page 203, line 12 of PDF version entitled: CRU Emails 1996-2009.pdf
[39] E-mail file 0938018124.txt, (September 22, 1999), page 203, lines 21-27 of PDF version entitled: CRU Emails 1996-2009.pdf
[40] E-mail files 0843161829.txt, (September 19, 2006), page 11, line 4 of PDF version entitled: CRU Emails 1996-2009.pdf
[41] E-mail files 0939154709.txt, (October 5, 1999), page 229, line 32 of PDF version entitled: CRU Emails 1996-2009.pdf

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> go from 1402 to 1995, although we usually stop the series in 1960 because of the recent non-temperature signal that is superimposed on the tree-ring data that we use. I haven't put a 40-yr smoothing through them - I thought it best if you were to do this to ensure the same filter was used for all curves.[42]

E-mail 0942777075[43] is from 1999 and similarly refers to the divergence issue, and has been quoted extensively because it used the term "Mike's Nature trick". We address this e-mail in Response 1-11 in Subsection 1.1.4 of this document, and find that this e-mail refers to a graph used in a 1999 WMO report which is unrelated to the IPCC and that the word "trick" does not imply deceit. The underlying issues involved with divergence are addressed in Section 1.1 of this document.

E-mail 1059664704[44] is the e-mail from Mike Mann discussing "calibration residuals." We respond to these issues in Response 1-80 in Section 1.3.3.6 where it is shown that the uncertainties arising from these residuals were discussed in the published papers by Dr. Mann.

None of these e-mails provide evidence of or support the conclusion that the e-mail authors conducted inappropriate "massaging" or manipulating of the data or suppressed their own data.

1.3.3.3 "Harry Read Me" file and other code

The petitioners submitted a large number of quotes from a 300 page, 90,000 word document named HARRY_READ_ME.txt[45]. The HARRY_READ_ME.txt debugging notes are a record of "Harry's"[46] attempt to update the CRU TS2.1 product to TS3.0 during the years 2006 to 2009 by merging six years of additional data (covering 2003 to 2008) to an old dataset running until 2002, and migrating the code to a new computer system at the same time. As noted in the science background in Subsection 1.3.2 of this document, CRU TS2.1 and 3.0 are different from the HadCRUT temperature record that is referred to in the EPA TSD. Arguments made by petitioners about the TS datasets are not relevant to the HadCRUT temperature record.

These quotes mainly fall into the following categories:

1) Expressions of frustration with documentation or system processes that do not indicate any problems in the underlying data.

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[42] E-mail file 0939141116.txt, (October 5, 1999), page 226, lines 32-37 of PDF version entitled: CRU Emails 1996-2009.pdf
[43] E-mail files 0942777075.txt, (November 16, 1999), page 243, line 31 of PDF version entitled: CRU Emails 1996-2009.pdf
[44] E-mail files 1059664704.txt, (July 31, 2003), page 558, line 6 of PDF version entitled: CRU Emails 1996-2009.pdf
[45] The complete text of this document has been placed in the docket for this action. See Docket ID No. EPA-HQ-OAR-2009-0171 at www.regulations.gov.
[46] "Harry" is a researcher at CRU.

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2) Notes about imperfections in the data received from various organizations that make it difficult to integrate the new data with the old database. The problems that arise from this integration are resolved one by one throughout the time period covered by the file.
3) Expressions of frustration based on introducing errors into code which then have to be fixed. Bugs are almost always introduced in the coding process, and the key is to find them and fix them. The file includes evidence that this is being done.
4) A few unresolved data issues arise at the end of the log file, and there is no indication in the log file of how these imperfections were fixed. This does not mean that these issues were not fixed between the version of the log file that was released with the CRU e-mails and the final TS3.0 version. Additionally, none of these issues appear to involve large-scale errors that would introduce bias, but rather unresolved inconsistencies in the data of one or two stations for a subset of the climate variables being recorded.

In sum, the HARRY_READ_ME.txt is a long, multi-year log of expressed frustrations with old codes, merging datasets from different sources, changing computer systems, and the arduous process of performing quality control. This file reflects both specific technical terminology and the personality of the researcher. Taken out of context, as done by petitioners, the quotes from the file can provide misleading impressions. As the files show, the datasets are not perfect, but that is not a surprise. As exemplified by the Brohan et al. (2006) uncertainty analysis discussed in Subsection 1.3.2 (Background), it is well known that there are a number of reasons for there to be errors and uncertainties in the underlying raw data set. Importantly, the petitioners have not identified any errors that are likely to bias that would affect the large-scale trends analyzed with the TS dataset. As discussed, measurement or other errors at individual stations matter for very local trends but tend to cancel out when averaged over large scales. Importantly, EPA was unable to identify any quotes among the many dozens submitted that indicated any deliberate attempt to bias the data (nor did EPA find any such evidence in its analysis of the underlying HARRY_READ_ME document).

The evidence shows that "Harry" was working on identifying and solving these errors in order to improve on the CRU TS2.1 dataset, much like the HadCRUT temperature record has gone through multiple iterations and improvements. Again, the petitioners have shown no evidence of bias or of errors that are of sufficient magnitude to compromise the climate signals in the various climate variables included in the TS dataset.

The CRU TS2.1 dataset was not used in the IPCC for evaluating the trends in surface temperature. The HadCRUT temperature record was used for that, and it is a separate and distinct dataset from TS2.1. The TS2.1 products are only directly cited in Working Group I of the IPCC AR4 in two places: in Figure 3.12/Table 3.4 as one example out of several of a global land precipitation dataset (Trenberth et al., 2007), and in Figure 9.19 for comparing Sahel precipitation trends to model simulations (Hegerl et al., 2007). Therefore, in addition to a lack of evidence that the contents of the HARRY_READ_ME.txt file materially change any large-scale trends, analyses of TS2.1

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data in most cases are presented alongside other independent data that support the same conclusions.

The TS datasets in particular involved up to nine different climate variables collected from thousands of weather stations from dozens of different countries covering a century of time. One problem in particular involving WMO codes that appears in many of the quotes highlighted by petitioners was explicitly highlighted in the paper published about TS2.1, as well as in other papers in the literature as discussed in Response 1-46. None of the quotes highlighted indicated any problems that are outside the bounds of the known uncertainties and imperfections in the data that are discussed in the literature.

Comment (1-41):
One petitioner provides a quote: "As far as I can see, this renders the (weather) station counts totally meaningless."

Response (1-41):
This quote is followed, a long time later, by a discussion from "Harry" of trying to get this code working on the computer system of a client (the British Atmospheric Data Center): "Next problem - station counts. I had this working fine in CRU - here it's insisting on stopping indefinitely at January 1957." The first part of the quote shows that "Harry" did fix the station count problem. The last part of this quote refers to additional frustrations involved in getting the code to work on an unfamiliar computer system, which is a fairly typical occurrence when moving from one system to another.

Comment (1-42):
The quote "COBAR AIRPORT AWS (data from an Australian weather station) cannot start in 1962, it didn't open until 1993!" is provided by Peabody Energy as an example of false data.

Response (1-42):
The paragraphs preceding and following the quote clearly indicate that this problem was identified by an automated quality control routine, that "Harry" followed up by e-mailing the Australia Bureau of Meteorology, and that he was able to resolve the problem by determining that the 1962 to 1993 portion of the COBAR AIRPORT AWS station was actually from the Cobar MO station.

Comment (1-43):
Southeastern Legal Foundation provides a quote: "Well, dtr2cld is not the world's most complicated program. Wheras cloudreg is, and I immediately found a mistake! Scanning forward to 1951 was done with a loop that, for completely unfathomable reasons, didn't include months! So we read 50 grids instead of 600!!!"

Response (1-43):
Examination of this file shows that this quote refers to a piece of code that "Harry" had just written, and the quote was immediately followed by the comment, "Running with those bits fixed improved matters somewhat…," showing that the goal of the exercise

was to identify and address issues with the merging/updating of the data system, and that the problems were addressed.

Comment (1-44):
Another quote Southeastern Legal Foundation provides is: "I was expecting that maybe the latter contained 94-00 normals, what I wasn't expecting was that they are in % x10 not %! Unbelievable - even here the conventions have not been followed. It's botch after botch after botch. Modified the conversion program to process either kind of normals line."

Response (1-44):
In this case, the problem was merely that some input data had different units than other input data, and that "Harry" developed a routine to address this. The resolution of the problem (modifying the conversion program) is included within the quote provided by the petitioner.

Comment (1-45):
Peabody Energy claims that if adjustments are made to a methodology of developing a temperature record after peer review, then the resulting temperature record no longer qualifies as peer-reviewed itself, stating "If CRU cannot replicate its adjustments (as in the case with their HadCRUT3 data), or if adjustments were made after the publication of peer-reviewed methodology (as in the case with their TS2.1/3.0 data), there is no basis to say that the adjustments, in fact, were properly applied. CRU—and EPA—in essence are saying "trust me," but any basis to do so seems to have collapsed with the Harry_Read_Me files." Peabody Energy further argues that any dataset that is updated or changed cannot count as peer reviewed, stating "Moreover, as is evident in several emails, the CRU temperature data set is in a constant state of flux, with the data set constantly being modified both in terms of the inclusion/exclusion of data as well as the methods employed. Thus, the datasets now available have not been directly peer-reviewed."

Response (1-45):
The petitioner misunderstands how the peer-review process is applied to the creation of temperature records and similar datasets. The papers published by CRU over the years detail the sources and methods used to generate the temperature record (as summarized in Subsection 1.3.2). It is expected that as new data become available, they will be incorporated, and as minor errors or updates are made that those too will be incorporated, without triggering any need for a new peer review. If any of this new data or updates resulted in substantial changes to the final output or the methodology, then that might call for further review. However, as has been noted repeatedly, the HadCRUT temperature record is both reliable and robust, with similar trends resulting from the analyses of NOAA, NASA, and other groups. The evidence suggests that these temperature records and other datasets are being produced in accordance with the peer-reviewed papers in which they are described, where these peer-reviewed papers discuss the limitations of the underlying data records and other uncertainties. The petitioner has not shown evidence of any changes that are substantial enough to warrant a new peer-review process.

The Harry_Read_Me file is not related to the HadCRUT temperature record, but rather to the creation of TS3.0, as explained in Subsection 1.3.2. TS3.0 (or Time-Series 3.0) is a separate dataset produced by CRU, with different stations, spatial resolution, and set of variables. Regardless, the notion that CRU and EPA are saying "trust me" with regard to the surface temperature record is flawed; the GHCN data is publicly available for any individual or researcher to use to generate his or her own global temperature record. The petitioners have not provided or referenced any credible analysis of the GHCN data that reaches a different conclusion than those of NOAA, NASA, and the CRU.

Comment (1-46):
The Coalition for Responsible Regulation, Peabody Energy, and Pacific Legal Foundation all provide sections of a quote from the HARRY_READ_ME file: "What the hell is supposed to happen here? Oh yeah - there is no 'supposed', I can make it up. So I have :-)" The Coalition for Responsible Regulation claims that "The programmer asserts in the HARRY READ ME.txt file that, in the absence of data from the period 1990 through 2003, he made up what to do" and states "EPA cannot support a scientific judgment premised on 'very artificial,' 'fudged,' and 'made up' data. Because these Disclosures demonstrate that at least some of the temperature data managed and maintained by CRU were 'fudged' or 'made up,' EPA must reconsider its Finding and demonstrate that the data upon which it relied are valid and not corrupted."

Related quotes about WMO codes are provided by the above petitioners and the Southeastern Legal Foundation: "You can't imagine what this has cost me - to actually allow the operator to assign false WMO codes!! But what else is there [in] such situations? Especially when dealing with a 'Master' database of dubious provenance (which, er, they all are and always will be)," "So with a somewhat cynical shrug, I added the nuclear option - to match every WMO possible, and turn the rest into new stations ... In other words, what CRU usually do. It will allow bad databases to pass unnoticed, and good databases to become bad, but I really don't think people care enough to fix `em, and it's the main reason the project is nearly a year late," and "False codes will be obtained by multiplying the legitimate code (5 digits) by 100, then adding 1 at a time until a number is found with no matches in the database. THIS IS NOT PERFECT but as there is no central repository for WMO codes - especially made-up ones – we'll have to chance duplicating one that's present in one of the other databases. In any case, anyone comparing WMO codes between databases - something I've studiously avoided doing except for tmin/tmax where I had to - will be treating the false codes with suspicion anyway. Hopefully."

The Coalition for Responsible Regulation claims that these quotes are evidence of "deliberately fabricating non-existent temperature-recording stations" and that "This kind of data manipulation, including creation of false temperature stations, undercuts the credibility of the CRU databases and requires EPA to reconsider its Endangerment Finding."

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Response (1-46):
Petitioners mischaracterize the emails by ignoring the context of the legitimate quality control process that they reflect. The problems encountered in merging WMO station data from different countries and time periods has been recognized and discussed in the peer reviewed literature (two examples are quoted in this response), and the quality control measures taken here are consistent with those discussed in the literature.

These quotes address a specific issue where the programmer had written an automatic quality control routine to be used when merging incoming data provided by national weather organizations to the existing data in the database. As mentioned in the background discussion above, data are assumed to be from the same weather station if their WMO codes match, but sometimes issues arise that cast doubt on this assumption. To address these situations, the programmer developed a routine that ran prior to merging the data that checked for sufficient correlation (e.g., seasonal patterns) between the new and the old data. If the data were correlated, the merge would proceed. However, in cases where the correlation routine finds something anomalous, the program warns the user that an inconsistency exists and provides the user with three options:

> You have failed a match despite the WMO codes matching.
> This must be resolved!! Please choose one:
>
> 1. Match them after all.
> 2. Leave the existing station alone, and discard the update.
> 3. Give existing station a false code, and make the update the new WMO station.

Therefore, this quality control check is ensuring that for any data that seems odd, a user will conduct a manual review and determine whether the best option is to assume that both datasets are from the same station or whether the new station should be discarded or turned into its own station. We note here that the use of "false codes" is not "falsification," as inferred by the Pacific Legal Foundation, but rather a way to address the problem that a few stations in the new data set had the same WMO code as stations in the old data set, despite the fact that quality control routines determined that the data from these stations had different statistical characteristics.

This is not "making up" data. No data have been created; the only thing "made up" is an identification number associated with the data (the WMO code), because the previous identification number was already in use. The petitioners did not highlight these additional quotes that show the fuller context of the now oft-cited "I can make it up" quote.

Moreover, the problems involved with WMO codes are not new and are well documented in the published literature. As explained in the published paper on the CRU TS2.1 database (e.g., Mitchell and Jones, 2005), there are challenges involved in matching WMO codes.

> However, not all sources attach WMO codes to their data, and not all stations have been assigned WMO codes, so additional information was used: location, name and country. Each additional station was compared with the stations already in the database, both to

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> avoid unnecessary duplication and to ensure that each station record is as complete as possible.
>
> If an additional station was already present in the database, then the two records were compared….The comparison was based on any available overlap between the records; if none was available, then an attempt was made to construct a reference series that overlapped both records (as in Section 2.4). If an overlap was found, then it was used to alter the statistical characteristics of the additional station to match those of the existing record, using the method in Section 2.4.4; the two records were then merged. If no overlap was found, then the records were assumed to be for different stations, because of the possibility of the two records having different normals.
>
> Where the sources were very recent (CLIMAT and MCDW) the additional station was assumed to be the same without the above data check. This was justified because the normals from these sources were likely to be the same as the post-adjustment normals from other sources. This assumption was necessary for some climate variables (notably wet days) for which overlaps with stations from other sources were very rare; without it the normals could be calculated for very few recent data.

As demonstrated by this quote from the published literature, the standard procedure was to assume that a new record was a different station if the data did not have sufficient overlap to merge the records with confidence. This is what "Harry" was doing when he was "making up" a new WMO code.

Peterson, Daan, and Jones (1997) also addressed some of the challenges involved when gathering data from many independent national services based on WMO codes, and the well understood imperfections in this procedure:

> These four sources total 15,433 stations. But how many are unique? To answer this question, all the stations needed to be merged into a single list, as shown in Fig. 2. This was not an easy task: in the four sources, latitudes and longitudes were recorded in hundredths of degrees, tenths of degrees, and minutes, depending on the source. Therefore, station locations seldom agreed exactly. In addition, stations often move slightly over time so data from earlier sources might not have the current location. Not only did the spelling of station names change over time, but in many cases, particularly in newly independent countries, the entire station name changed. These problems are compounded by keypunch errors that occur when keying in hard-to-read metadata from handwritten RCS lists. WMO station numbers also change with time, not only for individual stations. Sometimes a country will change all their WMO numbers at one time. Since most of the metadata flags were keyed to WMO numbers, the final station list was merged with the current WMO Volume A station list to tag each station with the appropriate WMO number whenever possible.
>
> The result was a list of 8653 unique stations, but the list is far from perfect. It is very likely that some errors in merging remain. An example is the assigning of a WMO number from a short-term synoptic reporting airport station to a nearby long-term climate station with a similar name. Also, normals stations were treated as if they started in 1961, which is often erroneous but was the best that could be done with the information available. Therefore, the list should be carefully inspected for accuracy by individuals from each country that has stations initially selected for the GSN.

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This quote from Peterson et al. (1997) is a perfect example of the difficulties involved in dealing with data from different time periods and different nations, which results in many of the frustrations expressed throughout the HARRY_READ_ME file. These kinds of difficulties would not lead to the kind of large-scale bias errors with the potential to impact large-scale trends that were discussed in Subsection 1.3.2 of this document.

As stated before, the "Harry" quality control program gives the user several options of how to treat the data. The three options are to merge the new and old data together in one station, to discard the new data, or to give the old data a "made-up" station number and use the existing WMO code for the new data. "Making up" a station number, and assigning it a code that is clearly not a standard WMO code, is a straightforward attempt to properly treat imperfect data in the case where the user of the code concludes that this is a better solution than either merging the data or throwing away the new data. Therefore, this is not a case of "fudged" or "made-up" data as claimed by the petitioners, but rather a legitimate attempt to address imperfect input data.

Comment (1-47):
The Pacific Legal Foundation claims that "the e-mails suggest that the CRU Data may have been falsified," stating that:

> The scientists referred to "false codes" and running programs to "allow bad databases to pass unnoticed, and good data bases to become bad," *see* Appendix A, 15-16, leading to the possible inference that the CRU scientists may have falsified or manipulated the data. The fact that the British Information Commissioner's Office has found that CRU violated British law by failing to make disclosures under British freedom of information laws lends substantial credence to the proposition that CRU engaged in at least some wrongdoing in connection with the CRU Data. *See* Guy Chazan, *U K Says University Broke Law on Turning Over Data,* Wall St. J., Jan. 29, 2010, at A8. *See also* David Derbyshire, *Scientists broke the law by hiding climate change data: But legal loophole means they won't be prosecuted,* Daily Mail, Jan. 30, 2010.

Response (1-47):
The statement about "false codes" is addressed in Response 1-46 above which demonstrates that this statement does not refer to falsification of data.

The issues involved with the British freedom of information laws are unrelated to the issues involved in the HARRY_READ_ME file. Freedom of information issues are addressed in Volume 3, Section 3.4 of the RTP document.

Comment (1-48):
The Coalition for Responsible Regulation provides the following quote from the HARRY READ ME.txt file

> OH F[---] THIS. It's Sunday evening, I've worked all weekend, and just when I thought it was done I'm hitting yet another problem that's based on the hopeless state of our databases. **There is no uniform data integrity, it's just a catalogue of issues that continues to grow as they're found.**

The petitioner claims that this shows that "the CRU programmer admits the CRU data are without integrity."

Response (1-48):
The programmer is upset because one dataset has a resolution of 2.5 degrees of latitude and longitude, but the programmer wanted to do an analysis comparing this dataset to another dataset with a resolution of 0.5 degrees. Data integrity in this case refers to the fact that the historical dataset used different procedures for calculating rain days before 1990 and from 1990 onwards, and therefore, "Harry" needs to add a conditional statement to his code to address this difference. "No uniform data integrity" does not mean "without integrity," it just means that different data have been treated in different ways. This makes a programmer's job more difficult, but it is not a major flaw in the data. The petitioner clearly misconstrues terminology commonly used by computer programmers. In addition, this dataset and analysis is unrelated to the HadCRUT temperature record. The petitioner provides no support for the assertion that "the CRU data" in general are without integrity.

Comment (1-49):
The Coalition for Responsible Regulation provides the following quote:

> But what are all those monthly files? DON'T KNOW, UNDOCUMENTED. Wherever I look, there are data files, no info about what they are other than their names. And that's useless... take the above example, the filenames in the _mon and _ann directories are identical, but the contents are not. And the only difference is that one directory is apparently `monthly' and the other `annual' - yet both contain monthly files.

Response (1-49):
In this quote, "Harry" is complaining about the way certain intermediate data products (monthly files) were stored. There is no evidence that these intermediate data products were ever meant to be used again, but "Harry" needed to go back to these because of a coefficients file. This coefficients file was eventually reconstructed. Therefore, this quote is not evidence of flaws in the output of either the older product (TS2.1) or the newer product (TS3.0) produced by CRU. Neither of these products is related to the dataset used for the HadCRUT temperature record.

Comment (1-50):
The Coalition for Responsible Regulation and Peabody Energy provide portions of the following quote:

> Back to the gridding. I am seriously worried that our flagship gridded data product is produced by Delaunay triangulation - apparently linear as well. As far as I can see, this renders the [weather] station counts totally meaningless. It also means that we cannot say exactly how the gridded data is arrived at from a statistical perspective - since we're using an off-the-shelf product that isn't documented sufficiently to say that. . . . Was too much effort expended on homogenisation, that there wasn't enough time to write a gridding procedure? Of course, it's too late for me to fix it too. Meh.

Response (1-50):
This quote refers to a quality control problem with the CRU TS dataset that is identified and later resolved. Delaunay triangulation is an alternate method for determining global maps from an uneven distribution of stations. One method used to produce a global map is to create a set of square grid cells and average together the stations within each grid cell before averaging all the grid cells together. The Delaunay method instead makes triangles of different sizes with stations at the vertices and weights the stations by the size of the triangles on which they are located. The use of an "off-the-shelf product" means that CRU did not have access to the code that was used for the Delauney triangulation method, and there might be subtle differences depending on exactly how the method is implemented. Petitioners provide no evidence that the "off-the-shelf product" is inaccurate or that Delaunay triangulation is an inappropriate method.

"Harry" does use a different product to determine station counts, because the Delaunay triangulation method is inappropriate for that use. He also refers to a functional gridding program that he wrote: "Got the gridding working, I think. IDL of course".

Comment (1-51):
The Coalition for Responsible Regulation provides the following quote:

> I am seriously close to giving up, again. The history of this is so complex that I can't get far Enough into it before my head hurts and I have to stop. Each parameter has a tortuous history of manual and semi-automated interventions that I simply cannot just go back to early versions and run the update prog.

Response (1-51):
This quote from the HARRY_READ_ME file expresses frustration that CRU TS2.1 was built by using both manual and automated procedures, making it more difficult to integrate new data. Good programming practice would have standardized the procedures. However, there is no evidence that this mix of manual and automated procedures produces incorrect results. Therefore, this quote is not evidence of flaws in the output of either the older product (TS2.1) or the newer product (TS3.0) produced by CRU. It is only evidence of the frustration generated by implementing an arduous quality control process.

Comment (1-52):
The Southeastern Legal Foundation claims that the "HARRY_READ_ME.txt" file reveals "an appalling series of manipulations of the data and the code, with no provisions for review, no QA/QC on the data or the code, no double-check on data integrity. As has been noted by several commentators, the HARRY_READ_ME.txt file really is the 'smoking gun' of the AGW argument."

Response (1-52):
As demonstrated by the responses in this section, these arguments by the petitioner are gross assertions without scientific merit. Indeed, in contrast to the assertion of the petitioner that this file included no QA/QC or double-checks on data integrity, the entire

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HARRY_READ_ME file is a massive and comprehensive QA/QC endeavor. There is no "appalling series of manipulations." Instead, there is clear evidence of a researcher attempting to do the best job possible of bringing together large disparate databases into one product with as much integrity as possible.

With respect to the "smoking gun" claim, as noted before, nothing in the HARRY_READ_ME file deals with issues in the data set used for the HadCRUT temperature record. The TS products that are the focus of this file are not related to the HadCRUT temperature record. Thus, we conclude that there is no "smoking gun" here.

Comment (1-53):
The Pacific Legal Foundation referenced the HARRY_READ_ME file and stated that "A complete analysis of the programming routines within this file and their implications would reasonably require more than five days, which is the number of days between the time EPA received the supplement to the petition to reopen the public comments based upon the CRU data, and the time that the Endangerment Finding was finalized."

Response (1-53):
The CRU data were made public on November 19th, which was more than five days before the Endangerment Finding was finalized. This was enough time for EPA's initial review to determine that the e-mails and data were not likely to materially change the Endangerment Finding. EPA's Response 11-2 of the RTC document addressed this issue:

> On December 2, 2009, another commenter (11537) submitted a supplement to an October 5th petition asking EPA to reopen the comment period in light of what they alleged was new information. This commenter claims that the recent disclosure of hacked e-mail messages and documents from the Climate Research Unit (CRU) of East Anglia University in the United Kingdom undermines the Intergovernmental Panel on Climate Change (IPCC) science and assessment process upon which the Technical Support Document (TSD) and the Findings primarily rely.
>
> From our review, it appears that the scientific issues raised in the e-mails were also raised in public comments. In fact, we believe that the public comments submitted on our Proposed Findings are more comprehensive than the discussions of the issues in the e-mails because many commenters expended considerable effort to describe their point of view and concerns to us, and several also provided supporting literature and data. In preparing the Finding, EPA has addressed many of the issues raised in the hacked e-mails, among the hundreds of issues raised by commenters. Our responses are fully documented, transparent and available to the public. The science on which the Administrator has based her determinations regarding the endangerment of both public health and welfare, and the process EPA has undertaken, have been fully open and transparent.
>
> Some groups have also used the hacked e-mails to attack the credibility of the IPCC process and its findings. We received many comments on the process used to develop, review and approve or accept IPCC reports; see our responses on these issues in Volume 1 of this Response to Comments document. The disclosure of the private communications of a few individual scientists, among the hundreds of scientists that have participated in

> the development of the IPCC reports and the thousands that have developed the literature that was assessed, provides no evidence that contradicts the key conclusions and basic science underlying climate change. As IPCC Chairman Rajendra K. Pachauri recently stated:
>
> IPCC relies entirely on peer reviewed literature in carrying out its assessment and follows a process that renders it unlikely that any peer reviewed piece of literature, however contrary to the views of any individual author, would be left out. The entire report writing process of the IPCC is subjected to extensive and repeated review by experts as well as governments. Consequently, there is at every stage full opportunity for experts in the field to draw attention to any piece of literature and its basic findings that would ensure inclusion of a wide range of views. There is, therefore, no possibility of exclusion of any contrarian views, if they have been published in established journals or other publications which are peer reviewed.
>
> We note that many of the concerns about the emails appear to be based on a misunderstanding of the importance of certain issues and how concerns raised about a specific issue or study relate to the fundamental conclusions reached through the assessment of hundreds of scientific studies; in other words a misunderstanding that results in an exaggeration of the importance of these issues. Our responses on these specific issues are provided in the relevant volumes of the Response to Comments document. As an example of overstatements regarding the events at CRU, many commenters and others have implied that the CRU dataset on global surface temperatures is "unique" or "the most important" or even "the basis for virtually all peer-reviewed literature." These statements are incorrect. In fact, as we discuss in detail in Volume 2 of the Response to Comments document, the CRU data set is not unique (in fact, the other two data sets are developed by NASA and NOAA), and it there are multiple lines of evidence that support the conclusions reached in the assessment literature upon which we primarily rely.

Additionally, the HARRY_READ_ME file is entirely concerned with the TS2.1 and TS3.0 products, which are not germane to the Endangerment Finding. The in-depth analysis of the e-mails and files provided in the Decision and this RTP document indicates that EPA was correct in its conclusions, reflected in the response above, that there were no issues in the CRU e-mails or the HARRY_READ_ME file that would materially change the Endangerment Finding.

Comment (1-54):
The Pacific Legal Foundation claims that "The 'HARRY READ ME' file may suggest that the data selected, used, and analyzed by CRU not only had substantial gaps but was also potentially irreparably compromised. *See* Appendix A, 10-21." Peabody Energy and other petitioners also provided a large number of quotes.

Response (1-54):
Appendix A of Pacific Legal Foundation's petition contains a large number of excerpts from HARRY_READ_ME. Most of the substantive excerpts are addressed in this section of the RTP. The majority of the comments included in the appendix provided by Pacific Legal Foundation are merely expressions of frustration or notes on the programming process that do not indicate "substantial gaps" or "irreparably

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compromised" data. In addition, as noted previously, this does not relate to the dataset used for the HadCRUT temperature record.

A number of quotes provided by the petitioners are completely innocuous, such as a complaint about the number of files involved, a quote about naming two files with the same name, and a quote indicating "Harry's" intention to start work on the final product. A large number of quotes bemoan inadequate documentation for the original code, but this is not an indication of "substantial gaps" or "irreparably compromised" data. One quote addresses a network crash: "The biggest immediate problem was the loss of an hour's edits to the program, when the network died," which is clearly not a problem related to the data produced by CRU. In some cases, the petitioners even quote statements that indicate success, such as "So let's say, anomalies are done. Hurrah. Onwards, plenty more to do!"

A large number of quotes address trivial errors that were quickly addressed. For example, one quote is the result of confusion about what number indicates missing data: "Harry" had been assuming that "-9999" indicated missing data, but the code for missing data was actually "-1999." Running an analysis using the wrong missing data code resulted in "Harry's" comment "Oh Tim what have you done, man?" But this was followed almost immediately by his parenthetical realization about the difference in codes. Another quote, "It's botch after botch after botch," refers to a file that had different units than the programmer had been expecting. Once he corrected his code to account for the proper units, this was not a problem.

One quote provided was "Oh, GOD, if I could start this project again and actually argue the case for junking the inherited program suite." But the very next line of the document (notably not highlighted by the petitioners) is "OK.. the .ann file was simply that it refuses to overwrite any existing one. Meh." Again, this quote reflects frustration because the programmer was unfamiliar with the code, but this is not a problem with the data. The solution to the problem of the program not overwriting files is merely to allow overwriting of existing files, and HARRY_READ_ME clearly indicates that "Harry" figured out and fixed the problem immediately.

A series of quotes result from the attempt by "Harry" to work on the precipitation database: e.g., "If the latest precipitation database file contained a fatal data error ... then surely it has been altered since Tim last used it to produce the precipitation grids?" In this case, the fatal data error was that one month of one year of data at one station had been corrupted and was providing a non-physical value. When that data point was removed, the program was able to read the data file. However, it appears that TS2.1 had used a different file without this corrupted data bit, and similarly, "Harry" appears to use a different version of the file later. Therefore, these quotes are about an inconsequential file (another example of messy, poorly documented code, but no evidence of flaws in the TS2.1 or TS3.0 output).

A large number of quotes result from "Harry's" work on merging the Australian Bureau of Meteorology (BOM) data with the CRU data. Because the Australian BOM changed

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formatting and coding for a number of their stations, this was a challenging process. The file indicates that "Harry" worked with the Australian BOM to resolve the majority of these issues. This is another example showing that the CRU researchers were working on quality control to properly merge a set of challenging datasets and succeeding in resolving a number of tricky issues.

A number of quotes refer to an issue with Russian "rain day" data from one or two stations, where quality control procedures found indications that there are internal inconsistencies between data before a "missing block" in the 1980s and data after that missing block. This particular error in the data for these one or two stations may never have been resolved (it is unclear from the debugging file). For these stations, "Harry" stated, "although I can match WMO codes (or should be able to), I must check that the data correlate adequately," indicating that he was doing the appropriate quality control for dealing with data provided by outside organizations. A few imperfect stations in a large dataset do not indicate that the data is "irreparably compromised." Imperfect data is accounted for in the uncertainty analyses in the data. As stated in New et al. (1999), "Isolated errors and subtle inhomogeneities not detected during quality control do not have a significant effect at the regional scale."

In sum, petitioners have assembled a lengthy collection of quotes that do not support the broad conclusions they drawn.

Comment (1-55):
Peabody Energy provides the quote, "… this should all have been rewritten from scratch a year ago !"

Response (1-55):
The programmer is complaining because some of the data is stored with longitudes from 0 to 360 rather than the more standard longitudes that run from -180 (W) to +180 (E). In the next line of the file, the programmer discusses his solution to the formatting issue ("So, I wrote 'revlons.for'") which changes the data from one format to the other. Again, this does not indicate any flaws with the data or the products of this work, and the file indicates that the issue "Harry" encountered was solved, as were almost all the other problems identified in the HARRY_READ_ME file. In addition, this does not relate to the HadCRUT temperature data set used for a long-term temperature record.

Comment (1-56):
Peabody Energy provides the quote, "Am I the first person to attempt to get the CRU databases in working order?! !"

Response (1-56):
This quote appears to be referring to an intermediate database (postdating the CRU TS2.1 product, as it includes more recent data than what was included in TS2.1), which had been assembled without checking for duplicate stations, and which apparently didn't always have the same number of stations recording maximum daily temperatures and minimum daily temperatures. The programmer resolved both these problems by

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producing TS3.0. Therefore, this problem was not present in TS2.1 and was solved for TS3.0. In any case, these problems, if left uncorrected, would have led to missing or duplicate data, but there is no evidence that these problems would have led to any kind of bias.

Comment (1-57):
Peabody Energy states that it "does not have the resources to try to untangle the coder notes and the TS2.1/3.0 data files to determine the magnitude of the errors in those files. Given the state of the record at this point, the TS2.1/3.0 dataset and the HadCRUT3 cannot legitimately be relied on nor can any study or modeling which utilized these data."

Response (1-57):
HadCRUT3 and TS2.1 and 3.0 are two different products. Peabody Energy and other commenters have not demonstrated that there are any problems with these databases that materially affect any conclusions based on the data. Imperfections with individual stations are to be expected when data is being collected from thousands of stations throughout dozens of nations, but the large-scale patterns are still robust (especially after quality control). While the code used to generate TS2.1 could have been better documented and organized, the petitioners have not shown that the output of this code was flawed or that the quality control improvements by the programmer "Harry" were not successful. The scientific conclusions drawn from use of these datasets by the research community are consistent with conclusions drawn from other similar datasets, as well as other sources of data on climatic changes over time. Therefore, the conclusion by Peabody Energy that these datasets cannot be relied on is not supported by our analysis of the underlying files.

Comment (1-58):
The Southeastern Legal Foundation claims that "The entire HARRY_READ_ME.txt file is so riddled with such damning admissions that there's really little point in highlighting them all. The key conclusion is inescapable: no reasonable person can conclude that the models that CRU produced, and the datasets on which they were based, meet basic scientific standards for reliability, and therefore the IPCC analyses and projections cannot be said to be reliable, and therefore EPA's incorporation of IPCC's findings and conclusions must be reconsidered. Put differently, there is zero chance that CRU's work could survive a *Daubert* challenge[15] that was armed with the Climategate documents. Since CRU's work would be inadmissible in federal court as junk science, it should not be relied upon by the EPA as the foundation of the most far-reaching and consequential action in its history."

Response (1-58):
While the petitioner has quoted from HARRY_READ_ME at length, none of the statements in this file are "damning." This file has demonstrated that the first version of the code was poorly documented, and that the process of integrating data from a large group of datasets provided by a number of different nations and sources is a challenging process. It also has demonstrated that CRU put a high value on tracking down and resolving inconsistencies in the data and being as complete as possible. The petitioners

have not shown that the issues raised in the internal quality control process documented in this README file would have resulted in any major change in the TS2.1 product, or that they were not addressed properly in creating the TS3.0 product. Therefore, the characterization of this product as "junk science" has no factual backing.

Moreover, the petitioner is making an unfounded leap to conclude that any problems involved with the TS2.1 and 3.0 products are also reflected in other CRU products. The TS product upgrade was unrelated to the HadCRUT temperature record. While the HadCRUT temperature record and the TS products include the GHCN temperature data set in common, there is no evidence that any of the issues discussed in the "Harry" file were related to the GHCN data set. CRU does not produce any models, counter to the claim of the petitioner. And finally, IPCC analyses and projections are based on a wide range of different sources and datasets that have produced consistent results, not just the CRU output. Therefore, the petitioner is making an unjustified leap to assume that any problems in the TS2.1 and TS3.0 product, or even CRU products as a whole, would undermine the conclusions of the IPCC, CCSP, National Academies, and other organizations that have all found after extensive assessments that there are robust conclusions about a number of aspects of the climate system. These robust conclusions are the ones that have formed the basis of EPA's Findings, and nothing presented by the petitioner has materially undermined these conclusions.

The reference to Daubert is unavailing. As described above, there is no basis to characterize this as "junk science." In addition, Daubert discusses the Federal Rule of Evidence 702, which establishes a threshold inquiry for introduction of scientific evidence at a trial, a formal adjudicatory proceeding. Even if that were applicable here, the criteria would be readily met:

> If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue" an expert "may testify thereto." (Emphasis added.) The subject of an expert's testimony must be "scientific . . . knowledge." The adjective "scientific" implies a grounding in the methods and procedures of science. Similarly, the word "knowledge" connotes more than subjective belief or unsupported speculation. The term "applies to any body of known facts or to any body of ideas inferred from such facts or accepted as truths on good grounds." Webster's Third New International Dictionary 1252 (1986). Of course, it would be unreasonable to conclude that the subject of scientific testimony must be "known" to a certainty; arguably, there are no certainties in science. See, e.g., Brief for Nicolaas Bloembergen et al. as Amici Curiae 9 ("Indeed, scientists do not assert that they know what is immutably 'true' -- they are committed to searching for new, temporary, theories to explain, as best they can, phenomena"); Brief for American Association for the Advancement of Science et al. as Amici Curiae 7-8 ("Science is not an encyclopedic body of knowledge about the universe. Instead, it represents a process for proposing and refining theoretical explanations about the world that are subject to further testing and refinement" (emphasis in original)). But, in order to qualify as "scientific knowledge," an inference or assertion must be derived by the scientific method. Proposed testimony must be supported by appropriate validation -- i.e., "good grounds," based on what is known. In short, the requirement that an expert's testimony pertain to "scientific knowledge" establishes a standard of evidentiary reliability. 509 U.S. 579, 589-90..

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1.3.3.4 Claims of Selective Use of Data From Russian Weather Stations

Comment (1-59):
Petitioners state that the "Moscow-based Institute of Economic Analysis (IEA) claims the UK Met Office's Hadley Center for Climate Change tampered with Russian meteorological station data that did not support the anthropogenic global warming theory." The Southeastern Legal Foundation further states

> The Institute for Economic Analysis in Moscow prepared a report showing that selective use of only 25% of the available Russian stations in the HadCRUT dataset imparted a warming bias of .64 C º greater than the trend calculated using all available data. D'Aleo & Watts (2010) at p. 16. This results from the disproportionate use of more southern and urban stations, and from interpolating or 'infilling' data from these warmer stations to colder areas for which actually available data was eschewed. *Id.* at 16-17. Russia represents 11.5% of the Earth's land mass, so this is a significant issue.

Petitioners claim that CRU selectively chose Russian data stations to create a biased dataset that would show more warming than the full dataset. Petitioners provide a link to a translation (hosted at a blog) of the original report written in Russian by the IEA in Moscow (Pivovarova, 2009).

Response (1-59):
EPA has carefully examined this document and finds that it does not support the petitioners' claims. The Moscow IEA temperature record derived from the full set of Russian stations agrees well with the record derived from the set of HadCRUT stations after 1955, and the difference between the records derived from the two datasets is mainly in the 1850 to 1950 section of the record, with the HadCRUT temperature record showing more warming over the period, but a smaller peak in 1940.[47] The validity of the IEA analysis is suspect, however, due to flaws in the methodology it used. IEA averaged together the 90 grid cells containing temperature data from HadCRUT and compared it to an average of the 152 cells containing temperature data from the full Russian set. A proper comparison would involve using the same kind of geographic infilling used by HadCRUT in calculating temperatures across all of Russia on both the 90-cell and 152-cell datasets. Because HadCRUT extrapolates temperatures from cells with data to some cells without data, when computing a regional or global average HadCRUT does not necessarily weight cells evenly; a cell with data that is adjacent to a cell without data will be used to help "fill" that cell in (along with other cells adjacent to the no-data cell), and therefore, this cell will be weighted more heavily than a cell that is surrounded by other cells that have their own data. The geographic weighting algorithm is more important when data is sparse, as it is in the decades before 1955 where the IEA finds that their analysis of the full station set diverges from their analysis using the HadCRUT stations (and where the Brohan et al. 2006 figure in Subsection 1.3.2 shows that there is more

[47] Figure 8 and Figure 9 in the original document at http://www.iea.ru/article/kioto_order/15.12.2009.pdf or in the unofficial English translation at http://climateaudit.files.wordpress.com/2009/12/iea1.pdf.

uncertainty in the temperature record). Because of the simplistic and flawed methodological approach taken by IEA, its analysis is a faulty "apples and oranges" comparison of the two datasets.

We also note that there has been no evidence provided that the station selectivity was a result of choices made by CRU. Because CRU depends on a number of other data sources, such as WMO reports, World Weather Records, GHCN, and NMS, it is possible that the HadCRUT dataset did not use all available stations because the data sources it was relying on also did not include these additional Russian stations. CRU also uses several metrics to ensure that data can be used, such as the quantity of data available during the baseline period. The petitioners did not assess whether these additional Russian stations were provided to CRU, or whether these stations met the criteria laid out in published papers. Thus, there is no support for the claim that CRU was biased in its use of the Russian data.

Moreover, in contrast to the petitioners' assertion that the HadCRUT data show excessive warming over Russia, a discussion of a preliminary analysis reported by the MET stated: "The ECMWF [European Centre for Medium-Range Weather Forecasts] analysis shows that in data-sparse regions such as Russia, Africa and Canada, warming over land is more extreme than in regions sampled by HadCRUT" (UK Met Office, 2009). If the data-sparse regions actually show a greater warming trend, this means that the approach for data infill taken by CRU in developing the HadCRUT temperature record may understate the recent warming over Russia, contrary to the assumption of petitioners.

In summary, petitioners' evidence does not support the conclusion that HadCRUT selectively picked stations. Their analysis comparing the HadCRUT data and the full Russian dataset is flawed, and the differences that they show with the flawed analysis mainly appear before 1950. Other analysis by the ECMWF suggests that HadCRUT may actually be underestimating recent warming in the region.

1.3.4 Claims of Flawed Approach to Correct for Urban Heat Island (UHI) Effects

Comment (1-60):
Petitioners take significant issue with UHI corrections in the light of a dispute about the possible relocation of certain Chinese weather stations that were used in a study by Jones et al. (1990). Petitioners argue that this study was challenged as fraudulent by Doug Keenan, an "amateur climate analyst" (as described by the State of Texas). The State of Texas asserts:

> "The history of where the weather stations were sited was central to the 1990 paper because it concluded that the warmer temperatures in China were caused by climate change rather than the heat-island effect of growing cities" and that "[t]he Fourth Assessment relied on the Jones-Wang study to support the conclusion that 'any urban-related trend' in global temperatures was 'an order of magnitude smaller' than other trends."

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The State of Texas further alleges that "Although the university found 'evidence of the alleged fabrication of results,' it exonerated Wang." The State of Texas finally notes that "Ironically, Phil Jones submitted a report to the Journal of Geophysical Research re-examining temperatures in eastern China. His report concluded that not only was the urban heat effect not 'negligible' it could account for 40% of the warming shown in the study."

Response (1-60):
Petitioners raise the treatment of UHI effects in the HadCRUT dataset as another example of alleged data manipulation. EPA has long been aware of the UHI issue and it is not new. There is substantial research underway to better determine the scope and magnitude of UHI effects and to improve methodologies for minimizing these effects in surface temperature records. We addressed UHI issues in responses 2-28 through 2-30 of the RTC document. Response 2-30, in particular, addresses the Jones et al. (1990) paper to which the petitioners refer, in the context of UHI corrections in the global dataset:

> "Though the assessment literature continues to cite Jones et al. (1990), we dispute that it is solely 'relied upon.' Many subsequent studies (Peterson et al., 1999; Peterson, 2003; Parker, 2004; Peterson and Owen, 2005; Parker, 2006) have found supporting results (as discussed in response 2-28). In IPCC (Trenberth et al., 2007), Jones et al. (1990) is referenced as just one of a number studies which support the Trenberth et al. (2007) conclusion that 'urban heat island effects are real but local, and have not biased the large-scale trends' which is summarized in the TSD."

As noted in Response 2-30, Jones et al. (1990) is referenced, but it is not the only study that the IPCC AR4 referenced with respect to UHI adjustments. We also note that satellite records are not susceptible to UHI and globally show similar trends to the HadCRUT and other records of land-based measurements over their overlapping time period.

There is no merit in the petitioners' claim that in a later paper Jones et al. (2008) published in the *Journal of Geophysical Research*, Jones found different results than in his previous study. This paper actually concluded that "accounting for site moves has no impact on the results given by Jones et al. (1990)," which is not supportive of the petitioners' claim regarding the results of the study. Jones et al. (2008) did find that changes in UHI effects contributed to measured temperature trends in China over the full time period up to 2004, but this was because of data not available for the original study. They also found that UHIs did not contribute to measured temperature trends in other urban areas such as London and Vienna. So the claim that UHI effects bias the temperature record upward in all urban areas is not supported.

We also note that this issue has been reviewed by other organizations. The University of East Anglia has also issued a statement on this controversy (University of East Anglia, 2010b), stating that the accuracy of the data was confirmed in a later paper and that the findings of the 1990 paper with regard to UHI effects were confirmed by other papers used by the IPCC. In addition, contrary to the assertion by the State of Texas that "the university found 'evidence of the alleged fabrication of results,'" the statement from the

University of Albany (as quoted in the news article used by the State of Texas as a reference—Pearce, 2010—and the linked copy of the confidential letter from the university) was "it found 'no evidence of the alleged fabrication of results' and exonerated him." Therefore, the State of Texas is misquoting its source and asserting the exact opposite.

In sum, contrary to the petitioners' claims, as discussed in the TSD and the RTC for the Finding, UHI effects are not inappropriately treated or masked but instead are appropriately accounted for using widely accepted and transparent methods. The petitioners' evidence and arguments do not show that the original Jones paper was mistaken or fraudulent, nor have they addressed the many papers on UHI effects in the subsequent two decades. We reviewed and responded to these same issues in Volume 2 of the RTC document, and based on the available literature, we found that the UHI effect was small on a global scale

1.3.5 Alleged Dependence of IPCC Conclusions on the HadCRUT temperature record

Comment (1-61):
Petitioners ascribe great significance to the alleged issues with the HadCRUT temperature record, claiming that it is the primary or core support for IPCC conclusions on current warming, attribution, and projections of future warming. For example, the Coalition for Responsible Regulation asserts:

> …the CRU data form the primary basis for EPA's determination that 'unprecedented' warming has occurred in recent decades.

Similarly, Southeastern Legal Foundation states:

> The CRU dataset constitutes one of the most important sets of information on which all analyses of anthropogenic global warming ("AGW") are based. In addition, the model used by CRU formed the basis for IPCC's models of future global warming.

Response (1-61):
EPA finds no merit in the view that the HadCRUT temperature record is the primary or core support on which our understanding of climate change rests. As we have previously discussed in the TSD and RTC document, the IPCC and USGCRP have concluded that warming of the climate system in recent decades is "unequivocal." This conclusion is not drawn from any one source of data, but is based on a review of multiple sources of data and information, including the HadCRUT temperature record as well as additional temperature records from other sources and numerous other independent indicators of global warming. All of the different elements of this body of scientific evidence have their strengths and weaknesses, and these are discussed and explained in the TSD and the RTC. However it is this entire body of evidence considered together that is the primary and core support for EPA's conclusions on warming. The overall consistency of the evidence of warming across multiple types of evidence is central to this conclusion. Petitioners have failed to consider or rebut this body of evidence, and instead have

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focused on arguments aimed at one source of surface temperature record. As shown above, their arguments and evidence concerning the HadCRUT temperature record are misplaced and do not warrant any change in the weight placed on this one part of a much broader body of evidence.

This consistency across various kinds of evidence of warming also supports the robustness of the evidence at issue here. As documented in Section 4(b) of the TSD, NOAA (from NCDC) and NASA temperature records (from GISS) show nearly identical warming trends to the HadCRUT temperature record, despite different analysis methodologies. As discussed below, satellite data and other methods of determining atmospheric temperature trends are also consistent with the HadCRUT and other surface temperature records, and the sources of atmospheric data are independent of the datasets relied upon for surface temperature records.

Contrary to the Coalition for Responsible Regulation's assertion, EPA does not refer to the warming observed in recent decades as being "unprecedented." We do note the following facts, which are consistent across the NOAA, NASA, and HadCRUT temperature records in the TSD's Box 4.1:

- Eight of the 10 warmest years on record have occurred since 2001.
- The 10 warmest years [on record] have all occurred in the past 12 years.
- The 20 warmest years [on record] have all occurred since 1981.

Significantly, entirely independent records of lower tropospheric temperature measured by both weather balloons (also known as radiosondes) and satellites (from the University of Alabama and Remote Sensing Systems) in recent decades demonstrate strong agreement with the HadCRUT surface temperature record as well as NOAA's and NASA's. Additional independently monitored indicators of global warming discussed in the TSD include:

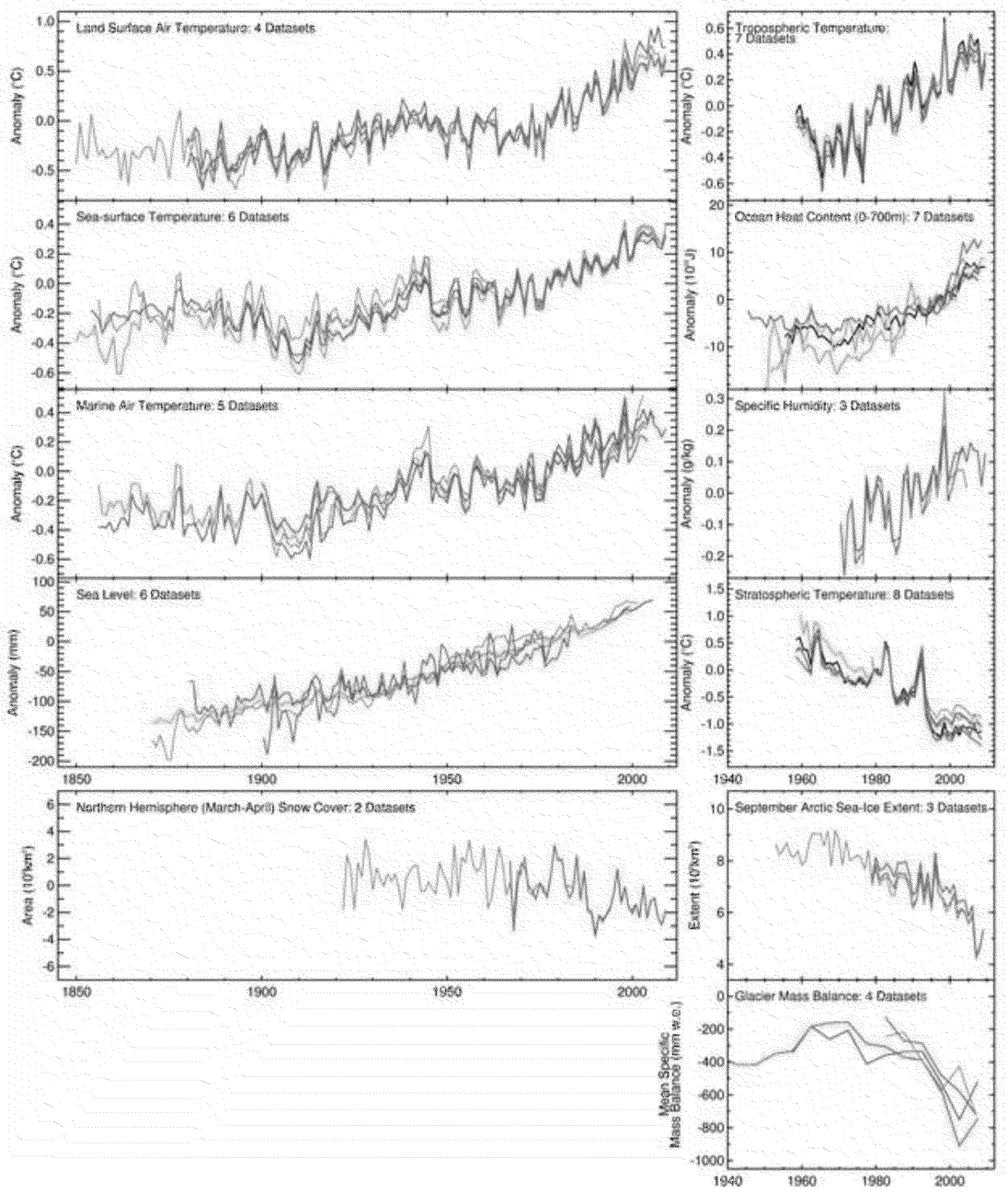
- Increasing global ocean heat content (Section 4(f) of the TSD)
- Rising global sea levels (Section 4(f) of the TSD)
- Shrinking glaciers worldwide (Section 4(i) of the TSD)
- Changes in biological systems, including poleward and elevational range shifts of flora and fauna; the earlier onset of spring events, migration, and lengthening of the growing season; and changes in abundance of certain species (Section 4(i) of the TSD)

Reaffirming this evidence, NOAA's State of the Climate in 2009 report (Kennedy et al., 2010) states:

> The IPCC conclusion (Alley et al. 2007) that "warming of the climate system is unequivocal" does not rest solely upon LSAT [land surface air temperature] records. These constitute only one line of evidence among many, for example: uptake of heat by the oceans, melting of land ice such as glaciers, the associated rise in sea level, and increased atmospheric surface humidity (Figure 2.5) [as shown below]. If the land surface records were systematically flawed and the globe had not really warmed, then it

would be almost impossible to explain the concurrent changes in this wide range of indicators produced by many independent groups. The observed changes in a broad range of indicators provide a self-consistent story of a warming world.

The figure below (Figure 2.5 from Kennedy et al., 2010) illustrates a range of indicators that would be expected to correlate strongly with the surface temperature record. Note that stratospheric cooling is an expected consequence of GHG increases.



In this figure, the indicators that we would expect to trend upward with surface temperatures (e.g. sea surface temperature, specific humidity) do so, and those that one

would expect to trend downward (e.g., stratospheric ozone, sea-ice extent) also behave as the science predicts. It is this large body of evidence that supports the conclusion that there is an unambiguous warming trend over the last 100 years, with an increase in the rate of warming over the past 30 years.

The investigation into the CRU e-mails and the validity of the HadCRUT surface temperature record conducted by the British Parliament's House of Commons Science and Technology Committee reached a conclusion that is consistent with our own assessment of these issues (UK Parliament, 2009):

> We have established to the extent that a limited inquiry of this nature can, that the NCDC/NOAA and GISS/NASA datasets measuring temperature changes on land and at sea have arrived at similar conclusions using similar data to that used by CRU, but using independently devised methodologies. We have further identified that there are two other datasets (University of Alabama and Remote Sensing Systems), using satellite observations that use entirely different data than that used by CRU. These also confirm the findings of the CRU work. **We therefore conclude that there is independent verification, through the use of other methodologies and other sources of data, of the results and conclusions of the Climate Research Unit at the University of East Anglia**. [emphasis in the original]

Thus, EPA finds that the Coalition for Responsible Regulation's claim that the HadCRUT temperature record serves as the basis for all anthropogenic warming studies is unsubstantiated and unsupportable. Numerous studies cited in the assessment literature have been published that rely on data and methods independent of the HadCRUT temperature record, many pertaining to the indicators above. Though it is true that many studies do, in fact, cite CRU data, there is no reason to question the legitimacy of those studies. Petitioners have not provided a basis for changing the weight placed on the HadCRUT temperature record, as described above. In addition, the CRU results are consistent with other surface temperature records and atmospheric temperature records, as well as with all of the other physical evidence of warming. Even if there were a basis to place less weight on this one surface temperature record, it would be grossly overbroad to conclude that all studies that even reference this dataset would be suspect.

The claim by Southeastern Legal Foundation and others that the HadCRUT temperature record is the foundation for computer modeling of the climate and that all climate models are thus suspect is also without merit. The models used to generate projections of future warming described in the IPCC AR4 do not use the CRU or other surface temperature data as an input. These projections of future temperatures arise from the use of Atmospheric-Oceanic General Circulation Models (AOGCM). These models are driven by physical equations describing the radiative properties and dynamics of the atmosphere and oceans and parameterizations of small-scale processes. They do not use observed CRU or other sources of temperature data as inputs.

The projections of future warming come from the largest coordinated global, coupled climate model experiment ever attempted, providing the most comprehensive multi-model perspective of any IPCC climate assessment. A set of coordinated, standard

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experiments was performed by 14 AOGCM modeling groups from 10 countries using 23 models. The HadCRUT and other temperature records may be compared with AOGCM output to assess how well the models replicate the observed climate, but temperature data are not input to these models. There is no "model" used by CRU that was used as a basis for the AOGCM models, and the AOGCM models do not rely on or use CRU analysis of historical temperature data.

1.3.6 Summary

The observed warming of the climate is an important factor considered in the Endangerment Finding. The Finding notes that this warming is observed in surface and ocean temperatures, atmospheric temperatures, melting of snow and ice, rising sea levels, and other physical indicators of warming. The Finding states, "The global surface temperature record relies on three major global temperature datasets, developed by NOAA, NASA, and the United Kingdom's Hadley Center. All three show an unambiguous warming trend over the last 100 years, with the greatest warming occurring over the past 30 years." The evidence and arguments relied on by petitioners do not show otherwise and do not support their broad assertions and conclusions.

Petitioners have not presented any additional or different analysis of the underlying surface temperature data. They have pointed to computer work that involves work on a non-public document with no relationship to the Endangerment Finding, or CRU datasets other than the HadCRUT temperature record. The CRU datasets at issue had a tangential at best relationship to the TSD supporting the Endangerment Finding. The computer quality control on this unrelated dataset appears to be just that— comprehensive and successful quality control—and does not provide support for allegations that changes made were intended to or did bias the resulting dataset. Petitioners' objections to the analysis of temperature data from Russia or China stations appear unfounded and speculative and not supported by the body of evidence.

Certain reviews of CRU and its scientific work have been completed, and there continues to be additional independent investigation. EPA supports and appreciates that these reviews and investigations are being conducted and takes the results into consideration as they are released. The reviews that have been completed to date are consistent with EPA's conclusions described above.

EPA and the assessment reports have considered the degree of certainty in the various lines of evidence on the existence of warming, including the HadCRUT (Brohan et al., 2006); NOAA (2009); and NASA (Hansen et al., 2010, submitted) temperature records; the satellite temperature records; and the observed changes in the global oceans, glaciers, and sea levels. Petitioners' evidence fails to show that these sources of information are not credible and reliable. EPA continues to believe that this body of evidence indicates an unambiguous warming trend, when viewed as a whole, and that petitioners have not presented evidence that would indicate otherwise. EPA remains confident in the appropriateness of its overall scientific conclusion of a warming trend over the last 100 years, with the greatest warming occurring over the past 30 years. This is based on

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the multiple sources of consistent information indicating such warming, information including the three separate surface temperature datasets, as well as a wide variety of other data and information independent of the three surface temperature datasets. This broad body of evidence is stronger than any one single source of data. Neither the evidence presented by petitioners and reviewed by EPA, nor the existence of an ongoing review of the CRU and its work, warrants a change in the scientific conclusion drawn by EPA concerning the existence of global warming.

1.4 Validity of NOAA and NASA Temperature Records

1.4.1 Overview

A number of petitioners (e.g., Competitive Enterprise Institute, the Southeastern Legal Foundation, Peabody Energy, the State of Texas, Pacific Legal Foundation, Commonwealth of Virginia, Coalition for Responsible Regulation) question the validity of NOAA and NASA surface temperature records. As discussed in detail below, they raise a number of claims, including station "drop-out," flawed or manipulative adjustments to data, improper use of smoothing in data presentations, and a lack of independence between the three major surface temperature records. To support their arguments, the petitioners reference a number of studies—two peer-reviewed and several non-peer-reviewed—and in one case provide a quote from the CRU e-mails.

Many of the issues raised by the petitioners were also raised in comments and responded to in the Endangerment Finding. Several of the petitioners' arguments have already been convincingly rebutted in the peer-reviewed literature or by the organizations in question. In these cases, petitioners have failed to acknowledge these rebuttals and have not provided any additional explanation for why their concerns remain valid. In addition, many of the sources on which petitioners rely are not peer-reviewed and use highly flawed methodologies. In some cases, petitioners have provided additional arguments or new information, which we have reviewed and evaluated. Upon review, petitioners' evidence and arguments do not support the conclusions they draw, and do not materially change the credibility or reliability of the NOAA and NASA global temperature record or the conclusions drawn from them.

The remainder of this section includes background on the scientific issues being discussed, a description of the petitioners' arguments, and EPA's responses.

1.4.2 Background on the Collection and Analysis of Surface Temperature Data

There are two steps to creating a global surface temperature record. The first is to collect the raw weather data, and the second is to process the data into a useable form. As described in Subsection 1.3.2 of this document, the CRU team, over several decades, acquired and merged data from a number of different sources and then applied corrections and geographical smoothing algorithms as appropriate to generate the HadCRUT temperature record. Petitioners' claims regarding the HadCRUT temperature

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record are responded to in Section 1.3 of this document. Here, we discuss petitioners' claims related to the NASA and NOAA surface temperature records, including claims that alleged problems with the HadCRUT temperature record also undermine the reliability and credibility of the work by NASA and NOAA. A list of temperature records and underlying datasets are also provided in Subsection 1.3.2 of this document.

One of the sources of data for the HadCRUT temperature record is the GHCN, which was developed and is maintained by NOAA's National Climatic Data Center (NCDC). The GCHN dataset is also used by both NOAA and NASA in their surface temperature records. NOAA, NASA, and CRU each have their own algorithms to calculate global surface temperature trends from a combination of GHCN data and other data sources, with each group applying its own set of adjustments and corrections. Subsection 1.3.2 of this volume describes the process used to develop the HadCRUT temperature record and algorithms; this section will describes the GHCN and the approaches used by NOAA and NASA to develop their temperature records.

The original version of GHCN is described in Vose et al. (1992). Version 2 is described in Peterson and Vose (1997). In this paper, Peterson and Vose describe how they collected data from 31 sources by "1) contacting data centers, 2) exploiting personal contacts, 3) tapping related projects, 4) conducting literature searches, and 5) distributing miscellaneous requests" because of the lack of a central repository of temperature and climate data. The raw GHCN dataset underwent quality control, which included merging data that was provided by different sources for the same weather station. In many cases, however, multiple duplicates of the same station are included in the record where the original data was not identical, so as to let users determine the best approach to merging these sources. The next quality control step involved rejecting datasets that did not include original observations, were derived from unreliable sources, or showed significant processing errors. Another step corrected mis-located stations, data that was repeated month to month, or unexplained discontinuities. A final stage examined outlying data—in cases where the data failed additional tests, they were kept in a separate file in case later researchers wanted to reincorporate them. Only three of the 31 sources used provide regular updates of additional monthly data.

NOAA (NCDC) (NOAA, 2009) and NASA (Goddard Institute of Space Studies or GISS, or sometimes GISTEMP) (Hansen et al., 2010, submitted) both use GHCN and other data (including sea surface temperature data) to calculate surface temperature trends around the globe. Each group performs different adjustments to the data in building their temperature records, and in some cases uses different subsets of the GHCN data or includes other outside datasets. As stated by Hansen et al. (2010, submitted):

> These analyses are not independent, as they must use much of the same input observations. However, the multiple analyses provide useful checks because they employ different ways of handling data problems such as incomplete spatial and temporal coverage and non-climatic influences on measurement station environment.

For example, the NASA algorithms include an adjustment to urban temperature stations based on satellite maps of nighttime lights and uses the fact that temperature anomalies

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measured at a specific spot are correlated with anomalies up to 1200 kilometers away to extrapolate measurements over large areas where the observations are sparse (giving greater coverage in certain areas such as the Arctic). The adjustments that NOAA and NASA make to the unadjusted GHCN dataset are almost all automated, in contrast to some of the adjustment procedures used in the HadCRUT temperature record. In the case of NASA, there were two stations (St. Helena Island and Lihue, Hawaii) where manual adjustments were made because of detected errors and the lack of neighboring stations that could be used by the automated algorithms. In both cases, the raw data shows more warming than the adjusted data.

The U.S. Historical Climate Network (USHCN) temperature record developed by NOAA and used by both NOAA and NASA uses a slightly different methodology than the adjustments used by NOAA for the global GHCN dataset. The most important difference is that NOAA corrects for several systematic changes in the U.S. monitoring system that could lead to artificial biases, the most important of which are shifts from afternoon to morning temperature data collection at many stations, and shifts from "liquid in glass" (LiG) measurement instruments to maximum/minimum temperature systems (MMTS) (described in Menne et al. 2009). USHCN2 uses a sophisticated automated methodology to detect and correct for discontinuities in the temperature data at specific stations such as these shifts in measurement time or instrumentation, and this methodology also corrects for station moves (whether documented or not).

GHCN data are available online, both in the unadjusted (raw) format and in an adjusted format that includes the automated corrections by NOAA (NOAA, 2010c). Similarly, the NASA-adjusted data is all available online along with the GHCN data used to derive the adjusted dataset (NASA, 2010a).

1.4.3 The Petitioners' Arguments and EPA Responses

1.4.3.1 Assessment of Issues Related to Alleged Station Dropout and Inappropriate Extrapolation

Comment (1-62):
Petitioners raise a number of issues regarding the alleged "drop-out" of stations after 1990 from surface temperature records, and the extrapolation of data from "warmer" areas to "colder" areas due to this drop-out or for other reasons, which the petitioners claim leads to bias in the global surface temperature record. The Competitive Enterprise Institute cites a non-peer-reviewed report by D'Aleo and Watts (2010), which states:

> "Around 1990, NOAA began weeding out more than three-quarters of the climate measuring stations around the world. They may have been working under the auspices of the World Meteorological Organization (WMO). It can be shown that they systematically and purposefully, country by country, removed higher-latitude, higher-altitude and rural locations, all of which had a tendency to be cooler."

Petitioners argue that station dropout (from 6,000 in the 1970s to about 1,500 currently) "likely contributed to false warming trends over the entire globe"—in part because the

dropped stations "are generally in colder climates" or because "remaining stations were biased towards lower latitudes, lower elevations, and urban locations."

Petitioners also cite the specific example of Bolivia, where they claim that GHCN has no data collection but shows interpolated warming there that "is purely an artifact of interpolation from distant warmer and lower altitude stations." The petitioners claim that station dropout is also a problem in the United States, stating, "The USHCN has dropped 90% of its climate stations. Most of the remaining stations are at airports, and in the west most of the higher elevation stations are gone. In California, the only remaining stations are in San Francisco, Santa Maria, Los Angeles and San Diego." Finally, the Southeastern Legal Foundation states, "Infilling from warmer temperature stations to colder grid cells for which no actual data is collected also imparts a spurious warming signal."

Response (1-62):
Many of the petitioners' arguments rest on a non-peer-reviewed document by D'Aleo and Watts (2010). D'Aleo and Watts' (2010) study contains a number of inaccurate statements, and relies on a scientifically flawed analysis.

Peterson and Vose (1997) describe the procedures for updating the GHCN database, and explain—in a clear and transparent manner—the reasons why there are fewer measuring stations covering the post-1992 period than there were for the 1980s. Namely, Peterson and Vose explain that only three out of 31 sources submit regular monthly updates, and that the remainder of the data would only be updated on "a highly irregular basis":

> Thirty-one different sources contributed temperature data to GHCN. Many of these were acquired through second-hand contacts and some were digitized by special projects that have now ended. Therefore, not all GHCN stations will be able to be updated on a regular basis. Of the 31 sources, we are able to perform regular monthly updates with only three of them (Fig. 5). These are 1) the U.S. HCN, 1221 high quality, long-term, mostly rural stations in the United States; 2) a 371-station subset of the U.S. First Order station network (mostly airport stations in the United States and U.S. territories such as the Marshall and Caroline Islands in the western Pacific); and 3) 1502 Monthly Climatic Data for the World stations (subset of those stations around the world that report CLIMAT monthly code over the Global Telecommunications System and/ or mail reports to NCDC). Other stations will be updated or added to GHCN when additional data become available, but this will be on a highly irregular basis.

Therefore, the reduction in stations with data after the 1990s is due to the fact that NOAA has not completed a major data collection effort since Peterson and Vose (1997). We note, however, that such an effort is indeed currently ongoing and will result in a new dataset—GHCN Version 3—likely in late 2010. In contrast to this public explanation of the GHCN process, D'Aleo and Watts provide no evidence that there was a systematic and purposeful "weeding out" process, and do not address the reasoning and process described in the public, peer reviewed documentation of the GHCN data set.

The petitioners, by relying on the flawed methodology used in the D'Aleo and Watts study, have assumed that dropping stations that are at higher latitudes and in colder

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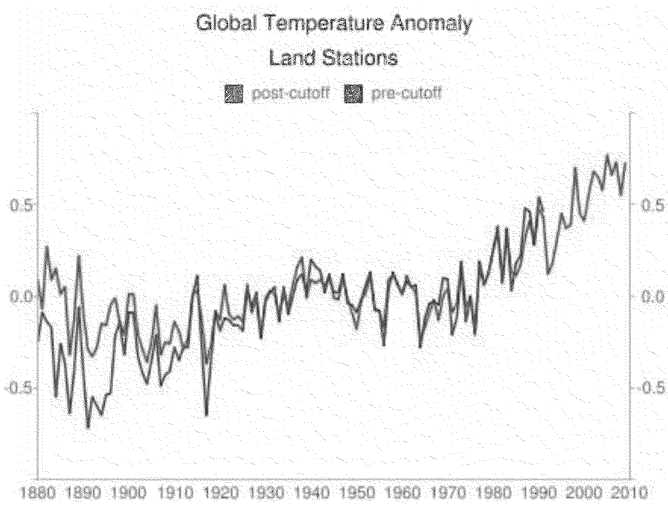
climates would result in a biased, warmer temperature trend. This is an unfounded assumption that is based on a misunderstanding of the basic methodology used in analyzing surface temperature data. The surface temperature datasets evaluate the change in temperature over time at the various stations (the temperature "anomaly"), and do not base their evaluation on the absolute temperature level, as discussed in Subsection 1.3.2. This use of temperature changes or anomalies minimizes localized differences in absolute temperature and makes the resulting temperature record relatively insensitive to addition or removal of stations. This is because of the correlation of temperature changes over distances.

In fact, theory predicts that high latitudes and colder climates will warm more rapidly than low latitudes and warmer climates. Thus, the change in temperature at higher latitude or colder climates should tend to indicate greater warming than elsewhere, and dropping those stations would thus tend to lead to underestimating the resulting trend not overestimating it (although as long as there are at least a couple of stations in any region, the correlation of temperature measurements over hundreds of kilometers should also reduce this potential bias). We previously responded to comments on this issue in Volume 2 of the RTC document (2-36). The petitioners incorrectly assume and do not explain why dropping these stations would bias the trend in the change in temperature toward greater warmth.



An analysis (Clear Climate Code, 2010) used an emulation of the NASA GISTEMP code to only output the data from those stations that kept reporting data after a given year, or only output data from stations that stopped reporting data after that year. A graph from this analysis is shown here, where the blue line is a graph of global land temperatures (no ocean data) from stations that "dropped out" before 1992, and the red line is the same analysis but only from stations that were still reporting past that date. As can be seen in the graph, the difference between the two groups of stations is very small in modern times. Differences are larger pre-1945 because there are a smaller number of stations, especially in the southern hemisphere, so taking a subset of a small number of stations increases the potential for errors due to insufficient coverage of the land surface (the increased uncertainty in early 20th century temperatures can be seen in the Brohan, 2006 figure reproduced in Section 1.3.2 of this document).

This graph shows that the station drop-out issue which many petitioners raise has not imparted any kind of "spurious warming signal." This analysis and graph were produced as part of the Clear Climate Code project, an independent project which

involved the replication the NASA GISTEMP code in Python. We have independently verified this analysis. Much like the Independent Climate Change Email Review creation of a surface temperature record from public data in two days, the ability of the group working on this project to exactly reproduce the NASA temperature record and then apply the same code to new analysis demonstrates the overall availability, transparency, and utility of public code and data which enable any scientist to examine the issues involved in developing temperature records.

It also appears that D'Aleo and Watts failed to account for the methodologies used by NOAA, NASA, and HadCRUT to create a record of the trend in changes in global temperature, called anomalies. These methods determine the change in temperature at various stations and then average the temperature changes; they do *not* average the absolute temperatures of the stations. Thus, dropping colder stations does not make the resulting record of the change in temperature warmer unless the change in temperature at colder stations is lower than the change in temperature at warmer stations. As discussed previously, this does not appear to be the case, and scientific literature in general indicates that the opposite is true (the change in temperature in colder, higher latitude regions is generally larger that at warmer, lower latitude regions).

In contrast, the D'Aleo and Watts analyses use a scientifically improper methodology to evaluate the change in temperature over time. They determine simple averages of the absolute temperatures at the stations—without, apparently, taking into account their geographic distribution, much less calculating the change in temperature at the stations (the anomalies). As discussed in the science background in Subsection 1.3.2 on HadCRUT, two nearby stations can have very different absolute temperatures but very similar anomalies or changes in temperature, which is one reason why using changes in temperature is a more correct method than using absolute temperatures. In addition, not taking into account the geographic distribution of stations leads to overweighting those regions with many temperature records, such as the United States, rather than weighting each area of the globe equally in order to determine the global average temperature. These are both significant errors that undermine the petitioners' critique of the temperature records.

With respect to Bolivia, the NASA temperature record does not appear to have any data for Bolivia after 1990. The reason is likely because stations in Bolivia have not been reporting through the CLIMAT network. However, there is no merit to the argument that extrapolating temperature changes or anomalies from bordering countries will create a warming bias in Bolivia because those countries are warmer than Bolivia. As already explained, the issue is not the absolute temperature, but rather temperature trends that have been shown to be correlated over large distances. The petitioners provide no data to support that neighboring countries are warming faster than Bolivia, rather than being warmer in an absolute sense.

There is no factual basis for the petitioners' claim that the USHCN has dropped 90% of its stations. As demonstrated in the following Figure (Number of U.S. HCN stations with

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temperature records) from Menne et al. (2009), the station coverage in the past few years is only slightly lower than the peak coverage:

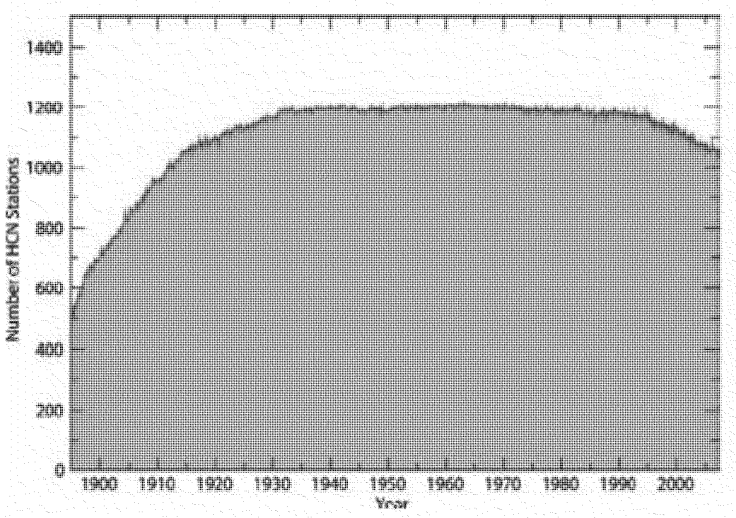


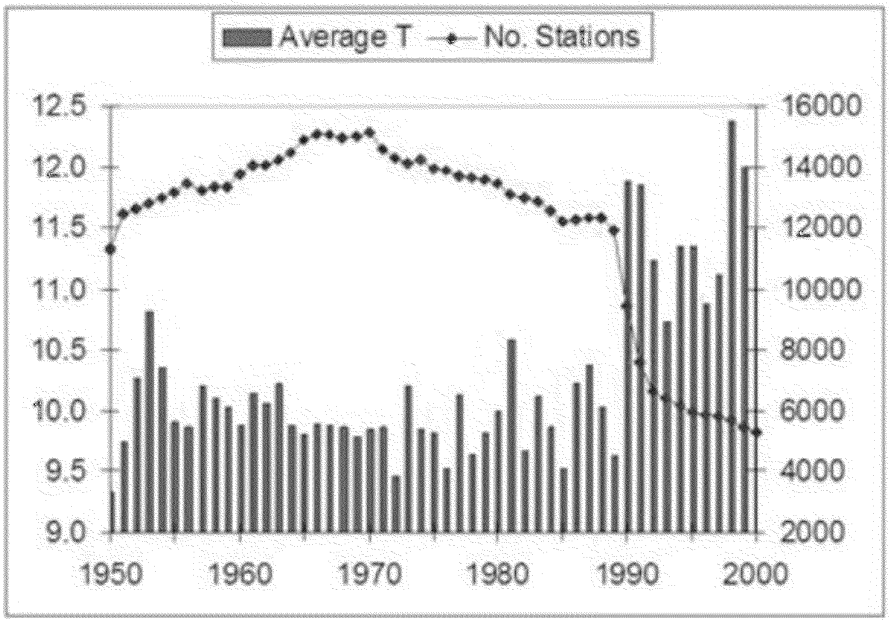
Fig. 2. Number of U.S. HCN stations with temperature records.

Similarly, the claim that only four stations are reporting from California conflicts with the NOAA temperature record for California (NOAA, 2010), which shows more than 40 stations in California with data in 2009.

Finally, we also note that the station dropout comes during the period when satellite data are available. As noted in the TSD, "The satellite tropospheric temperature record is broadly consistent with surface temperature trends," confirming that the reduction in the raw data reported from weather stations has not created a warming bias in the surface temperature dataset.

<u>Comment (1-63)</u>:
The Southeastern Legal Foundation, in their Third Amendment to Petition, discussed the issue of "station drop-out" at length:

> "Station drop-out" refers here to the precipitous decline in the number of temperature records included in the GHCN dataset. In the 1970's more than 6000 stations were active. Today the figure is 1500 or less. D'Aleo & Watts, p. 10, n. *94* The following graph, prepared by Ross McKitrick[5] shows the relationship between station drop-out and average temperature, where "Average T" is a mean of raw unprocessed temperature data, and No. of Stations.



D'Aleo & Watts, p. 11. *See* http://www.uoguelph.ca/~rmckitri/research/nvst.html (last visited Feb. 10, 2010) for a full explanation of this chart, and access to data it represents. This chart shows that the station drop out coincides with a sharp and significant increase in average raw temperature, and thus suggests that the change in temperature is the result of sampling bias and not climate change.

The stations that were dropped were disproportionately rural. D'Aleo & Watts, p. 11-12. Further, the remaining stations were biased towards lower latitudes, lower elevations, and urban locations. *Id.,* citing E.M. Smith[6], http://chiefio.wordpress.com/2009/11 /03/ghcn-the-global-analysis/ (last visited Feb. 10, 2010). All of these tendencies away from random sampling impart a warm bias to the record. D'Aleo & Watts show that station drop out has occurred all over the world, but the greatest station drop-out has occurred in Siberia and Canada, where these global temperature datasets purport to show the greatest warming has occurred.

Response (1-63):
In the previous response, EPA addressed petitioners' allegations that weather station dropouts have led to a warming bias in the temperature record. As described above, 1) petitioners rely on a non-peer-reviewed source that contains a number of inaccurate statements and relies on a scientifically flawed analysis; 2) petitioners demonstrate a fundamental misunderstanding of how to determine a warming or cooling trend from a temperature record and what issues actually would lead to either a warming or cooling bias in that record; and 3) petitioners fail to acknowledge that climatic records other than land surface temperature records also show clear warming trends consistent with the trend shown by the surface temperature data.

The graph submitted by the petitioner shows the absolute temperature averaged across all the stations existing at any given point in time, which has no real physical meaning—proper analysis averages the changes of station temperatures across a set of stations. Additionally, the analysis should take into account station location when making global

average rather than weighting every station equally. Equal weighting tends to introduce a bias by overweighting regions with many stations.

Comment (1-64):
The Competitive Enterprise Institute states that D'Aleo and Watts found that "NASA modified 20% of the historical record 16 times in two and one-half years ending in 2007" and that every modification "resulted in temperature trends that appeared to increase faster than they did in reality."

Response (1-64):
EPA's review of the information provided indicates that the Competitive Enterprise Institute' statement that "every instance of manipulation resulted in temperature trends that appeared to increase faster than they did in reality" is not supported by D'Aleo and Watts (2010) or by Goetz (2010), the source on which D'Aleo and Watts rely. On the contrary, D'Aleo and Watts (2010) state: "John Goetz showed that 20% of the historical record was modified 16 times in the 2½ years ending in 2007. 1998 and 1934 ping pong regularly between first and second warmest year as the fiddling with old data continues." The Web page with the Goetz analysis states, "I will note that the overall trend in changes between now and Sep. 24, 2005 is very close to zero" (Goetz, 2010). This contrasts with the assertion by the Competitive Enterprise Institute that these changes to the temperature record always resulted in a warmer trend. The petitioners evidence does not support their claim of manipulation with the intent to bias the temperature record inappropriately.

Comment (1-65):
The Competitive Enterprise Institute also cites D'Aleo and Watts:

> In late January 2010, the findings of D'Aleo, Watts, and Smith were confirmed by investigative journalists. They found, for example, that in the 1980s 600 Canadian monitoring stations were used in the NOAA dataset. Now only 35 are used, with only one above the Arctic Circle. Yet, Environment Canada reports that the government maintains 1400 stations with over 100 above the Arctic Circle.

Response (1-65):
According to Environment Canada, there are 1480 stations with climate normals in Canada. Of these stations, only a subset (about 140) are marked as reporting data through the CLIMAT system (WMO, 2010). As noted in the Section 1.4.2 of this document, Peterson and Vose (1997) finished their data collection effort in the mid 1990s. As part of this collection effort, they integrated historical data from hundreds of Canadian stations. The main source of updated data since this collection effort has been the automated CLIMAT reports. Therefore, the weather stations that do not produce CLIMAT reports would not be expected to be included in GHCN records for the past decade—this includes the majority of the Canadian stations. The NOAA GHCN dataset does contain data from 49 stations in Canada. Because many of the Canadian stations that report CLIMAT data only started doing so recently, they do not have the minimum quantity of data during the baseline period (1961 to 1990) to be included in the GHCN dataset. Given that Jones (1994) found that only 100 well-placed stations

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around the world would be sufficient to determine hemispheric average trends, 49 stations within Canada should be more than sufficient for determining large-scale trends.

1.4.3.2 Issues Raised With Respect to Adjustments for the UHI Effect

Comment (1-66):
Petitioners assert that the UHI adjustments performed by NASA are insufficient or improperly applied, both globally and in the USHCN. The State of Texas claims, "But according to the TSD, the CRU's temperature data 'applies an urbanization adjustment,'" and therefore "the CRU temperatures cited by both the IPCC and EPA do not reflect temperatures that were actually captured by weather station thermometers, but rather temperatures that have been recalculated by the CRU for one purported scientific reason or another." The Southeastern Legal Foundation objects that Version 2 of the USHCN record does not correct for UHI, that "The notion that there is zero urban heat island effect in Manhattan is not valid," and that NASA UHI adjustments have the wrong sign based on an analysis by D'Aleo and Watts (2010) of the Puerto Maldon station in Peru. The Southeastern Legal Foundation points to an analysis of UHI adjustments by the Science & Public Policy Institute (Long, 2010). The petitioner quotes from the study, "Thus, the adjustments to the data have increased the rural rate of increase by a factor of 5 and slightly decreased the urban rate, from that of the raw data," and states that therefore, "The consequence, intended or not, is to report a false rate of temperature increase for the Contiguous U.S." Additionally, the Southeastern Legal Foundation claims that a project—surfacestation.org—has shown that 90% of stations in the United States "were sited in ways that result in errors exceeding 1°C."

Response (1-66):
The Long (2010) study cited by petitioners averaged together 48 rural stations (one per state) in the continental United States and compared them with 48 urban stations (one per state). Based on this method, Long found that the net effect of NOAA adjustments to the raw data had little effect on temperature trends for urban stations but led to more warming in rural stations. However, neither the petitioners nor Long analyze the reasons for the adjustments to rural stations or present any reason or argument indicating that the adjustments were inappropriate. Their sole argument is that the result of the adjustment must mean the adjustment was wrong. However it is the reason behind the adjustment that determines its validity, not the result of the adjustment. In the United States, the time of day at which temperature observations were made was changed at some stations. This change of observation time is known to introduce a nonclimatic trend into the raw data that would create apparent cooling if uncorrected (Vose et al. 2003). These time of observation changes were mostly limited to rural stations in the United States. Therefore, the warming adjustments found in rural stations by Long are likely the result of the correction of this "time of observation bias."[48]

[48] Time of observation bias refers to the fact that if temperatures were recorded at noon for one year, but at 8 a.m. for another year, there needs to be an adjustment to make them consistent.

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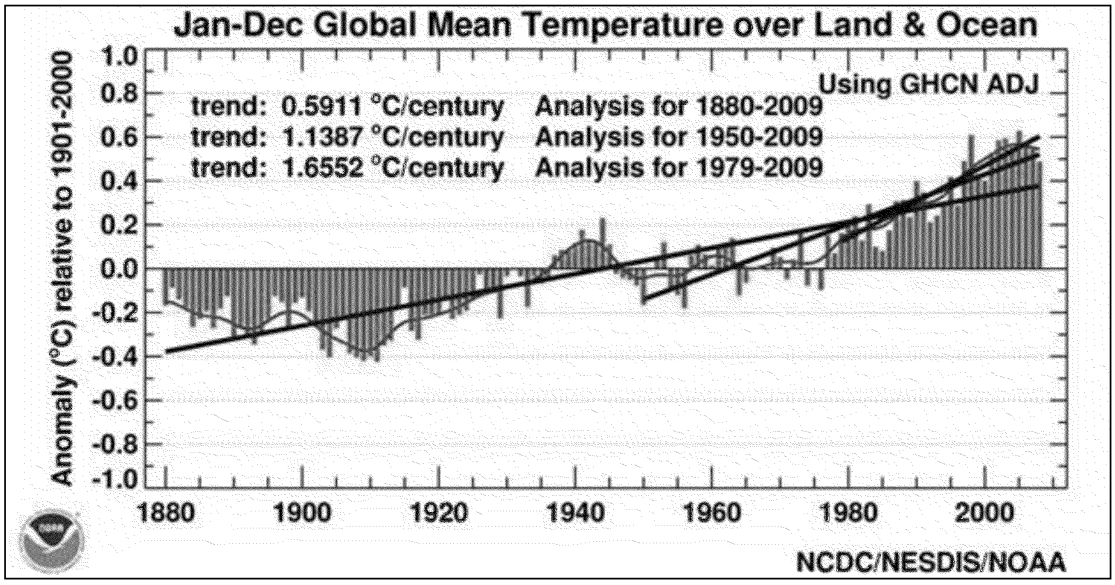
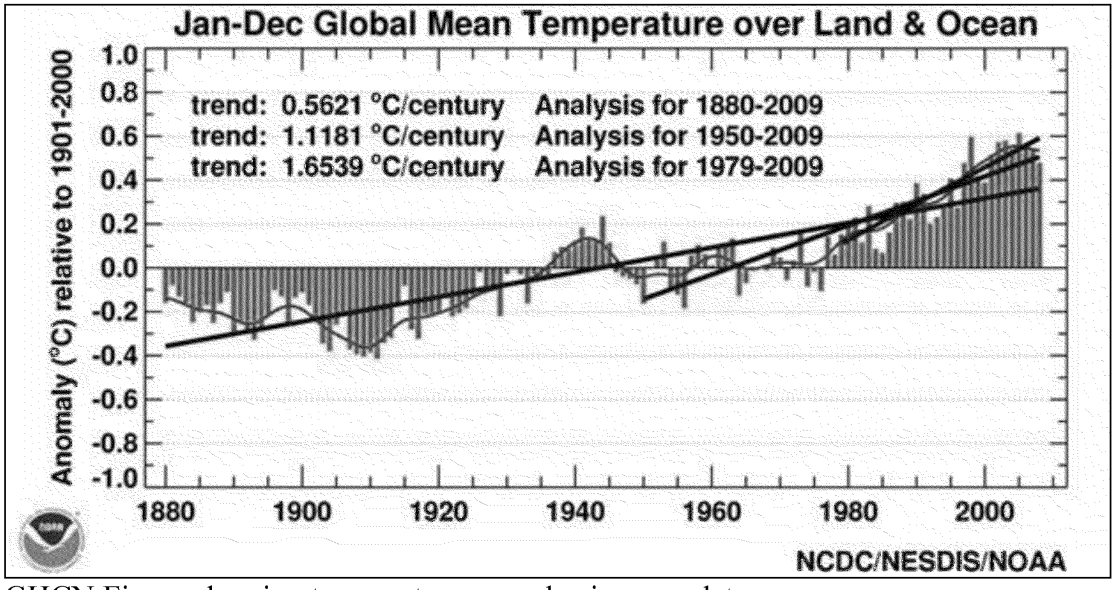
With regard to the objection that some temperature records do not correct for the UHI effect, we responded to a very similar comment when finalizing the Endangerment Findings. Response 2-28, notes, "The different surface temperature datasets shown or cited in the TSD all account for urbanization, either directly and/or indirectly." The claim that NASA makes corrections of the wrong sign, using Puerto Maldon as an example, does not take into account the homogenization routine that NASA employs that uses neighboring stations to correct station data. Under that routine, stations identified as urban are automatically shifted to come into agreement with the neighboring stations. These automated homogenization routines use the fact that temperature changes over time (i.e., anomalies) are correlated over distances to correct for things like weather station moves and other changes of the immediate environment of a weather station. These changes, as explained in NASA's documentation, can be either positive or negative.

The argument by the State of Texas that these temperature records "do not reflect temperatures that were actually captured by weather station thermometers" is without scientific merit as the adjustments are appropriate and necessary either because of station moves, changes in time of observation, urbanization, or other reasons. If changes such as switching from afternoon measurements to morning measurements were not corrected, then the temperature record would not accurately reflect the surface temperature reality.

We also note that overall, these adjustments have had little effect on the global temperature trends. This can be seen in the two GHCN figures included below, one based on adjusted data and one based on the unadjusted, raw data. Adjustments are more important on a local basis. Also, within the United States itself, adjustments have more importance because of the need to correct for systematic changes in the time of observations and measurement instruments that were more widespread in the United States than elsewhere.



GHCN Figure showing temperature record using adjusted data.

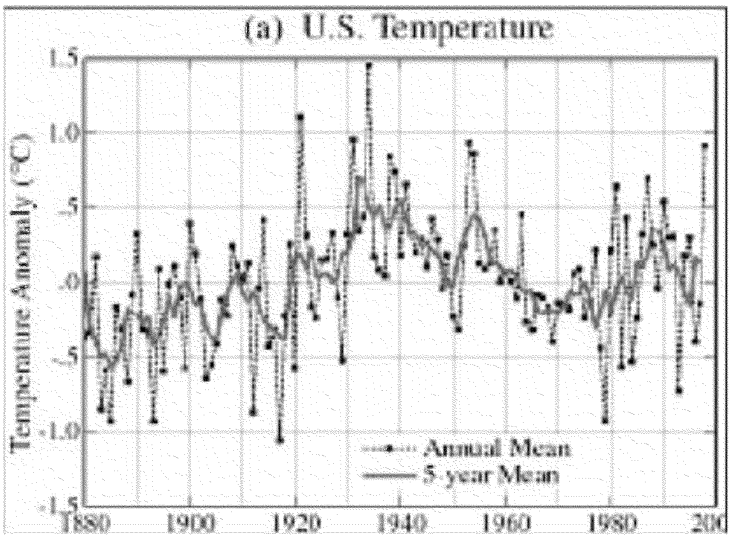


GHCN Figure showing temperature record using raw data.

With regard to the surfacestation.org analysis, this was addressed in depth in response 2-27 of the RTC document for the Endangerment Findings. EPA found that "NOAA has provided extensive information to the public in response to the concerns raised by the commenters, available at http://www.ncdc.noaa.gov/oa/about/response-v2.pdf (NOAA Climate Services, 2009)." NOAA stated in this document, "A peer-reviewed study specifically quantified the potential bias in trends caused by poor station exposure (Peterson, 2006). The analysis examined only a small subset of stations – all that had their exposure checked at that time – and found no bias in long-term trends." Since the publication of the RTC document, another analysis by Menne et al. (2010) has also concluded that well-sited stations give a trend similar to the full set of stations, therefore

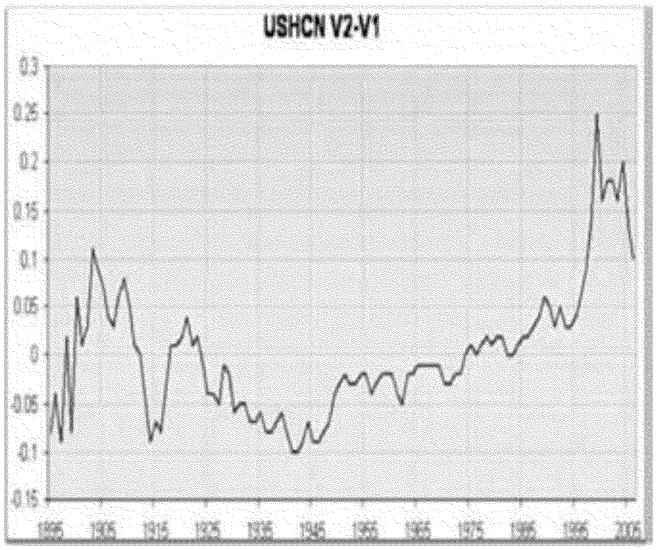
providing further evidence that poorly sited stations have not undermined the final temperature record. The surfacestation.org analysis estimated station errors by visual inspection, not by measuring actual temperatures. In addition, the station error visual rating method results in estimated errors for absolute temperatures, not for changes in temperature. Therefore, methodologies using changes in temperature that average across a large number of stations could be expected to have much smaller errors than the error in absolute temperature at any individual station. This projection of small errors for large-scale trends was confirmed by the analyses by Peterson (2006) and Menne et al. (2010).

Comment (1-67):
The Southeastern Legal Foundation, in their Third Amendment to Petition, objects to the changes in the USHCN temperature record between Version 1 and Version 2. To support this argument, they present several graphs. The first is a temperature graph from D'Aleo and Watts (2010) attributed to James Hansen in 2010.



The petitioner states that the 20th-century record was "misrepresented" in order to "exaggerate a 20th century warming trend and claim it was caused by AGW [anthropogenic global warming]." They object to the replacement of the UHI adjustment used in Version 1 of the USHCN with the "change point algorithm" used in Version 2 because the petitioners claim that while this algorithm can detect abrupt changes it "cannot account for long term changes to the temperature record, such as UHI, making such signals indistinguishable from the climate change signal that is sought."

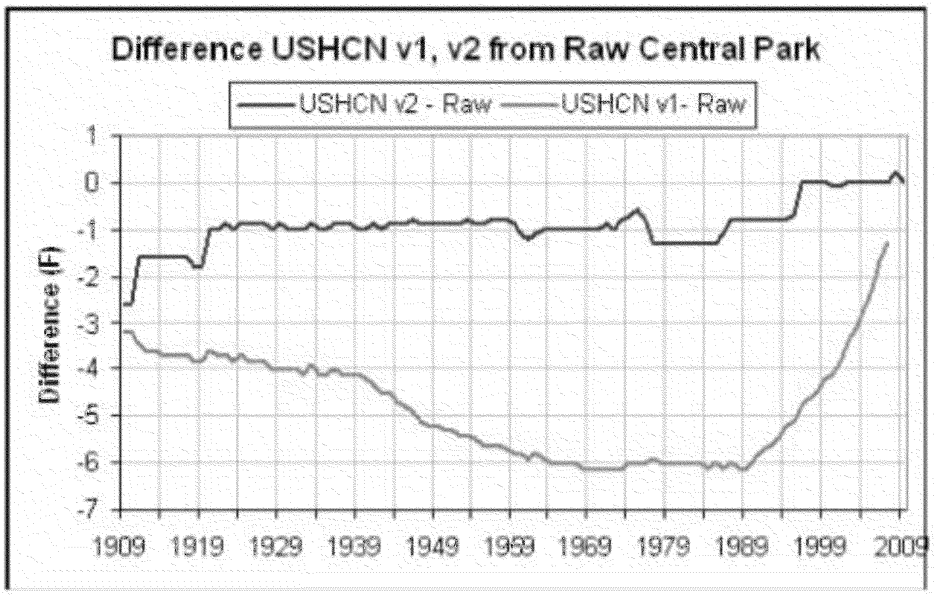
The petitioner provides another chart from D'Aleo and Watts (2010) showing the difference between USHCN Version 1 and Version 2 (Figure USHCN V2-V1).



The petitioner objects: "The warming of the 1930's has been minimized by negative adjustments, and the recent warming has been exaggerated by positive adjustments (or by failure to properly adjust for urban heat islands), thereby imparting to the 20th century a warming trend that the raw data and

rural stations do not show."

A third chart that the petitioner provides related to this issue is one showing the adjustments to the temperature record in Central Park in New York City, stating: "The notion that there is zero heat island effect in Manhattan is not valid."



The petitioners note that GISS uses a different procedure:

> The GISS temperature dataset maintained by NASA retains an urban heat island adjustment for the US, and for this reason diverges from USHCN. Between 1950-2008, the trend difference between GISS and USHCN is approximately 0.7 F°/century. *See id.* at 42-43. The asserted warming trend over the 20th century is 0.74 ± 0.18°C (TSD p. 27). However, for the rest of the world, the GISS UHI adjustments *have the wrong sign. Id.* At *47-50*. As summarized by D'Aleo & Watts, there is compelling evidence that the 20th century surface temperature record has been improperly adjusted downward during the warming of the 1930's, and improperly adjusted upward (or not adjusted for UHI) in the late 20th century warming. These improper adjustments and failures to adjust impart a spurious warming signal to the 20th century temperature record and render it scientifically invalid and unreliable for use in the EPA's Endangerment Finding.

Response (1-67):

The changes between USHCN Version 1 and Version 2 are well documented. This documentation shows that the changes between the two versions in the past 50 years are not related to any changes in how the USHCN versions address the UHI effect (although the UHI adjustment change is important pre-1960). In their analysis, the petitioners do not account for the valid corrections to the data for dates after 1995 due to a lack of correction for known instrumentation changes. Furthermore, the petitioners make assertions about NASA adjustments that are not supported by the underlying document they cite, and that show a misunderstanding of the purpose of the NASA algorithms.

Figure 11 in Menne et al. (2009) shows an analysis of the differences between the various USHCN versions.

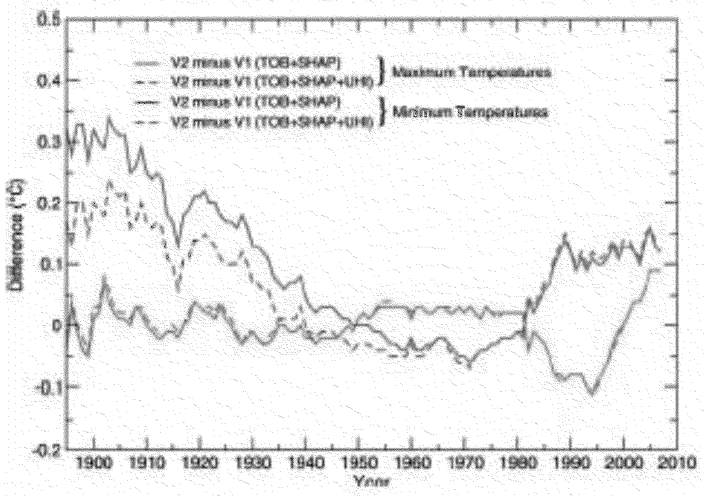


Fig. 11. Average annual differences over the CONUS between HCN version 2 and HCN version 1 (Revision 3; Easterling et al. 1996)

The changes between the two versions after 1995 are a result of the fact that USHCN Version 1 had not updated its data to correct for changes in measurement instrumentation at some weather stations after that date.

An analysis of gradual trends (like those expected from the UHI effect) by Menne et al. (2009) found that in some cases the fully adjusted HCN Version 2 did remove trends at the station when compared with its neighboring stations (including a specific example of Reno, Nevada). Additionally, when comparing the HCN network with the larger Cooperative Observer Program (COOP) Network, the analysis found that trends in the HCN network were more likely to be cooler than warmer than the trends in the COOP network. Finally, Menne et al. calculated a trend from the 30% of stations that were identified as being most urbanized and found that the trend from these urbanized stations was actually slightly smaller than the trend from the remaining stations. These analyses suggest that the USHCN Version 2 methodology is appropriately accounting for UHI trends.

With regards to the assertion that outside of the United States the NASA UHI adjustments "have the wrong sign," the petitioners ignore the clearly documented methodology regarding the NASA adjustments, and they make unsupported extrapolations of the non-peer-reviewed literature that they are quoting.

A discussion of the data sources and routines used by NASA to produce the GISS temperature record can be accessed on the NASA website (NASA 2010b). As stated on this site, the urban homogenization adjustments are designed to address a changing urban environment—whether "warming or cooling":

> The goal of the homogenization effort is to avoid any impact (warming or cooling) of the changing environment that some stations experienced by changing the long term trend of any non-rural station to match the long term trend of their rural neighbors, while retaining the short term monthly and annual variations. If no such neighbors exist or the overlap of the rural combination and the non-rural record is less than 20 years, the station is completely dropped; if the rural records are shorter, part of the non-rural record is dropped.

What this documentation states is that NASA's methodology replaces the long-term trend of any "urban" station (as identified by nightlights) with the trend of the neighboring rural stations, regardless of whether these rural stations are warming faster or slower than the urban station. If there are no neighboring rural stations, the urban station's trend is not used at all. Therefore, the existence of some stations that are adjusted to have a larger warming trend is consistent with the documentation.

The implication by the petitioners that all of the NASA adjustments outside the United States lead to greater warming than the unadjusted data would show is without support: the literature on which petitioners rely shows only one example of a station that was adjusted to show greater warming in order to agree with neighboring rural stations, along with a hypothetical example where the methodology could potentially result in a warming adjustment to an urban station that would be problematic if the rural stations all had artificial warming.

Several analyses have been replicated for different subsets of the data: stations ranked highly by surfacestations.org compared with stations ranked poorly (Menne et al., 2010), stations that drop out early compared with stations that are still reporting (Clear Climate Code, 2010), rural stations compared with urban stations (Menne et al., 2010), and so forth. Every one of these analyses that we are aware of that uses appropriate methodologies (e.g., anomaly and spatial interpolation techniques and, in the United States, corrections for time of observation bias changes) has resulted in similar trends over the century for the United States and for the globe with only small differences from analysis to analysis.

With regards to the differences between the United States temperature record in the NOAA and NASA analyses, the petitioners' comments are not new: see Response 2-28 in the RTC. Note that the discrepancy between NASA and NOAA discussed in Response 2-28 is much smaller now that NASA has updated to using USHCN Version 2. NASA previously used Version 1 without the UHI adjustment, and now uses Version 2 as an input. As noted above, Version 2 includes important corrections for stations that changed measurement instruments after 1995. The updated trends for U.S. data in the two datasets are 1.28°F/century for NOAA and 1.12°F/century for NASA from 1901 to 2008. For 1950 to 2008, the trends are 1.50 and 1.39 °F/century for the two temperature records respectively. The smaller trend in the NASA temperature record is due to the nightlight based urban correction routines.

We find that while NASA uses a nightlights map and an adjustment methodology for the United States that produces a smaller trend, it is not clear that this is to be preferred over

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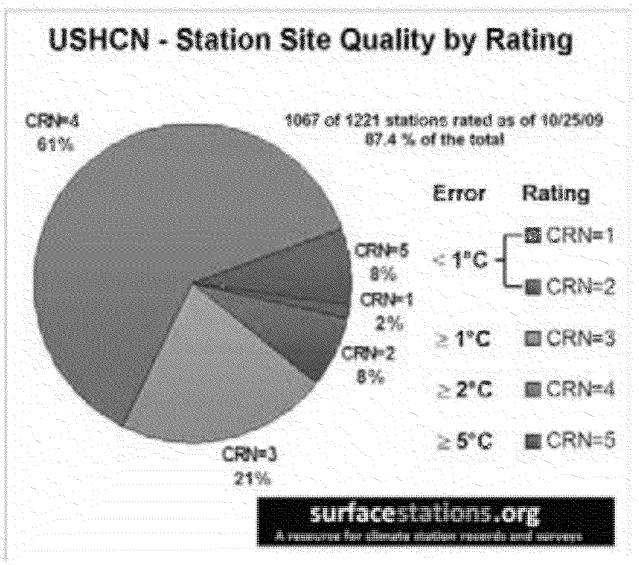
the NOAA approach. It might produce more realistic temperature estimates for some stations, but might over-correct for urban effects for other stations. Also, the NOAA algorithm has the advantage of using the larger COOP database for its closest neighbor calculations. In the case of Central Park specifically, NASA's nightlight adjustment routine does result in a smaller trend than NOAA uses in its USHCN temperature record. Recall, however, that it is not the heat island effect in Manhattan that is in question, but rather the change in the heat island effect over time that is important. NASA uses more distant HCN stations to determine such trends and the appropriate correction, whereas NOAA uses a larger number of nearby COOP stations to determine appropriate "changepoint" corrections. (The HadCRUT temperature record does not include the Central Park station, as it does not use the USHCN dataset.)

In sum, the petitioners have not shown inappropriately manipulated data in terms of either the U.S. or global temperature records. The findings of a warming temperature trend in the United States and the globe over both the past 50 years and the past century remains robust, as shown by different methodologies used by different groups, as well as analyses that use only subsets of the data (such as only those stations that are not near brightly lit areas as defined by nighttime satellite measurements).

Comment (1-68):

The Southeastern Legal Foundation, in their Third Amendment to Petition, discusses the surfacestations.org project and the related critiques of the USHCN network and the U.S. temperature record:

> Anthony Watts' project, surfacestations.org, has surveyed 1067 of 1221 (87.4%) surface stations in the USHCN network. Stations are evaluated for the quality of their location according to criteria developed by the Climate Reference Network ("CRN") Site Information Handbook, which specifies the requirements for establishing and maintaining a weather instrument site. *Id.* at 32.[8] Deviations from the siting standards introduce a range of error in the measurements according to a scale set forth in the handbook. The error scale runs from less than 1° C for stations classified as CRN class 1 or 2, up to greater than *5*° C for stations rated CRN class *5*. *Id.* 28-33. For the stations surveyed the SurfaceStations.org volunteers determined that 90% were sited in ways that result in errors exceeding 1° C according to the handbook's error scale. In the following chart, these stations are categorized by where they fall in the CRN handbook's error scale:



Since the asserted warming trend over the 20th century is 0.74 ± 0.18°C (TSD p. 27), the petitioner claims that the error swamps the signal. On this basis, the petitioner asserts that the data are invalid and unreliable and cannot be relied on for the Endangerment Finding.

Response (1-68):

The petitioner cites a study that has determined that a large number of stations do not match the best criteria as developed for the Climate Reference Network. However, the petitioner does not show that the identified siting issues contribute to a systematic bias. The error scale used covers both positive and negative error. Errors that vary randomly from one station to another would not be expected to bias large-scale temperature records. In addition, these errors refer to errors in absolute temperatures, not in changes in temperature. In contrast, researchers at NOAA have performed analyses that show the difference between trends calculated from stations that have been identified as "well-sited" compared to trends calculated from stations that have been identified as "poorly sited." A key figure from Menne et al. (2010) (Figure 7, provided below) compares various U.S. temperature records derived by using all the stations, only stations using "good" siting, only stations using "poor" siting, and only stations using the new US Climate Reference Network (USCRN). USCRN was developed over the past few years with the goal of having stations designed for the purpose of long-term climate monitoring, in contrast to the current network of stations primarily designed for weather monitoring. These USCRN stations are all designed for the purpose of long-term climate monitoring. Note that all four sets of stations give almost identical trends (for USCRN, only over the recent years that it has been operational).

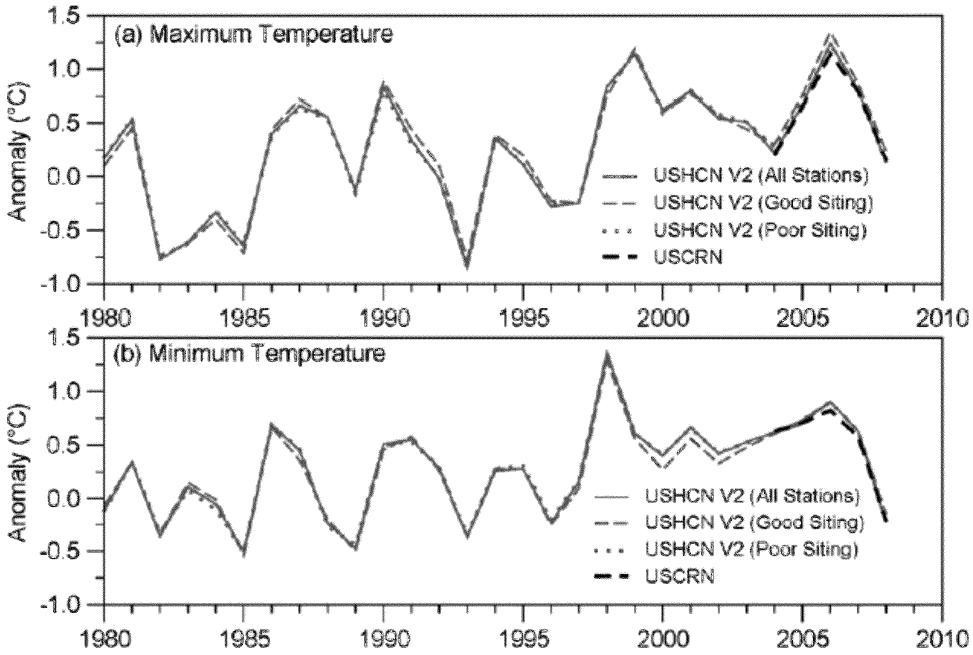


Figure 7. Comparison of the CONUS average annual (a) maximum and (b) minimum temperatures calculated using USHCN version 2 adjusted temperatures [*Menne et al.* 2009] and USCRN departures from the 1971-2000 normal. Good and poor site ratings are based on *surfacestations.org* as in Fig. 1.

The assumption by the petitioner than an error of 1 degree or more at individual stations "swamps the signal" is also incorrect based on basic statistics. Because there are a large number of measurements at a large number of stations, the statistical error is much smaller than the error for a single measurement at a single station.

See also Response 1-67 in this document regarding the surfacestations.org project.

Therefore, the conclusion of the Watts surfacestation.org project that, using one method of rating stations, only a small subset of the U.S. temperature stations are well sited does not demonstrate that the overall temperature record is biased or unreliable. In fact, analysis using only the subset of stations determined as "good" by Watts, as well as analysis using the new Climate Reference Network stations, found very similar trends to the analysis using all the stations, demonstrating that the conclusions about U.S. temperature trends are robust.

Comment (1-69):
The Southeastern Legal Foundation in their Fifth Amendment to Petition and in their Petition to Stay refer to a study by Edward Long (2010) stating:

On February 25, 2010, Edward R. Long, Ph.D.[10] published a paper through the Science and Public Policy Institute analyzing the effect of adjustments to the temperature record for the continental United States that are made in the NCDC temperature record for rural and urban stations.[11] For the rural stations in the study, the raw data showed a linear trend of 0.13° C per century, while for urban stations the raw data showed a trend of 0.79° C per century. Id. at p. 8-9. The long term trends were very similar until about 1965, when the trend in the urban raw data increases faster than in the rural data. Id. at 9-10.

NCDC's adjusted data for rural stations show a trend of 0.64 ° C per century, compared to 0.13 ° C per century for the raw data. In other words, the NCDC adjustment increased the rural trend by nearly five times. Id. at 11. The adjusted data for urban stations show a trend of 0.77° C per century, compared to a raw urban trend of 0.79° C per century. *Id.* "Thus, the adjustments to the data have increased the rural rate of increase by a factor of 5 and slightly decreased the urban rate, from that of the raw data." *Id.* This has the effect of hiding urban heating, and permitting the warming present in the adjusted data to be attributed not to urban warming, but to climactic warming. As Long concludes, "The consequence, intended or not, is to report a false rate of temperature increase for the Contiguous U.S." *Id.* at 13. The EPA should not base economically devastating regulations, or any regulations, on false reports, and should reconsider the Endangerment Finding to make sure that it has not done so here.

Response (1-69):
The Long study does not demonstrate inappropriate adjustment for rural temperature stations, because this study did not take into account the appropriate "time of observation bias" adjustments or adjustments for changes in measurement instruments. Because of these flaws in the Long analysis, the conclusions by Long are without scientific merit. As demonstrated in previous responses, U.S. trends calculated using only "good" stations or only Climate Reference Network stations show very similar trends to the trends calculated using the full set of data. See also Response 1-66 on the Long study and other UHI issues in this section.

1.4.3.3 Issues Raised in Additional Literature Provided by Petitioners

Comment (1-70):
The Coalition for Responsible Regulation cited two papers that they state show that replication of temperature records is difficult, and that therefore, EPA's Endangerment Finding does not meet the requirements of the Data Quality Act. Regarding these two papers, the coalition states, "One study, noting that the raw temperature records in the USHCN are adjusted substantially to account for a variety of potential contaminants, concluded the effects of such adjustments 'produce a significantly more positive, and likely spurious trend in the USHCN data'" (Balling and Idso, 2002). The other study concluded "that the inability to replicate the [Northern Hemisphere surface thermometer temperature] trend was likely a result of 'data padding' used to smooth and filter data" (Soon et al., 2004).

Response (1-70):
EPA has reviewed the petitioners' submission of Balling and Idso (2002) and Soon et al. (2004) and finds that it was not impracticable to raise the objection during the public

comment period and that the reasons for the objection did not arise between June 24, 2009, and February 16, 2010. Petitioners could have submitted these studies during the comment period on the proposed Endangerment Finding. Although, in most cases, the petitioners provide excerpts from the CRU e-mails in support of their assertions, EPA's review has determined that this evidence does not support their allegations, and that the information submitted by petitioners on these topics was available before the comment period for the Endangerment Finding. Petitioners have not shown why it would have been impractical for them to have submitted these studies then. Indeed, similar points were already raised, and responded to, in the RTC. Despite the fact that these objections fail to meet the statutory timeframe for evidence supporting a petition for reconsideration, we briefly explain why, contrary to petitioners' allegation, they fail to call into question the Finding.

Balling and Idso (2002) draws conclusions based on an analysis that is no longer valid, as it relies on the University of Alabama–Huntsville (UAH) satellite temperature dataset *before* corrections identified by Karl et al. (2006) in CCSP Product 1.1 were applied to the satellite record. These corrections have been accepted by all the researchers involved, including those at UAH, and increased the temperature trend in the satellite dataset, eliminating many of the discrepancies with the surface temperature dataset. Additionally, even before these corrections were identified, Vose et al. (2003) found with respect to Balling and Idso (2002) that "the time of observation bias adjustments in HCN appear to be robust," contrary to the assertions of Balling and Idso that these adjustments were biased.

As background, Soon et al. critiqued the application of the smoothing algorithm used by Mann and Jones (2003) at the very end of the time period that was analyzed. The algorithm is a 20-year average, and a decision must be made about what temperature to use for the last 10 years. For example, one could choose to reflect the end of the temperature record (making the years after the end of the record a mirror image of the years before the end of the record), or assume that all years after the last year of the record are equal in temperature to the last year, or assume that the subsequent years continue the trend of the previous years in the record. Soon et al. felt that application of this "data padding" (though they were not able to exactly duplicate Mann and Jones) led to unjustifiably high temperatures at the end of the smoothed temperature record.

A subsequent peer-reviewed rebuttal of Soon et al.'s critique was published by Mann (2004). Mann (2004) states that "Comparisons that are uninformed (e.g., Soon et al., 2004) by objective evaluation criteria (e.g., MSE [Mean Square Error]), are unlikely to provide useful insights into the relative merits of alternative boundary constraints." Mann's contention is that there needs to be an objective way to evaluate which smoothing routine to use. While he does not claim that MSE is necessarily the best function, he notes that Soon et al. do not use any objective criteria at all. His analysis also suggests that his approach will choose methods that reflect the underlying trends in the data, whereas smoothing that does not use the MSE criteria can generate spurious trends.

1.4.3.4 Petitioners' Allegations Regarding Data Adjustments at Specific Stations

Comment (1-71):
Petitioners identify several instances of allegedly flawed data adjustments at specific weather stations, citing the records of some individual stations that they claim show inappropriate manipulation. The Coalition for Responsible Regulation references a non-peer-reviewed analysis by Eschenbach (2009) as a basis for claiming: "For example, adjustments made by the Global Historical Climatology Network (GHCN) in Darwin, Australia, transformed a temperature trend falling at 0.7°C per century to one that was warming 1.2°C per century."

The Southeastern Legal Foundation, the State of Texas, and the Coalition for Responsible Regulation makes similar claims regarding stations in New Zealand, stating, "Similar 'adjustments' are also evident in one striking comparison of raw temperature data with homogenized temperature data 'adjusted' by the New Zealand national weather service, the National Institute of Water & Atmospheric Research (NIWA)," claiming that the "New Zealand Climate Science Coalition concluded that all of the 'adjustments' made by Salinger and the NIWA served to show inaccurate increases in warming" (referencing a non-peer-reviewed analysis by Treadgold, 2009).

Response (1-71):
The specific assertions made about the Darwin and New Zealand stations rely upon two non-peer-reviewed analyses that found that temperature adjustments at various stations caused temperatures to be higher than they otherwise would have been. In the case of New Zealand, the petitioners do not show that the adjustments performed by these organizations were inappropriate, just that the adjustments resulted in a larger warming trend. As we have explained previously, there are several legitimate reasons to adjust temperature records, from time of observation changes to moving the location of the thermometer.

NIWA has published details of its temperature analysis online (New Zealand NIWA, 2010). Their site includes links both to a set of 11 stations with no required adjustments since 1930 and the set of seven stations analyzed by Treadgold. Both sets of stations show warming over the period between 1930 and present. In the latter set, NIWA links to a complete description of the station history of Hokitika, the station with the largest change in trend due to adjustments. NIWA shows that the composite, adjusted Hokitika record is similar to that of two nearby stations from the unadjusted set during those periods when the stations were all recording data. We also note that the raw data (for all 18 New Zealand stations linked to by NIWA) provided to NOAA for the GHCN dataset does not include the homogeneity adjustments from the NIWA researchers. The adjusted NOAA temperature record does show a warming trend for these stations, however. While the NOAA GHCN adjustments differed in some ways from the NIWA adjustments, the largest adjustment made to the Hokitika station by both NOAA and NIWA occurred before 1912, consistent with this statement from NIWA: "It is noted in the Hokitika station history file (see Appendix 2) that the maximum temperatures were believed to be about 3°F too high through the period 1894 to August 1912." Given that

NOAA uses automated procedures to correct for station moves based on data from neighboring stations, this is strong independent confirmation that the manual adjustments made by NIWA were appropriate (and vice versa).

Of the other 2 major temperature records, HadCRUT uses most of the same manual adjustments as NIWA. The automated algorithm used by NASA, on the other hand, is designed to correct for changes in trends at urban stations rather than sharp discontinuities, and therefore does not capture the errors that are corrected by both the NOAA algorithm and the HadCRUT/NIWA manual adjustments.

While NIWA has only addressed in depth one of the seven stations analyzed by Treadgold, based on comparisons to nearby stations, New Zealand researchers have shown that the adjustments to the other stations were appropriate (New Zealand NIWA, 2010). Additionally, Folland and Salinger (1995) found that the nearby sea surface temperatures also showed similar warming since the beginning of the century, adding further independent confirmation that the adjusted trend used by NIWA, NOAA, and HadCRUT is a good reflection of reality. Therefore the evidence indicates that NOAA and NIWA both made similar, independent, and appropriate adjustments. Note that this example is also further confirmation of the independence of the adjustment methodologies of the NOAA, NASA, and HadCRUT temperature records addressed in 1.4.3.5.

Regarding the Darwin station, these adjustments only appear in one of the three temperature records—the adjusted GHCN record from NOAA (HadCRUT uses raw GHCN data, and NASA uses raw data starting in the 1960s). There is a clear discontinuity at Darwin in 1941 at the time of a major station move when the temperature record apparently dropped by more than half a degree, and it would be expected that adjustments would be required under such circumstances to ensure that the station trend best represents the real temperature trend at that location. However, according to a letter by Tom Peterson of NOAA (reproduced in full in Response 1-73 below), the Darwin station might be an example of a "random walk" where a rare combination of circumstances means the automated algorithm can introduce an erroneous trend. However, a possible error at one station (which only occurs in one out of three datasets) will not materially affect large scale trends. Statistical analysis has showed that:

> [t]he difference in trends between homogeneity-adjusted and unadjusted data can be enormous at an individual station and very significant in regional analyses. However, Easterling and Peterson (1995a,b) found that on very large spatial scales (half a continent to global), positive and negative homogeneity adjustments in an individual station's maximum and minimum temperature time series largely balance out, so when averaged into a single time series, the adjusted and unadjusted trends were similar (Peterson et al. 1998).

Thus, it is not surprising that data from one station or region would show a large difference between adjusted and unadjusted data. The important point is that when the stations and regions are combined for a global analysis, these kinds of effects are balanced out and do not introduce bias in the overall result.

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Therefore, we find that the petitioners have not shown evidence that the adjustments in New Zealand were inappropriate, or shown that the adjustments at Darwin biased larger scale temperature reconstructions. We also note that the three temperature records used different methods to determine the appropriate adjustments: in the case of New Zealand, NOAA and HadCRUT used independent methods (one manual and one automatic) and found similar adjustments needed to be made, whereas in the case of Darwin NASA and HadCRUT both used the raw data with no adjustments (though different time periods of useable data).

Comment (1-72):
The Coalition for Responsible Regulation provides a number of references (Exhibits K through V) to support their statement that "There are numerous and recently-released studies documenting significant warming biases in the temperature databases that, in light of the Disclosures [i.e. the CRU emails], reveal the fruit of this manipulated process."

Exhibits K through V are Balling and Idso, 2002; Christy et al., 2006; Christy and Norris, 2009; D'Aleo, 2009; D'Aleo, 2010; Davey and Pielke, 2005; Davey et al., 2006; Hale et al., 2006; Pielke et al., 2007a; Pielke et al., 2007b; Soon et al., 2004; and Watts, 2009.

Response (1-72):
EPA has reviewed the petitioners' submission of these 12 studies and finds that for many of these submissions it was not impracticable to raise the objection during the public comment period or that the reasons for the objection did not arise between June 24, 2009, and February 16, 2010. Petitioners could have submitted most of these studies during the comment period on the proposed Endangerment Finding. Although, in most cases, the petitioners provide excerpts from the CRU e-mails in support of their assertions, EPA's review has determined that this evidence does not support their allegations, and that the information submitted by petitioners on these topics was available before the comment period for the Endangerment Finding. Petitioners have not shown why it would have been impractical for them to have submitted these studies then. Indeed, similar points were already raised, and responded to, in the RTC. Despite the fact that these objections fail to meet the statutory timeframe for evidence supporting a petition for reconsideration, we briefly explain why, contrary to petitioners' allegation, they fail to call into question the Finding.

Most of the 12 references provided to support the statement by the petitioners that "document significant warming biases" are not new. Three references (Christy et al., 2006, 2009; Pielke Sr. et al., 2007a) were explicitly addressed in the Volume 2 of the RTC document (Responses 2-28 and 2-29), which found that these effects would be negligible on hemispheric and continental scale averages. Below is EPA's response from RTC Volume 2:

> EPA has reviewed additional literature submitted by commenters on this issue (e.g., Christy et al., 2006, 2009; Lin et al., 2007; Pielke Sr. et al., 2007, Ren et al., 2007; Walters et al., 2007), which documents effects that may result in biases at individual stations. CCSP (2006) also addresses this issue, and finds: "To the effect that these effects could be

> large enough to have a measurable influence on global temperature, these changes will be detected by the land-based surface network [which corrects for these effects]." The large number of stations in land-based surface networks greatly facilitates temporal homogenization, since a given station may have several "near-neighbors" for "buddy checks" where adjustments and/or change point algorithms can be employed per the previous response 2-28 (CCSP, 2006). In a comprehensive reassessment of errors in the HadCRUT temperature record, Brohan et al. (2006) conclude: "Since the mid-20th century the uncertainties in global and hemispheric mean temperatures are small and the temperature increase greatly exceeds its uncertainty."
>
> Through our review of the data sets and the literature, EPA concurs with IPCC (Trenberth et al., 2007) and CCSP's overall assessment that the effects of urbanization and land use changes on the land-based temperature record are negligible as far as hemispheric- and continental-scale averages are concerned because the very real but local effects are avoided or accounted for in the datasets used.

Three more references (Davey and Pielke, 2005; Hale et al., 2006; and Pielke et al., 2007b) were not raised during public comment, but we find that they are variations on the same issues of effects at individual stations that may result in bias at the individual stations and responded to with respect to the Christy and Pielke studies discussed in the RTC document (as quoted above). Thus, these references do not lead to any changes in EPA's conclusions on the robustness of global and continental-scale averages.

Davey et al. (2006) is a study of the use of a different metric (equivalent temperature) that takes into account how the heat capacity of air depends on humidity and explores the implications of weighting temperature measurements by this heat capacity. However, while this is an interesting academic exercise, the current standard metric is the average surface temperature, and this study does not demonstrate any biases in the measurement of this standard metric. The equivalent temperature trends found in Davey et al. (2006) are actually larger (averaged over the year) than the comparable, standard surface temperature trends for the region examined.

Two more references (Soon, 2004; Balling, 2002) have been superseded in the literature or depend on obsolete data, as discussed in Response 1-70.

The only new material (D'Aleo, 2009, 2010; Watts 2009) addressed the U.S. surface temperature record and are very similar to D'Aleo and Watts (2010) and share the same, fundamental flaws that were discussed in many responses in Section 1.4 (such as Response 1-62).

Therefore none of the 12 exhibits submitted by the petitioner support the contention that there are "significant warming biases" in the U.S. or global surface temperature records, and most of them do not meet the statutory timeframe for evidence supporting a petition for reconsideration.

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Comment (1-73):
The Southeastern Legal Foundation cites Eschenbach (2009), stating:

> A similar instance of chicanery arose with the manipulation of the Australian climate data. The HARRY_READ_ME.txt file makes numerous references to manipulating the Australian data, but one must examine the data itself to fully understand what the Climategate crew was doing. While it concerns a single location, the adjustments to data from Darwin, Australia, admit no legitimate explanation.

The petitioner quotes Willis Eschenbach:

> Those, dear friends, are the clumsy fingerprints of someone messing with the data Egyptian style … they are indisputable evidence that the "homogenized" data has been changed to fit someone's preconceptions about whether the earth is warming. One thing is clear from this. People who say that "Climategate was only about scientists behaving badly, but the data [are] OK" are wrong. At least one part of the data is bad, too. The Smoking Gun for that statement is at Darwin Zero.[20] [Footnote 20: *Id.*]

The Coalition for Responsible Regulation also cites the same Web page (Eschenbach, 2009) as further support for their statement that "There are numerous and recently-released studies documenting significant warming biases in the temperature databases that, in light of the Disclosures, reveal the fruit of this manipulated process."

Response (1-73):
EPA responds to the allegations regarding data adjustments in Response 1-71. There is a clear rationale for at least one adjustment to the Darwin station because of a major station move in 1941. Because the adjustments by NOAA use an automated procedure based on nearest neighbor and other calculations, there is no opportunity for human "chicanery" or "messing with the data." Note that we are unclear as to what is meant by messing with the data "*Egyptian-style.*"

Additionally, as shown in Response 1-66, the sum total effect of all land-based adjustments by NOAA on trends in the global GHCN temperature record are very small (as discussed in Subsection 1.3.2, ocean data adjustments result in a *smaller* warming trend). For the continental United States, the time of observation bias correction (to correct for the shift in temperature measurement from the afternoon to the morning) and the corrections due to changes in measurement technology do result in a warmer trend than the raw data would suggest, but these corrections are essential for proper analysis, not "chicanery."

Tom Peterson from the NCDC at NOAA responded to a request for information from the author of the "smoking-gun-at-darwin-zero" post, posted in the comments at Watts (2010) and reproduced here:

> Dear Willis Eschenbach,
>
> I received your questions today. They are quite detailed and would take some digging through files from the mid to late 1990s for me to answer all of them. This would take time

I don't have right now (I actually should be on annual leave right now, but had a few things I wanted to get done before I take off for the rest of the year in a few hours). So let me respond in general terms first and provide you with some articles to make sure we're both starting from the same page.

One of the problems we were trying to address in some of the procedures we developed back in the mid-1990s was how to take advantage of the best climate information we had at each location at each point in time. We had spent a great deal of time and energy digitizing European colonial era data (article sent) which went a great deal towards making global data prior to 1950 more global (see http://www.ncdc.noaa.gov/img/col.gif for a movie loop of the stations we digitized or acquired for GHCN by this project). This means that in some parts of the world, we might have more stations available to build a reference series from prior to the country's independence than afterwards. To utilize data that did not span the whole period of record, we used what we called the first difference method (article sent). Using this approach we built a reference series (article sent) one year at a time.

There were two concerns about this approach. The first was how to make sure we didn't incorporate a change in station location (etc.) artifact into the reference series. That aspect was done by using the 5 highest correlated stations for the reference series and removing the value from the highest and lowest of the 5 highest correlated first difference values for that year based on the assumption that the mean of the three center most values provided a robust measure of the climate signal and if a station moved up or down a hill, its value would likely be the highest or lowest due to the impact of the station move that year. (This last part was a later addition and is explained in the homogeneity review paper (paper sent).)

The homogeneity review paper explains the reasons behind adopting this complex reference series creation process. It did indeed maximize the utilization of neighboring station information. The downside was that there was a potential for a random walk to creep into the reference series. F or example, if the nearest neighbor, the one with the highest correlation, had a fairly warm year in 1930, its first difference value for 1930 would likely be fairly high. The first difference value for 1931 would therefore likely be low as it probably was colder than that experienced in that very warm year preceding it. So the reference series would go up and then down again. The random walk comes in if the data for 1931 were missing. Then one gets the warming effect but not the cooling of the following year. The likelihood of a warm random walk and a cold random walk are equally possible. Based on the hundreds of reference series plots I looked at during my mid-1990s evaluation of this process, random walks seemed do be either non-existent or very minor. However, they remained a possibility and a concern.

Partly in response to this concern, over the course of many years, a team here at NCDC developed a new approach to make homogeneity adjustments that had several advantages over the old approaches. Rather than building reference series it does a complex series of pairwise comparisons. Rather than using an adjustment technique (paper sent) that saw every change as a step function (which as the homogeneity review paper indicates was pretty standard back in the mid-1990s) the new approach can also look at slight trend differences (e.g., those that might be expected to be caused by the growth of a tree to the west of a station increasingly shading the station site in the late afternoon and thereby cooling maximum temperature data). That work was done by Matt Menne, Claude Williams and Russ Vose with papers published this year in the Journal of Climate

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(homogeneity adjustments) and the Bulletin of the AMS (USHCN version 2 which uses this technique).

Everyone here at NCDC is very pleased with their work and the rigor they applied to developing and evaluating it. They are currently in the process of applying their adjustment procedure to GHCN. Preliminary evaluation appears very, very promising (though of course some very remote stations like St Helena Island (which has a large discontinuity in the middle of its long record due to moving downhill) will not be able to be adjusted using this approach). GHCN is also undergoing a major update with the addition of newly available data. We currently expect to release the new version of GHCN in February or March along with all the processing software and intermediate files which will dramatically increase the transparency of our process and make the job of people like you who evaluate and try to duplicate surface temperature data processing much easier.

I hope this email and the series of articles I am sending will answer some of your questions at least (e.g., in the homogeneity review paper it clearly states that the first difference correlation threshold of 0.8 is between the candidate station and the final reference series, not the individual stations that make up the reference series). They are likely to also stimulate some additional questions. So if it is all right with you, I won't follow up on your questions when I return in January but rather will wait until you send in a new set of questions or just send these old ones back to me.

We're doing a lot of evaluation of our new approach to adjusting global temperature data to remove artificial biases but additional eyes are always welcome. So I would encourage you to consider doing additional GHCN evaluations when we release what we are now calling GHCN version 2.5 in, hopefully, February or March of 2010.

Happy Holidays,
Tom Peterson

This letter demonstrates the care and rigor used by the researchers at NOAA when considering possible problems involved in the methodologies being used to construct global surface temperature records. Even though the researchers had determined that problems such as "random walks" were "non-existent or very minor," they were working to develop a new methodology that would be superior and would not include the possibility of these errors. Importantly, such "random walks" would be, as the name suggests, random—as likely to be a random walk warmer as cooler—and therefore very unlikely to be a source of large scale bias, even if a spurious trend on a local scale might be introduced. Darwin might actually be an example of such a "random walk" where missing data, a lack of nearby neighbors, and the fact that Darwin included a lot of data from the colonial era and therefore had more data in the past than in more modern times, could have led to a rare case of the automated procedure introducing a spurious warming. However, on the global scale Darwin is a very small contributor, and there is no evidence that the algorithm performed similarly elsewhere. Neither NASA nor CRU use the same algorithm as NOAA, and therefore this potential spurious warming is not included in either of those records. Yet the large-scale trends of the NASA and HadCRUT temperature records are consistent with the large-scale trends of the NOAA temperature record, demonstrating the robustness of large-scale trends to errors in individual stations.

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Additionally, note that the "Darwin" adjustments highlighted by the petitioner are from NOAA, not CRU, and have nothing to do with the HARRY_READ_ME file which was about the CRU TS (time series) dataset and not the HadCRUT temperature record.

Comment (1-74):
The Southeastern Legal Foundation cites a document by Richard Treadgold of the New Zealand Climate Science Coalition (Treadgold, 2009) to support their contention that there is data manipulation to show warming:

> Other instances of such data manipulation are also beginning to surface. For example, new information published November 25, 2009 also shows an eerily similar pattern of "adjustments" was made to raw temperature data in New Zealand – downward adjustments in the early 20th century and upward adjustments from the middle of the 20th century onward.[23] While the information on the New Zealand temperature adjustments was not part of Climategate, it is new, and it adds to the pattern of similar manipulations - downward adjustments in the first part of the 20th century and upward adjustments in the latter half - yielding a warming trend over the last century that is almost entirely fictitious. EPA should evaluate this controversy to determine whether these recently revealed "adjustments," like those of Climategate, indicate more of the same collusion, manipulations, and chicanery.[24]

The Southeastern Legal Foundation also states (in a footnote to the above paragraph): "Without belaboring the point, yet another curious manipulation occurs in the context of the USHCN dataset. *See* 'Difference Between Raw and Final USHCN Data Sets,' found at: http://www.ncdc.noaa.gov/img/climate/research/ushcn/ts.ushcn_anom25_diffs_urb-raw_pg.gif (last visited December 23, 2009). Absent Climategate, one might assume the adjustments were legitimate. In light of the extensive (and ever expanding) evidence of improper manipulations, however, one must wonder."

The Southeastern Legal Foundation raises similar questions about New Zealand in their Third Amendment to Petition, citing D'Aleo and Watts (2010). The State of Texas claims that "the CRU created an exaggerated appearance of 20th century warming in New Zealand" and cites the USHCN graphic discussed by the Southeastern Legal Foundation to support the statement "The CRU manipulated the raw data to show lower temperatures for New Zealand in the early century." The Coalition for Responsible Regulation also cites Treadgold about the New Zealand Temperature record.

Response (1-74):
As discussed previously (see Response 1-71), EPA has evaluated claims concerning adjustments to data in New Zealand, and concluded that the adjustments by NIWA are in line with the station records and nearby station trends. Note that in almost all the stations the majority of the adjustments come before 1950. Therefore, the adjustments do not influence any warming trends after 1950. In addition, the State of Texas and the Southeastern Legal Foundation cite the graph "Difference Between Raw and Final USHCN Data Sets" in support of their contentions about the New Zealand data. This graph documents the NOAA adjustments that correct for variations in the time of observation and changes in temperature measurement instruments for the U.S. temperature record. Petitioners do not explain or present argument to show why the

adjustments are inappropriate. Also, this graph is not pertinent to the claims of inappropriate manipulations by CRU to the New Zealand data.

Comment (1-75):

The Southeastern Legal Foundation, in their Third Amendment to Petition, references a blog discussion of Nordic temperature reconstructions:

> Their fifth case study is by Willis Eschenbach[10] recounting the attempts by Professor Wibjorn Karlen to replicate the IPCC's temperature analysis for the Nordic region. *See Id.* at 79; *available at* http://wattsupwiththat.com/2009/11/29/when-results-go-bad/ (last visited Feb. 10, 2010). Eschenbach was drawn to the subject by the inclusion in the Climategate e-mails of correspondence between Professor Karlen and Phil Jones, former Director of the CRU, which follows the now familiar pattern of Jones willfully obstructing legitimate scientific inquiry. The IPCC shows substantial increases in temperature in the late 20th century, to 0.5 C above the levels of the 1930s in the Nordic region. Karlen could not replicate the assertion by the IPCC that the recent warming exceeded that of the 1930s, either in the Nordic regions or in many other regions of the world, and sought clarification from Jones and Trenberth. They did little more than refer him back to the IPCC reports from which the question arose in the first place. Karlen's analysis, replicated by Eschenbach, shows the same pattern of suppressing the warming of the 1930's and inflating the warming of the late 20th century that is seen in surface temperature record discussed above. Eschenbach's analysis of the Climategate e-mails concludes that Karlen made legitimate inquiries and "got incomplete, incorrect and very misleading answers." *Id.*

Response (1-75):

The analysis by the IPCC was of the "NEU" region (Northern Europe), which included 48N to 75N, and 10W to 40E. Therefore, in addition to the Nordic region analyzed by Karlen, the IPCC region included Ireland, the United Kingdom, half of France, Germany, Belarus, and several other nations. Thus the Karlen and Eschenbach analysis covers a different geographic region, which they failed to account for. In addition, they appear to have used a flawed methodology as there is no evidence that either Karlen or Eschenbach performed any kind of spatial interpolation. Instead it appears that they used the flawed approach of taking a straight average of station anomalies (which is not the appropriate method to use unless the stations are perfectly evenly distributed geographically, which they are not). Additionally, Eschenbach used a 17-year Gaussian average to compare against an IPCC figure that is clearly labeled as using decadal averages. Therefore, the Eschenbach analysis was of a different region, using a different (and inferior) methodology for combining weather station data, and using different temporal averaging. These reasons explain why the results of Eschenbach differ from those of the IPCC, and do not support petitioners claim that the trend was manipulated, thus "inflating" the late 20th-century warming.

The assertion by Eschenbach that Karlen received "incomplete, incorrect and very misleading answers" is not supported by the record, which showed two researchers (Trenberth and Jones) taking the time to answer repeated questions from an emeritus

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professor from Sweden. The final e-mail cited by Eschenbach was from Phil Jones to Karlen, demonstrating the completeness and helpfulness of these researchers in contrast to the assertions by the petitioners:

> [Jones] Fennoscandia is just a small part of the NH. When I'm back next week, I'll be able to calculate the boxes that encompass Fennoscandia, so you can compare with this region. As you're aware Anders did lots of the update work in 2001-2002 and he included all the NORDKLIM data. I can send you a list of the Fennoscandian data if you want – either the sites used or their data as well.[49]

Therefore, it is clear that the analysis by Eschenbach was a flawed and inappropriate comparison, and that Trenberth and Jones, in contrast to the assertions of the petitioners, were attempting to be helpful in their answers.

1.4.3.5 Allegations Regarding the Independence of NOAA, NASA, and HadCRUT Temperature Records

Comment (1-76):
Some petitioners claim that the NOAA and NASA temperature records are not independent from the HadCRUT temperature record because they share the same raw data. The Commonwealth of Virginia states, "If NASA and NOAA used the same raw data as CRU, and if they have reached conclusions similar to those of CRU, then a finding of data unreliability with regard to the CRU Data may indicate systemic problems with all three of the data sets upon which EPA relied in promulgating its Endangerment Finding." The Competitive Enterprise Institute cites D'Aleo and Watts (2010) as stating, "Since all three use the same data, all three have experienced the same degradation in data quality in recent years" (referring to the station dropout issue). Pacific Legal Foundation refers to the EPA RTC document, stating, "Curiously, EPA admits that the NOAA and NASA datasets show similar trends and were developed at least in part through similar methodologies to those employed by CRU. By making this admission, EPA unintentionally leads us to the inexorable conclusion that, if the CRU Data are methodologically problematic, the NOAA and NASA data may share such methodological problems. *See* EPA's Response to Public Comments, Vol. 2, 2-28" and that therefore "any finding that the CRU Data and its conclusions are unreliable should lead to a review of the NOAA and NASA data sets as well."

Response (1-76):
We agree that these three major temperature records rely on a large amount of raw data obtained from GHCN, although the HadCRUT temperature record, in particular, integrates additional data obtained from other, independent sources. However, the petitioners have not demonstrated any major flaws in the raw data. The allegations that station dropout was inappropriate or would bias the data are unfounded as described in Response 1-62 of this document. A number of analyses using different subsets of data have produced similar global temperature trends to the whole set of data. See the

[49] E-mail file 1221683947.txt, (September 17, 2008), page 1554, lines 25-29 of PDF version entitled: CRU Emails 1996-2009.pdf

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description of the Jones paper (Jones, 1994) in the previous section, which found that 100 well-placed stations were sufficient to determine a global temperature trend, the Menne et al. (2010) paper that showed that subsets of the U.S. data that had been rated more highly by surfacestations.org also led to the same trend as the whole set of data, and the Clear Climate Code project (Clear Climate Code, 2010) which demonstrated that the dropped stations and remaining stations have similar trends in overlapping periods.

The processing of the GHCN and other data by the three groups is independent. HadCRUT used significant manual processing of the data; NOAA uses an automated adjustment procedure that corrects for discontinuities; and NASA uses an automated adjustment procedure that changes trends in urban stations to match nearby rural stations. The three groups use different procedures to extrapolate temperatures to data sparse regions, and different sources of ocean sea surface temperature data. Therefore, the similarities of the final temperature trends resulting from the processing of the raw data between the three groups provide additional confidence in those processing routines. Additionally, the GHCN data are available online, so it is possible for independent parties to test their own algorithms for producing global temperature records from the raw data. Petitioners and others have not done so, and instead rely on arguments and claims, discussed above, that do not support the broad conclusions they draw. Finally, the temperature trends derived from these datasets are consistent with modeling, satellite data, and various observational indicators, further supporting their reliability.

Comment (1-77):
Peabody Energy, the Southeastern Legal Foundation (in their Third Amendment to Petition), and the Competitive Enterprise Institute all argue that the "similar trends" between the three major surface temperature records are not sufficient if the three datasets are not independent and are, in the words of the Competitive Enterprise Institute, "extensively compromised." Peabody Energy states:

> EPA says that the NOAA and NASA surface temperature records show "similar trends" as the HadCRUT3 data set and hence the IPCC's and EPA's reliance on the HadCRUT3 records is not unreasonable.[246] This contention does not hold up. The HadCRUT3 data was relied on extensively by the IPCC and in numerous studies cited by both the EPA and all of the "assessment literature" that EPA cites. It is not enough for EPA to say that the HadCRUT3 data reveals "similar trends" as other data. The specific amount of warming that occurred during the last several decades of the 20th century, and how that warming compares to other periods in the temperature record, was obviously critically important in all of these studies. Many of these studies involved complex statistical analyses of the underlying data. Those studies may have yielded different results had they used the NASA or NOAA data instead of the HadCRUT3 data.
>
> Moreover, there are now significant questions about whether the NASA and NOAA temperature records are truly independent of the HadCRUT3 data set. In this regard, the investigation of the Science and Technology Committee of the United Kingdom Parliament that was recently initiated to investigate CRU's conduct includes investigation into the question of "How independent are the other two international data sets?"[247] This is a critically important question given EPA's view, based on the IPCC, that the rate and extent of warming in the last several decades of the 20th century is the key "fingerprint"

> of an anthropogenic GHG cause. If that warming has been overstated in all three data sets, then the "fingerprint" disappears, or grows more faint even if all three data sets show "similar" warming.

Response (1-77):
As EPA shows throughout these responses, the petitioners have not demonstrated that there are flaws in the global temperature datasets that would call into question the clear warming trends. In addition, these issues were raised during notice and comment on the Endangerment Findings, and EPA responded in Volume 2 of the RTC document. The full statement from RTC 2-29 was:

> EPA has concluded that the three primary global surface temperature records (NOAA, NASA, and HadCRUT) are reliable and credible. We note that these datasets have been widely reviewed and assessed within the climate change research community, and that while they are distinct and use different approaches, there is good agreement in the overall trend (as described in response 2-28).

EPA did not state that the similar trend was the only basis for concluding that the HadCRUT temperature record was reliable. EPA also recognizes that each temperature record includes possible errors as discussed both in the RTC and in this RTP Document. However, potential errors are reflected in the uncertainty assessments developed for these datasets, such as the Brohan et al. (2006) figure reproduced in Subsection 1.3.2, and are small compared with the overall trend. The petitioner provides no evidence that any study would have yielded substantially different conclusions had it used the NOAA or NASA temperature records instead of HadCRUT. Indeed, many studies do use these other datasets.

Additionally, the British House of Commons Science and Technology Committee report (2010), referred to by the petitioner, has been released. With respect to the independence of these datasets, it states:

> 48. In its memorandum UEA explained the differences between the methodologies used by three basic datasets for land areas of the world, NOAA, NASA and CRU/UEA:
>
> > All these datasets rely on primary observations recorded by NMSs [National Meteorological Services] across the globe.
> >
> > GISS and NCDC each use at least 7,200 stations. CRUTEM3 uses fewer. In CRUTEM3, each monthly temperature value is expressed as a departure from the average for the base period 1961–90. This "anomaly method" of expressing temperature records demands an adequate amount of data for the base period; this limitation reduces the number of stations used by CRUTEM3 to 4,348 (from the dataset total of 5,121). The latest NCDC analysis [...] has now moved to the "anomaly method" though with different refinements from those of CRU.
> >
> > NCDC and GISS use different approaches to the problem of "absolute temperature" from those of CRUTEM3. The homogeneity procedures undertaken by GISS and NCDC are completely different from those adopted for CRUTEM3. NCDC has an

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> automated adjustment procedure [...], whilst GISS additionally makes allowances for urbanization effects at some stations.

> 49. In our call for evidence we asked for submissions on the question of how independent the other international data sets are. We have established to the extent that a limited inquiry of this nature can, that the NCDC/NOAA and GISS/NASA data sets measuring temperature changes on land and at sea have arrived at similar conclusions using similar data to that used by CRU, but using independently devised methodologies. We have further identified that there are two other data sets (University of Alabama and Remote Sensing Systems), using satellite observations that use entirely different data than that used by CRU. These also confirm the findings of the CRU work. We therefore conclude that there is independent verification, through the use of other methodologies and other sources of data, of the results and conclusions of the Climate Research Unit at the University of East Anglia.

> 50. The fact that all the datasets show broadly the same sort of course of instrumental temperature change since the nineteenth century compared to today was why Professor John Beddington, the Government Chief Scientific Adviser, had the confidence to say that human induced global warming was, in terms of the evidence to support that hypothesis, "unchallengeable":

> I think in terms of datasets, of the way in which data is analysed, there will always be some degree of uncertainty but when you get a series of fundamentally different analyses on the basic data and they come up with similar conclusions, you get a [...] great deal of certainty coming out of it.

> 51. Even if the data that CRU used were not publicly available—which they mostly are—or the methods not published—which they have been—its published results would still be credible: the results from CRU agree with those drawn from other international data sets; in other words, the analyses have been repeated and the conclusions have been verified.

Therefore, EPA finds that the three major global surface temperature records use independent methodologies, though they do share a large quantity of the same raw data. Because the results are robust to different choices of and adjustments to the raw data, and because there are additional data (from satellites, oceans, ice sheets, ecosystem shifts, and so forth) that are consistent with these surface temperature records, there is great confidence in the major conclusions based on these records of historical temperature change (within the acknowledged uncertainty limits). Petitioners inappropriately look at the overlap of underlying raw data in isolation, and draw conclusions about the resulting temperature records based on this. EPA's confidence in the results shown by the various global surface temperature records is based on considering all of the evidence, including the differences and similarities in the analyses performed by NOAA, NASA, and CRU, and the consistency with other records of warming, as discussed above.

Comment (1-78):
The State of Texas quotes EPA as stating that "The NOAA global surface temperature dataset (Smith et al., 2008) employs the same methodology for addressing urbanization as is used in the HadCRUT." and draws the conclusion that "two of the three temperature

sets that EPA relied on to reach its Endangerment Finding were homogenized based on CRU mathematical models."

Response (1-78):
EPA has already addressed these issues in Responses 1-76 and 1-77 above, as well as other UHI issues in Subsection 1.3.4. While NOAA does use urbanization uncertainty estimates based on the methodology developed by CRU, that urbanization estimate is only a small part of the full analysis, and not used for the U.S. portion of the temperature record. Therefore, it is not correct to state that two of the three temperature sets that EPA relied on were homogenized based on CRU mathematical models.

1.4.3.6 Additional Issues Regarding Allegations of Manipulation of Data

Comment (1-79):
The Coalition for Responsible Regulation claims that there was another type of "manipulation of data to produce the outcome IPCC authors wanted" related to the temperature data. In support of their assertion that "Emails contained in the Disclosures confirm certain scientists' efforts to 'artificially adjust' data through active collaboration," the Coalition for Responsible Regulation provides the following evidence:

> Sept. 27, 2009 (Tom Wigley, of the University Corporation for Atmospheric Research, (UCAR) strategizing "to partly explain the 1940s warming blip," and noting that "if we could reduce the ocean blip by, say, 0.15 degC, then this would be significant for the global mean - but we'd still have to explain the land blip . . . It would be good to remove at least part of the 1940s blip, but we are still left with `why the blip'.")

Response (1-79):
We first note that this quote is clearly not related to the IPCC AR4. In the e-mail, Wigley explicitly states that he was working on a report that he was "writing for EPRI" (the Electric Power Research Institute).[50] There is no evidence that the analysis was performed or that it was used in IPCC reports, or how it was a "manipulation of data to produce the outcome IPCC authors wanted."

In addition, there is a known issue with the sea surface data in the 1940s that was recently highlighted by Thompson et al. (2008). This is based on the shift from recording sea surface temperature mainly by U.S. vessels (already using modern engine intake measurements) to a higher percentage of UK vessels (still using the older bucket measurements) after the end of World War II. The e-mail from Wigley does not make clear whether this is or is not the attempt of a modeler to assess potential implications of correcting for known biases in the instrumental ocean record in the 1940s. The language from Wigley suggests that he is interested in an explanation for the existence of a "land blip" in addition to the ocean blip. This makes sense in the context of the Thompson et al. paper. This paper explains the ocean blip as being the result of an artificial bias of

[50] E-mail file 1254108338.txt, (September 27, 2009), page 1743, line 15 of PDF version entitled: CRU Emails 1996-2009.pdf

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shifting to U.S. ships during World War II, but this explanation of bias would not explain a blip in land temperatures. Therefore, a full explanation of the historical temperature record would require some other rationale for the "land blip," whether an actual temperature event due to natural variability, or another artificial bias due to some other issue involved with temperature records during World War II. It is normal science to work to understand the minor variations or wiggles in the temperature record. In addition, Wigley's language does not appear to be the language of someone trying to "artificially adjust data" for a deceitful purpose. Note that Wigley specifically is not suggesting any adjustments to the land record of that time period. Therefore, the petitioners' evidence is too vague and uninformative to support a claim of improper data manipulation particularly in the context of IPCC assessments.

Comment (1-80):
The Coalition for Responsible Regulation quotes a number of e-mails in support of their contention that scientists "artificially adjust" data:

> The pressure to conform to a perceived "global warming" consensus also led to manipulation of data to produce the outcome IPCC authors wanted. Emails and computer code contained in the Disclosures reveal that scientists at CRU manipulated their temperature databases and their findings with undisclosed, unverified and arbitrary adjustments. See supra, Section III(A) and (B). Emails contained in the Disclosures confirm certain scientists' efforts to "artificially adjust" data through active collaboration to "reduce the positive slope," "reduce the ocean blip," and "contain the medieval warm period." See, e.g., Exhibit A, 843161829.txt, Sept. 19, 1996 (Gary Funkhouser, of the University of Arizona, writing to Briffa, "I really wish I could be more positive about the Kyrgyzstan material, but I swear I pulled every trick out of my sleeve trying to milk something out of that");[51] Exhibit A, 1163715685.txt, Nov. 16, 2006 (Briffa noting that "the PC1 time series in the Mann et al. analysis was adjusted to reduce the positive slope in the last 150 years," and that "this adjustment was arbitrary and the link between Bristlecone pine growth and CO2 is, at the very least, arguable."); [52]Exhibit A, 1254108338.txt, Sept. 27, 2009 (Tom Wigley, of the University Corporation for Atmospheric Research, (UCAR) strategizing "to partly explain the 1940s warming blip," and noting that "if we could reduce the ocean blip by, say, 0.15 degC, then this would be significant for the global mean - but we'd still have to explain the land blip . . . It would be good to remove at least part of the 1940s blip, but we are still left with 'why the blip'."); [53]Exhibit A, 1059664704.txt, July, 31, 2003 (Mann sending calibration residuals to Tim Osborn, at CRU, and acknowledging that some are "pretty red," and asking Osborn not to "pass this along to others without checking w/ me first. This is the sort of 'dirty laundry' one doesn't want to fall into the hands of those who might potentially try to distort things...");[54] Exhibit A, 0939154709.txt, Oct. 15, 1999 (Osborn discussing how

[51] E-mail file 0843161829.txt, (September 19, 1996), page 11, lines 12-14 and 15-16 of PDF version entitled: CRU Emails 1996-2009.pdf
[52] E-mail file 1163715685.txt, (November 16, 2006), page 1239, lines 9-10 and 15-16 of PDF version entitled: CRU Emails 1996-2009.pdf
[53] E-mail file 1254108338.txt, (September 27, 2009), page 1742-1743, line 45-46 and 6-7 of PDF version entitled: CRU Emails 1996-2009.pdf
[54] E-mail file 1059664704.txt, (July 31, 2003), page 558, line 23-25 of PDF version entitled: CRU Emails 1996-2009.pdf

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data are truncated to stop an apparent cooling trend that appears in the results);[55] Exhibit A, 1054736277.txt, June 4, 2003 (Mann noting "it would be nice to try to 'contain' the putative 'MWP' [Medieval Warm Period]").[56]

Response (1-80):
EPA responds to these allegations of data manipulation in Subsection 1.1.4 of this Response to Petitions document. These e-mails are in general quoted out of context and in many cases are examples of scientists following appropriate procedures of not using data that doesn't meet proper standards (e.g., Funkhouser) or testing the impacts of hypotheses (e.g., Wigley). Only two quotes were not addressed in those previous sections, and these two quotes are addressed here.

First, with regards to the calibration residuals mentioned in the e-mail from Mann to Osborn, Mann also states in the same e-mail, "In any case, the incremental changes are modest after 1600--its pretty clear that key predictors drop out before AD 1600, hence the redness of the residuals, and the notably larger uncertainties farther back...". This quote indicates that the redness of the residuals (a term related to the type of noise in the signal: white noise is perfectly random, red noise indicates a "random walk" where the signal can drift over time) are already reflected in the fact that the uncertainties presented in the paper are "notably larger" before 1600. This is also consistent with the general conclusions of the NRC (2006) and the IPCC (2007c) assessments. In fact, the paper discussed in the e-mail (MBH1999) (Mann et al., 1999) explicitly discusses red noise in the context of reconstructions, though it does not present the specific data that Mann is sharing with Osborn. In other words, the e-mail quote is consistent with the published literature.

The Osborn e-mail discussing data truncation "to stop an apparent cooling trend" is a reference to the divergence issue discussed in Section 1.1 on Paleoclimate Reconstructions and the "Divergence" Issue, and as discussed in that section the divergence issue was well known in the literature, and therefore this e-mail is not evidence of inappropriate data manipulation.

1.4.4 Summary

The observed warming of the climate is an important factor in the Endangerment Finding. The Finding states, "The global surface temperature record relies on three major global temperature datasets developed by NOAA, NASA, and the United Kingdom's Hadley Center. All three show an unambiguous warming trend over the last 100 years, with the greatest warming occurring over the past 30 years." The Finding notes that this observed warming is observed in surface and ocean temperatures, melting of snow and ice, rising sea levels, and other evidence as well. Petitioners do not attempt to review the body of scientific evidence and show that the conclusion on warming is inaccurate or more

[55] E-mail file 0939154709.txt, (October 15, 1999), page 229, line 32 of PDF version entitled: CRU Emails 1996-2009.pdf
[56] E-mail file 1054736277.txt, (June 4, 2003), page 520, lines 7-8 of PDF version entitled: CRU Emails 1996-2009.pdf

uncertain than indicated. Instead they contest certain individual aspects or details of the surface temperature evidence, and in general raise objections that fail to take into account the context and reason behind various aspects of the surface temperature record.

Many of the issues raised by the petitioners are not new, and have been addressed within the TSD and RTC documents. Some objections fail to distinguish assessments that evaluate absolute temperature rather than changes in temperature. The petitioners, and the researchers on which the petitioners rely, repeatedly use incorrect methodology to make their claims. They average temperatures between stations without using anomaly-based methods that properly take into account the change in temperature rather than the absolute temperature, and they average together stations without methods that account for the geographic distribution of these stations. These basic and fundamental flaws underlie many of the petitioner's arguments.

Other objections misconstrue the underlying studies. In several cases petitioners object that various adjustments to the raw data have an effect of changing the data, but they fail to consider that adjustments to the data are appropriately performed for the purpose of having an effect: to account for circumstances that otherwise would interfere with accurately isolating and determining a trend in surface temperature. For example, adjustments are made to account for the effect of a change in the measurement devices, so that such changes do not interfere with accurately assessing any change in the actual surface temperature. Petitioners fail to address the reasons behind the adjustments and fail to explain or show that the types of adjustments are not appropriate. Petitioners also fail to account for the various analyses which generally show that the same temperature trends result on a global scale using the adjusted or unadjusted temperature data,

Likewise petitioners fail to account for the valid data-driven reasons that have led to a reduction over time in the number of weather stations used for the surface temperature analysis, fail to explain or show that the reductions have biased the temperature record, and overstate the magnitude of the reduction in some cases. Petitioners fail to account for the analyses that show even a limited number of stations can provide a robust global temperature trend, and the same trends are indicated using only those stations that were not reporting data after 1992 or the stations that were reporting data the entire time.

Petitioners fail to explain why consistency between all three separate surface temperature records, as well as consistency between the three surface temperature records and other evidence of warming, such as satellite data, ocean temperature data, physical evidence of the effects of warming, should not be seen as confirmation of the evidence of warming. Petitioners instead appear to assume that all of this evidence must be wrong because they allege some of it is, and implicitly suggest EPA do the same.

Overall, petitioners' arguments about the portions of the evidence they focus on fail to withstand scrutiny. They also fail to evaluate and take into account the entire body of evidence before EPA. The arguments made by petitioners do not change EPA's views on the validity and reliability of the three major surface temperature records, or the overall

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body of evidence supporting the basic conclusion that there is an unambiguous warming trend over the last 100 years, with the greatest warming occurring over the past 30 years.

1.5 Implications of New Studies and Data Submitted by the Petitioners

1.5.1 Overview

Several petitioners identify new scientific studies and data published since the Endangerment Finding was finalized, which they claim require EPA to reconsider our Finding. Some petitioners also argue that EPA ignored or misinterpreted scientific data that were significant and available when the Finding was made.

EPA has reviewed the new literature provided by petitioners. In many cases, we note that the issues raised by the petitioners are not new, but were in fact raised and addressed during notice and comment on the Endangerment Findings. In other cases, petitioners have misinterpreted or misrepresented the meaning and significance of the scientific literature, findings, and data they cite. Finally, there are instances where the petitioners have failed to take into account relevant other new studies in making their arguments.

The following issues are addressed in this section:

- Implications of a new study on stratospheric water vapor.
- Implications of material concerning whether CO_2 is well mixed in the atmosphere and whether the airborne fraction of CO_2 has changed.
- Implications of new tropical cyclone studies.
- Implications of new data on observational snow cover trends.
- A claim that EPA ignored a satellite dataset.

After reviewing all of these issues, EPA concludes that the studies, data, and arguments presented by petitioners do not change the solid scientific basis for the Administrator's Finding.

1.5.2 Implications of a New Study on Stratospheric Water Vapor

Comment (1-81):
Several petitioners (the Competitive Enterprise Institute, Coalition for Responsible Regulation, Peabody Energy) argue that a new study published by Solomon et al. (2010), "Contributions of Stratospheric Water Vapor to Decadal Changes in the Rate of Global Warming," demonstrates that scientific understanding of the causes of climate change is incomplete. This study finds that stratospheric water vapor concentrations decreased by about 10% after 2000, and that this decrease slowed the rate of increase in global surface temperature over the period 2000– by about 25% compared with that which would have occurred due only to CO_2 and other GHGs. According to the Coalition for Responsible Regulation, the study's findings "indicate that human emissions may have a considerably smaller role in climate change than previously thought." Peabody Energy concludes that

the study "provides another example of how unsettled global warming science actually is."

Response (1-81):
This study improves our understanding of how changes in the composition of the stratosphere can act to enhance or dampen GHG-induced climate change. Contrary to the petitioners' claims, it does not demonstrate that anthropogenic GHG emissions play a smaller role in climate change. Just as reductions in stratospheric water vapor might have acted to decrease warming from 2000 to 2009, the study finds that increases in stratospheric water might have acted to steepen the observed warming trend in the 1990s.

The study's authors make no claim that global warming science is "unsettled." In fact, they introduce the study with the following statement: "Over the past century, global average surface temperatures have warmed by about 0.75°C. Much of the warming occurred in the past half-century, over which the average decadal rate of change was about 0.13°C, largely due to anthropogenic increases in well-mixed greenhouse gases."

The study improves scientific understanding of effects of changes in atmospheric composition on climatic observations, and it should lead to further improvements in the representation of stratospheric processes in models, allowing more refined projections of short-term climate behavior. As the study concludes (Solomon et al., 2010): "This work highlights the importance of using observations to evaluate the effect of stratospheric water vapor on decadal rates of warming, and it also illuminates the need for further observations and a closer examination of the representation of stratospheric water vapor changes in climate models aimed at interpreting decadal changes and for future projections."

This study does not have meaningful implications for the Endangerment Finding, as it does not cast doubt on the fundamental role that GHGs have in climate change. As Solomon told the New York Times (Bhanoo, 2010):

> This [study] doesn't alter the fundamental conclusion that the world has warmed and that most of that warming has to do with greenhouse gas emissions caused by man.

As in almost all areas of scientific endeavor, further research often leads to greater understanding, but contrary to the petitioners' claim, an advance in knowledge does not per se mean the prior knowledge base was any more or less certain or settled. The advance in knowledge needs to be put in context to understand its meaning, and petitioners fail to do that. In this case, the study increases our knowledge of other factors that can amplify or reduce the warming effect of GHGs, but it does not change in any way the warming trend that is expected from the GHGs themselves.

1.5.3 Implications of Material Indicating That CO_2 Is Not Well Mixed in the Atmosphere and That the Airborne Fraction of CO_2 Has Not Changed

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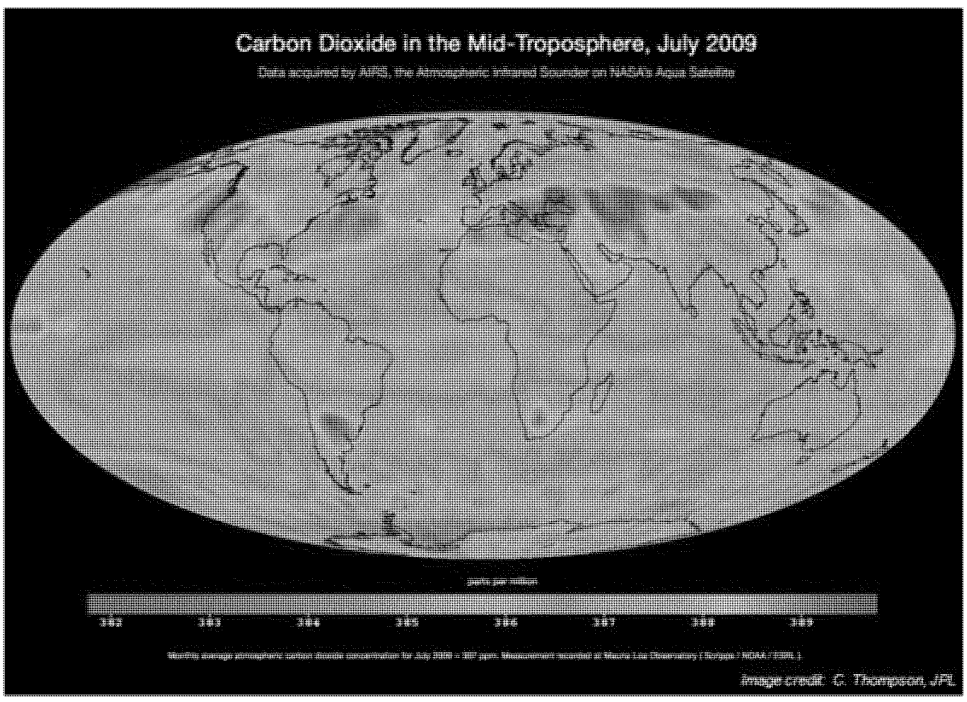
Comment (1-82):
One petitioner (the Southeastern Legal Foundation) refers to literature that it claims alters our understanding of the distribution of CO_2 in the atmosphere. The Southeastern Legal Foundation challenges the long-held conclusion that CO_2 is well mixed in atmosphere (i.e., that its concentration is about the same everywhere across the globe). It cites a NASA press release (NASA, 2009c, dated December 15, 2009), which describes findings drawn from data taken from its Atmospheric Infrared Sounder (AIRS) instrument on the Aqua spacecraft. In this press release, NASA reports:

> …data have shown that, contrary to prior assumptions, carbon dioxide is not well mixed in the troposphere, but is rather "lumpy." Until now, models of carbon dioxide transport have assumed its distribution was uniform.

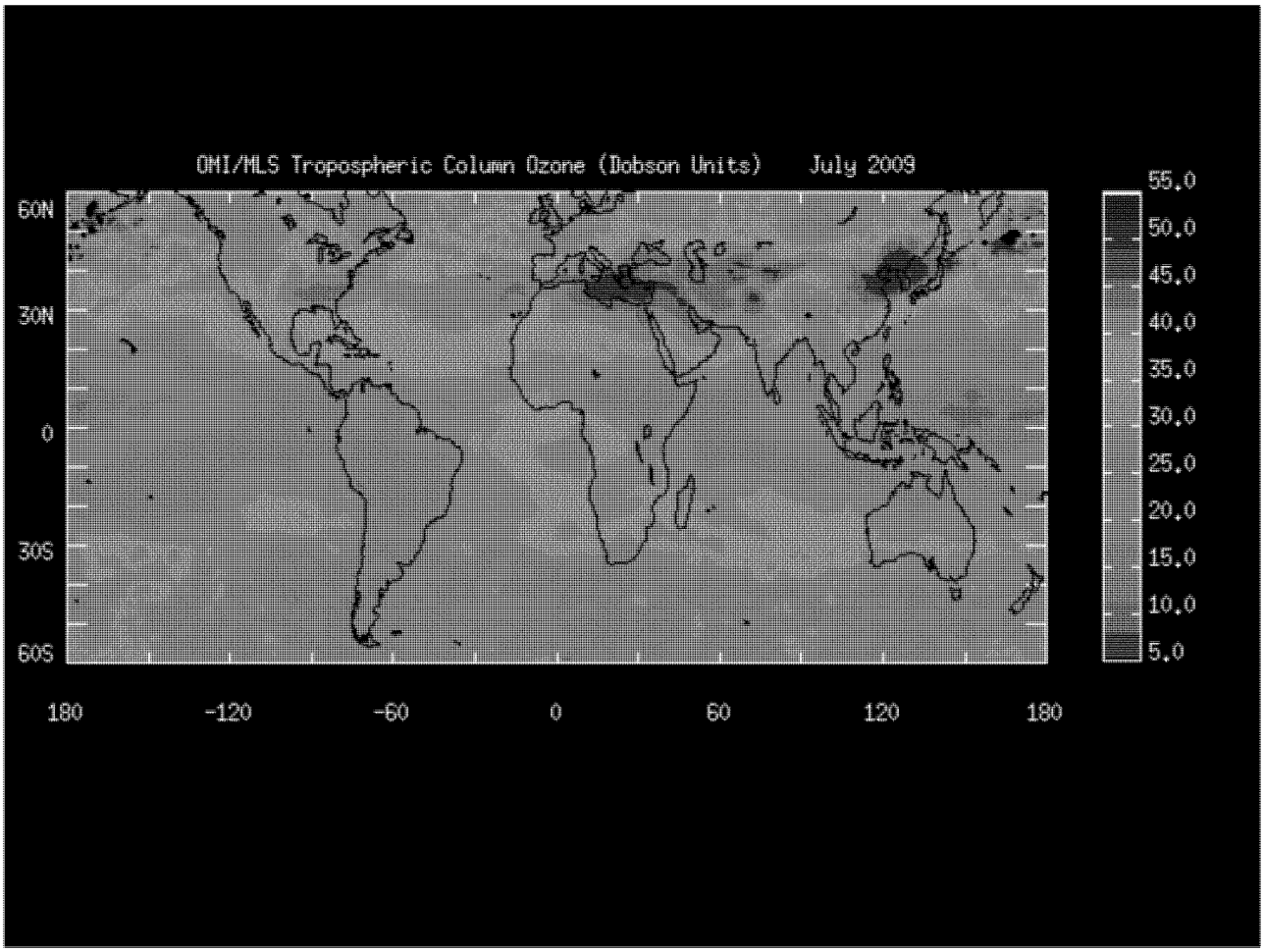
The Southeastern Legal Foundation states that the "AIRS satellite has collected data refuting the well-mixed assumption" and that the "well-mixed assumption is indispensible to AGW model of the CO_2 cycle."

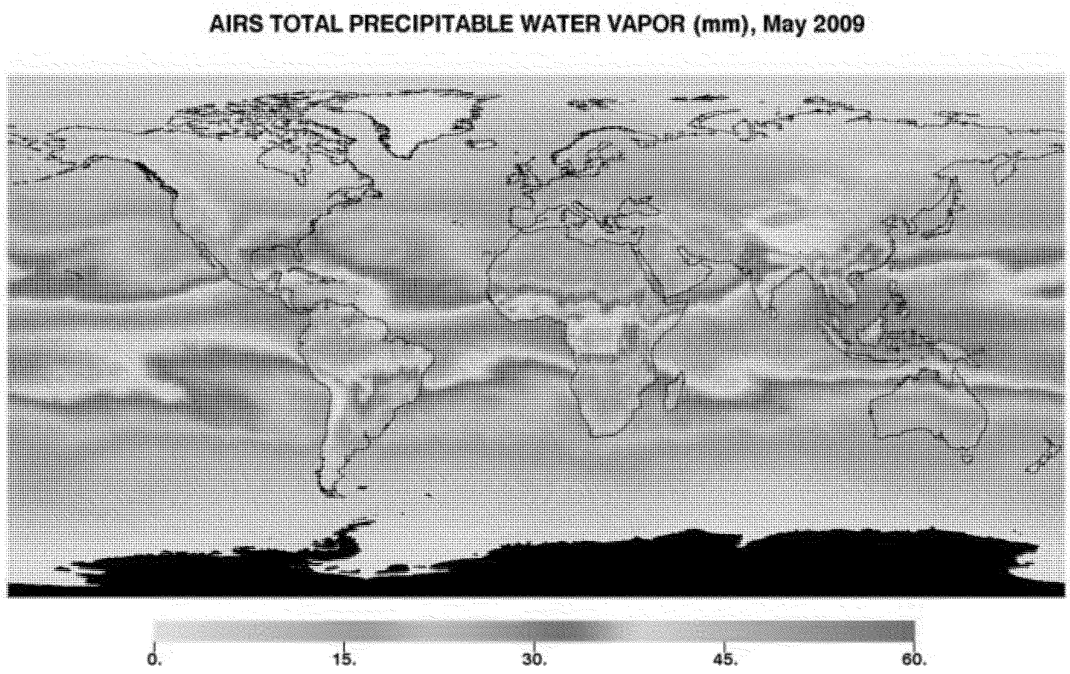
Response (1-82):
We agree with NASA that on shorter time scales, there is some variability in the distribution of CO_2 and that it is not uniformly mixed. This has long been known. For example, Seinfeld and Pandis (1998) discuss hemispheric and seasonal differences in CO_2 distribution. In fact, we acknowledge this behavior in the RTC (2-8), noting that there is a period of time or a lag before long-lived gases become well mixed in the atmosphere: "all long-lived gases become well-mixed at large distances from their sources or sinks over a period of one to two years." It is, therefore, not surprising that there may be some variability in CO_2 concentrations averaged over a month as shown in this NASA image (referenced by the Southeastern Legal Foundation, NASA, 2009b):



But even this variability is small in magnitude, only on the order of 1.5 to 2% at most across this highly sensitive concentration gradient.

CO_2's variability is especially small compared with GHGs that are traditionally described as non-well-mixed, such as tropospheric ozone, the concentration of which typically varies by a factor of 10 as shown in the July 2009 graphic from NASA below (NASA, 2009d), and water vapor, as also shown below from May 2009 in a graphic from NASA (NASA, 2009a):





The relatively low spatial variability in CO_2 shown in the AIRS imagery would even be smaller averaged over a longer time scale. While NASA's press release does not distinguish between short and long time scales, there is no ambiguity that CO_2 is well mixed on time scales relevant to the study of climate change—decades—as documented in the assessment literature and discussed by EPA. In referring to the group of well-mixed GHGs, including CO_2 (methane and nitrous oxide), the IPCC (Solomon et al., 2007) states:

> Because these gases are long lived, they become well mixed throughout the atmosphere much faster than they are removed and their global concentrations can be accurately estimated from data at a few locations.

When NASA states that researchers had not previously assumed CO_2 is "lumpy" as the AIRS data visualizations demonstrate, it is to highlight the improvements in resolution of small-scale CO_2 variability made possible by the AIRS data. The data allow scientists to see the very limited variability in CO_2 in much finer detail than before. The fact that this finer detail has not yet been incorporated into CO_2 transport models is not relevant for the projections of climate change on which EPA's Endangerment Finding relied. For further discussion about the relevance of this NASA finding for computer models, see Response 1-84.

<u>Comment (1-83)</u>:
Background: The Southeastern Legal Foundation raises an issue concerning our understanding of how CO_2 in the atmosphere cycles through the Earth system. As background, some of the CO_2 that is emitted to the atmosphere remains in the atmosphere, and some of it is absorbed by other parts of the Earth system, for example,

the oceans and terrestrial biosphere (vegetation and trees) sometimes referred to as CO_2 "sinks." The portion of CO_2 that remains in the air is known as the "airborne fraction." If the airborne fraction of CO_2 increases, the rate of global warming would likely increase. EPA states in Section 6(a) of the TSD (U.S. EPA, 2009):

> ….for future projections, Meehl et al. (2007) found "unanimous agreement among the coupled climate carbon cycle models driven by emission scenarios run so far that future climate change would reduce the efficiency of the Earth system (land and ocean) to absorb anthropogenic CO_2. As a result, an increasingly large fraction of anthropogenic CO_2 would stay airborne in the atmosphere under a warmer climate."

Comment: The Southeastern Legal Foundation disputes the IPCC's projection cited by EPA that the airborne fraction of CO_2 will increase and disputes whether CO2 is well-mixed. Southeastern Legal Foundation claims the airborne fraction will not increase because the airborne fraction metric has been relatively constant since 1850 according to a study the Southeastern Legal Foundation cites by Knorr (2009). Specifically, Knorr (2009) finds:

> It is shown that with those uncertainties, the trend in the airborne fraction since 1850 has been … close to and not significantly different from zero.

The Southeastern Legal Foundation concludes that the Knorr study:

> … gravely undermines the assumption that CO_2 is long-lived and well-mixed and by the same token dovetails with NASA's observations that CO_2 is in fact not well-mixed, and with many experimental proofs that CO_2 has a short residence time.

<u>Response (1-83)</u>:
The Southeastern Legal Foundation presents no new evidence to challenge the IPCC's projections, as summarized by EPA. The Knorr (2009) finding is not new. Section 6(a) of the TSD, referring to the assessment literature (IPCC), describes exactly the same conclusion as found in Knorr:

> Historically, the airborne fraction of CO_2 … has shown no long term trend … (Denman et al., 2007).

However, there are several scientific problems with the Southeastern Legal Foundation's conclusion that the Knorr study "gravely undermines the assumption that CO_2 is long-lived and well-mixed." First, by itself a trend in the airborne fraction of a gas provides no information about its atmospheric lifetime and whether it is well mixed, and the Southeastern Legal Foundation offers no explanation to the contrary. Second, as discussed in Response 1-82 above, NASA's observations do not change the finding that the CO_2 is well mixed on time scales relevant to the study of climate change. Third, the Southeastern Legal Foundation's reference to "proofs" that CO_2 has a short residence time, citing work by Segalstad (e.g., Segalstad, 1997), were responded to in Volume 2 of EPA's RTCs in the endangerment record. After reviewing this public comment, EPA determined (in RTC 2-3) that Segalstad's work "does not address the lifetime of a change in atmospheric concentration of CO_2, but rather the lifetime in the atmosphere of an

individual molecule of CO_2" and that these "are two different concepts." This confusion of residence time and the adjustment time in the atmosphere is discussed at length in O'Neill (1997).

In addition, the latest scientific research suggests that the airborne CO_2 fraction is likely increasing—consistent with future projections. A recent (December 2009) study (Le Quéré et al., 2009) published in *Nature Geoscience* updates trends in the sources and sinks of CO_2 and finds: "In the past 50 years, the fraction of CO_2 emissions that remains in the atmosphere each year has likely increased, from about 40% to 45%, and models suggest that this trend was caused by a decrease in the uptake of CO_2 by the carbon sinks in response to climate change and variability."

The Southeastern Legal Foundation does not acknowledge or take into account this new study.

Comment (1-84):
Southeastern Legal Foundation suggests that the current computer models on which EPA relies are based on assumptions that are challenged by the NASA finding regarding CO_2 not being well mixed and the Knorr study discussed above (in Response 1-82 and 1-83). It concludes: "These results contradict the IPCC's version of the carbon cycle, on which the climate models and claims of catastrophic AGW are based" and that EPA should, therefore, reconsider its Endangerment Finding.

Response (1-84):
As described above (in Response 1-82), the NASA finding does not refute the well-established conclusion that CO_2 is well mixed on time scales relevant to the study of climate change. Moreover, the primary finding of the Knorr (2009) study cited by the Southeastern Legal Foundation pertaining to trends in the CO_2 airborne fraction is not new and was already reflected in EPA's TSD. The information presented by the Southeastern Legal Foundation does not change or undermine either the view that GHGs are long lived and well mixed, in the time scales relevant to climate change projections, or the basis for scientific projections suggesting the airborne fraction of CO_2 will increase as the climate warms. And, in fact, another peer-reviewed study (Le Quéré et al., 2009) presents contrasting results finding an increase in the airborne fraction in the past 50 years.

Significantly, the same NASA press release that the Southeastern Legal Foundation cites concerning the short term "lumpy" distribution of CO_2 provides validation for the climate models results cited by EPA in the TSD which project substantial CO_2-induced warming (NASA, 2009c):

> "AIRS temperature and water vapor observations have corroborated climate model predictions that the warming of our climate produced as carbon dioxide levels rise will be greatly exacerbated -- in fact, more than doubled -- by water vapor," said Andrew Dessler, a climate scientist at Texas A&M University, College Station, Texas.

> Dessler explained that most of the warming caused by carbon dioxide does not come directly from carbon dioxide, but from effects known as feedbacks. Water vapor is a particularly important feedback. As the climate warms, the atmosphere becomes more humid. Since water is a greenhouse gas, it serves as a powerful positive feedback to the climate system, amplifying the initial warming [caused by CO_2]. AIRS measurements of water vapor reveal that water greatly amplifies warming caused by increased levels of carbon dioxide. Comparisons of AIRS data with models and re-analyses are in excellent agreement.

In summary, the Southeastern Legal Foundation's evidence and arguments do not change the validity of EPA's characterization of CO_2 and/or the carbon cycle, or their representation in climate models whose results were cited in support of the Endangerment Finding.

1.5.4 Implications of New Tropical Cyclone Studies

Comment (1-85):
Two petitioners (the Competitive Enterprise Institute and the Southeastern Legal Foundation) present new studies that provide new and/or updated information on 1) historical trends in tropical cyclone activity, including frequency and intensity, and 2) whether these trends can be attributed to anthropogenic GHGs. The petitioners claim that the conclusions of these studies cast doubt on EPA's characterization of these issues in the Endangerment Finding and therefore require a reconsideration of the Finding.

The Competitive Enterprise Institute provides a study by Hatton (2010) titled, "Has the Intensity and Frequency of Hurricanes Increased?" This non-peer-reviewed study analyzes trends in hurricane data from 1999 to 2009 tested against the period from 1946 to 2009. It finds "that hurricane intensity and frequency is significantly higher in this period [1999–2009] in the North Atlantic. However in the Eastern Pacific, Western Pacific, and Northern and Southern Indian oceans, there is no evidence of significant change." The Competitive Enterprise Institute states that this finding "undermines EPA's own claims regarding the supposedly increased risk of storms and hurricanes."

Southeastern Legal Foundation presents a peer-reviewed study from Knutson et al. (2010). This study, developed under the auspices of the WMO, evaluates the current state of knowledge of tropical cyclones and climate change. The Southeastern Legal Foundation highlights two key findings from the study:

1) "In terms of global tropical cyclone frequency, it was concluded that there was no significant change in global tropical storm or hurricane numbers [i.e. frequency] from 1970 to 2004, nor any significant change in hurricane numbers [i.e. frequency] for any individual basin over that period, except for the Atlantic..."

2) "….we cannot at this time conclusively identify anthropogenic signals in past tropical cyclone data."

On the basis of these findings, the Southeastern Legal Foundation argues, "EPA should reconsider its conclusions that GHGs endanger human health and welfare."

Response (1-85):
We have reviewed both of the studies and considered their implications for EPA's characterization of trends in tropical cyclone activity, including frequency and intensity, and our ability to attribute the trends to anthropogenic GHGs.

With respect to observed trends in frequency and intensity of tropical cyclones, the findings in these two studies are, in fact, consistent with EPA's TSD and the Endangerment Finding. The TSD states in Section 4(k), "Kunkel et al. (2008) refer to a study that was not able to corroborate the presence of upward intensity trends over the last two decades in ocean basins other than the North Atlantic" and "there is no clear trend in the annual numbers [i.e. frequency] of tropical cyclones [globally]...". Specific to trends in the North Atlantic, the TSD states in Section 4(l): "IPCC (2007b) and Karl et al. (2009) report observational evidence of an increase in intense tropical cyclone activity in the North Atlantic (where cyclones develop that affect the U.S. East and Gulf Coasts) since about 1970, correlated with increases of tropical sea surface temperatures of nearly 2ºF (1ºC) in the main Atlantic hurricane development region (Karl et al., 2009). The strongest hurricanes (Category 4 and 5) have, in particular, increased in intensity (Karl et al., 2009)."

EPA's characterization of whether any trends in tropical cyclone activity (either frequency or intensity) could be attributed to anthropogenic GHGs, drawn from the IPCC, does differ slightly from the Knutson et al. study (the Hatton study does not address attribution). Knutson found no conclusive evidence of an anthropogenic signal in observed hurricane activity to date, and like Knutson, the TSD did not claim any such conclusive evidence. Instead, the TSD states in Section 5(a) that it is "more likely than not that anthropogenic influence has contributed to increase in the frequency in the most intense storms." After that statement, EPA provided the following caveat, reflecting the uncertainty in science regarding attribution, stating:

> … the IPCC (Hegerl et al., 2007) cautions that detection and attribution of observed changes in hurricane intensity or frequency due to external influences remains difficult because of deficiencies in theoretical understanding of tropical cyclones, their modeling, and their long-term monitoring.

Importantly, given this uncertainty, EPA did not refer to any anthropogenic signal in historical tropical cyclone trends in the Findings themselves (nor in the Executive Summary of the TSD) and instead focused only on the limited evidence of a directional trend in the Atlantic, and more importantly on increasing future risks (Section I.A. of the Findings):

> The conclusion in the assessment literature that there is the potential for hurricanes to become more intense (and even some evidence that Atlantic hurricanes have already become more intense) reinforces the judgment that coastal communities are now

> endangered by human-induced climate change, and may face substantially greater risk in the future.

The risk of stronger hurricanes in the future is echoed by the Knutson et al. (2010) study, which finds:

> …future projections based on theory and high-resolution dynamical models consistently indicate that greenhouse warming will cause the globally averaged intensity of tropical cyclones to shift towards stronger storms…

In summary, the new studies presented by petitioners are consistent with EPA's characterization of observed tropical cyclone trends. The Knutson et al. (2010) study reaches a slightly revised conclusion on an anthropogenic GHG signal to date, but the revision is not meaningful considering EPA's qualified discussion of the issue and the similarities in EPA's and Knutson et al.'s characterization of future projections.

1.5.5 Implications of New Studies on the Statistical Significance of Increases in Antarctic Sea Ice

Comment (1-86):
The Southeastern Legal Foundation discusses two studies (Comiso and Nishio, 2008; Turner et al., 2009), which it alleges find that the observed increase in Antarctic sea ice is statistically significant. The petitioner argues that this finding is contrary to information in the record for EPA's Endangerment Finding, as well as information contained in the IPCC AR4. It states: "If the increase [in Antarctic sea ice] is statistically significant, then it is yet another empirical refutation of the IPCC models, which predict a loss of sea ice in the Antarctic." It ultimately concludes:

> EPA has contradicted the literature and mischaracterized the statistical significance of the trend in Antarctic sea ice extent increase. It appears that this mischaracterization permits EPA to claim that the model projections have not been refuted and remain "robust" even though any fair analysis shows they have been at best undermined and at worst falsified.

Response (1-86):
EPA has reviewed the petitioner's submission of Comiso and Nishio (2008) and Turner et al. (2009) and finds that it was not impracticable to raise the objection during the public comment period and that the reasons for the objection did not arise between June 24, 2009, and February 16, 2010. Nonetheless, we have reviewed these arguments and responded.

The first study by Comiso and Nishio (2008) computes a positive trend in Antarctic sea extent of 0.9 ± 0.2% per decade since the late 1970s, but contrary to the assertion of the Southeastern Legal Foundation, the study does not assess statistical significance. The second study, Turner et al. (2009), states, "the annual mean extent of Antarctic sea ice has increased at a statistically significant rate of 0.97% per decade since the late 1970s." In other words, both studies compute a similar trend, and one assesses statistical significance while the other does not.

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In Section 4(i) of the TSD, EPA cites U.S. National Snow and Ice Data Center (NSIDC) data indicating that for the period 1979–2008, Antarctic sea ice had undergone a not statistically significant increase of 0.9% per decade (U.S. EPA, 2009). Although the conclusion about statistical significance differs from Turner et al. (2009), the magnitude of the trend reported by EPA is very similar, and the NSIDC trend reported by EPA is identical to the trend found in Comiso and Nishio (2008).

Therefore, EPA's TSD and the studies referenced by the Southeastern Legal Foundation all portray Antarctic sea ice as increasing at about the same rate. The only difference between the TSD and one of the studies referenced by the Southeastern Legal Foundation is in the characterization of statistical significance in Turner et al. (2009). This narrow and limited basis does not support the Petitioner's sweeping and unsupportable conclusion.

The fact that studies reach different conclusions regarding statistical significance in observed trends does not imply that model projections have been "refuted," "undermined," or "at worst falsified," especially when the trends do not materially differ in either direction or magnitude. Furthermore, the statistical significance of observed trends is not a criterion required for validation of models. Of particular importance is that EPA's reporting of Antarctic sea trends is substantively consistent with the literature.

Although EPA did not rely on the IPCC (2007a) for this discussion in the TSD, the Southeastern Legal Foundation makes much of the fact that the newer literature also differs from the IPCC's coverage of this issue. It claims that the IPCC's finding that Antarctic sea ice trends are not statistically significant is "an outlier that is inconsistent with the peer reviewed literature"—specifically referring to literature published after publication of the IPCC AR4. But given that the one study (Turner et al., 2009) referenced by the Southeastern Legal Foundation (finding statistical significance) was not available to the IPCC when it did its assessment, its claim that the IPCC's treatment of the issue is inconsistent with more recent literature has little relevance. EPA relied on the latest available data and analysis from NSIDC rather than the IPCC.

Separate from its discussion of the new literature, the Southeastern Legal Foundation—in a footnote—refers to a blog post (Knappenberger, 2010) that alleges that the IPCC's treatment of the issue was incomplete based on literature that was available at the time of its assessment. But again, this is not relevant to EPA's treatment of the issue because EPA relied on the more current analysis by NSIDC, which is consistent with the latest literature on the issue, aside from statistical significance as discussed above.

Finally, it is important to put this issue into context. Antarctic sea ice is one climate indicator referenced in the TSD but not explicitly referred to in the Findings themselves. Given the multiple lines of evidence presented in the TSD, a small, and in this context trivial change in the statistical characterization of one of numerous physical indicators of warming does not materially impact the Endangerment Finding. The TSD appropriately states that Antarctic sea ice is increasing. The fact that as more studies are published it

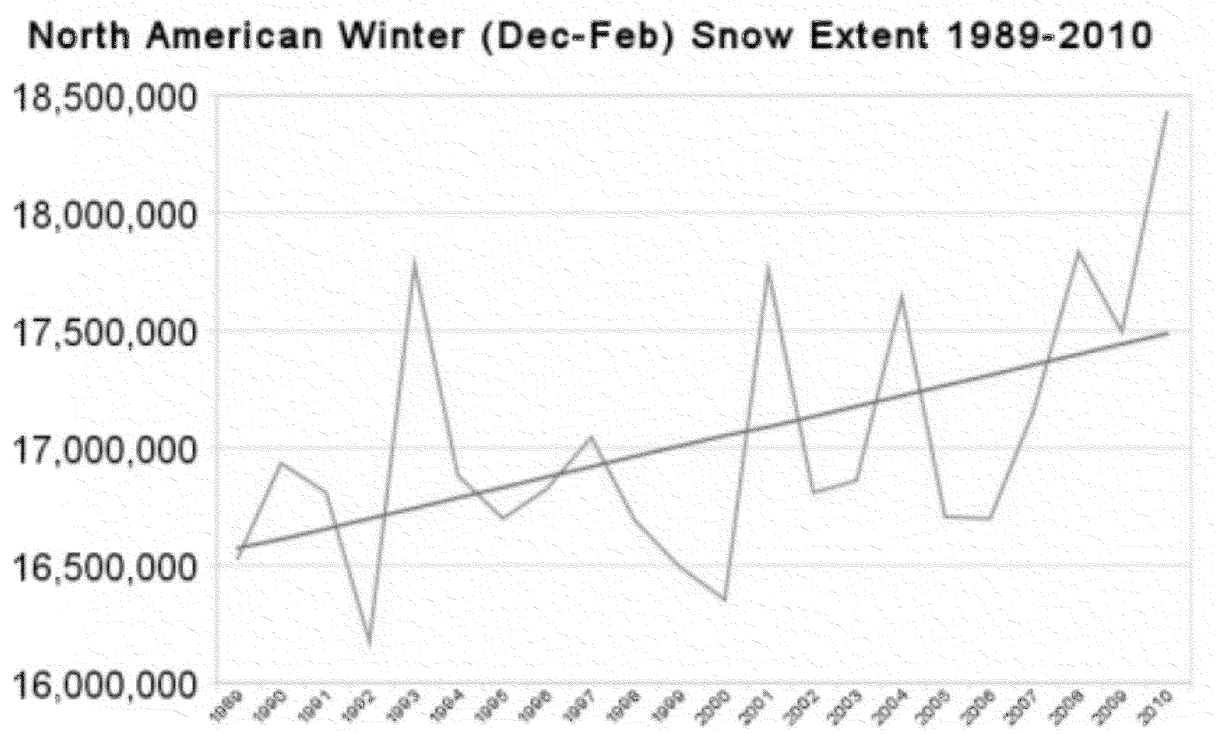
may now be possible to ascribe "statistical significance" to this increase is not of material impact for the Endangerment Finding.

1.5.6 Implications of Recent Data on Observational Snow Cover Trends

Comment (1-87):
One petitioner (the Southeastern Legal Foundation) argues that recent trends in winter snow cover over the Northern Hemisphere and North America are at odds with future model projections. It notes that since 1989, there has been virtually no trend in snow cover in the Northern Hemisphere and that winter snow extent in North America has been increasing over this period.

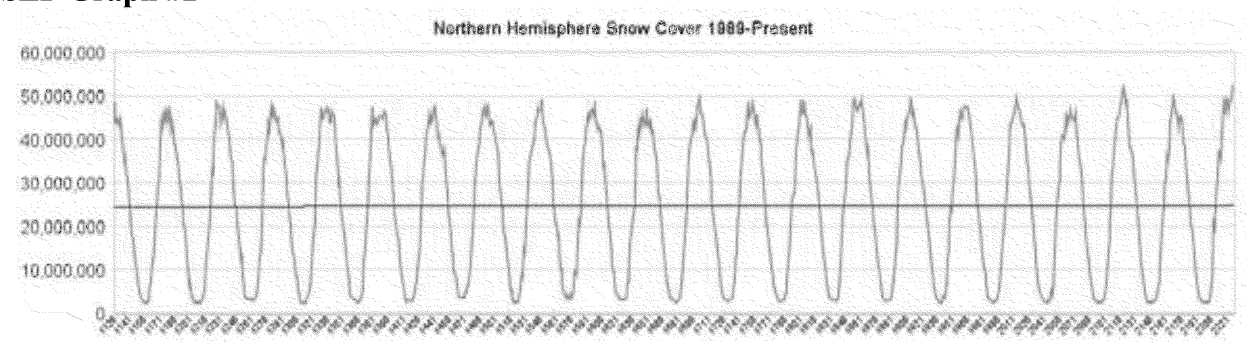
To support its arguments, the Southeastern Legal Foundation relies primarily on two snow cover data time series (Goddard 2010a, 2010b) published on the blog WattsUpWithThat.com. These time series exhibit data from the Rutgers University Global Snow Laboratory (GSL). The first time series the petitioner displays shows an increasing trend in North American winter snow cover extent (e.g., for the months of December to February) from 1989 to 2010 (source of image: Goddard, 2010a) (SLF Graph #1).

SLF Graph #1



The second time series the petitioner displays shows the annual Northern Hemisphere snow cover since 1989, which shows "virtually no trend" according to the Southeastern Legal Foundation (source of image: Goddard, 2010b) (SLF Graph #2).

SLF Graph #2



On the basis of these graphs, the petitioner concludes that "the IPCC and the EPA predicted reduced snow fall and reduced snow cover due to AGW [anthropogenic global warming]" and that this is "yet another instance of the failure of model predictions."

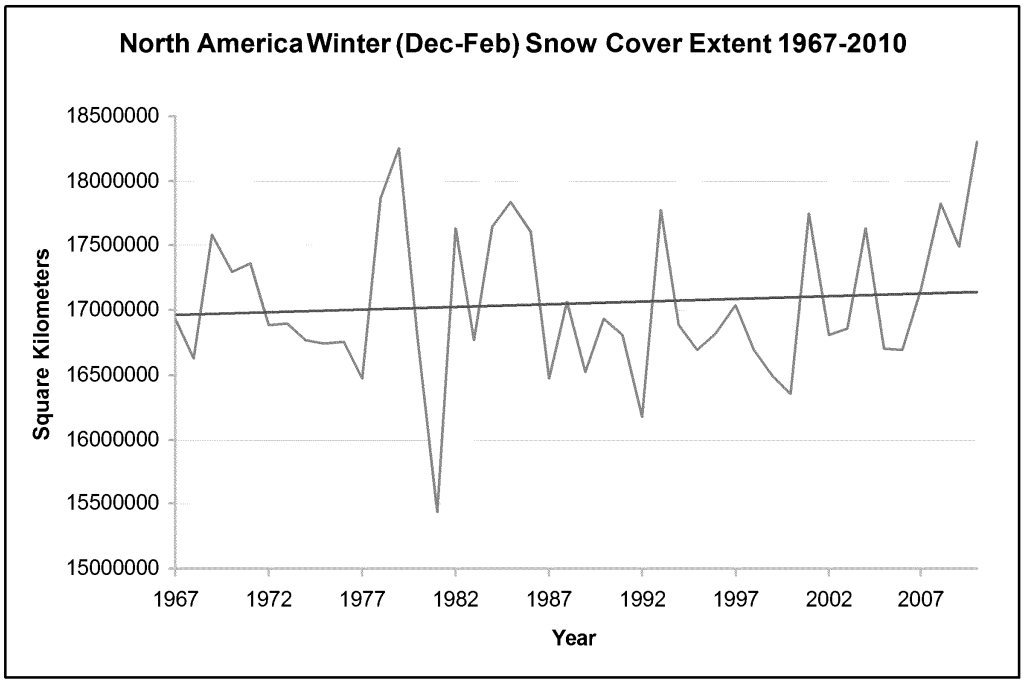
<u>Response (1-87)</u>:
The Rutgers GSL is a credible and legitimate source of data on snow cover, and numerous peer-reviewed studies have used Rutger's GSL data, including some that were cited by the IPCC. However, the Southeastern Legal Foundation reaches inappropriate and flawed conclusions based on these graphs, as the conclusions are biased by the selective time periods analyzed.

Southeastern Legal Foundation's North American Winter Snow Cover Extent Graph (SLF Graph #1)

The North American winter snow cover graphic presented by the Southeastern Legal Foundation and shown above only samples the period 1989–2010, yet Rutgers GSL data date back to 1967. Using GSL data for the entire period of record (1967–2010, source: Rutgers, 2010a), EPA produced the following graph (EPA Graph #1[57]):

[57] For underlying data, see file North American Winter Snow Cover Extent.PDF in Docket ID No. EPA-HQ-OAR-2009-0171

EPA Graph #1

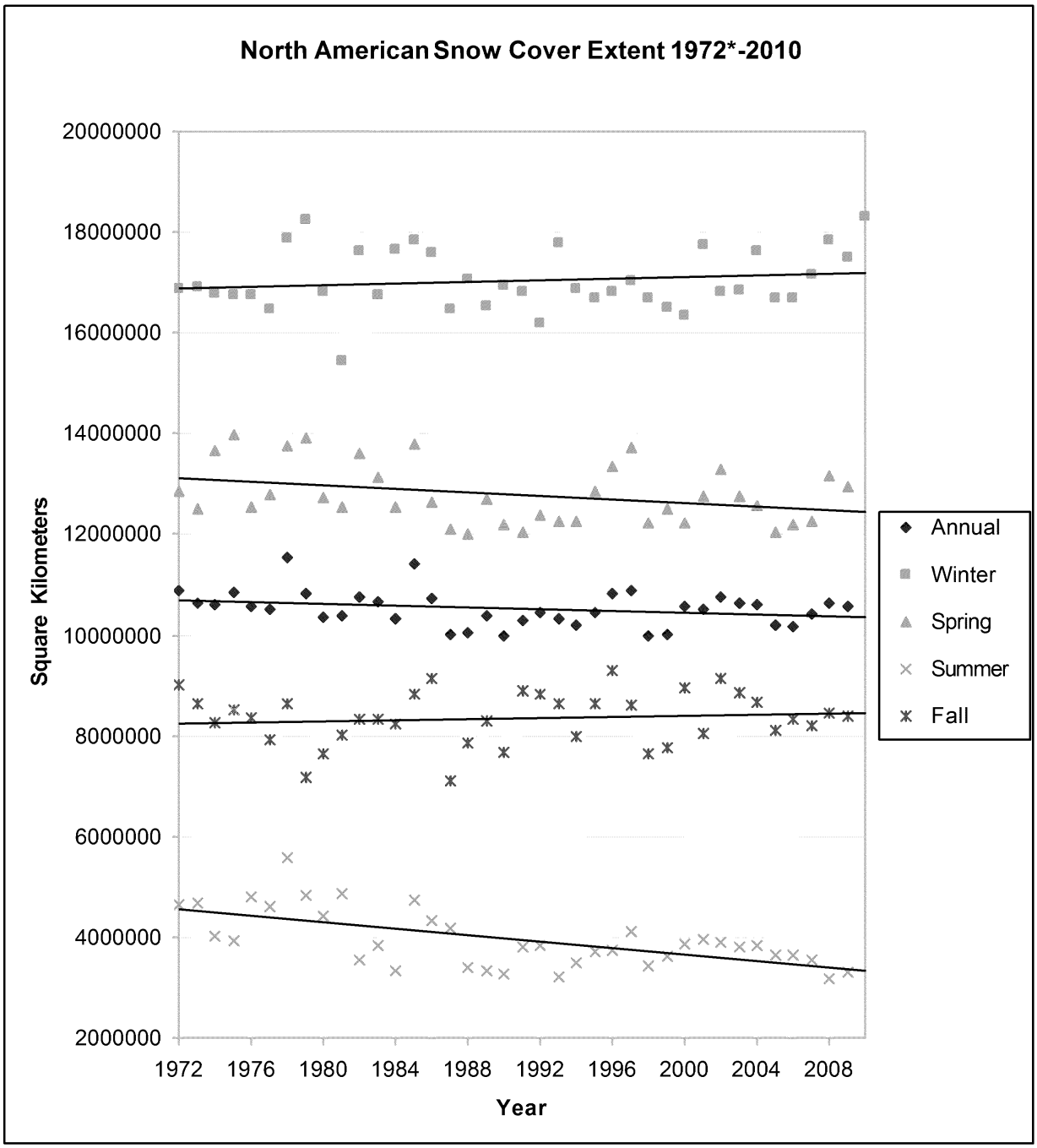


An examination of this graph of the entire dataset (EPA Graph #1) makes it clear that Southeastern Legal Foundation relies upon a graph (SLF Graph #1) that presents an exaggerated upward snow cover extent trend during the winter months by using unrepresentative start and end dates. The SLF Graph #1 start and end dates coincide with relatively small (1989) and large (2010) snow cover extents. The full time series we produce above shows a much smaller upward trend. The small long-term increase we show is broadly consistent with our statement in the TSD on this issue. In Section 4(j) of the TSD, citing the IPCC, we state that over North America "from 1915 to 2004, snow-covered area increased in November, December, and January due to increases in precipitation" (U.S. EPA, 2009).

It is also important to recognize that snow cover trends in one season over one continent are not representative of snow cover trends in other seasons, on an annual basis, or in other parts of the world. In fact, one impact of climate change is expected to be an increase in snow cover in many areas due to increases in precipitation, which have been observed as noted above. As the TSD notes in Section 5(a): "…heavy precipitation events averaged over North America have increased over the past 50 years … consistent with the observed increases in atmospheric water vapor, which have been associated with human-induced increases in GHGs." In contrast, in the warmer seasons of spring and summer, when cold air is more limited, warming has tended to deplete snow cover, and there has been little trend (slightly positive) during fall. The graph below, which EPA produced (EPA Graph #2[58], data source: Rutgers, 2010a), shows long-term North America snow cover extent by season and on an average annual basis.

[58] For underlying data, see file North American Snow Cover Extent.PDF in Docket ID No. EPA-HQ-OAR-2009-0171

EPA Graph #2



**Whereas winter snow cover data are available from GSL beginning in 1967, annual snow cover data begin in 1972.*

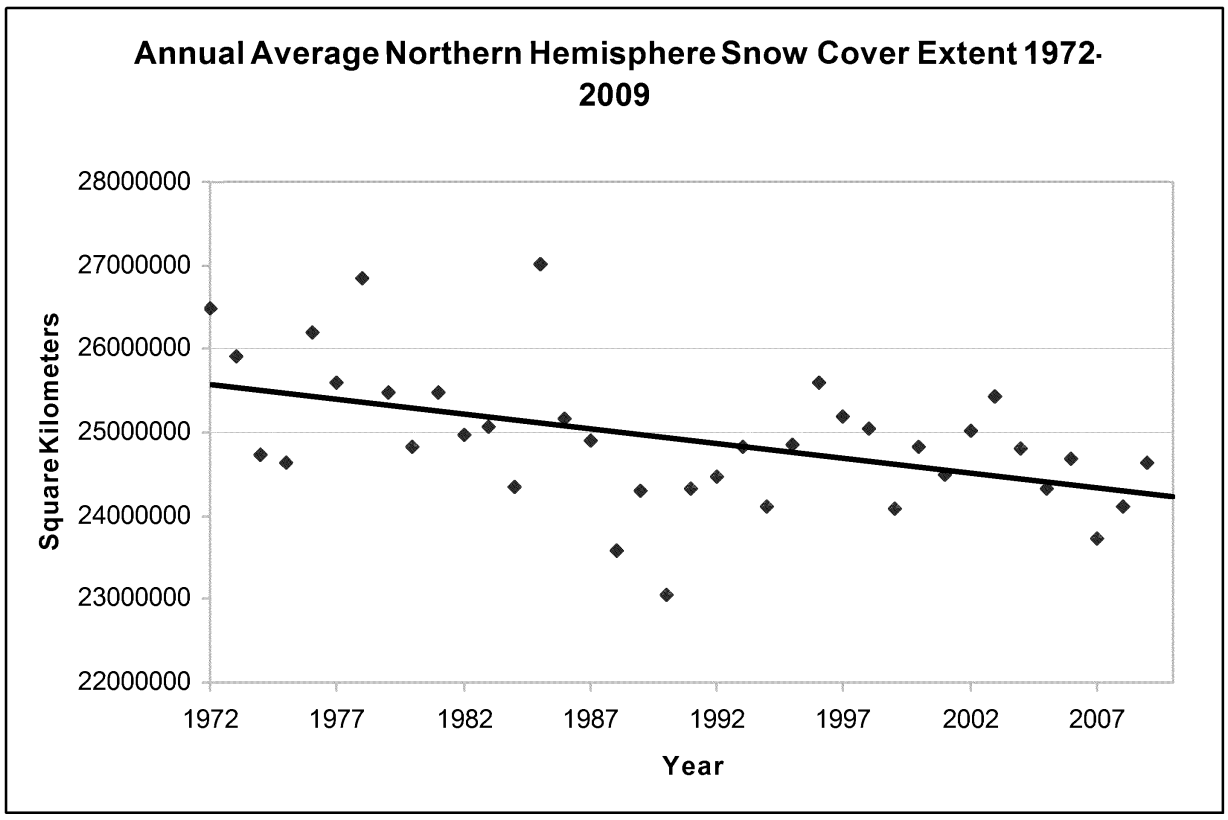
This graph (EPA Graph #2) clearly shows that average annual snow cover (blue diamonds) has declined over the long term over North America, with pronounced declines in spring (yellow triangles) and summer (light blue Xs) and small increases in fall (purple asterisks) and winter (pink squares). By focusing on just one season and

arbitrarily using only part of the available dataset, the Southeastern Legal Foundation (SLF Graph #1) provides an incomplete analysis, which does not change or undermine projections for future declines in snow cover over North America.

Southeastern Legal Foundation's Annual Northern Hemisphere Snow Cover Extent Graph (SLF Graph #2)

As with its first graph (SLF Graph #1), the petitioner's second graph (SLF Graph #2) for the Northern Hemisphere also presents only a portion of the available data. Importantly, its choice of start date (1989) is biased because it conceals the long-term decline in snow cover extent evident when analyzing the entire data series. We graphed the entire Northern Hemisphere Snow Cover extent time series, plotting annual averages to produce the time series below (EPA Graph #3[59], data source: Rutgers, 2010b).

EPA Graph #3



This time series (EPA Graph #3) clearly shows a long-term decline in annual average Northern Hemisphere snow cover extent, which is consistent with model projections for the future.

[59] For underlying data, see file Annual Average Northern Hemisphere Snow Cover Extent.PDF in Docket ID No. EPA-HQ-OAR-2009-0171

The clear conclusion is that the petitioner bases its claim that the models are wrong on the use of time series that are biased both with respect to the time of year analyzed and choice of start and end date. Their assertion that future projections are flawed is based on this inappropriately limited analysis. The petitioner's evidence and arguments do not show that models projecting future decreases in snow cover are flawed. In fact, observed long-term snow cover trends over both North America and the Northern Hemisphere are directionally consistent with future projections. Therefore, the information presented by the petitioner is inaccurate and does not support their claims.

1.5.7 Petitioners Claim That EPA Ignored a Satellite Dataset

Comment (1-88):
One petitioner, the Competitive Enterprise Institute, contends that EPA's Endangerment Finding ignores satellite datasets, which, unlike surface datasets, provide comprehensive coverage of the globe. The Competitive Enterprise Institute specifically refers to the satellite dataset produced by UAH. It states:

> This dataset meets the critical principle of science of repeated, independent verification. These data show modest thirty year warming trends in the middle to upper latitudes of the Northern Hemisphere, little warming of the tropics and the Southern Hemisphere, and distinct cooling of the Antarctic region - hardly the endangering global warming proclaimed by EPA.

Response (1-88):
EPA clearly did not ignore satellite datasets, including the UAH dataset. The satellite datasets are discussed in detail in the record for the Endangerment Finding. EPA summarized trends from satellite datasets in both the TSD and RTC document. The TSD contains an entire section (4b) in which upper air temperatures are summarized, and that incorporates the trends from both Remote Sensing System and UAH satellite temperature records. In Section 4(b), the TSD summarizes the IPCC's discussion of tropospheric satellite temperature records, which incorporate the UAH dataset:

> The satellite tropospheric temperature record is broadly consistent with surface temperature trends. The range (due to different data sets) of global surface warming since 1979 is 0.29°F (0.16°C) to 0.32°F (0.18°C) per decade compared to 0.22°F (0.12°C) to 0.34°F (0.19°C) per decade for estimates of tropospheric temperatures measured by satellite.

Furthermore, also in Section 4(b), we update the IPCC's summary of the satellite temperature record with a summary of the latest satellite temperature data trends in NOAA publications (NOAA, 2009 and Peterson and Baringer, 2009) through 2009, which also incorporate the UAH data:

> For example, in NOAA (2009b) the satellite mid-tropospheric temperature trend computed for 1979–2008 ranges from +0.20 to 0.27°F (+0.11°C to + 0.15°C) per decade compared to the estimate of +0.22 to +0.34°F (+ 0.12°C to + 0.19°C) per decade given in IPCC (2007a). Combining the radiosonde and satellite records of the troposphere, the [NOAA] *State of the Climate in 2008* report estimates the trend is +0.261 ± 0.04°F

(+0.145 ± 0.02°C) per decade for the period 1958–2008 with the range of the trends calculated from the various datasets (Peterson and Baringer, 2009).

In addition, Volume 2 of the RTC document specifically refers to UAH data in four separate comment responses (2-47, 2-48, 2-49, and 2-51).

The commenter's assertion about specific regional trends in temperatures derived from satellite records (including UAH's) were also already addressed in the RTC:

- Temperature trends in the tropics were discussed in RTC 3-7.
- Temperature trends in the Southern Hemisphere relative to the Northern Hemisphere were discussed in RTC 3-5.
- Antarctic temperature trends were discussed in RTC 2-56.

To conclude, the warming observed in the satellite record, including the UAH data, was considered by EPA and supports EPA's conclusion that the warming of the climate system is "unequivocal" (see the Findings, Section IV.2.a.).

1.5.8 Summary

None of the issues raised by petitioners pertaining to new science or data that EPA allegedly did not address changes or undermines the scientific basis for EPA's Findings. In many cases, the issues raised by the petitioners are not new, but were fact raised and addressed during the rulemaking. Petitioners have misinterpreted or misrepresented the meaning and significance of the scientific literature, findings, and data they cite, made claims that are not supported by the evidence they rely on, provided incomplete and biased analyses to support their claims, failed to acknowledge or account for important results, and, at times, ignored EPA's endangerment record.

Climate science continues to advance and our understanding will continue to improve as new data and studies that are published will continue to add to our understanding of important climate science issues. But rather than challenging the scientific basis for the Endangerment Finding, the new science cited by petitioners does not undermine the key findings and conclusions that were reached in the assessment literature, and the very solid scientific foundation for EPA's Findings.

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United States Environmental Protection Agency

EPA's Response to the Petitions to Reconsider the Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act

Volume 2: Issues Raised by Petitioners on EPA's Use of IPCC

U.S. Environmental Protection Agency
Office of Atmospheric Programs
Climate Change Division
Washington, D.C.

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ACRONYMS

°C	degrees Celsius
°F	degrees Fahrenheit
AIRS	Atmospheric Infrared Sounder
AMS	American Meteorological Society
AOGCM	Atmosphere-Ocean General Circulation Models
AR4	IPCC Fourth Assessment Report
BOM	Australian Bureau of Meteorology
CH_4	methane
cm	centimeter
CCSP	U.S. Climate Change Science Program
CDIAC	Carbon Dioxide Information Analysis Center
CMIP	Coupled Model Intercomparison Project
CO_2	carbon dioxide
CRU	Climatic Research Unit
EPA	U.S. Environmental Protection Agency
FOIA	Freedom of Information Act
GHCN	Global Historical Climatology Network
GHG	greenhouse gases
GISS	Goddard Institute for Space Studies (NASA)
GSL	Global Snow Laboratory (Rutgers University)
IAC	InterAcademy Council
IEA	Institute of Economic Analysis
IISD	International Institute for Sustainable Development
IJC	International Journal of Climatology
IPCC	Intergovernmental Panel on Climate Change
IQA	Information Quality Act
LIA	Little Ice Age
MET	United Kingdom Meteorological Office
MWP	Medieval Warm Period
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NIWA	National Institute of Water & Atmospheric Research
NMS	National Meteorological Station
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NSIDC	U.S. National and Snow and Ice Data Center
ORNL	Oak Ridge National Laboratory
PBL	Netherlands Environmental Assessment Agency
RMS	Risk Management Solutions
RTC	Response to Comments
RTP	Response to Petitions
SAB	Scientific Advisory Board
SALR	saturated adiabatic lapse rate
TSD	Technical Support Document

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UAH	University of Alabama–Huntsville
UCAR	University Corporation for Atmospheric Research
UHI	urban heat island
UK	United Kingdom
USGCRP	U.S. Global Change Research Program
USHCN	United States Historical Climatology Network
W/m^2	watts per meter squared
WMO	World Meteorological Organization
WWR	World Weather Reports

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2.0 Issues Raised by Petitioners on EPA's Use of IPCC

2.1 Claims That IPCC Errors Undermine IPCC Findings and Technical Support for Endangerment

2.1.1 Overview

Several petitioners (Peabody Energy, the State of Texas, the Coalition for Responsible Regulation, the Competitive Enterprise Institute, the Ohio Coal Association, and the Southeastern Legal Foundation) contend that alleged errors and/or unsupported findings in IPCC reports demonstrate that the science on which the Administrator relied for the Endangerment Finding is uncertain and/or not credible. We have examined each specific instance of error, alleged error, and/or alleged unsupported statement in the voluminous IPCC report and we find that the evidence cited by petitioners does not support this conclusion.

In reviewing the information provided by petitioners, EPA has determined that most—if not all—of the alleged errors and/or unsupported statements highlighted by petitioners are not relevant, not truly erroneous or unsupported, and/or inconsequential to the Administrator's Finding. In many cases, the petitioners' interpretation of both the alleged error (or alleged unsupported statement) and its implications is not supported by the evidence provided. Clearly, the charge that there are or might be errors or unsupported statements in the IPCC's Fourth Assessment Report (AR4) is serious, and we agree with petitioners that such claims merit thorough review. EPA has done such a review; we find that the documented errors in the AR4 are not significant, and do not call into question the fundamental and broad evidence on which the Endangerment Finding rests. Moreover, the occurrence of the few documented errors in a study the size of the IPCC report is not unexpected and does not call into question the credibility of the entire report and all of its findings.

The Netherlands Environmental Assessment Agency (PBL) conducted its own independent assessment of the regional chapters (9 through 16) in Working Group II's contribution to the AR4, where many of the errors, alleged errors, and/or alleged unsupported statements have been identified. The report *Assessing an IPCC Assessment* (PBL, 2010a) finds "no significant errors" in summary conclusions, though it notes that "provenance of summary statements needs to become more transparent in future reports."

PBL (2010a) also states that "examples of negative impacts dominate at summary level," indicating that the IPCC selected a "risk-oriented" approach in communicating to policymakers. The report states:

> The PBL subscribes to the importance of an approach that highlights what may go wrong under unmitigated climate change, but Working Group II Report lacked a clear explanation of the choice of approach and its consequences. Alternatively, it could be argued that policymakers should be presented with a complete picture in the Summary for Policymakers, not just with negative examples (without suggesting that potential positive effects cancel out potential effects).

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While we cited the IPCC Working Group II Summary for Policymakers in the Endangerment Technical Support Document (TSD), we relied most heavily on information from the full chapters in the Working Group II report, specifically Chapter 14 on North America, as well as other assessment literature such as the U.S. Global Change Research Program (USGCRP) assessment *Global Climate Change Impacts in the United States* (Karl et al., 2009). The Administrator considered both the positive and negative effects of climate change, as the Endangerment Finding states (Section I.A.):

> The Administrator is using her judgment, based on existing science, to weigh the threat for each of the identifiable risks, to weigh the potential benefits where relevant, and ultimately to assess whether these risks and effects, when viewed in total, endanger public health or welfare.

In addition, the Administrator found endangerment based on impacts in the United States alone, with international impacts providing some supporting information, as the Endangerment Finding states (Section III.D):

> EPA is not considering international effects to determine whether the health and welfare of the public in a foreign country is endangered. Instead, EPA's consideration of international effects for purposes of determining endangerment is limited to how those international effects impact the health and welfare of the U.S. population.
>
> The Administrator looked first at impacts in the United States itself, and determined that these impacts are reasonably anticipated to endanger the public health and the welfare of the U.S. population. That remains the Administrator's position, and by itself supports her determination of endangerment.

Despite its few criticisms of the IPCC, PBL (2010a) concludes:

> Our findings do not contradict the main conclusions of the IPCC on impacts, adaptation and vulnerability related to climate change. There is ample observation evidence of natural systems being influenced by climate change on regional levels. The negative impacts under unmitigated climate change pose substantial risks to most parts of the world, with risks increasing at higher global average temperatures.

This conclusion is very consistent with the conclusion the Administrator reached in the Endangerment Finding, after weighing the balance of evidence.

This section responds to the major arguments of the petitioners on the significance of alleged errors and/or unsupported statements in the IPCC reports, and assesses the implications of these errors and/or unsupported statements for the credibility and reliability of the major findings and conclusions of the IPCC and other assessment literature.

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2.1.2 Accuracy of Statement on Percent of the Netherlands Below Sea Level

Comment (2-1):
Peabody Energy and the State of Texas contend that the IPCC erroneously stated (in Working Group II's contribution to the AR4) that 55% of the Netherlands is below sea level, whereas the actual number is much lower according to Dutch materials (26%).

Response (2-1):
The statistic quoted in the IPCC AR4 is inaccurate. When this error was identified, PBL (2010b) published a correction:

> In the 2007 IPCC report by the Working Group 2 (Climate change 2007: Impacts, Adaptation and Vulnerability) a mistake has entered the text that was supplied by the Netherlands Environmental Assessment Agency, regarding the risks of flooding for the Netherlands. In the chapter on Europe, on page 547, it says that 55 per cent of the Netherlands is below sea level ('The Netherlands is an example of a country highly susceptible to both sea level rise and river flooding because 55% of its territory is below sea level'). This should have read that 55 per cent of the Netherlands is at risk of flooding; 26 per cent of the country is below sea level, and 29 per cent is susceptible to river flooding. Examples of the latter are the near floodings, in the mid-1990s, of areas along the rivers Meuse and Waal – areas that are well above sea level.

The IPCC agrees that this statistic is incorrect in the AR4, and also notes that the same mistake was made by other reputable groups (Reuters, 2010). For example, the IPCC—in a written statement provided to Reuters—indicated that a report from the Dutch Ministry of Transport had stated "'about 60%' of the country is below sea level," and referred to a European Commission study saying "about half" (Reuters, 2010). As noted by the IPCC statement, the error was not made by authors of the AR4, but originated with PBL, which supplied the text. To correct the mistake, the IPCC published an official erratum (IPCC, 2010d):

> 2) Page 547. Section 12.2.3. Line 20: Delete "below sea level" and replace with "at risk flooding".

The IPCC was further quoted as saying (Reuters, 2010): "The sea level statistic was used for background information only, and the updated information remains consistent with the overall conclusions."

In its independent report *Assessing an IPCC Assessment* (PBL, 2010a), PBL, which was responsible for the error, states:

> We acknowledge that this error was not the fault of the IPCC (Coordinating) Lead Authors or Co-Chairs. The error was made by a Contributing Author from the PBL, and the (Coordinating) Lead Authors [of the IPCC] are not to blame for relying on Dutch information provided by a Dutch agency.

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EPA concludes that this error is minor and inconsequential to the Administrator's Endangerment Finding. EPA does not refer to or rely on this statistic in the Endangerment Finding or supporting documents, and this information does not pertain to endangerment of public health and welfare in the United States in any meaningful way. It does not call into question the integrity of the IPCC, and it has no impact on the scientific support for EPA's Endangerment Finding. Furthermore, as the error pertains to a statistic outside the United States, it is not relevant to the Endangerment Finding. As noted in Subsection 2.1.1, the Endangerment Finding states (Section III.D): "The Administrator looked first at impacts in the United States itself, and determined that these impacts are reasonably anticipated to endanger the public health and the welfare of the U.S. population. That remains the Administrator's position, and by itself supports her determination of endangerment."

2.1.3 Validity of Himalayan Glacier Projection

Comment (2-2):
Several petitioners (the Coalition for Responsible Regulation, the Competitive Enterprise Institute, the Ohio Coal Association, Peabody Energy, the Southeastern Legal Foundation, and the State of Texas) state that the IPCC erred in including a projection that glaciers in the Himalayas would disappear by 2035, and they claim EPA relied on this projection in the Endangerment Finding. Petitioners argue that this error undermines the credibility of the IPCC reports. The Ohio Coal Association writes: "The Agency no longer has a basis for unquestioned confidence that the IPCC reports present a fair, unbiased, and accurate assessment of climate science." Peabody states the error: "…undercuts EPA's conclusion that the IPCC review process was 'rigorous' and shows how reliance on the IPCC led to errors in EPA's Endangerment Finding."

Response (2-2):
The IPCC has issued a correction pertaining to this projection for the melting of Himalayan glaciers (IPCC, 2010f):

> The Synthesis Report, the concluding document of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (page 49) stated: "Climate change is expected to exacerbate current stresses on water resources from population growth and economic and land-use change, including urbanization. On a regional scale, mountain snow pack, glaciers and small ice caps play a crucial role in freshwater availability. Widespread mass losses from glaciers and reductions in snow cover over recent decades are projected to accelerate throughout the 21st century, reducing water availability, hydropower potential, and changing seasonality of flows in regions supplied by meltwater from major mountain ranges (e.g. Hindu-Kush, Himalaya, Andes), where more than one-sixth of the world population currently lives."
>
> This conclusion is robust, appropriate, and entirely consistent with the underlying science and the broader IPCC assessment. It has, however, recently come to our attention that a paragraph in the 938-page Working Group II contribution to the underlying assessment refers to poorly substantiated estimates of rate of recession and date for the disappearance of Himalayan glaciers. In drafting the paragraph in question, the clear and well-

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> established standards of evidence, required by the IPCC procedures, were not applied properly.
>
> The Chair, Vice-Chairs, and Co-chairs of the IPCC regret the poor application of well-established IPCC procedures in this instance. This episode demonstrates that the quality of the assessment depends on absolute adherence to the IPCC standards, including thorough review of "the quality and validity of each source before incorporating results from the source into an IPCC Report". We reaffirm our strong commitment to ensuring this level of performance.

First, as described in Response 2-3 below, this error concerns a single study, out of many that support the IPCC's conclusions regarding glacier recession. Second, EPA does not refer to this projection in the Endangerment Finding or supporting material. We acknowledge that the TSD mentions Himalayan glaciers; Table 16.1 of Section 16(b) ("Overview of International Impacts"), highlighting "examples" of international impacts, states (U.S. EPA, 2009):

> Glacier melt in the Himalayas is projected to increase flooding and rock avalanches from destabilized slopes and to affect water resources within the next two to three decades. This will be followed by decreased river flows as the glaciers recede.

This statement is entirely consistent with the IPCC's statement in its Synthesis Report (on page 49) (IPCC, 2007b), cited above, which the IPCC notes is "robust, appropriate, and entirely consistent with the underlying science and the broader IPCC assessment." EPA did not refer to a rate of recession or a timeframe in which the Himalayan glaciers would be gone.

This error represents one lapse in the deliberate preparation and review of a multi-volume assessment containing thousands of pages of findings and conclusions. Despite petitioners' claims to the contrary, the timing of glacier recession in the Himalayas has no impact on the scientific support for EPA's Endangerment Finding. As noted in Section 2.1.1, the Endangerment Finding states (Section III.D):

> The Administrator looked first at impacts in the United States itself, and determined that these impacts are reasonably anticipated to endanger the public health and the welfare of the U.S. population. That remains the Administrator's position, and by itself supports her determination of endangerment.

After careful review, the facts do not substantiate the petitioners' assertion that this error undercuts EPA's conclusion that the IPCC review process was 'rigorous' or that reliance on the IPCC, among other assessments, led to errors in EPA's Endangerment Finding.

Comment (2-3):
The Southeastern Legal Foundation questions the IPCC claim that the conclusions regarding Himalayan glaciers presented in the AR4 Synthesis Report are "robust, appropriate, and entirely consistent with the underlying science and the broader IPCC assessment" despite the erroneous projection. The Southeastern Legal Foundation states: "The IPCC has now grudgingly retracted

the claim of imminent Himalayan glacier melt, though it claims the overall conclusions regarding glacial melt are robust. How their conclusions can be fake but accurate is not evident."

Response (2-3):
Southeastern Legal Foundation is referring to the following conclusions in the IPCC's 2007 Synthesis Report (IPCC, 2007b, page 49):

> Climate change is expected to exacerbate current stresses on water resources from population growth and economic and land-use change, including urbanization. On a regional scale, mountain snow pack, glaciers and small ice caps play a crucial role in freshwater availability. Widespread mass losses from glaciers and reductions in snow cover over recent decades are projected to accelerate throughout the 21st century, reducing water availability, hydropower potential, and changing seasonality of flows in regions supplied by meltwater from major mountain ranges (e.g. Hindu-Kush, Himalaya, Andes), where more than one-sixth of the world population currently lives.

EPA has reviewed the complete discussion of this issue in the AR4, in the Synthesis Report, and in the contributions of Working Groups I (IPCC, 2007e) and II (IPCC, 2007g). The IPCC cites numerous studies that document Himalaya and other Asian glacier trends, projections, and impacts. For example, it references the following findings from a range of studies supporting its conclusion:

- Glaciers in the Asian high mountains have generally shrunk at varying rates (from Su and Shi, 2002; Ren et al., 2004; Solomina et al., 2004; Dyurgerov and Meier, 2005)—in IPCC Working Group I Chapter 4 (Lemke et al., 2007).

- The entire Hindu-Kush-Himalaya ice mass has decreased in the last two decades. Water supply in areas fed by glacial meltwater from the Hindu Kush and Himalayas, on which hundreds of millions of people in China and India depend, will be negatively affected (Barnett et al., 2005)—in IPCC Working Group II Chapter 3 (Kundzewicz et al., 2007).

- The Himalayan glacier Gangotri receded at an average rate of 7.3 meters every year from 1842 to 1935; from 1985 to 2001, it receded at a rate of 23 meters per year (Hasnain, 2002)—in IPCC Working Group II Chapter 10 (Cruz et al., 2007).

- Reductions in the mass of a sample of Northern Hemisphere glaciers (including several in Asia) of up to 60% are projected by 2050 (Schneeburger et al., 2003)—in IPCC Working Group II Chapter 3 (Kundzewicz et al., 2007).

- Rapid melting of glaciers can lead to flooding of rivers and the formation of glacial melt-water lakes, which may pose a serious risk of outburst floods (Coudrain et al., 2005)—in IPCC Working Group II Chapter 3 (Kundzewicz et al., 2007).

Thus, EPA finds that the single faulty projection highlighted by petitioners does not compromise the IPCC's overall assessment of observed glacier loss, projected glacier loss, and the impacts of glacier loss on water resources in the Himalayas. Numerous studies document a general decline in Himalayan glacier mass, project substantial future declines, and discuss the impacts of these

changes on water resources and society, which is consistent with the conclusions drawn by the IPCC. The petitioner's claim implies that the IPCC conclusion in the Synthesis Report depends upon a single study, without which we are uncertain as to the fate and timing of Himalayan glacier melt. The full discussion of this issue by the IPCC clearly demonstrates that the petitioners' argument is flawed and that the IPCC's conclusions are well-supported by the scientific literature.

2.1.4 Characterization of Climate Change and Disaster Losses

Comment (2-4):
Some petitioners raise concerns with certain aspects of the IPCC's treatment of climate change and natural disasters. The Southeastern Legal Foundation asserts that the IPCC mischaracterized the findings of a non-peer-reviewed study (Muir-Wood et al., 2006) on climate change and disaster losses. It states that the IPCC reported that global warming was causing an increase in losses from weather disasters of 2% per year, even after controlling for economic growth, citing the Muir-Wood study even though that study had actually found no trend. Along with the Southeastern Legal Foundation, the Competitive Enterprise Institute refers to an article in the *Sunday Times* (Leake, 2010b) indicating that the IPCC wrongly linked climate change to natural disasters. Southeastern Legal Foundation finds:

> The EPA Endangerment Finding relies heavily on the assertion that AGW [anthropogenic global warming] will cause extreme weather events to become more frequent and more severe and thus constitute a danger to human health and welfare—an essential element of the Finding. To support this assertion the Finding in turn relies heavily on the IPCC's reports on weather disasters.

Response (2-4):
To support the Endangerment Finding, EPA cited the potential impacts of climate change on the number and/or severity of certain extreme weather events, for which the Southeastern Legal Foundation levels no specific criticism. The TSD did not discuss the link between climate change and the historical trends in the economic magnitude of disaster losses. In responding to public comments on the issue (e.g., see Responses 7-5 and 7-38 in the Response to Comments [RTC] document), EPA acknowledged that many factors influence the economic losses caused by disasters which make it difficult to use historical data on trends in economic disaster loss to determine the impact of climate change on the losses from weather events in the past. Further, the Endangerment Finding is clear that the Administrator's decision was based on the physical and environmental impacts associated with climate change, and how they can affect the characteristics of weather events, not the link between climate change and disaster losses. As the Endangerment Finding states (Section I.A):

> The evidence concerning how human induced climate change may alter extreme weather events also clearly supports a finding of endangerment, given the serious adverse impacts that can result from such events and the increase in risk, even if small, of the occurrence and intensity of events such as hurricanes and floods.

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With respect to the Muir-Wood study, we neither cited nor relied upon it in our discussion of extreme events. In fact, our only specific reference to this study in the record for the Endangerment Finding is in Response 1-15 in the RTC documents, which addressed criticism of the IPCC's use of gray literature. The technical aspects of this study were not discussed because EPA did not focus on the relationship between climate change and the economic magnitude of disaster losses as underlying support for the Endangerment Finding. We note that the TSD did include a figure (TSD Figure 14.1) showing information on several factors, including one portion (panel e) on observed U.S. hurricane economic damages compared to a measure of Atlantic hurricane intensity. This figure was taken from the chapter on North America from Working Group II's contribution to the AR4 (Field et al., 2007, Figure 14.1); the TSD provides no commentary on the hurricane economic damages portion (panel e).

The controversy surrounding the relationship between climate change and economic losses from disasters did arise in public comments (e.g., see comments 7-5 and 7-38 in the RTC document), to which EPA provided measured, balanced responses consistent with the assessment literature. In comment 7-38, for example, the commenter argued that increasing raw damage totals associated with tropical storm (or hurricane) damage in coastal communities are not the result of climate change, but rather are caused by changes in coastal population, the wealth of the population, inflation, and poor sediment management practices. EPA responded:

> EPA agrees that the interaction of a series of drivers adversely impacts coastal areas and can contribute to tropical storm damage totals. These drivers include changes in coastal population, wealth of the population, inflation, and sediment management practices.

EPA's response then focused on the physical impacts of climate change that suggest increased risk to the public from severe weather events, pointing to the following findings from the assessment literature:

- Superimposed on accelerated sea level rise, the present storm and wave climatology and storm surge frequency distributions suggest more severe coastal flooding and erosion hazards (Nicholls et al., 2007).
- Higher sea level provides an elevated base for storm surges to build upon and diminishes the rate at which low-lying areas drain, thereby increasing the risk of flooding from rainstorms (CCSP, 2009a).
- Apart from nonclimatic events such as tsunamis, extreme sea levels occur mainly in the form of storm surges generated by tropical or extra-tropical cyclones. There is evidence for an increase in extreme high sea level since 1975 based upon an analysis of 99th percentiles of hourly sea level at 141 stations over the globe (Bindoff et al., 2007).

We also noted: "USGCRP concludes that future increases in losses will be attributable to climate change with high confidence as climate change increases the frequency and intensity of many types of extreme weather (Karl et al., 2009)." EPA agrees with this conclusion regarding losses in the future—if climate change causes an increase in the frequency or intensity of certain severe weather events, then it follows that climate change could lead to increased losses compared with what would occur without the increase in those severe weather events. However,

EPA did not focus on historical trends in the magnitude of economic disaster losses to evaluate the likelihood that climate change would lead to an increase in the number or frequency of such weather events. For that reason, the charge that the IPCC mischaracterized reports on the implications of such historical trends does not materially affect the basis for EPA's Endangerment Finding.

For its part, the IPCC responded to the allegation that it mischaracterized the Muir-Wood study on climate change and disaster losses with an official statement (IPCC, 2010e). The IPCC stated, among other things, that the *Sunday Times* article cited by Southeastern Legal Foundation and the Competitive Enterprise Institute:

> Incorrectly assumes that a brief section on trends in economic losses from climate-related disasters is everything the IPCC Fourth Assessment Report (2007) has to say about changes in extremes and disasters. In fact, the Fourth Assessment Report reaches many important conclusions, at many locations in the report, about the role of climate change in extreme events. The assessment addresses both observations of past changes and projections of future changes in sectors ranging from heat waves and precipitation to wildfires. Each of these is a careful assessment of the available evidence, with a thorough consideration of the confidence with which each conclusion can be drawn.

To summarize, petitioners do not properly characterize the information on which EPA relied in making the Endangerment Finding. Petitioners also mischaracterize the statements of the IPCC. The IPCC reasonably characterized the links between climate change and the projected increase in frequency and severity of severe weather events. The IPCC discussed the various types of evidence supporting this view, which include but are clearly not limited to consideration of the evidence for and against the ability to identify a climate change impact from the trend in economic magnitude of disaster losses, and the IPCC caveated its discussion of this issue. To support the Endangerment Finding, EPA cited the physical and environmental factors indicating that climate change would lead to an increase in frequency and severity of certain severe weather events. Only in response to public comments did EPA discuss what can be determined from analyses of past trends in disaster losses. Accordingly, EPA did not rely on a linkage between climate change and the economic magnitude of disaster losses to support the Endangerment Finding, and petitioners' arguments do not undermine the reasoning supporting EPA's Endangerment Finding.

Our response to a petitioner's specific claims regarding the Muir-Wood study is provided in Response 2-5, below.

Comment (2-5):
Southeastern Legal Foundation writes:

> The IPCC reported that global warming was causing an increase in losses from weather disasters of 2% per year, even after controlling for economic growth, citing a non-peer reviewed study by Robert Muir-Wood. Yet the IPCC mischaracterized the study, which actually found no trend and expressly eschewed the proposition for which it was cited.

> Muir-Wood *et al.* expressly caveated that the exceptionally strong hurricane seasons in 2004 and 2005 accounted for almost all of the 2% increase from 1970-2005.

Response (2-5):
First, while the version of the Muir-Wood et al. (2006) paper cited in the IPCC was not yet peer-reviewed, a subsequent version of this work was peer-reviewed and accepted for publication just weeks after the cutoff for inclusion in the IPCC, according to a statement by Risk Management Solutions (RMS), where Robert Muir-Wood is employed as a chief research officer. In a frequently asked questions document posted on its website (RMS, 2010), RMS states:

> The research was conducted during the first half of 2006 and the full paper summarizing the results was peer reviewed and accepted for publication in November 2006. This was a few weeks outside of the cut-off date for the IPCC 4th Assessment Report in October, which is why an earlier summary version of the paper—written for a scientific workshop held in May 2006 and published in the conference proceedings in October 2006—was referenced (the IPCC can only cite published material). Despite not being able to reference it, the IPCC was aware of the full report and that it had been accepted for publication before the 4th Assessment Report was finalized.
>
> While the paper was completed and accepted for publication in November 2006, delays in publication meant that it did not officially appear as a book chapter until 2008.

Second, the same frequently asked questions document (RMS, 2010) indicates that the IPCC did not mischaracterize the results of the paper:

> RMS believes the IPCC fairly referenced its paper, with suitable caveats around the results, highlighting the factors influencing the relationship that had been discovered between time and increased catastrophe costs. We believe it was appropriate to include the RMS paper in the report because, at that time, it was the only paper addressing global multi-peril catastrophe losses over time that had been normalized for changes in the values and exposure at risk.

Thus, we find the study to be valid. As discussed in Response 1-15 of the RTC document, the use of non-peer-reviewed literature is allowed under IPCC procedures. In this case, the paper was clearly a reasonable reference and was ultimately peer-reviewed. We further find the petitioner's discussion of the caveats in the Muir-Wood paper to be potentially misleading. The petitioner claims that "the IPCC mischaracterized the study" and states in the next sentence that "Muir-Wood *et al.* expressly caveated that the exceptionally strong hurricane seasons in 2004 and 2005 accounted for almost all of the 2% increase from 1970-2005." This could give the impression that the IPCC does not provide such caveats. An examination of the discussion in Working Group II's contribution to the IPCC AR4, however, reveals that it also caveats the 2% increase, stating (Rosenzweig et al., 2007): "The significance of the upward trend is influenced by the losses in the USA and the Caribbean in 2004 and 2005 and is arguably biased by the relative wealth of the USA, particularly relative to India."

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Comment (2-6):
Background: Southeastern Legal Foundation cites the following IPCC expert reviewer comment (IPCC, 2006c), which was submitted while the Working Group II report was in preparation and pertains to the IPCC's characterization of climate change and disaster losses and the Muir-Wood et al. (2006) study:

> I think this is inappropriate. It leads the reader into interpreting recent events in a particular way without providing supporting information. This suggestion, that the losses in 2004 and 2005 draw Pielke's results into question, needs to be supported with a reference or a solid in-chapter assessment. What does Pielke think about this? (Francis Zwiers, Canadian Centre for Climate Modelling and Analysis)

According to Roger Pielke Jr. (Pielke, 2010a), a professor of environmental studies at the University of Colorado, the expert reviewer, Zwiers, is referring to this passage in the AR4 (Rosenzweig et al., 2007):

> A previous normalisation of losses, undertaken for U.S. hurricanes by Pielke and Landsea (1998) and U.S. floods (Pielke et al., 2002) included normalising the economic losses for changes in wealth and population so as to express losses in constant dollars. These previous national U.S. assessments, as well as those for normalised Cuban hurricane losses (Pielke et al., 2003), did not show any significant upward trend in losses over time, but this was before the remarkable hurricane losses of 2004 and 2005.

The IPCC writing team responded to the Zwiers comment with the following: "I believe Pielke agrees that adding 2004 and 2005 has the potential to change his earlier conclusions – at least about the absence of a trend in US Cat losses" (IPCC, 2006c).

Comment: The Southeastern Legal Foundation claims that "The IPCC knew from the comments of reviewers that their use of the [Muir-Wood] study was wrong before the report was published." Citing a blog post from Roger Pielke Jr., Southeastern Legal Foundation suggests the IPCC fabricated its response to the expert reviewer, Zwiers:

> The IPCC reviewer had asked "What does Pielke think about this?" The answer given was a fabrication, according to Pielke, Jr. As he commented on his blog, "[N]ot only did the IPCC AR4 WGII egregiously misrepresent the science of disasters and climate change, but when questions were raised about that section by at least one expert reviewer, it simply made up a misleading and false response about my views."

Response (2-6):
It is unfortunate that Dr. Pielke found that his views were misrepresented by the IPCC. EPA cannot speculate how or why this happened. Dr. Pielke had the opportunity to comment on the IPCC's draft treatment of these issues as a reviewer, but did not. (He is officially listed as an IPCC Working Group II expert reviewer for the United States in Appendix III of the IPCC AR4 Working Group II report (IPCC, 2007f).

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The representative for the IPCC's author team wrote "I believe Pielke agrees," which suggests a possible honest misunderstanding of Dr. Pielke's views. This incident certainly does not support the petitioner's contention that the IPCC "knew" that its use of the Muir-Wood study was wrong. In fact, as discussed in the previous response (2-5), it is not at all clear that the study was wrong or was used inappropriately by the IPCC in any way.

At the time the Muir-Wood et al. study was completed in 2006, it was the only global analysis we are aware of that included 2004 and 2005 data. While it is true that Pielke Jr.'s remarks from the Seventh Annual Roger Revelle Commemorative Lecture contained an analysis of normalized Atlantic hurricane damages through 2005 and were published in *Oceanography* (Pielke, 2006), those remarks were not assessed by the IPCC, likely because they were presented as a lecture rather than a scientific study. Much of the scientific content of Dr. Pielke's talk was subsequently peer-reviewed and published in 2008 (Pielke et al., 2008), but this was well after the IPCC deadline for inclusion in the AR4. Furthermore, whereas Dr. Pielke's 2006 analysis in *Oceanography* limited its focus to Atlantic hurricanes, the Muir-Wood analysis was multi-hazard and global.

Thus, while the IPCC may have made mistaken assumptions about Dr. Pielke's views, its reliance on the Muir-Wood et al. (2006) study was reasonable, as that study contained the latest and most relevant published global analysis.

Comment (2-7):
The Southeastern Legal Foundation states that EPA's Response 1-15 (in Volume 1 of the RTC document, concerning the use of non-peer-reviewed literature) did not respond to the substance of the comment concerning the IPCC's and Climate Change Science Program's (CCSP's) misrepresentation of the literature and the central underlying point that there was no legitimate evidence that manmade climate change was causing an increase in weather disasters.

The Southeastern Legal Foundation notes: "This comment showed that both the IPCC and especially the CCSP had fraudulently asserted that AGW was causing increased frequency and severity of extreme weather events." It provides the following excerpt from the comment (3303):

> In 2007 the IPCC released its Fourth Assessment Report and it relied on the single non-peer reviewed Muir-Wood (2006) [9] study cherrypicked from the Hohenkammer workshop as the single study to highlight in its review of this topic. [12] The same critique of the Stern report's reliance on this Muir-Wood study above applies to the IPCC's reliance on it as well. Further, the IPCC included a graph [13] attempting to show how closely temperature anomalies match up with disaster losses, using a scaling of the axes to suggest a relationship where none has been shown in the peer-reviewed literature. Again it relies on Muir-Wood *(2005)*. Coincidentally, Robert Muir-Wood, of Risk Management Solutions, Inc., was an author of the chapter of the IPCC report that selectively highlighted his own non-peer reviewed work.
>
> The US Climate Change Science Program systematically and repeatedly misrepresented the science of disasters and climate change. First, the CCSP US extremes report [14] miscited several of Roger Peilke's papers in support of claims that they did not make and

> relied on Mills 2005 as the definitive source on this topic. [16] The disasters and climate change section of this CCSP report is also a fact checker's nightmare. Second the CCSP draft Synthesis report and final Synthesis report [15] relied on non-peer reviewed work by Evan Mills and ignored relevant peer reviewed research showing different results (in fact all peer reviewed research points in the same direction on this subject). Coincidentally, Evan Mills was an author of the CCSP Synthesis Report that highlights his own non-peer reviewed work. Mills also apparently consults for companies with an interest in climate policies, and yet this was not disclosed by the CCSP.

It then cites EPA's response (RTC 1-15):

> The commenter describes two pieces of literature that were referenced by IPCC but not published in peer reviewed journals: 1) a natural catastrophes report by Munich Re (2000) that was cited in IPCC Third Assessment Report (IPCC, 2001), and 2) a paper on trends in weather-related catastrophes by Muir-Wood et al. (2006). The identification of only two examples out of the thousands of references cited in the IPCC (2000) and (2007) reports provides more support for the rigor of the IPCC process. Further, these specific studies were neither the central nor sole evidence used in forming the broader conclusions of the IPCC; such broader conclusions are based on multiple lines of evidence and peer-reviewed literature.

On the basis of EPA's response, the Southeastern Legal Foundation concludes:

> It is a very peculiar logic that treats proof of what appears to be scientific fraud as demonstrating "the rigor of the IPCC's process." No response whatsoever is made to the substance of the comment concerning the CCSP's misrepresentation of the literature and the central underlying point that there was no legitimate evidence that manmade climate change was causing an increase in weather disasters. The question naturally arises as to why the EPA avoided these points. One of the lead authors of the CCSP report so vigorously attacked in Comment 3303 is Thomas Wilbanks, of the DOE Oak Ridge National Laboratory. The same Thomas Wilbanks was a Federal expert reviewer for the TSD. TSD p. 2. Thus, the EPA ignored and avoided the substance of a comment that pointed out that a report of which one of its expert reviewers was a lead author had "systematically and repeatedly misrepresented the science of disasters and climate change."

Response (2-7):
First, EPA's RTC document, Volume 1, covers EPA's "General Approach to the Science and Other Technical Issues," not the substantive issues pertaining to climate change and disaster losses. Those issues are discussed in RTC Volume 7, "Water Resources, Coastal Areas, and Ecosystems and Wildlife." Specifically, RTC 7-38 address substantive issues pertaining to climate change and disaster losses raised by commenters (as does RTC 7-5) as discussed in Response 2-4 above. Accordingly, EPA's commentary on the Muir-Wood literature in Volume 1 focuses on process issues, and the scientific issues are addressed in Volume 7.

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Furthermore, as we indicate in Response 2-5 above, a subsequent version of Muir-Wood et al. (2006) was, in fact, peer-reviewed and accepted for publication just weeks after the IPCC cutoff according to RMS. Irrespective of the peer review issue, we reiterate our conclusion from RTC 1-15: "…these specific studies were neither the central nor sole evidence used in forming the broader conclusions of the IPCC; such broader conclusions are based on multiple lines of evidence and peer-reviewed literature." The magnitude of observed disaster losses from extreme events in general, and the Muir-Wood study in particular, were not central to EPA's Endangerment Finding.

We discuss allegations that the IPCC misrepresented the literature on observed climate change and disaster losses in Response 2-5. With respect to the "graph [13, IPCC Supplementary Material Figure SM1.1, Working Group II AR4, 2007] attempting to show how closely temperature anomalies match up with disaster losses" referred to in the cited comment (3303) above, we note that said graph was not cited or relied upon in the Endangerment Finding and, furthermore, that it did not appear in the main IPCC Working Group II report but in supplementary material. We acknowledge this graph is controversial. RMS, for example, stated the following in its frequently asked questions document pertaining to climate change and disaster losses (RMS, 2010):

> A graph showing averaged global temperature and averaged catastrophe loss since 1970 was included in supplementary material rather than the IPCC report itself and was not itself published. RMS believes that the graph could be misinterpreted and should not have been included in these materials.

Despite this statement, the inclusion of one controversial graph in supplementary material does not compromise the IPCC's credibility or legitimacy.

The charges that CCSP (and hence USGCRP) miscited and misrepresented Roger Pielke Jr.'s work, over-relied on the work of Evan Mills, and ignored some other studies on the issue of climate change and disaster loss are difficult to assess as they were made in blog posts (of Roger Pielke Jr. (Pielke, 2010b)), represent the perspective of one individual (Roger Pielke Jr.), and have not been published in any official capacity (e.g., in the peer-reviewed literature). However, they do not materially affect the basis for EPA's Endangerment Finding. Dr. Pielke himself stated: "…I am of the view that the Obama Administration is perfectly justified in advancing the [Endangerment] finding" (Pielke, 2010b). As we state in Response 2-4, EPA did not focus on historical trends in the magnitude of economic disaster losses to evaluate the likelihood that climate change would lead to an increase in the number or frequency of extreme weather events. Furthermore, in RTC 7-5 we cite the CCSP (2008) statement acknowledging that the relative contribution of climate change and socioeconomic vulnerability (to weather and climate extremes) to observed increases in disaster costs are "subject to debate."

Finally, the fact that Robert Muir-Wood and Evan Mills were selected as authors for chapters in the IPCC and CCSP, respectively, and may have cited their own work does not delegitimize these assessments or their findings. Rather, it is only appropriate that leading experts on these topics—familiar with the range of literature—would be asked to assist in these assessments. Petitioners provide no evidence to support the allegation that Evan Mills' work was

compromised or biased; speculating that he "apparently" does consulting for companies "with an interest in climate policies" is innuendo, not proof.

Lastly, the fact that Thomas Wilbanks was an expert reviewer for EPA's TSD (U.S. EPA, 2009) and was lead author of a report that the petitioner alleges "systematically and repeatedly misrepresented the science of disasters and climate change" is irrelevant. As we state in Response 2-4, EPA did not discuss observed climate change and disaster losses in the TSD. Thus, though we discuss some of CCSP's conclusions in RTC 7-5 and 7-38 that focus on the challenges in linking observed climate change and disaster losses, CCSP's treatment of this issue was not and is not materially relevant to the Endangerment Finding. Furthermore, the petitioner does not present evidence Wilbanks played any role in the presentation of material on this issue. Thus, the charge that EPA "ignored and avoided" the substance of the comment on disasters and climate change because of Wilbanks is unsupported and false. EPA relied on a team of federal experts to ensure that EPA was correctly synthesizing the existing assessment literature in the TSD. As RTC 1-10 states:

> ….the purpose of the federal expert review was to ensure that the TSD accurately summarized the conclusions and associated uncertainties from the assessment reports. The federal experts were ideal candidates because they have contributed significantly to the body of climate change literature and played active roles in IPCC and CCSP—therefore making them experts on various aspects of climate science and very familiar with the underlying literature and state of the science. Furthermore, the federal climate change experts represent a range of technical specialties that span the range of topics covered in the TSD and covered by the range of topics that the Administrator needed to consider. In addition, the federal experts were not involved with developing the TSD or Findings in any way other than their review roles.

Petitioners are making a very serious accusation—that "what appears to be scientific fraud" occurred—without providing supporting scientific evidence. Instead, they mischaracterize EPA's actions in claiming that disaster losses are central to the Endangerment Finding when they clearly are not. They mischaracterize EPA's treatment of comments on the proposed Endangerment Finding by implying that we did not address the issues surrounding disaster losses, when the issue is clearly addressed in the appropriate volume of the RTC. And they impugn the integrity of several scientists, on the basis of speculation not evidence, seemingly for no other reason than that they disagree with the conclusions of the assessment literature.

2.1.5 Validity of Alps, Andes, and African Mountain Snow Impacts

Comment (2-8):
Several petitioners (the Competitive Enterprise Institute, the Ohio Coal Association, Peabody Energy, the State of Texas, and the Southeastern Legal Foundation) argue that claims of glacier melt in the Andes, the Alps, and parts of Africa arise from anecdotal comments in a magazine article and a master thesis. They challenge the IPCC's use of this non-peer-reviewed literature, suggesting the findings may be suspect. The Southeastern Legal Foundation states: "The EPA should reconsider its reliance on the IPCC's reporting now that the IPCC's conclusion has been shown to be so poorly supported."

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Response (2-8):
The citations referred to by petitioners regarding the reduction of mountain ice in the Andes, Alps, and Africa are actually references to "loss of ice climbs," not assessments of mountain glacier retreat. Loss of ice climbs is an example of the observed effects of warming on the ice-covered areas of the Earth. In this context, these citations are appropriate and within the IPCC's guidelines on the use of so-called gray literature. They provide additional evidence consistent with the well-supported peer-review conclusions that snowpack is declining in many places and that glaciers are melting worldwide. Note that we respond to petitioners' broader claims regarding the IPCC's use of gray literature in Subsection 2.2.4.4.

Furthermore, as the finding in question pertains to indicators outside the United States, the petitioners' claims are not relevant to the Endangerment Finding. As noted in Subsection 2.1.1, the Endangerment Finding states (Section III.D): "The Administrator looked first at impacts in the United States itself, and determined that these impacts are reasonably anticipated to endanger the public health and the welfare of the U.S. population. That remains the Administrator's position, and by itself supports her determination of endangerment."

EPA did not rely on these specific references or refer to "loss of ice climbs" as an indicator of climate change. Our primary focus was on the implications of climate change for the United States, and we relied on peer-reviewed literature to assess these impacts. We did not refer to this specific issue in either the TSD or the Endangerment Finding, and we did not include any discussion on "loss of ice climbs." The TSD does include discussion of mountain glacier retreat, based on peer-reviewed literature, which the petitioners do not critique.

2.1.6 Validity of Amazon Rainforest Dieback Projection

Comment (2-9):
Several petitioners (the Competitive Enterprise Institute, the Ohio Coal Association, Peabody Energy, the State of Texas, the Southeastern Legal Foundation) challenge the IPCC's statement that "[U]p to 40% of the Amazonian forests could react drastically to even a slight reduction in precipitation," alleging that it arises from gray literature and cannot be substantiated. The Southeastern Legal Foundation states that the source for the IPCC's statement, Nepstad et al. (1999) from the journal *Nature,* "does not support the IPCC's assertion". Peabody states that "the Nature article does not contain the 40% figure" and "the provenance of the IPCC's striking '40%' figure is uncertain." The Competitive Enterprise Institute finds that "the IPCC claim that the findings in AR4 are based on peer reviewed science is false."

Response (2-9):
First, we note that this issue is not discussed anywhere in the TSD or Endangerment Finding, and is thus of little relevance to the Finding. Second, while we agree that the IPCC cited gray literature in this case—i.e., Rowell and Moore (2000), a report of the World Wildlife Federation—we note that the underlying studies supporting the Rowell and Moore report are, in fact, peer-reviewed.

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In response to the publicity surrounding this purportedly unsubstantiated finding in the IPCC AR4, Daniel Nepstad—a senior scientist at Woods Hole Research Center and author of the study (Nepstad et al., 1999) that contained the finding referred to by Rowell and Moore—issued a statement on this matter. In the statement, he noted that the citations listed in the Rowell and Moore report were incomplete but that the AR4's statement on Amazon forest susceptibility to rainfall reduction was correct. Here is the relevant excerpt from his statement (Nepstad, 2010):

> The IPCC statement on the Amazon is correct, but the citations listed in the Rowell and Moore report were incomplete. (The authors of this report interviewed several researchers, including the author of this note, and had originally cited the IPAM website where the statement was made that 30 to 40% of the forests of the Amazon were susceptible to small changes in rainfall). Our 1999 article (Nepstad et al. 1999) estimated that 630,000 km2 of forests were severely drought stressed in 1998, as Rowell and Moore correctly state, but this forest area is only 15% of the total area of forest in the Brazilian Amazon. In another article published in Nature, in 1994, we used less conservative assumptions to estimate that approximately half of the forests of the Amazon depleted large portions of their available soil moisture during seasonal or episodic drought (Nepstad et al. 1994). After the Rowell and Moore report was released in 2000, and prior to the publication of the IPCC AR4, new evidence of the full extent of severe drought in the Amazon was available. In 2004, we estimated that half of the forest area of the Amazon Basin had either fallen below, or was very close to, the critical level of soil moisture below which trees begin to die in 1998. This estimate incorporated new rainfall data and results from an experimental reduction of rainfall in an Amazon forest that we had conducted with funding from the US National Science Foundation (Nepstad et al. 2004). Field evidence of the soil moisture critical threshold is presented in Nepstad et al. 2007.

Specifically, we note that the Nepstad et al. (2004) study states: "Increases in ET [evapo-transpiration] of only 15% or similar reductions in rainfall can lead to severe soil moisture deficits over roughly half of the Amazon." This statement certainly is consistent with the statement "Up to 40% of the Amazonian forests could react drastically to even a slight reduction in precipitation" in the IPCC AR4.

Nepstad's 2010 statement in response to this controversy reached the following conclusion (Nepstad, 2010):

> In sum, the IPCC statement on the Amazon was correct. The report that is cited in support of the IPCC statement (Rowell and Moore 2000) omitted some citations in support of the 40% value statement.

Similarly, in its report *Assessing an IPCC Assessment*, PBL (2010a) identified a problem with the IPCC's referencing of this finding, but not the finding itself. It states:

> More adequate peer-reviewed, scientific journal literature would have been available to support this statement, such as Cox et al. (2000; 2004) (C6). This minor comment has no consequences for the IPCC conclusions in the various Summaries for Policymakers.

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Finally, the United Kingdom's *Sunday Times* newspaper, which reported the alleged problem with the IPCC's representation of this issue on January 31, 2010 (Sunday Times, 2010), has subsequently reversed itself, arriving at the same conclusion as Nepstad. Consequently, it removed the article from its website and printed a correction on June 20, 2010 (Sunday Times, 2010), which stated in part:

> The article "UN climate panel shamed by bogus rainforest claim" (News, Jan 31) stated that the 2007 Intergovernmental Panel on Climate Change (IPCC) report had included an "unsubstantiated claim" that up to 40% of the Amazon rainforest could be sensitive to future changes in rainfall. The IPCC had referenced the claim to a report prepared for the World Wildlife Fund (WWF) by Andrew Rowell and Peter Moore, whom the article described as "green campaigners" with "little scientific expertise." The article also stated that the authors' research had been based on a scientific paper that dealt with the impact of human activity rather than climate change.
>
> In fact, the IPCC's Amazon statement is supported by peer-reviewed scientific evidence. In the case of the WWF report, the figure had, in error, not been referenced, but was based on research by the respected Amazon Environmental Research Institute (IPAM) which did relate to the impact of climate change. We also understand and accept that Mr Rowell is an experienced environmental journalist and that Dr Moore is an expert in forest management, and apologise for any suggestion to the contrary.

To summarize, contrary to the assertions of the petitioners, though the IPCC may have not adequately referenced the Amazon finding, the basis for its statement originated from and is supported by peer-reviewed literature. Furthermore, as this finding is specific to the Amazon region, petitioners' claims are not relevant to the Endangerment Finding. As noted in Subsection 2.1.1, the Endangerment Finding states (Section III.D): "The Administrator looked first at impacts in the United States itself, and determined that these impacts are reasonably anticipated to endanger the public health and the welfare of the U.S. population. That remains the Administrator's position, and by itself supports her determination of endangerment."

For further discussion on petitioners' broader claims regarding the IPCC's use of gray literature, please refer to Subsection 2.2.4.4.

2.1.7 Validity of African Rain-Fed Agriculture Projection

The comments and responses in this section refer to the following statement pertaining to crop yields in Africa from Chapter 9 of Working Group II's contribution to the IPCC AR4 (Boko et al., 2007):

> In other countries [of Africa] additional risks that could be exacerbated by climate change include greater erosion, deficiencies in yields from rain-fed agriculture of up to 50% during the 2000-2020 period, and reductions in the crop growth period (Agoumi, 2003).

A version of this statement appeared in the IPCC's AR4 Synthesis Report (IPCC, 2007b):

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> By 2020, in some countries, yields from rain-fed agriculture could be reduced by up to 50%. Agricultural production, including access to food, in many African countries is projected to be severely compromised. This would further adversely affect food security and exacerbate malnutrition.

A similar statement also appeared in the IPCC's AR4 Working Group II Summary for Policymakers (IPCC, 2007c):

> Agricultural production, including access to food, in many African countries and regions is projected to be severely compromised by climate variability and change. The area suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, are expected to decrease. This would further adversely affect food security and exacerbate malnutrition in the continent. In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020.

The same statement (from IPCC, 2007c) was incorporated into EPA's TSD (U.S. EPA, 2009) within Table 16.1: "Examples of Key Regional Impacts as Identified by IPCC."

Comment (2-10):
The Competitive Enterprise Institute, the Ohio Coal Association, Peabody Energy, and the Southeastern Legal Foundation take issue with a statement in Section 16(b) of the TSD that: "In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020." They claim the statement originated from gray literature in the IPCC AR4 and is therefore illegitimate. Southeastern Legal Foundation concludes: "The African Crop Yields claim stands as another example of the IPCC making a claim of imminent disaster that inappropriately relied on non-peer-reviewed literature…"

Response (2-10):
The IPCC statement cites a report by Dr. Ali Agoumi, a climate expert from Morocco (Agoumi, 2003) that was published by the International Institute for Sustainable Development (IISD) and funded by the government of Canada, the U.S. Agency for International Development, and other public and private institutions. Based on EPA's review of the report, it appears that the 50% number was not obtained from the peer-reviewed literature but rather from "vulnerability studies on three North African countries (Algeria, Morocco and Tunisia) with respect to climatic changes." These vulnerability studies were prepared under the U.N. Environment Programme Global Environment Fund and included in the National Communications of these three countries to the U.N. Framework Convention on Climate Change (Ministry of Territory Development and Environment, 2001, Kingdom of Morocco, 2001 and Republic of Tunisia, 2001).

In response to publicity regarding this purportedly unsubstantiated statement in the IPCC report, Dr. Coleen Vogel, a contributing lead author of the IPCC chapter on Africa impacts, described the context in which Dr. Agoumi's research was used. She explained that Agoumi's report received rigorous scrutiny by her fellow authors and was thoroughly discussed during development of the chapter (Kretzmann, 2010). She explained that the decision to include this (gray literature) study was based on the paucity of peer-reviewed material relating to some parts

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of the world, particularly Africa, and the desire of the authors of the report to provide balanced information. The process described by Dr. Vogel is consistent with the IPCC's guidance on the use of gray literature, as previously described in Volume 1 of the RTC document and further discussed in Subsection 2.2.4.4 of this Response to Petitions (RTP) document.

Finally, we note that this statement relates to impacts outside the United States, and it did not materially impact the determination of endangerment of public health and welfare in the United States. As noted in Subsection 2.1.1, the Endangerment Finding states (Section III.D): "The Administrator looked first at impacts in the United States itself, and determined that these impacts are reasonably anticipated to endanger the public health and the welfare of the U.S. population. That remains the Administrator's position, and by itself supports her determination of endangerment."

Comment (2-11):
Referring to an analysis published by Ben Pile, co-editor of the blog climateresistance.org (on the blog of Roger Pielke, Jr.) (Pile, 2010), the Southeastern Legal Foundation states that the primary reference supporting the IPCC's statement on African crop yields "Vulnerability of North African Countries to Climatic Changes" (Agoumi, 2003) was from IISD, an advocacy group.

Regarding the IISD reference, Peabody Energy states:

> Thus, the EPA based its findings on the IPCC WGII report, which based its findings on a report [the IISD report] published by an organization with a declared political interest in climate change that based its findings from an assessment of other non-peer reviewed national studies. This is not the way EPA science should be carried out.

Response (2-11):
The implication that the credibility of IPCC's statement on African crop yields is diminished because the IPCC's source (Agoumi, 2003) for the statement was published by an advocacy organization or an organization with a "declared political interest in climate change" is unsupported. The organization in question is IISD, which describes itself as follows:

> The International Institute for Sustainable Development contributes to sustainable development by advancing policy recommendations on international trade and investment, economic policy, climate change, measurement and indicators, and natural resource management. By using Internet communications, we report on international negotiations and broker knowledge gained through collaborative projects with global partners, resulting in more rigorous research, capacity building in developing countries and better dialogue between North and South.
>
> IISD's vision is better living for all—sustainably; its mission is to champion innovation, enabling societies to live sustainably. IISD receives operating grant support from the Government of Canada, provided through the Canadian International Development Agency (CIDA) and Environment Canada, and from the Province of Manitoba. The institute receives project funding from the Government of Canada, the Province of

Manitoba, other national governments, United Nations agencies, foundations and the private sector. IISD is registered as a charitable organization in Canada and has 501(c)(3) status in the United States.

We find no reason to question the credibility and legitimacy of information produced by this organization on the basis of either its mission or funding sources. Moreover, neither the Southeastern Legal Foundation nor Peabody Energy provide any support for the implication that work by an organization such as IISD is automatically suspect or flawed.

Finally, Peabody Energy's statement that EPA's findings are based on this material is incorrect. As noted in Subsection 2.1.1, the Endangerment Finding states (Section III.D): "The Administrator looked first at impacts in the United States itself, and determined that these impacts are reasonably anticipated to endanger the public health and the welfare of the U.S. population. That remains the Administrator's position, and by itself supports her determination of endangerment."

We discuss the legitimacy of the science and underlying references for the African crop yields statement in Response 2-12.

Comment (2-12):
The Southeastern Legal Foundation alleges that EPA uncritically adopted the IPCC's "faulty conclusion" with respect to crop yields. It refers to a blog by writer/commentator Richard North (North, 2010) to conclude the Agoumi (2003) reference cited by the IPCC on the issue of rain-fed agricultural yields in Africa relies on studies that "do not support the proposition for which they are cited."

Relying on Richard North's blog, the Southeastern Legal Foundation summarizes the vulnerability studies cited by Agoumi (2003) from the National Communications of Morocco, Tunisia, and Algeria. The Southeastern Legal Foundation notes that the Morocco National Communication "lends some support [to the Agoumi reference], saying that by 2020 during drought conditions cereal yields would decline up to 50%" but that "the data apply to cereal yields only, not crops in general as is implied by the IPCC." The Southeastern Legal Foundation further states that "Algeria's report said their yields would double, and be trimmed only slightly by 'climate change'" and "Tunisia's submission concluded the picture was mixed, but they could have an increase in rain and agricultural production."

Response (2-12):
The IPCC's statement on rain-fed agriculture in Northern Africa is not "faulty" and the Southeastern Legal Foundation presents no evidence that it was included uncritically in EPA's TSD. Furthermore, the Southeastern Legal Foundation's portrayal of findings on climate and crop yields from the National Communications of Morocco, Tunisia, and Algeria derived from Richard North's blog is not complete. When all of the information in these National Communications is considered, we find there is broad support for Agoumi's (2003) statements on North African rain-fed agriculture, which are:

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- "Some of the key statistics regarding water, soil, urban areas and coastal zones are outlined below. . . . Decreasing rain-based agricultural yields with grain yields reduced by up to 50 percent in periods of drought."

- "Studies on the future of vital agriculture in the region have shown the following risks, which are linked to climate change: . . . deficient yields from rain-based agriculture of up to 50 percent during the 2000–2020 period."

PBL, in its report *Assessing an IPCC Assessment* (PBL, 2010a), makes the following important point with respect to IPCC's statement on rain-fed agriculture in Africa:

> This statement is not directly a statement on climate change, but on climate variability: in individual years, droughts can cause up to 50% in yield reductions. The implicit message here is that when droughts would become more frequent due to climate change, more years with up to 50% in yield reductions would occur. The statement could easily mislead readers into thinking that average annual yields could be reduced by up to 50% due to climate change. In the Summary for Policymakers of the Working Group II Report, the paragraph that contains this statement starts with a sentence introducing the notion of climate variability, which puts the statement more into context.

It is possible that petitioners misinterpreted the IPCC's statement as suggesting that the IPCC's projection was on the basis of climate change alone, given the Southeastern Legal Foundation's assertion, for example, that IPCC was projecting "imminent disaster." While we agree with PBL that the IPCC's statement could easily mislead readers without the proper context, we note that, before quoting the IPCC's projection on rain-fed agriculture, EPA's TSD includes the statement "Agricultural production, including access to food, in many African countries and regions is projected to be severely compromised by **climate variability** [emphasis added] and change." Therefore, EPA provided the proper context for the IPCC's conclusion.

With respect to the basis for the conclusion itself, the following excerpts from the three countries' National Communication reports on the issues of climate variability and change, precipitation, and crop yields provide broad support for the Agoumi (2003) statements along with accompanying discussion:

- The National Communication of Morocco states (Kingdom of Morocco, 2001):

  > The development of climate scenarios for Morocco according to IPCC methodology reveals the following results: . . .
  >
  > - A trend towards a decrease in average annual rainfall volume by about 4% in 2020 compared to 2000 levels. . . .
  > - An increase in the frequency and intensity of droughts in the south and the east of the country.

> The first quantitative estimate of possible CC [climate change] impacts on water resources in 2020 points to the fact that there would be an average and general decrease in water resources (in the order of 10 to 15 %...).
>
> The study of CC [climate change] impacts on agriculture (dominated by cereal cultivation) in 2020 unfolds the following results: A decrease in cereal yields by 50% in dry years and 10% in normal years.

As the Southeastern Legal Foundation admits, the numbers from Morocco's National Communication lend support to the statement in Agoumi (2003) that "studies on the future of vital agriculture in the region have shown the following risks, which are linked to climate change: . . . deficient yields from rain-based agriculture of up to 50 per cent during the 2000–2020 period."

Richard North's contention (North, 2010, as referred to by the Southeastern Legal Foundation) that "the data apply to cereal yields only, not crops in general as is implied by the IPCC" is arguable considering that Morocco's National Communication indicates that agriculture is "dominated by cereal cultivation." Thus, it is not unreasonable to use cereal cultivation as a proxy for all of agriculture in this cereal-crop-dominated region.

- The National Communication of Algeria (Ministry of Territory Development and Environment, 2001) states:[1]

> Because of global warming, we must brace ourselves for chronic climate instability and greater frequency of droughts and floods. Droughts damage soils and floods destroy ground cover and contribute to the erosion of soils. With longer spans of time between dry and wet spells comes an even greater impact due to erosion. The southern regions of the country will be most directly impacted by increased temperatures and will be subject to the numerous consequences of accelerated desertification. The increased risk of drought presents the greatest challenge as a result of climate change. The Intergovernmental Panel on Climate Change (IPCC) expect that the desert regions will extend northward in the Maghreb.

The above text provides a clear qualitative description of the risks climate change pose to agriculture in Algeria. In addition, this information from the National Communication of Algeria provides quantitative output from a model known as CROPWAT, which estimates changes in crop yields using climate change projections obtained from two general circulation models. The National Communication of Algeria reports:

> … one can consider an average reduction in the output cereal of about 5.5 to 6.8%, corresponding mainly to instances of climate change [in 2020](Ministry of Territory Development and Environment, 2001)

[1] The excerpt that follows was professionally translated from French.

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When considering these quantitative cereal yield changes, it is very important to note that these percentages refer to changes in cereal yields resulting primarily from climate change alone and not *climate variability and change* combined. The climate and hence precipitation variability in northern Africa can be quite large. For example, in the report *Assessing an IPCC Assessment* (PBL, 2010a), PBL states "…the [IPCC] authors made plausible that, due to current climate variability, the yields in Algeria, Morocco and Tunisia have been varying annually, including yield reductions of nearly 70% in individual years, in the period between 2000 and 2006."

In other words, if these yield reductions resulting from greenhouse gas–induced climate change were superimposed on the yield reductions that might occur during a particularly dry period arising from the region's characteristic precipitation variability, they would be higher and comparable with the results from the Morocco National Communication.

Finally, the Southeastern Legal Foundation's reference to the Algeria National Communication's projections for net increases in cereal projections in 2020 (relative to prior decades) is irrelevant and misleading. These increases are related not to climate variability and change but to changing agricultural practices and technology. Algeria's National Communication makes clear that the effect of climate change on cereal yields is projected to be negative.

- The National Communication of Tunisia states (Republic of Tunisia, 2001):

> …Tunisia is in a hydrous stress situation close to a shortage, sharpened by a high anthropic pressure. So minor they be, the Climate Changes can so, result in harmful consequences on water resources, on ecosystems depending of water, and on the different economic activities that need large quantities of water such as agriculture and tourism.
>
> By modifying the evaporation and precipitation rate, the global warming will probably affect the hydrous climate balance and therefore the Tunisian water resources. In this way, if the intensification of the evaporation can lead to a possible important increase of the rain falls, it might not be sufficient to offset the decrease of the sweet water resources. Moreover, due to the global warming, the rain situation can be characterized by a bigger frequency of rains resulting from torrential storms and downpours, disappearing generally in streaming waters rather than be absorbed by the soils.

This information in the Tunesian National Communication does not provide any quantitative estimates of climate variability and/or change on rain-fed agriculture, but the clear qualitative implication is that climate changes—both drought and heavy precipitation events—will stress agriculture in Tunisia. We, therefore, find that the Southeastern Legal Foundation's statement that "Tunisia's submission concluded the picture was mixed, but they could have an increase in rain and agricultural production" is an overly optimistic interpretation of clearly expressed negative impacts.

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Overall, these three National Communications (Morocco, Algeria, and Tunisia) provide qualitative support for the fact the climate change will likely stress rain-fed agriculture in northern Africa, consistent with the portrayal of Agoumi (2003) and the IPCC. The National Communication of Morocco presents quantitative information consistent with what is reported by Agoumi (2003) and the IPCC (and hence the TSD), while the National Communication of Algeria provides quantitative information that is consistent with these sources when factoring in precipitation variability in addition to climate change. The National Communication of Tunisia does not provide quantitative information.

Our view of the literature behind Agoumi (2003) provides considerable evidence that the scientific basis for the IPCC's conclusion is legitimate. The PBL assessment of the IPCC notes that "…additional explanations could have provided further foundations for the statement, had they been included in [IPCC's Working Group II] Chapter 9." We concur, but the Southeastern Legal Foundation conclusion that "…there is no support for the IPCC's dramatic pronouncement on African crop yields" is significantly overstated.

Comment (2-13):
The Southeastern Legal Foundation provides the following reaction to the African rain-fed agriculture projection, which appeared in the *Sunday Times* (Leake, 2010a) and comes from former IPCC chair Robert Watson: "Any such projection [pertaining to African crop yields] should be based on peer-reviewed literature from computer modeling of how agricultural yields would respond to climate change. I can see no such data supporting the IPCC report."

Response (2-13):
Watson may not have appreciated that peer-reviewed modeling studies of climate change impacts on agriculture in parts of Africa are limited. As the IPCC's AR4 WGI report states (Christensen et al., 2007): "Several climate change projections based on RCM (regional climate model) simulations are available for southern Africa, but are much scarcer for other regions." Accordingly, as we discuss in Subsection 2.2.4.4 of this RTP document, the IPCC references gray literature in these circumstances. We also note in Response 2-10 that these studies are not central to the TSD or the Endangerment Finding. Finally, though we discuss some additional modeling studies pertinent to Africa in RTP 2-15, those modeling studies (Parry et al., 2005 and Hulme et al., 2001) were conducted at the global and continental scales and contain limited results pertinent to northern Africa specifically.

Comment (2-14):
The Southeastern Legal Foundation states that EPA ignored contrary peer-reviewed literature and submits literature that the Sahel is greening (from *National Geographic* and several studies) in contrast to "IPCC horror stories" (projecting reductions in rain-fed agriculture).

Response (2-14):
EPA is aware of the literature cited by the petitioner that suggests greening in parts of the Sahara and Sahel (e.g., Seaquisti, et al., 2009; Anyamba, and Tucker, 2005; Hutchinsonet al., 2005; Olsson et al., 2005). The issue raised by petitioners is not new and was raised and responded to through the public comment process (see Response 2-73 in Volume 2 of the RTC document). Thus, these objections do not meet the test in Clean Air Act (CAA) Section 307(d)(7)(B) that it be impracticable to raise the objection during the public comment period or the reasons for the

objection arose between June 24, 2009, and February 16, 2010. Nonetheless, we have reviewed these arguments and respond once again.

The fact that precipitation has increased recently in this region, as we note in our TSD in Section 4(d), does not mean that a combination of climate variability and change could not substantially reduce rain-fed agriculture in the future. The climate in this region is highly variable and while it has been relatively wet over the past decade or so, severe drought impacted the region for several decades from the 1960s to the 1990s and dry patterns could return to the region. As one of the studies (Nicholson, 2005) cited by the petitioner states: "The fluctuations between 'wet' and 'dry' in the Sahel/Soudan zones are extreme even on decadal and multi-decadal time scales." Therefore, if the current wet period reverses to a dry period, the impacts of rain-fed agriculture on the region could be profound, especially when considering the potential enhancement of the drying from human-induced warming (i.e., climate change).

Finally, we note that the literature presented relates to impacts outside the United States, and it did not materially impact the determination of endangerment of public health and welfare in the United States. As noted in Subsection 2.1.1, the Endangerment Finding states (Section III.D): "The Administrator looked first at impacts in the United States itself, and determined that these impacts are reasonably anticipated to endanger the public health and the welfare of the U.S. population. That remains the Administrator's position, and by itself supports her determination of endangerment."

Comment (2-15):
The Southeastern Legal Foundation suggests that the IPCC ignored literature that drew different conclusions on the issue of rain-fed agriculture projections in Africa, specifically referring to two studies: Parry et al., 2005 and Hulme et al., 2001. The Southeastern Legal Foundation states: "Both Parry's own paper and Hulme's paper were known to and available to Professor Parry [co-chair of IPCC Working Group II] in composing the WGII Report and the Synthesis Report. Yet, Parry's WGII report ignored his own paper and that of Hulme, which did not predict disaster, and instead relied on one that did, the Agoumi paper, even though it did so incorrectly and improperly and was not peer-reviewed." The Southeastern Legal Foundation further notes that Hulme et al. (2001) were careful to note uncertainties in understanding African climate change, and implies that the IPCC was not as careful.

Response (2-15):
We have reviewed these papers (Parry et al., 2005, and Hulme et al., 2001) and find that, while not directly comparable with Agoumi (2003), they do not contradict that source. We also find, contrary to the Southeastern Legal Foundation's assertion, that both of these studies were in fact cited by the IPCC, although not always in the same section or context as Agoumi (2003).

The Parry et al. (2005) study reports the results of a series of research projects that aimed to evaluate the implications of climate change for food production and risk of hunger. The analysis in this study is performed at global and continental scales rather than the regional scale. This is likely why it is not discussed in Chapter 5 of Working Group II's contribution to the AR4 (Easterling et al., 2007), where Agoumi (2003) is cited in a section focusing on regional impacts in Africa (specifically on Morocco, Algeria, and Tunisia). The Parry et al. (2005) study is cited

multiple times in Chapter 5 of Working Group II's contribution ("Food, Fiber, and Forest Products," Easterling et al., 2007), which provides a global perspective. Therefore, Parry did not "ignore his own paper" as stated by the Southeastern Legal Foundation.

One of the primary conclusions of Parry et al. is that "the region of greatest risk [of losses in food production, and hunger due to climate change] is Africa." Parry et al. (2005) provide specific cereal yield projections for the 2020s and 2080s resulting from different GHG emission scenarios. They state for the globe: "By the 2020s, small changes in cereal yield are evident in all scenarios, but these fluctuations are within historical variations." For the 2080s, Parry et al. (2005) provide projections specific to Africa – but not northern Africa specifically, stating that climate change could reduce cereal yields by up to 30%. Importantly, the changes in cereal yield projected for the 2020s and 2080s are driven by GHG-induced climate change and likely do not fully capture interannual precipitation variability which can result in large yield reductions during dry periods, as the IPCC (Christensen et al., 2007) states: "…there is less confidence in the ability of the AOGCMs (atmosphere-ocean general circulation models) to generate interannual variability in the SSTs (sea surface temperatures) of the type known to affect African rainfall, as evidenced by the fact that very few AOGCMs produce droughts comparable in magnitude to the Sahel droughts of the 1970s and 1980s." Given the different scopes of the two analyses, it is misleading to state that the Parry et al. projections are inconsistent with the Agoumi (2003) yield projections.

The Hulme et al. (2001) study, which reviews observed (1900–2000) and possible future (2000–2100) continent-wide changes in temperature and rainfall over Africa, is also not ignored by the IPCC, contrary to the assertion of the petitioner. In fact, it is cited twice in IPCC's Working Group II Chapter 9 on Africa (Boko et al., 2007):

- Hulme et al. (2001) is cited in a statement about the complexity of African climatology: "Other factors that complicate African climatology include dust aerosol concentrations and sea-surface temperature anomalies, which are particularly important in the Sahel region (Hulme et al., 2001; Prospero and Lamb, 2003) and southern Africa (Reason, 2002), deforestation in the equatorial region (Semazzi and Song, 2001; Bounoua et al., 2002)…"

- Hulme et al. (2001) is also cited in a statement pertaining to uncertainties in precipitation projections in the western Sahel (Boko et al., 2007): "For the western Sahel (10 to 18°N, 17.5°W to 20°E), there are still discrepancies between the models: some projecting a significant drying (e.g., Hulme et al., 2001; Jenkins et al., 2005) and others simulating a progressive wetting with an expansion of vegetation into the Sahara (Brovkin, 2002; Maynard et al., 2002; Claussen et al., 2003; Wang et al., 2004; Haarsma et al., 2005; Kamga et al., 2005; Hoerling et al., 2006)."

These examples demonstrate that the IPCC both cited Hulme et al. (2001) and transparently discussed the complexity of Africa's climate and the uncertainty in African climate projections. This treatment is appropriate and reasonable, contrary to the petitioner's implication.

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Even in light of the complexities and uncertainties, Hulme et al. (2001) state that a "warming climate will nevertheless place additional stresses on water resources [in Africa], whether or not future rainfall is significantly altered" and they project reduced precipitation over Tunisia. Hulme et al. (2001) do not, however, provide projections for changes in cereal yields (from changes in rain-fed agriculture), so their results cannot be compared directly with Agoumi (2003) or its supporting documents (discussed in Response 2-12).

Overall, the IPCC does not ignore either the Parry et al. (2005) or Hulme et al. (2001) studies. The findings of these studies, while not directly comparable with Agoumi (2003), are broadly consistent. Hulme et al. (2001) project increased drying over northern Africa while Parry et al. (2005) project an increased risk of reduced cereal yields over all of Africa. The petitioner's claim that IPCC was not careful or acted inappropriately in this regard is not confirmed by careful review of the material.

2.1.8 Summary

The small number of real or alleged errors in the IPCC report is not materially relevant for EPA's Endangerment Finding. Neither of the two errors that are verifiable (the percentage of the Netherlands below sea level and the projections for Himalayan glaciers) is relevant to the United States and neither is contained within EPA's endangerment record. Although it is unfortunate when any error occurs, two errors in a nearly 3,000-page study are not evidence of a complete breakdown of the IPCC's review process, contrary to petitioners' suggestions.

The remaining alleged errors or unsupported statements have not been shown to be erroneous and can be traced to findings in the gray literature from which they were derived. As discussed further in Subsection 2.2.4.4 in this volume and previously in Volume 1 of the RTC, the IPCC provides guidance on how and when to use gray literature, and petitioners do not demonstrate that the guidance was not followed. There is no de facto assumption that all gray literature is incorrect or suspect, and an examination of the instances raised by petitioners demonstrates that the specific allegations of petitioners are unfounded. Furthermore, the statements at issue drawn from the gray literature have no material relevance to conclusions supporting EPA's Findings, as explained in RTP Subsection 2.1.1.

In conclusion, the evidence cited by petitioners does not undermine the overall credibility and reliability of the scientific conclusions relied upon and underlying EPA's Endangerment Finding.

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2.2 Claims That the IPCC Has a Policy Agenda and Is Not Objective and Impartial

2.2.1 Overview

Several petitioners argue that the e-mails from the University of East Anglia's Climatic Research Unit (CRU), and other information that has arisen since publication of the Endangerment Finding, show that a select group of influential authors who wrote, contributed to, or reviewed parts of IPCC assessment reports (or the studies on which the assessment reports were based) were not objective and impartial while developing the reports. Several petitioners also argue that the CRU e-mails confirm that the IPCC and some of its authors and reviewers have a policy agenda and are tailoring the science to suit that agenda. The petitioners allege that the e-mails show that the peer-review and report development processes employed by the IPCC are "fundamentally corrupt," lack scientific integrity, are policy prescriptive, and do not yield "true" consensus conclusions regarding the state of the science. The petitioners request that EPA reconsider its reliance on the IPCC assessment reports that were used as the basis for the Endangerment Finding.

As discussed in detail below, after reviewing the petitioners' arguments, EPA finds that the evidence and arguments provided by petitioners do not support their conclusion that the peer-review and assessment report processes employed by the IPCC were "fundamentally corrupt" and policy prescriptive. Further, the petitioners' arguments, which for the most part rely on selective use of the CRU e-mails, misinterpretations of the e-mails, and quotations from press articles, do not show that either the IPCC peer-review and report development processes were inadequately designed or that they were not implemented properly. We note that several of the petitioners' arguments are not new; many of these comments were submitted and responded to in the process of developing the Findings.

2.2.2 Background

Several petitioners criticize the IPCC's report development and peer-review procedures. We respond specifically to each allegation in the sections that follow. EPA received similar comments during notice and comment on the Endangerment Findings. In Volume 1 of the RTC document, we responded in detail to these comments, describing the IPCC's report development and peer-review procedures. However, to provide context for evaluating the merit of these more recent allegations, in this background section we revisit the structure and procedures employed by the IPCC in developing their reports.

In response to the allegations raised against it, the IPCC released the following statement in December 2009 describing their report development process from beginning to end (IPCC, 2010a).

> The assessment process begins with a Scoping Meeting attended by scientific experts whose task it is to outline the report. The IPCC Bureau selects the experts attending the Scoping Meeting after an open call for nominations to Governments and IPCC observer organizations. The Bureau consists of experts elected by an IPCC Plenary composed of all WMO and UNEP member nations. The outline is then approved by Working Group

Sessions and endorsed by the Plenary. A call for nominations of authors for the report is sent out to Governments and observer organizations. The individual Working Group Bureaus select the authors for respective contributions to the Assessment Report, ensuring that the composition of the author teams reflects a range of views, scientific expertise and geographical diversity. Over the ensuing 3-4 years, writing teams collaborate on drafting chapters – including four Lead Author meetings, plus chapter meetings as necessary. The author teams prepare two externally reviewed drafts and then a final version of their respective chapters. All chapters undergo a rigorous writing and open review process to ensure consideration of all relevant scientific information from established journals with robust peer review processes or from other sources which have undergone robust and independent peer review. Additional procedures are provided for information found in sources that have not been published or peer-reviewed. In these cases, authors and chapter teams should critically assess and review the quality and validity of each source before incorporating results.

The First Order Draft is subject to a formal Expert Review, where any expert is encouraged to comment on all aspects of the draft, including, but not limited to, issues of interpretation, missed literature, and presentation. Author teams must make a written response, explaining how they responded to each comment in developing the next draft. A Second Order Draft is compiled based on the comments received during the Expert Review. This draft undergoes a second combined formal Expert and Government Review. Author teams have to react to the second round of review comments as well and prepare the final draft, taking into account all the comments received. The entire review process is overseen by a team of 2-3 independent Review Editors for each chapter, whose role is limited to overseeing the reviews, ensuring the thoroughness of the responses. All the AR4 review comments and responses by the author teams are available online (IPCC, 2006a).

In parallel, the Summary for Policymakers and the Technical Summary are prepared by authors selected from chapter writing teams. The Summary for Policymakers and the Technical Summary undergo a formal Expert and Government Review and are revised based on the review comments. Again, 2-3 Review Editors oversee the review process for the Technical Summary. The Summary for Policymakers is then distributed to the Governments for final comment. The Summary for Policymakers undergoes a line-by-line approval process by Governments during a multi-day meeting. The Governments must reach consensus before text is approved. After the Working Group Session approves the Summary for Policymakers, the IPCC Plenary then accepts the entire underlying Report (including the individual chapters and Technical Summary).

To ensure objectivity, transparency, and information quality, the IPCC's report development procedures (IPCC, 1999) clearly describe the roles and responsibilities of coordinating lead authors, lead authors, contributing authors, expert reviewers, and review editors in report development. It states:

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1. LEAD AUTHORS
Function:
To be responsible for the production of designated sections addressing items of the work program on the basis of the best scientific, technical and socio-economic information available.
Comment:
Lead Authors will typically work as small groups which have responsibility for ensuring that the various components of their sections are brought together on time, are of uniformly high quality and conform to any overall standards of style set for the document as a whole.

The task of Lead Authors is a demanding one and in recognition of this the names of Lead Authors will appear prominently in the final Report. During the final stages of Report preparation, when the workload is often particularly heavy and when Lead Authors are heavily dependent upon each other to read and edit material, and to agree to changes promptly, it is essential that the work should be accorded the highest priority.

The essence of the Lead Authors' task is synthesis of material drawn from available literature as defined in Section 4.2.3. Lead Authors, in conjunction with Review Editors, are also required to take account of expert and government review comments when revising text. Lead Authors may not necessarily write original text themselves, but they must have the proven ability to develop text that is scientifically, technically and socio-economically sound and that faithfully represents, to the extent that this is possible, contributions by a wide variety of experts. The ability to work to deadlines is also a necessary practical requirement. Lead Authors are required to record in the Report views which cannot be reconciled with a consensus view but which are nonetheless scientifically or technically valid.

Lead Authors may convene meetings with Contributing Authors, as appropriate, in the preparations of their sections or to discuss expert or government review comments and to suggest any workshops or expert meetings in their relevant areas to the Working Group/Task Force Bureau Co-Chairs. The names of all Lead Authors will be acknowledged in the Reports.

2. COORDINATING LEAD AUTHORS
Function:
To take overall responsibility for coordinating major sections of a Report
Comment:
Coordinating Lead Authors will be Lead Authors with the added responsibility of ensuring that major sections of the Report are completed to a high standard, are collated and delivered to the Working Group/Task Force Bureau Co-Chairs in a timely manner and conform to any overall standards of style set for the document.

Coordinating Lead Authors will play a leading role in ensuring that any crosscutting scientific or technical issues which may involve several sections of a Report are addressed in a complete and coherent manner and reflect the latest information available.

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The skills and resources required of Coordinating Lead Authors are those required of Lead Authors with the additional organizational skills needed to coordinate a section of a Report. The names of all Coordinating Lead Authors will be acknowledged in the Reports.

3. CONTRIBUTING AUTHORS
Function:
To prepare technical information in the form of text, graphs or data for assimilation by the Lead Authors into the draft section.
Comment:
Input from a wide range of contributors is a key element in the success of IPCC assessments, and the names of all contributors will be acknowledged in the Reports. Contributions are sometimes solicited by Lead Authors but unprompted contributions are encouraged.

Contributions should be supported as far as possible with references from the peer reviewed and internationally available literature, and with copies of any unpublished material cited; clear indications of how to access the latter should be included in the contributions. For material available in electronic format only, the location where such material may be accessed should be cited. Contributed material may be edited, merged and if necessary, amended, in the course of developing the overall draft text.

4. EXPERT REVIEWERS
Function:
To comment on the accuracy and completeness of the scientific/technical/socio-economic content and the overall scientific/technical/socio-economic balance of the drafts.
Comment:
Expert reviewers will comment on the text according to their own knowledge and experience. They may be nominated by Governments, national and international organizations, Working Group/Task Force Bureau, Lead Authors and Contributing Authors.

5. REVIEW EDITORS
Function:
Review Editors will assist the Working Group/Task Force Bureau in identifying reviewers for the expert review process, ensure that all substantive expert and government review comments are afforded appropriate consideration, advise lead authors on how to handle contentious/controversial issues and ensure genuine controversies are reflected adequately in the text of the Report.
Comment:
There will be one or two Review Editors per chapter (including their executive summaries) and per technical summary. In order to carry out these tasks, Review Editors will need to have a broad understanding of the wider scientific and technical issues being addressed. The workload will be particularly heavy during the final stages of the Report preparation. This includes attending those meetings where writing teams are considering

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> the results of the two review rounds. Review Editors are not actively engaged in drafting Reports and cannot serve as reviewers of those chapters of which they are Authors. Review Editors can be members of a Working Group/Task Force Bureau or outside experts agreed by the Working Group/Task Force Bureau. Although responsibility for the final text remains with the Lead Authors, Review Editors will need to ensure that where significant differences of opinion on scientific issues remain, such differences are described in an annex to the Report. Review Editors must submit a written report to the Working Group Sessions or the Panel and where appropriate, will be requested to attend Sessions of the Working Group and of the IPCC to communicate their findings from the review process and to assist in finalizing the Summary for Policymakers, Overview Chapters of Methodology Reports and Synthesis Reports. The names of all Review Editors will be acknowledged in the Reports.

In implementing these procedures across the three working groups of the IPCC's AR4, 1,250 scientists (450 lead authors and more than 800 contributing authors) from 130 countries served as authors and more than 2,500 experts provided over 90,000 review comments. Many petitioners specifically critique the practices employed by IPCC Working Group I, for which there were 152 lead authors and 26 review editors from 32 countries, in which 6,000 peer-reviewed publications were cited, for which 625 experts from 42 countries provided over 30,000 review comments, and for which the Summary for Policymakers was approved line by line by 113 countries. Furthermore, the petitioners specifically critique the practices employed by Chapter 6 (Jansen et al., 2007) authors and reviewers of Working Group I, which had two coordinating authors and 14 lead authors from 12 countries, 33 contributing authors from nine countries, and two review editors who oversaw the handling of more than 2,900 comments from the rounds of expert and governmental review. The petitioners also critique the practices employed by Chapter 9 (Hegerl et al., 2007) authors and reviewers of Working Group I, which had two coordinating authors and seven lead authors from nine countries, 44 contributing authors from 12 countries, and three review editors who oversaw the handling of about 2,600 comments from the rounds of expert and governmental review.

The IPCC processes have been developed for the express purpose of ensuring integrity and avoiding any possibility of bias in the conclusions drawn from the scientific literature. The level of detail and clarity of the requirements—especially concerning report review, the specific responsibilities of review editors to assess the quality of author responses to comment, and the transparency of the record of comments and responses—provide the foundation for ensuring that the reports are credible and sound.

The IPCC's peer-review and report development processes are very important components of the overall integrity, quality, transparency, and objectivity of its reports. As stated in the TSD (U.S. EPA, 2009) for the Endangerment Finding, EPA relied on the assessment literature because:

> they 1) are very recent and represent the current state of knowledge on GHG emissions, climate change science, vulnerabilities, and potential impacts; 2) have assessed numerous individual, peer-reviewed studies in order to draw general conclusions about the state of science; 3) have been reviewed and formally accepted, commissioned, or in some cases

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authored by U.S. government agencies and individual government scientists; and 4) they reflect and convey the consensus conclusions of expert authors.

Finally, we note the following recent IPCC statement regarding their report development process:

> The IPCC procedures, which are regularly reviewed and amended by the IPCC members, have served the international community effectively for over 20 years. The conclusions of the IPCC assessment reports, and especially the Fourth Assessment Report, are as solid as careful science can make them. They reflect the current state of knowledge about one of the most complex and important of all topics -- climate change science (IPCC, 2010b).

2.2.3 Responses to Arguably New Objections Raised by the Petitioners

The petitioners submit four arguably "new" objections along with excerpts from the CRU e-mails related to: 1) authorship and reviewer roles among IPCC personnel; 2) an e-mail allegedly showing that IPCC authors were aware that citing their own papers could be seen as using the IPCC process to advance their own views rather than to present a neutral overview of the science; 3) allegations that the IPCC is a biased organization, including claims that IPCC lead authors encouraged other authors to focus on policy-prescriptive science; and 4) allegations that IPCC authors forced consensus and altered the contents of the assessment reports to eliminate any suggestion of non-consensus. We respond to each of these allegations in the subsections below.

2.2.3.1 Allegations of Inappropriate Authorship and Reviewer Roles Among IPCC Personnel

Comment (2-16):
Peabody Energy argues that the CRU e-mails show inappropriate authorship roles in the development of Chapter 6 ("Paleoclimate") of Working Group I's contribution to AR4 (Jansen et al., 2007). The petitioner alleges that Michael Mann (Penn State) and Thomas Crowley (University of Edinburgh) contributed significantly to the development of the chapter, but were not listed as contributing authors. In addition, the petitioner alleges that Mann and Crowley were inappropriately given the opportunity to comment on drafts of the chapter outside the formal review process, thereby compromising their objectivity as reviewers and introducing bias to the chapter development process.

Response (2-16):
EPA has reviewed the petitioners' submissions and finds that the evidence and arguments they provide do not support the conclusions they draw. The content of the e-mails does not show that Michael Mann or Thomas Crowley contributed substantially to the writing or key development decisions of Chapter 6 (Jansen et al., 2007), or that they introduced any bias. Chapter 6 assesses paleoclimatic data and knowledge of how the climate system changes over inter-annual to millennial time scales and how well these variations can be simulated with climate models.

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- On December 23, 2004, Michael Mann wrote to Keith Briffa (Chapter 6 lead author) and stated, "Thanks again for your phone call, and the (informal) opportunity to help out where I can. I'm perfectly happy in that role (as an informal contributor and a formal reviewer, for example), if you and Peck, for example, are both comfortable with that." [2] He also sent some website links regarding arguments that some have made against his work. In a follow-up e-mail that same day[3], Mann again writes to Briffa, stating "I went ahead and tried to make some constructive comments on what you sent…Let me say I think it's shaping up very nicely--looks like it should be a significant improvement on the '01 report. You've handled the various controversies and points of dispute delicately and adeptly…I made a dozen or so minor comments--please make use of them as you see fit…Thanks again for including me in and giving me an opportunity to comment." [4]

  These e-mails show that Mann served as an informal contributor on a preliminary draft of Chapter 6 (Jansen et. al, 2007), and the IPCC's response to comments document for Chapter 6 confirm that Mann was also a formal reviewer (IPCC, 2006a). The petitioners allege that Mann could not have objectively reviewed the chapter if he also provided information for its development, but these e-mails do not show that Mann "significantly contributed" to the development of this chapter. In fact, the evidence provided by the petitioner indicates that Mann participated at most in a limited way as an informal contributor, providing a small amount of information, such as Web links, to the authors. This level of involvement would not warrant being listed as a contributing author, as Mann was involved neither with assessing the underlying literature nor with writing text for the chapter. The IPCC does not require informal contributors of this nature to be acknowledged as authors in the final report. There is no basis to conclude that listing him as an author would have changed the content or conclusions of the chapter in any way. There is also no basis to conclude that his comments were biased or lacked objectivity, or that the resulting chapter was biased or lacked objectivity. The fact that Mann provided the Chapter 6 authors with a limited amount of information does not mean that his objectivity was compromised during the formal review process. Petitioners appear to conclude otherwise, but nothing they provide supports drawing such a broad conclusion. Finally, we note that the petitioner does not provide any examples of Mann's review comments on this chapter that they claim demonstrate bias or lack of objectivity.

- Several e-mails from June and July of 2005 (e-mail files 1122300990.txt[5], 1121869083.txt[6], and 111886641.txt)[7] show that Thomas Crowley was consulted by Keith Briffa and Jonathan Overpeck (Chapter 6 coordinating lead author) regarding a medieval warming figure that Crowley had been developing, which Briffa and Overpeck

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[3] E-mail file 1102956436.txt, (December 13, 2004), page 763, line 13 of PDF version entitled: CRU Emails 1996-2009.pdf
[3] E-mail file 1103828684.txt, (December 23, 2004), page 771, line 37 of PDF version entitled: CRU Emails 1996-2009.pdf
[4] E-mail file 1103828684.txt, (December 23, 2004), page 771, line 37 of PDF version entitled: CRU Emails 1996-2009.pdf
[5] E-mail file 1122300990.txt, (July 25,2005), page 952, line 33 of PDF version entitled: CRU Emails 1996-2009.pdf
[6] E-mail file 1121869083.txt, (July 20,2005), page 916, line 42 of PDF version entitled: CRU Emails 1996-2009.pdf
[7] E-mail file 1118866419.txt, (June 15,2005), page 889, line 32 of PDF version entitled: CRU Emails 1996-2009.pdf

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were possibly interested in using for Chapter 6. There is no evidence in the e-mails that Crowley helped write or develop the chapter in any other capacity. In fact, the e-mails simply document an interaction between the lead authors and Crowley, in which the authors are seeking clarification regarding a particular figure. Such inquiries are completely appropriate and in no way compromise the objectivity and credibility of that chapter's development. It appears that Crowley provided useful background and advice on the use of his figure, and the e-mails provide no support that he contributed significant text or had any editorial power over the chapter.

Given the technical nature of this field of climate science, it is reasonable and expected that IPCC authors might require detail or clarification regarding some of the underlying studies. Therefore they might need to consult the authors of specific studies to better understand how the results were achieved or to ask questions regarding how the data were applied, as was the case in this situation. Petitioners have not explained how the mere fact that this type of correspondence occurred between Crowley and Briffa/Overpeck lead to the conclusion that bias was introduced to the chapter development process. The evidence provided by the petitioner does not support this argument.

- In the same set of e-mails, Crowley also states, "I am not sure whether it is wise to add me to the CA [contributing author] list, just because the reviewer is supposed to be impartial and a CA loses that appearance of impartiality if he has now been included as a CA - may want to check with Susan S. on this one to be sure - still happy to provide advice." The petitioner alleges that Crowley's e-mail signifies that he knew of the risk of compromising objectivity and did so anyway by both contributing significantly to the chapter's development and being an expert reviewer. The evidence provided by the petitioner does not show that Crowley participated in any manner beyond having a limited role in answering questions concerning a figure he had developed, or that his doing so compromised his objectivity as a reviewer. The petitioners do not, for example, provide any examples of his review comments on this chapter that they claim demonstrate bias or lack of objectivity. As stated above, IPCC does not require informal contributors to be acknowledged in the final report. The petitioners' evidence does not show that Crowley's informal contribution and correspondence with the Chapter 6 authors led to improper and erroneous changes or conclusions in the report. Furthermore, after the exchange of these e-mails, Overpeck wrote: "Thanks for moving this forward and making sure we do it right (i.e., without any bias, or perception of bias)".[8] This demonstrates that the coordinating lead author understood IPCC's guidelines, ensured that they were properly implemented, and therefore avoided any lack of or lapse in objectivity.

The petitioner draws broad conclusions from these e-mails about the intentions of the authors and the content of the IPCC chapters, in an attempt to discredit overall the chapter development and review processes of the IPCC, and implicitly the IPCC reports themselves. However, the e-mails cited show that Mann and Crowley had very limited, informal roles in the chapter and the

[8] E-mail file 1121869083.txt, (July 20, 2005), page 918, line 8 of PDF version entitled: CRU Emails 1996-2009.pdf

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e-mails provide no evidence to support assertions of bias or a lack of objectivity. The interactions that occurred are allowable under IPCC procedures, and petitioners have not demonstrated that the events in question changed the content or conclusions of the chapter in any way.

The Muir Russell investigative panel summarized information Briffa gave them on this issue, describing Briffa as having said (Russell, 2010):

> There is no proscription in the IPCC rules to prevent the author team seeking expert advice when and where needed. The Technical Support Unit (TSU) and the CLAs of Chapter 6 agree that the author team was allowed to seek such advice. Copies of communications from both CLAs (Jansen and Overpeck) and the IPCC WG1 TSU are provided by Briffa (and published on the website) to provide support to Briffa's claim that his actions did not contravene IPCC procedures.

Even if the petitioner's allegations that Mann and Crowley "significantly contributed" to the development of Chapter 6 were true—which we do not believe to be the case—and even if this contribution were atypical, this does not lead to the conclusion that the scientific integrity of the conclusions from the chapter was compromised. The evidence provided by petitioners does not indicate errors or significant changes that resulted from involvement of these persons, and does not demonstrate that the final product was either inaccurate or lacked impartiality, nor does the petitioner to any such result. We find that Chapter 6 was developed in an objective manner, is accurate, and represents the best available scientific information.

Comment (2-17):
Peabody Energy argues that the CRU e-mails show that IPCC lead authors "viewed their work as advocacy, rather than scientific analysis, which could be marshaled against opponents." In support of this argument, the petitioner provides a February 2005 e-mail from Michael Mann to Phil Jones, which states "I saw the paleo draft (actually I saw an early version, and sent Keith some minor comments). It looks very good at present--will be interesting to see how they deal w/ the contrarian criticisms--there will be many. I'm hoping they'll stand firm (I believe they will--I think the chapter has the right sort of personalities for that)."

Response (2-17):
The petitioner's interpretation of the e-mail statement is unfounded. The e-mail from Michael Mann[9] describes his reaction to a preliminary draft of a Medieval Warm Period (MWP) section of Chapter 6 ("Palaeoclimate") of Working Group I's contribution to the AR4 (Jansen et al., 2007). First, it is important to note that Michael Mann and Phil Jones were neither lead nor contributing authors for Chapter 6, as the petitioner implies. Therefore, any allegations that Mann and Jones used their authorship authority to advocate against critics of Chapter 6's findings are unfounded. For our response to allegations that Michael Mann had a significant role in the development of Chapter 6, please see Response 2-16 in this section. Moreover, the e-mail does not support the petitioner's allegation that Mann and Jones were viewing their work as "advocacy" to use "against opponents." Rather, Mann is simply stating his opinion regarding

[9] E-mail file 1107454306.txt, (Feb. 3, 2005), page 821, line 44 of PDF version entitled: CRU Emails 1996-2009.pdf

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how the paleoclimate chapter should be written and that he looked forward to seeing how the Chapter 6 authors dealt with criticisms. At no point does Mann suggest that the scientific findings be manipulated to support a pre-determined view. It is clear that he is merely expressing his hope for how the authors will respond to comments they (not Mann) are tasked with addressing.

Comment (2-18):
The State of Texas argues that the IPCC scientists who wrote the CRU e-mails "wielded tremendous authority over the IPCC." In support of their argument, the petitioners state, "For example, AR4 cites Dr. Jones's work 38 times in 21 chapters of two Working Groups, Mann is cited 27 times in 7 chapters of two Working Groups, Briffa is cited 23 times in 9 chapters of two Working Groups, Wigley is cited 66 times in 18 chapters of all three Working Groups, Overpeck is cited 15 times in 5 chapters of two Working Groups, Osborn is cited 30 times in 10 chapters of two Working Groups, Trenberth is cited 58 times in 18 chapters of two Working Groups, and Santer is cited 26 times in 8 chapters of two Working Groups, just to name a few." The petitioner goes on to argue that "Thus, to the extent their objectivity, impartiality, truthfulness, and scientific integrity are compromised or in doubt, so too is the objectivity, impartiality, truthfulness, and scientific integrity of the IPCC report, the CRU temperature data, the NOAA [National Oceanic and Atmospheric Administration] temperature data, and other scientific research that is shown to have relied on their compromised research."

Response (2-18):
Many of the scientists who wrote the CRU e-mails were and still are important figures in the field of climate change science. It is important to note that the statistics provided by the petitioner regarding how frequently the studies of these scientists (e.g., Phil Jones and Michael Mann) were cited in AR4 are neither surprising nor unreasonable. The IPCC AR4 (IPCC, 2007a) cited over 18,000 peer-reviewed studies. Therefore these statistics (e.g., "Wigley is cited 66 times in 18 chapters of all three Working Groups, Overpeck is cited 15 times in 5 chapters of two Working Groups") do not support the petitioner's allegation that these studies were cited too frequently and that these scientists therefore "wielded tremendous authority over the IPCC." These scientists are some of the most well-published climate scientists in the world, and their work was synthesized across the three Working Group reports of the AR4. We conclude that these facts by themselves demonstrate nothing other than the fact that the IPCC, as intended, is assessing available, peer-reviewed literature. The simple fact that these individuals are well-published and that their studies are cited in AR4 does not imply "tremendous authority." The petitioner provided no additional evidence to support their allegation.

As explained in Section 2.2.2 (Background) of this Volume, over 1,250 scientists from 130 countries served as authors for the AR4. It was these hundreds of authors who had the authority to assess the available literature, summarize the state of the science, and reference the studies in the AR4. The IPCC has robust procedures to ensure that the assessment reports are objective, unbiased, and represent the state of the science regarding climate change. These procedures include processes to ensure that no one individual or group of individuals exerts disproportionate influence in developing any piece of the assessment reports. Further, as addressed in the specific responses in Section 2.2.3.1 of this Volume, the evidence provided by the petitioners does not show that these procedures were flawed or improperly implemented. For more information on

these procedures, please see Volume 1, Section 1, of the RTC document and this section (2.2) of the RTP document.

The mere fact that someone is frequently cited is also not evidence for the petitioners' argument. The petitioner must also demonstrate that the referenced literature is biased or flawed, which they have not done, as compared to the straightforward view that the studies produced by these scientists are very robust and of high quality. The petitioner is making allegations without giving due regard for the content of the actual science, which we thoroughly reviewed in the Endangerment Finding's RTC documents and again in the response to both the new and previously submitted comments of the petitioners.

Please see the Denial and Volume 1 of the RTP document for our response to specific allegations regarding what the CRU e-mails mean for the objectivity and integrity of the IPCC assessments, the CRU temperature data, the NOAA temperature data, and other research that is based on this information.

Comment (2-19):
Peabody Energy argues that "An IPCC chapter author should not peer review journal articles that he intends to include in his chapter because of the clear conflict of interest. The chapter author is supposed to be providing a neutral summary of the science, not advancing his own view of the science. If the chapter author reviews papers that are then included in his chapter, he could be seen as advancing his own agenda both in his review of the paper and its selection for inclusion in the IPCC report." To support their argument, the petitioner provides a July 2005 e-mail from Phil Jones to John Christy that states, "I am reviewing a couple of papers on extremes, so that I can refer to them in the chapter for AR4. Somewhat circular, but I kept to my usual standards"[10]. The petitioner goes on to state that "Jones reviewed papers so that he could get them published and therefore could refer to them in AR4 Chapter 3. The petitioner concludes that "this is indeed 'circular' and violates his supposed neutrality both as an AR4 author and as a reviewer of the paper." As additional support, Peabody Energy references another e-mail dated May 20, 2005, from Phil Jones to Michael Mann regarding Jones' review of a temperature reconstruction paper for *Climatic Change*.[11] The petitioner states: "One wonders just how unbiased Jones' review of this paper really was, particularly in light of Jones' admission that he applied less than stringent review standards to papers that he favored."

Response (2-19):
First, we find it unconvincing and unclear why, according to the petitioner, an author of an IPCC chapter should not serve as a peer reviewer of a journal paper that in turn may be incorporated into that IPCC chapter. Thus, we disagree with the petitioner's allegations that Phil Jones introduced bias and reviewed these papers unobjectively in an effort to advance his own views of the science. Jones did not appoint himself to review the papers for the journals, but was selected

[10] E-mail file 1120593115.txt, (July 5, 2005), page 906, lines 21-22 of the PDF version entitled: CRU Emails 1996-2009.pdf

[11] E-mail file 1116611126.txt, (May 20, 2005), page 882, line 45 of the PDF version entitled: CRU Emails 1996-2009.pdf

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by an independent editor to be a reviewer based on his experience and expertise related to climate science. Since Jones is well-published and a prominent paleoclimate scientist, it is reasonable and logical to conclude that the editor who chose him was aware of his work on the AR4 and judged that it was not an inherent conflict of interest. In addition, Jones would not have been the only reviewer for those studies. Typically, between two and four independent experts are selected to review manuscripts. Therefore, Jones would not have had the authority or power to coerce or bias the process to "advance his own agenda." The petitioner is inferring that Jones was trying to do this, but provides no evidence that Jones' actions resulted in papers being unjustly published when they should not have been, or papers being unjustly cited in the AR4 when they should not have been.

The petitioner's claim that an e-mail between Jones and Mann represents an "admission that he [Jones] applied less than stringent review standards to papers that he favored" is also unsupported by evidence. Rather, the petitioner misinterprets and misrepresents Jones' e-mail to Michael Mann regarding Jones' review of a temperature reconstruction paper for *Climatic Change*. This e-mail sent on May 20, 2005, reads:

> Mike,
> Just reviewed Caspar's [Amman, of the National Center for Atmospheric Research] paper with Wahl [Eugene Wahl of the National Climatic Data Center] for Climatic Change. Looks pretty good. Almost reproduced your series and shows where MM [Steve McIntyre, formerly of Northwest Exploration Co., and Ross McKitrick of the University of Guelph] have gone wrong. Should keep them quiet for a while. Also they release all the data and the R software. Presume you know all about this. Should make Keith's life in Ch 6 easy! Also, confidentially for a few weeks, Christy and Spencer [John Christy and Roy Spencer of the University of Alabama in Huntsville] have admitted at the Chicago CCSP meeting that their 2LT record is wrong!! They used the wrong sign for the diurnal correction! Series now warms - not quite as much as the surface but within error bands. Between you and me, we'll be going with RSS in Ch 3 and there will be no discrepancy with the surface and the models. Should make Ch 3 a doddle now! Keep quiet about this until Bern at least. Can tell you more then. RSS (Carl Mears and Frank Wentz) found the mistake! The skeptic pillars are tumbling!
> Cheers Phil[12]

Despite the allegations by the petitioner, this e-mail shows no indication that Jones' review of the Ammann and Wahl paper for *Climatic Change* was biased or that he did not employ rigorous standards of objectivity and neutrality in evaluating the merits of the studies. The e-mail simply indicates that Jones approved of the findings by the authors and that he found the results to have important implications regarding the validity of temperature reconstructions. The petitioner is significantly skewing the meaning of these e-mails and misrepresenting what Jones said to infer improper conduct in his review of the paper.

[12] E-mail file 1116611126.txt, (May 20, 2005), page 882, lines 6-15 of the PDF version entitled: CRU Emails 1996-2009.pdf

Finally, the evidence provided by Peabody Energy does not support their allegation that Jones was biased or failed to objectively assess the available literature for the AR4 as a result of having reviewed these papers. From our review of the evidence, we conclude only that Jones reviewed the studies and that he was also an author for Chapter 3 ("Observations: Surface and Atmospheric Climate Change") of Working Group I's contribution to the AR4 (Trenberth et al., 2007). For that chapter, over 65 authors from 16 countries were tasked with reviewing and assessing the best available science regarding observed climate change and distilling this information into key messages that capture the state of knowledge. Once again, Jones would not have had the authority or power to coerce or bias the process to "advance his own agenda" by developing conclusions that do not represent the state of the science. Chapter 3, like all of the AR4, went through multiple rounds of expert and government review, in which more than 3,400 comments were received and addressed, to ensure that the conclusions accurately represent and summarize the best available science. The large number of authors, the multiple rounds of expert and government reviews, and the detailed approval process are all deliberate procedures developed by the IPCC to ensure that the reports maximize objectivity, credibility, and quality. See Section III.A of the Findings, Volume 1 of the RTC document and Section 2.2.2 (Background) of the RTP document for more information on the IPCC's report development procedures.

2.2.3.2 Allegations That Citing One's Own Papers Compromises Objectivity

Comment (2-20):
Peabody Energy states that IPCC authors cited their own papers extensively in the AR4, which invalidates the purpose of these assessment reports, which are designed to objectively look across the literature and convey the state of the science. The petitioner cites an e-mail by Jonathan Overpeck from June 2005[13] as evidence that allegedly "reveals that the IPCC authors were aware that citing their own papers could be seen as using the IPCC process to advance their own views rather than to present a neutral overview of the science." The petitioner further provides a statistic regarding the frequency at which the authors of Chapter 9 of Working Group I of AR4 cited their own papers: "About 40% of the papers cited in Chapter 9 were written by Chapter 9 authors."

Response (2-20):
It should come as no surprise that many papers by Chapter 9 authors were cited in the chapter. IPCC authors are chosen in part based on their expertise on a particular subject and the degree to which they have published recent, high-quality papers in the field. Moreover, in some areas (e.g., medieval warming period analysis, ocean acidification), there can be limited studies outside the research published by particular scientists, including IPCC authors, on which to base summaries of the science. Contrary to the petitioner's allegations, this does not mean that IPCC authors were not providing neutral and objective summaries of the science. In fact, the petitioner provides no evidence that the practice of citing one's own papers led to biased conclusions in the AR4. Given the rigor of the IPCC review process, described in Section 2.2.2 (Background) of this Volume, it is indeed highly unlikely that an author's improper citation of his or her own work would escape notice.

[13] E-mail file 1120014836.txt, (June 28, 2005), page 900, line 32 of the PDF version entitled: CRU Emails 1996-2009.pdf

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Moreover, the e-mail from Jonathan Overpeck (coordinating lead author of Chapter 6 of Working Group I's contribution to the AR4), does not support the petitioner's assumption of misconduct, and instead shows that Overpeck was encouraging the authors of that chapter to *minimize* citing their own papers to the extent possible, and to only do so when "absolutely necessary." Overpeck's awareness that the authors "citing their own papers could be seen as using the IPCC process to advance their own views rather than to present a neutral overview of the science" does not mean that such citation actually was for the alleged improper purpose—especially when the e-mail demonstrates that Overpeck intentionally took steps to avoid impropriety, or even the appearance of impropriety. The evidence provided by petitioners does not show that the authors cited their own studies in order to advance their own policy views; in fact, it shows they were cautioned to avoid citing their own studies except where absolutely necessary and appropriate. The full text of Overpeck's e-mail is provided here:

> Hi all - thanks Fortunat and Stefan for more debate on the 1470. Sounds like the final decision is up to Eystein, but I can guess the way he's thinking. With regard to refs - remember that our goal is to cut the number of references significantly. Since this is an assessment and not a review, we can delete all but the most recent and comprehensive references. I don't like cutting out the original refs any more than you, but we just don't have room, and its more important to have text than exhaustive references. Our colleagues will hopefully understand, and if they don't then they need to do an ego check. It's more important that we make an impact with policy makers rather than with citation indices. Does this make sense? In any case, please help make sure we trim the total references DOWN in number by a significant number. This is not happening [to] the degree it should. Also, please not[e] that in the US, the US Congress is questioning whether it is ethical for IPCC authors to be using the IPCC to champion their own work/opinions. Obviously, this is wrong and scary, but if our goal is to get policy makers (liberal and conservative alike) to take our chapter seriously, it will only hurt our effort if we cite too many of our own papers (perception is often reality). PLEASE do not cite anything that is not absolutely needed, and please do not cite your papers unless they are absolutely needed. Common sense, but it isn't happening. Please be more critical with your citations so we save needed space, and also so we don't get perceived as self serving or worse. Again, we can debate this if anyone thinks I've gone off the deep end.
> Thanks, peck
> PS - this is not to say anything critical of the refs Fortunat is suggesting - we must cite the most relevant papers, and we must be as up to date as possible.[14]

Regarding the statistics submitted, the petitioner has not provided any evidence that the Chapter 9 authors cited their own studies more frequently than would be appropriate given the number of peer-reviewed and published studies on this particular climate science topic (understanding and attributing climate change in the case of Chapter 9), and the statistics alone, without context, prove nothing. More than 50 authors from 15 different countries contributed to the development of Chapter 9. Given the large number of perspectives and the wide-ranging expertise of this group, it is not surprising that 40% of the papers were written by the chapter's authors. Contrary

[14] E-mail file 1120014836.txt, (June 28, 2005), page 901, line 13 of the PDF version entitled: CRU Emails 1996-2009.pdf

ED_001612_00028343-00047

to the petitioner's allegations, and consistent with the IPCC's report development guidelines as described in Volume 1 of the RTC document, the statistics provided by the petitioner show that the most qualified and experienced personnel contributed to the development of this chapter. When read in full, Overpeck's email clearly shows that he was taking deliberate actions to ensure that the science was presented in an objective and unbiased manner.

We note that the petitioners do not provide or reference any studies that they say should have been included instead. Importantly, petitioners again fail to show how the allegedly irregular practice that they challenge resulted in conclusions that are inaccurate or contrary to the consensus science.

2.2.3.3 Allegations That IPCC Is Biased

Comment (2-21):
The Competitive Enterprise Institute, the Southeastern Legal Foundation, the State of Texas, and the Ohio Coal Association argue that Jonathan Overpeck, the coordinating lead author for Chapter 6 ("Palaeoclimate") of Working Group I's contribution to the AR4, encouraged contributing authors to focus on findings that are most policy relevant (thereby, according to the petitioners, "supporting preconceived" assessments of the science), and that he did not encourage open and neutral presentations of the science. The petitioners draw this conclusion from an e-mail written by Overpeck and Eystein Jansen (the other coordinating lead author) to the lead and contributing authors for Chapter 6, which states, "With respect to text, try hard to get it down to size, and to ensure that it is FOCUSED on only that science which is policy relevant. ALL TEXT should support an Exec Summary Bullet"[15].

[15] E-mail file 1121392136.txt, (July 14, 2005), Page 912, Line 35 of PDF version entitled: CRU Emails 1996-2009.pdf.

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Response (2-21):
The Overpeck/Jansen e-mail to Chapter 6 authors indicates that he encouraged them to focus on the findings that are most policy relevant. However, "policy relevant and compelling" does not mean or imply "policy prescriptive," as alleged by the petitioners. "Policy relevant" means the neutral and objective presentation of scientific, technical, and socio-economic factors that are relevant to the issues or policies that policymakers care about. This is to be contrasted with other issues that are less relevant to policymakers and thus less appropriate for these types of assessment reports, which aim to objectively and thoroughly synthesize scientific information to support development of informed policies. "Policy relevant" is completely different from "policy prescriptive," which refers to the presentation of scientific information with the aim of advancing a particular public policy agenda.

The e-mail from Overpeck and Jansen does not support petitioners' conclusion that they were being policy prescriptive. There is no indication that authors were encouraged to limit their contributions only to findings that supported a particular policy agenda. Rather, it shows the opposite: they were encouraged to avoid this and to provide policy relevant information that would be of use to policymakers as they consider the various possible policies. We further note that the petitioners do not identify information in Chapter 9 that is "policy prescriptive," or provide any information on what policies Overpeck and Jansen were purportedly advancing.

As the IPCC clearly states on its website regarding its mission statement, the organization reviews and assesses the most recent scientific information to produce assessment reports that are "policy relevant and policy neutral, never policy prescriptive" (IPCC, 2010c). The petitioners' evidence does not show that the IPCC failed to execute this very important principle. The petitioners' allegations and implications do not call into question the integrity of these IPCC authors. Finally, we note (as described in Volume 1 of the RTC document) that the official expert and government reviews of the summary for policymakers for each working group (IPCC, 2007c, 2007d, 2007h) further ensure that the reports are *not* policy prescriptive.

Comment (2-22):
Peabody Energy argues that the contents of several CRU e-mails from August 2005[16] between Jonathan Overpeck, Tim Osborn, and Keith Briffa show that the authors for Chapter 6 of Working Group I's contribution to the AR4 (Jansen et al., 2007) were focusing not on the presentation of "neutral science" but rather on "presenting a strong case."

Response (2-22):
The full content of the e-mails at issue is important for understanding what the authors were actually saying.

[16] E-mail file 1123268256.txt, (August 5, 2005), page 963, line 29 of PDF version entitled: CRU Emails 1996-2009.pdf; e-mail file 1123513957.txt, (August 8, 2005), page 964, line 25 of PDF version entitled: CRU Emails 1996-2009.pdf

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E-mail from Overpeck to Osborn and Briffa on Monday, August 5, 2005
Hi Tim and Keith - Hope you're not going to kill me, but I was talking with Susan Solomon today, and she impressed me with the need to make several points if we can. One issue (other to come in a subsequent email) is whether we can extend the MWP box figure to include the 15th century. I don't read the blogs that regularly, but I guess the skeptics are making hay of their being a global warm event around 1450AD. I agree w/ Susan that it is our obligation to weigh in on issues like this, so.... can we extend the fig to extend up to 1500AD? Sorry about this, Tim. Of course we need it yesterday. Thanks x10**6 best, peck[17]

E-mail from Osborn and Briffa to Overpeck on Monday, August 8, 2005
Hi Peck, there is a period around 1400 AD when the proxy records we've used in this MWP figure do indicate a warm period - and all records show positive anomalies at the same time. Thus it couldn't/shouldn't be dismissed in the same way as the MWP, as a period of disparate regional behaviour, albeit with more records showing warming than cooling. For 1400, all indicate warming but with smaller magnitude than the 20th century. If the figure were extended to cover the 15th century, then it would also seem necessary to extend it to the present so that the 1400 period could be compared with the 20th century. I've attached 3 versions of the figure. 850-1350 as originally sent. 850-1500 showing warm anomaly in 1400, but cannot tell how warm relative to present-day. 850-2000 showing 1400 was not as anomalous as present-day. Take your pick, Peck! Cheers Tim and Keith[18]

E-mail from Overpeck to Osborn and Briffa on Monday, August 8, 2005
Hi Tim - Decisions, decisions... thanks so much for taking the initiative. I think - for the reason you state, we should go for the one that includes the 20th century. We make clear that these are not reconstructed temp, but normalized anomalies - this keeps us out of some trouble. But, I think the main message is that we're looking at this issue from every angle. And, we're letting others see the issue from every angle. It adds punch. this means that the MWP box needs to talk about the period around 1400 - can you make sure that's on Keith's radar screen. I believe that historians talk about the Medieval Period going to at least 1450, so what the heck... I you can adjust the caption to work, and then send both it and the final fig to Øyvind, me and Eystein that would be good - make sure Keith is ok with it all first, too. Thanks Tim! Best, Peck[19]

These e-mails describe a conversation between the three scientists in which they are deciding the most appropriate timeframe for a particular set of graphics depicting normalized temperature anomalies. From our review, the context for the e-mails in question is that Susan Solomon (of NOAA, and serving as the co-chair of IPCC Working Group I) wanted to ensure that the views

[17] E-mail file 1123268256.txt, (August 5, 2005), page 963, line 29 of PDF version entitled: CRU Emails 1996-2009.pdf.
[18] E-mail file 1123513957.txt, (August 8, 2005), page 964, line 25 of PDF version entitled: CRU Emails 1996-2009.pdf.
[19] E-mail file 1123513957.txt, (August 8, 2005), page 964, line 43 of PDF version entitled: CRU Emails 1996-2009.pdf.

of various climate change scientists were addressed in AR4. She was clearly trying to acknowledge and respond to their concerns, even to the point of reading blogs to better understand their arguments when there was no peer-reviewed literature articulating their points. In response, Jonathan Overpeck, Tim Osborn, and Keith Briffa discussed a number of options for presenting their data on normalized temperature anomalies: first extending the timeline to 1500 A.D. to address the concerns with data around 1450 A.D., then extending the timeline to the present day to provide even more context for these early data. They discussed and ultimately decided to modify the graphic to depict the relationship of the MWP to the 20th century because that approach would provide important context for understanding current temperature trends, it would be "looking at this issue from every angle. And, we're letting others see the issue from every angle." There is no evidence of bias in this decision. Their presentation of various options for the graphic demonstrates their commitment to considering alternative viewpoints and thoroughness in assessing the science. The e-mails speak for themselves and show no inappropriate behavior among these individuals. We disagree with the petitioner that these e-mails indicate that the scientists were trying to present science that is not neutral or were motivated by a desire to present a "strong case" rather than to present the best science. We further note that this graphic went through expert and governmental review and was deemed appropriate for inclusion in the IPCC chapter. The petitioner provided no additional evidence beyond the text of the e-mails to further justify this allegation.

Thus, these e-mails do nothing more than indicate that three scientists were trying to present a figure that was comprehensive and offered key contextual information on temperature trends over the past several centuries. There is nothing inappropriate or biased about that, and the petitioner has not provided evidence suggesting that there was. When examined in their full context, the e-mails do not indicate any wrongdoing by the three scientists or support the petitioner's claims.

Comment (2-23):
In support of their argument that the IPCC is a politicized and biased organization, the Competitive Enterprise Institute provided a quote from the Environment Minister of India in which he responds to the incorrect IPCC conclusion of disappearing glaciers by announcing that India is forming its own independent climate change review panel that will not depend on IPCC reports. The Minister stated that "There is a fine line between climate science and climate evangelism. I am all for climate science but not for climate evangelism. I think people misused the IPCC report" (Indo-Asian News Service, 2010).

Response (2-23):
See Subsection 2.1.3 in this Volume of the RTP document for EPA's responses regarding the validity of the IPCC's Himalayan glacier projection and our conclusion that this error does not undermine the IPCC's broader findings and the technical support for endangerment.

With respect to the implications of the statements from the Indian Environment Minister, Jairam Ramesh, they clearly show that he disagreed with the specific IPCC Himalayan glacier projection that has been identified as being an error. His statement indicates that he thought that the projection was inappropriately developed based on inconclusive science. As described in Subsection 2.1.3, the IPCC's overall assessment of observed glacier loss, projected glacier loss,

and the impacts of glacier loss on water resources in the Himalayas was not compromised by this single faulty projection. Numerous studies cited by the IPCC document a general decline in Himalayan glacier mass, project substantial future declines, and discuss the impacts of these changes on water resources and society, which is consistent with the conclusions drawn by the IPCC.

The evidence provided by the petitioner appears to mischaracterize the Minister's position. The Minister did not make any statements that support the petitioner's allegation that the IPCC is biased or politicized. Rather, the Minister expressed his disapproval of the incorrect glacier projections and stated that India needed to perform its own research related to this issue and other climate change impacts in the country. Specifically, the Minister stated (Indo-Asian News Service, 2010):

> I respect the IPCC. At the same time India is a large country... we can't depend only on IPCC. So we have launched the Indian Network on Comprehensive Climate Change Assessment... It's got 125 research institutions from across the country. We will have international collaborations. It's a kind of an Indian IPCC and not a rival to the IPCC. We will do our own assessment.

It is not uncommon for countries to undertake their own climate change assessments, and it is misleading for the petitioner to imply that the Minister's statements represent a lack of faith in the IPCC. Finally, even if the statements by the Minister were to be stretched and interpreted as a comment about the IPCC as a politicized organization, it would be the view of one representative of one country and would not represent the official position of the 194 countries that participate in the IPCC. The fact that another country chooses to complement the IPCC with another assessment process has no implications for the Endangerment Finding. For example, the United States has its own climate change science assessment process that is administered by the USGCRP, and this body has provided excellent and robust information.

Comment (2-24):
The Competitive Enterprise Institute and Ohio Coal Association argue that the IPCC is "not a scientific organization," that people in the organization realize it is not, and that the IPCC is a political "organization that reviews and reports science that support its goals." In support of their argument, the petitioner provided a quote from *The Guardian* (a UK newspaper) which in turn quoted Anton Imeson, a former IPCC Working Group II author:

> The Nobel prize was for peace not science ... government employees will use it to negotiate changes and a redistribution of resources. It is not a scientific analysis of climate change… For the media, the IPCC assessments have become an icon for something they are not. To make sure that it does not happen again, the IPCC should change its name and become part of something else. The IPCC should have never allowed itself to be branded as a scientific organization.

Response (2-24):
The quote provided by the petitioner comes from a newspaper article in *The Guardian* (Adam and Goldenberg, 2010), not a scientific journal or a comprehensive review of the IPCC. Imeson

was one of 10 lead authors for Chapter 1 ("Assessment of Observed Changes and Responses in Natural and Managed Systems") of Working Group II's contribution to the AR4 (Rosenzweig et al., 2007). He is presenting an opinion, not a scientific evaluation, and is one of more than 1,250 authors from 130 countries that wrote the AR4 with him. It appears that Imeson is concerned about potential policy implications of the IPCC reports, namely that governments may use the IPCC reports to "redistribute resources." He does not provide a specific scientific critique, but rather a critique of how governments and the media characterize the IPCC reports and government policy direction.

The evidence provided by the petitioner does not show that Imeson's views are shared by other IPCC authors. To evaluate the merits and credibility of Imeson's statements, one must look at the principles governing the IPCC's work, and the organization's established procedures for the preparation, review, acceptance, adoption, approval, and publication of the assessment reports. In addition, it is also important to assess how these principles and procedures were implemented in developing the AR4. EPA has conducted such assessments; they are described in detail in Section III.A of the Findings; Volume 1, Sections 1 and 5, of the RTC document; Appendix A of Volume 1 of the RTC document; and this section of the RTP document. Ultimately, one author's sentiments about how the IPCC's key findings may be used do not provide us with evidence indicating wrong-doing.

Comment (2-25):
The Southeastern Legal Foundation and the State of Texas argue that since the comment period closed, it has been revealed in the press that the chairman of the IPCC, Rajendra K. Pachauri, has multiple potential conflicts of interest. As support for their argument, the petitioners reference a *Daily Telegraph* (UK newspaper) article published on December 20, 2009, titled "Questions over business deals of UN climate change guru Dr. Rajendra Pachauri" (Booker and North, 2009). The article, along with several other newspaper blogs and articles referenced by the petitioners, allege that Pachauri's connections with various corporations, along with consulting services provided to some of these companies, have generated conflicts of interest and resulted in biased and compromised IPCC reports. The Southeastern Legal Foundation further states:

> It is remarkable how only very recently has the staggering scale of Dr Pachauri's links to so many of these concerns come to light, inevitably raising questions as to how the world's leading "climate official" can also be personally involved in so many organizations which stand to benefit from the IPCC's recommendations.

Similarly, the State of Texas argues:

> Pachauri's conflicts of interest weaken the Endangerment Finding. Dr. Pachauri's conflicts of interest indicate that the IPCC is being led toward a conclusion that climate change is a dire threat to the planet that must be reversed; a conclusion that would enrich Dr. Pachauri and the entities that employ him. Consequently, EPA has relied on an assessment that ensures bias and imbalance, a result that EPA claims to want to avoid.

Response (2-25):
Rajendra Pachauri is the elected, unpaid chairman of the IPCC. The IPCC chairmanship requires expertise and experience in climate change science and policy. The chairperson is elected based on this level of expertise and experience. As a result, it is difficult to imagine that a qualified candidate would not have connections and interactions with various academic, science, political, and business communities. Having such connections is not, in and of itself, evidence of conflict of interest in the development of the assessment reports. The petitioners insinuate that Pachauri's professional connections with various companies constitute conflicts of interest, yet they did not provide any evidence that Pachauri's outside activities generated conflicts of interest or violated any ethics rules of the World Meteorological Organization or the U.N. Environment Programme. In fact, in the interest of transparency, Dr. Pachauri has made available his tax returns and details regarding the honorariums and payments from his consulting activities. Further, it appears that the auditing firm KPMG examined his personal finances and found that all such payments were made to The Energy and Resources Institute, an Indian non-governmental organization chaired by Dr. Pachauri (Harvey, 2010).

Most importantly, the petitioners' argument that these consulting activities led to biased, imbalanced, and compromised IPCC assessments is completely unsupported by evidence. The petitioners do not provide a single example of a scientific conclusion that was somehow influenced by Dr. Pachauri's alleged conflicts of interest. The Endangerment Finding must and does rest on strong science, not innuendo and speculation of the sort provided by the petitioners. See Sections 2.2.2 and 2.2.3 in this volume of the RTP document, which address our view that the IPCC's procedures are sufficient to ensure that no one individual—including the IPCC chairman—or group of individuals can exert disproportionate influence in developing any piece of the assessment reports. The IPCC has robust procedures to ensure that the assessment reports are objective, are unbiased, and represent the state of the science regarding climate change. Thus, EPA has no reason to conclude, and there is no evidence to suggest, that Pachauri's professional connections influenced the IPCC reports in any way.

Comment (2-26):
The State of Texas argues that EPA's RTC document insufficiently addressed comments on the Administrator's consideration of studies that disagreed with the assessment literature. Specifically, the petitioner stated:

> In response to public comments suggesting that the Administrator should have included studies that disagreed with the Endangerment Finding, EPA notes that "IPCC, USGCRP/CCSP [the U.S. Global Change Research Program/Climate Change Science Program], and NRC [National Research Council] make considerable effort to ensure that their assessment reports reflect a balance of perspectives regarding the state of the science." To support that response, EPA quotes a National Academies report noting that the NRC screens all "provisional committee members . . . in writing and in a confidential group discussion about possible conflicts of interest.... [N]o individual can be appointed to serve (or continue to serve) on a committee of the institution used in the development of reports if the individual has a conflict of interest that is relevant to the functions to be performed." Thus, EPA identifies the National Academies' prohibition on conflicts of interest as a means of ensuring that the Endangerment Finding is balanced and unbiased.

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Response (2-26):
We responded to this issue in Response 1-2 of Volume 1 of the RTC document, and we find that our response to public comments on this issue was sufficient, detailed, and responsive. The petitioner misrepresents EPA's actual response, which we provide again here to put the petitioner's allegation in perspective.

Comment (1-2):
A number of commenters (3324.1, 3394.1, 3429.1, 3440.1, 3481.1, 3533.1, 3579.1, 3596.1, 3707.1, 3747.1, 3764.1, 3915, 4509, 5716, 8624, 10197, 10948, and 11335) argue that the Administrator did not reference any documents in her decision-making process that offered alternative views on the scientific basis for causes of climate change. Commenters recommend that EPA provide a more complete discussion of global warming science by using information outside the assessment literature, including studies that do not support its conclusions and studies submitted to the docket through the public comment period for the Proposed Findings.

Response (1-2):
We disagree that the Administrator did not consider alternative views on climate change science and impacts. Such a contention incorrectly implies that all individual studies reviewed and incorporated into the assessments of U.S. Global Change Research Program (USGCRP), U.S. Climate Change Science Program (CCSP), Intergovernmental Panel on Climate Change (IPCC), and National Research Council (NRC) support uniform conclusions on the different elements of greenhouse gas (GHG) and climate change science, and that the many thousands of studies reviewed and reflected in these major assessment works represent a narrow view of GHG and climate change science. In fact, these assessment reports look at the range of the scientific literature without "cherry-picking" and it is EPA's conclusion that by placing primary reliance on the major assessment reports, we have ensured that the determinations are based on reports that have considered and weighed all views. EPA relied on the major peer-reviewed assessment reports in developing the TSD (U.S. EPA, 2009) precisely to avoid an over-reliance on and narrow consideration of individual studies and to ensure that the Administrator's decision would be based on a comprehensive assessment of the scientific literature. EPA has determined that the approach taken provided the high level of transparency and consistency outlined by EPA's *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility and Integrity of Information Disseminated by the Environmental Protection Agency.*

Regarding the recommendation that EPA provide a more comprehensive discussion and consideration of global warming science and literature that is representative of "alternative views," we have done this through our review of comments and literature submitted, the associated revision of the TSD, and the development of the eleven volumes of the Response to Comments document. See Section III.A. of the Findings, "The Science on Which the Decisions Are Based," for our response to comments on the use of the assessment literature and previous responses in this section regarding our treatment of new and additional scientific literature provided through the public comment

process. For EPA's responses to comments and literature provided on specific climate science issues in the TSD, please refer to the appropriate Response to Comment volumes.

Finally, we note that IPCC, USGCRP/CCSP, and NRC make considerable effort to ensure that their assessment reports reflect a balance of perspectives regarding the state of the science. We note that the CCSP report *Guidelines for Producing CCSP Synthesis and Assessment Products* state that the reports should "identify disparate views that have significant scientific or technical support" (CCSP, 2004). We refer commenters to Appendix B of this volume for the full listing of these *Guidelines*. Further, NRC (National Academies, 2006) report development procedures state that:

> [C]areful steps are taken to convene [report development] committees that meet the following criteria:
> *An appropriate range of expertise for the task.* The committee must include experts with the specific expertise and experience needed to address the study's statement of task. One of the strengths of the National Academies is the tradition of bringing together recognized experts from diverse disciplines and backgrounds who might not otherwise collaborate. These diverse groups are encouraged to conceive new ways of thinking about a problem.
>
> *A balance of perspectives*. Having the right expertise is not sufficient for success. It is also essential to evaluate the overall composition of the committee in terms of different experiences and perspectives. The goal is to ensure that the relevant points of view are, in the National Academies' judgment, reasonably balanced so that the committee can carry out its charge objectively and credibly.
>
> *Screened for conflicts of interest.* All provisional committee members are screened in writing and in a confidential group discussion about possible conflicts of interest. For this purpose, a "conflict of interest" means any financial or other interest which conflicts with the service of the individual because it could significantly impair the individual's objectivity or could create an unfair competitive advantage for any person or organization. The term "conflict of interest" means something more than individual bias. There must be an interest, ordinarily financial, that could be directly affected by the work of the committee. Except for those rare situations in which the National Academies determine that a conflict of interest is unavoidable and promptly and publicly disclose the conflict of interest, no individual can be appointed to serve (or continue to serve) on a committee of the institution used in the development of reports if the individual has a conflict of interest that is relevant to the functions to be performed."

We refer commenters to Appendix C of this volume for more information on NRC report development process. In addition, please see response to comments below regarding the IPCC report development process and procedures for ensuring a balance of perspectives.

Petitioners reference only a small part of our response in their allegations. Our full response and the record for the Endangerment Finding demonstrate that the Administrator thoroughly

considered a range of studies, including those that disagree with the conclusions of the assessment literature.

2.2.3.4 Allegations That IPCC Lead Authors Forced Consensus and Suppressed Dissenting Views

Comment (2-27):
The Southeastern Legal Foundation, the State of Texas, Peabody Energy, the Competitive Enterprise Institute, and the Ohio Coal Association argue that the CRU e-mails (in particular an e-mail from Phil Jones to Michael Mann expressing their disapproval of two new studies authored by Stephen McIntyre and Ross McKitrick) reveal that the contents of the IPCC reports, in this case Chapter 3 of the AR4 Working Group I report (Trenberth et al., 2007), were altered to eliminate any suggestion of non-consensus on key issues. Petitioners claim that this occurred so as to support a specific policy agenda, and that dissenting views were not given appropriate attention and consideration. The petitioners also argue that a group of authors have actively tried to suppress external challenges to consensus.

Response (2-27):
Although the petitioners draw broad conclusions of unethical and biased conduct from the e-mail between Phil Jones and Michael Mann, this e-mail does not show that the two IPCC authors acted unethically, or that they took any actions to suppress dissenting views, as alleged by the petitioners. The e-mail at issue was sent on July 8, 2008, and states:

> Mike,
> Only have it in the pdf form. FYI ONLY - don't pass on. Relevant paras are the last 2 in section 4 on p13. As I said it is worded carefully due to Adrian knowing Eugenia for years. He knows the're wrong, but he succumbed to her almost pleading with him to tone it down as it might affect her proposals in the future ! I didn't say any of this, so be careful how you use it - if at all. Keep quiet also that you have the pdf. The attachment is a very good paper - I've been pushing Adrian over the last weeks to get it submitted to JGR or J. Climate. The main results are great for CRU and also for ERA-40. The basic message is clear - you have to put enough surface and sonde obs into a model to produce Reanalyses. The jumps when the data input change stand out so clearly. NCEP does many odd things also around sea ice and over snow and ice. The other paper by MM is just garbage - as you knew. De Freitas again. Pielke is also losing all credibility as well by replying to the mad Finn as well - frequently as I see it. I can't see either of these papers being in the next IPCC report. Kevin and I will keep them out somehow - even if we have to redefine what the peer-review literature is!
> Cheers Phil[20]

The e-mail shows that Phil Jones strongly disapproved of the quality of the two studies[21] and that he did not deem them to be of sufficient quality and credibility for inclusion in an IPCC

[20] E-mail file 1089318616.txt, (July 8, 2008), Page 720, Line 46 of PDF version entitled: CRU Emails 1996-2009.pdf
[21] The paper Jones refers to by "MM" was McKitrick and Michaels (2004). It is not clear what the second paper is, however it was possibly De Laat and Maurellis (2006).

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assessment report. In addition, both of the papers were in fact included in the IPCC assessment report. The "MM" study (McKitrick and Michaels, 2004) is referenced in the IPCC chapter, and assuming that the second study Jones referred to is De Laat and Maurellis (2006), that was included as well. This disproves the allegations of the petitioners that this e-mail is evidence that dissenting views were suppressed or that the IPCC assessment report was biased by such efforts. For example, these two studies are discussed in Chapter 3 (Trenberth et al., 2007):

> McKitrick and Michaels (2004) and De Laat and Maurellis (2006) attempted to demonstrate that geographical patterns of warming trends over land are strongly correlated with geographical patterns of industrial and socioeconomic development, implying that urbanization and related land surface changes have caused much of the observed warming.

Thus, the events surrounding the citation of the McKitrick and Michaels (2004) and De Laat and Maurellis (2006) studies provide stronger support for the proposition that the IPCC assessed and cited critical literature than for the petitioners' view that these events demonstrate that the IPCC is biased.

The e-mail between Jones and Mann, which is the only evidence offered by petitioners to support this allegation, simply does not show that either 1) the contents of this chapter, let alone all of the IPCC assessment reports, were altered to eliminate a suggestion of nonconsensus, or 2) IPCC authors actively tried to suppress external challenges to consensus. It is not uncommon for scientists to disagree with the work of others, and this e-mail does not provide evidence that Phil Jones or any other IPCC author acted unethically or took actions to suppress dissenting views, notwithstanding the loose talk in the e-mail.

Our conclusion regarding this e-mail is consistent with the findings of the Independent Climate Change E-mails Review investigation, which concluded "that it is not uncommon for strongly opposed and robustly expressed positions to be taken up in heavily contested areas of science. We take the view that such behaviour does not in general threaten the integrity of peer review or publication." The final report of the investigation also stated that the panel has "not found any direct evidence to support the allegation that members of CRU [in this case Phil Jones] misused their position on IPCC to seek to prevent the publication of opposing ideas"(Russell, 2010). On this issue, Brian Hoskins, one of three review editors for Chapter 3, provided statements to the Independent Climate Change E-mails Review that were summarized in the panel's report as stating (Russell, 2010):

> Hoskins confirmed that Las [lead authors], working individually and as small groups, were responsible for the collation and primary assessment of material relevant to the topics for which they were responsible. The CLAs [convening lead authors] led the plenary meetings of the writing team prior to production of each of the drafts, led the process of overall collation of the Chapter material and the production of the initial drafts of the First and Second Draft Reports and the Final Draft Report of the Chapter. These drafts were discussed and agreed during plenary meetings of the whole writing team.

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> There were a very large number of comments from reviewers, of which a majority were from a relatively small group. The Review Editors made sure that they were all given proper consideration, and that they were either responded to by a change in the text or by an adequate reason for omission that was recorded in the author responses to expert and governmental review comments. Hoskins, as a Review Editor, took part in the Chapter 3 plenary discussions and ensured that conflicting views were addressed.
>
> Led by the two CLAs, Jones and Trenberth, the writing team for Chapter 3 was assiduous in dealing with comments. Hoskins was very impressed by Jones' attention to detail, and the rigor of the Chapter 3 process.
>
> The levels of confidence and uncertainty reflected in the drafts were based on the consensus of a group of CLAs and LAs who were chosen for their expertise and experience in relevant fields. Irrespective of whether a paper is published in a peer reviewed journal, it is the responsibility of the whole team to assess whether a paper's conclusions are robust and to justify whether its arguments should carry weight in the assessment. These decisions for each draft were taken in plenary sessions of the whole team. Hoskins said that it is inconceivable that a paper making significant claims relevant to the work of IPCC and the Chapter 3 team would not be considered by the team as a whole. The basis for rejecting one of the papers that is a focus of the allegation is included in IPCC records. Decisions about the inclusion of the MM2004 [McKitrick and Michaels] paper would have been taken by the whole team. Jones' voice would have been one amongst many.

The petitioners do not present scientific evidence or argument showing that the IPCC assessment is inaccurate or that it does not appropriately reflect the degree of scientific consensus on the issues discussed. The petitioner's broad conclusion that this is the case is unsupported by evidence or arguments on the science and assessment literature itself. Finally, we note that the science regarding this issue was raised in the comment period for the Endangerment Finding and responded to in Response 2-29 of the RTC document. Response 2-29 states:

> "In the case of de Laat and Maurellis (2006) and an earlier paper by McKitrick and Michaels (2004), IPCC (Trenberth et al., 2007) assessed these papers and noted that the locations of greatest socioeconomic development coincided with those most warmed by atmospheric circulation changes, which are not limited to urban areas but rather have large-scale coherence. When this is taken into account, IPCC concludes that the correlation of warming with industrial and socioeconomic development ceases to be statistically significant."

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Comment (2-28):
The Southeastern Legal Foundation argues:

> The so-called "science" of global warming has been conducted in an ideologically charged environment, such that any possibility of giving due regard to dissenting views was foreclosed at the outset. Thus, the conclusions of organizing bodies, especially IPCC, cannot be said to reflect scientific "consensus" in any meaningful sense of that word. Instead, they reflect a political movement that has commandeered science to the service of its agenda. This is "post-normal science": the long-dreaded arrival of deconstructionism to the natural sciences, according to which scientific quality is determined not by its fidelity to truth, but by its fidelity to the political agenda. A leading climate scientist and contributor to the IPCC, Mike Hulme, has called the IPCC "a classic example" of "post normal science."

The petitioner further asserts:

> Post-normal science was defined by Eva Kunseler, in her paper "Towards a new paradigm of Science" as follows: A new concept of science was introduced by Funtowicz and Ravetz during the 1990s…The concept of post-normal science goes beyond the traditional assumptions that science is both certain and value-free…The exercise of scholarly activities is defined by the dominance of goal orientation where scientific goals are controlled by political or societal actors…Scientists' integrity lies not in disinterestedness but in their behaviour as stakeholders."(Kunseler, 2007)

Response (2-28):
We first note that this allegation that the IPCC's work does not represent objective scientific assessment but is motivated by a political agenda is not new. The petitioner is rehashing an argument previously submitted during public comment on the proposed endangerment finding. We responded to numerous comments received regarding the scientific integrity and objectivity of the IPCC's processes in developing its assessment reports in Volume 1, Section 1, of the RTC document.

We note that the evidence submitted by the petitioner—consisting of a newspaper op-ed by Mike Hulme in *The Guardian* (Hulme, 2007) and the definition of "post-normal science" from a non-peer-reviewed essay by Eva Kunseler (Kunseler, 2007)—are not new; they were both developed in 2007. Therefore, it was not impracticable to raise the objection during the public comment period and the reasons for the objection did not arise between June 24, 2009, and February 16, 2010. The petitioner could have raised this comment during the comment period on the proposed Endangerment Finding. The petitioner has not shown why it would have been impractical to do so.

In addition, the evidence does not support the petitioner's allegation that the science behind climate change has been developed in a biased and "ideologically charged environment." The petitioner mischaracterizes Hulme's discussion of post-normal science and defines what he meant by "post-normal science" with the use of an unrelated paper by Eva Kunseler that has

nothing to do with climate change. This is an excerpt of the relevant part of Hulme's op-ed in *The Guardian* newspaper:

> That science is an unfolding process of discovery is fairly self-evident. The more we seem to know, the more questions we seem to need answering. Some avenues of scientific inquiry may close off, but many new ones open up. We know a lot more about climate change now than 17 years ago when the first IPCC scientific assessment was published. And no doubt in another 17 years our knowledge of how the climate system works and the impact that humans have made on it will be significantly different to today. Yet it is important that on big questions such as climate change scientists make an assessment of what they know at key moments when policy or other collective decisions need to be made. Today is such a time. But our portrayal of the risks of climate change will always be provisional, subject to change as our understanding advances. Having challenges to this unfolding process of discovery is essential for science to thrive, as long as those challenges play by the methodological rule book that science has painstakingly written over many generations of experience.
>
> The other important characteristic of scientific knowledge - its openness to change as it rubs up against society - is rather harder to handle. Philosophers and practitioners of science have identified this particular mode of scientific activity as one that occurs where the stakes are high, uncertainties large and decisions urgent, and where values are embedded in the way science is done and spoken. It has been labelled "post-normal" science. Climate change seems to fall in this category. Disputes in post-normal science focus as often on the process of science - who gets funded, who evaluates quality, who has the ear of policy - as on the facts of science.

Hulme's discussion of post-normal science presents his opinion about how societal values and policy decisions intersect with the practice of science. His statement does not say or imply that post-normal science means that "a political movement [has] commandeered science to the service of its agenda," nor does he state that climate change is a "classic example of post-normal science." In contrast, Hulme stresses that science is a "process of discovery" that thrives on challenges that "play by the methodological rule book that science has painstakingly written over many generations of experience." This is clearly not a statement about science being controlled by politics, nor a statement that politics have prevented climate change scientists from giving "due regard to dissenting views," as the petitioner asserts.

Even if Hulme did claim an overly "ideologically charged environment," this would only represent the opinion of one person among numerous scientific fields comprising an immense number of scientists, institutions, assessment bodies, and governmental organizations. This evidence, presented as a conclusion with no supporting evidence and with no scientific explanation of the errors that resulted, would not come close to undermining the credibility and quality of the findings of the assessment literature. As described in this volume, and Volume 1 of the RTC document for the Endangerment Finding, the assessment literature upon which EPA based the Endangerment Finding has robust processes and procedures to ensure that the best available scientific information is reviewed and assessed, with checks and balances included to

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produce high-quality, unbiased reports. We respond to specific objections raised by petitioners regarding the implementation of the IPCC procedures throughout Section 2.2 of this volume.

We also note that we considered and responded to multiple perspectives and views of climate science in the RTC document for the Endangerment Finding, and considered and responded again to the various perspectives of the petitioners here in the RTP document and in the Denial. As discussed extensively in our responses, the IPCC and the USGCRP also considered alternative views in their assessment processes. See Volume 1 of the RTC document and Section 2.2.2 (Background) of this Volume of the RTP document for a discussion of these report development processes.

We have reviewed the petitioner's arguments and materials and do not find that they support the allegations that the IPCC was co-opted by politics and biased against dissenting views. The balance of the scientific literature represented in the assessment reports on climate change, of which the IPCC is one, clearly supports the Administrator's findings.

Comment (2-29):
The Ohio Coal Association and the Coalition for Responsible Regulation argue that the CRU e-mails "demonstrate that climate scientists felt pressured to present a unified front - and an agreed-upon narrative of global warming - even when there was not one." Both petitioners reference an e-mail from Keith Briffa to Michael Mann which states: "I tried hard to balance the needs of the science and the IPCC, which were not always the same." Also, as evidence to support their argument, the Coalition for Responsible Regulation provides a letter to the IPCC from Christopher Landsea, a former IPCC author, in which he states that he could not "in good faith continue to contribute to a process that I view as both being motivated by preconceived agendas and being scientifically unsound" (Landsea, 2005).

Response (2-29):
Seeing the entire content of the e-mails cited by the petitioner is important to place the first issue raised by petitioners in context:

> E-mail from Mann to Briffa on Sunday, April 29, 2007
> Keith, just a quick note to let you know I've had a chance to read over the key bits on last millennium in the final version of the chapter, and I think you did a great job. obviously, this was one of the most (if not the most) contentious areas in the entire report, and you found a way to (in my view) convey the the[sic] science accurately, but in a way that I believe I will be immune to criticisms of bias or neglect--you dealt w/ all of the controversies, but in a very even-handed and fair way. bravo! I hope you have an opportunity to relax a bit now. Looking forward to buying you a beer next time we have an opportunity :) mike[22]
>
> E-mail from Briffa to Mann on Sunday, April 29, 2007
> Mike your words are a real boost to me at the moment. I found myself questioning the whole process and being often frustrated at the formulaic way things had to be done -

[22] E-mail file 1177890796.txt, (April 29, 2007) page 1310, line 44 of PDF version entitled: CRU Emails 1996-2009.pdf

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> often wasting time and going down dead ends. I really thank you for taking the time to say these kind words. I tried hard to balance the needs of the science and the IPCC, which were not always the same. I worried that you might think I gave the impression of not supporting you well enough while trying to report on the issues and uncertainties. Much had to be removed and I was particularly unhappy that I could not get the statement into the SPM [Statement for Policymakers] regarding the AR4 reinforcement of the results and conclusions of the TAR [Third Assessment Report]. I tried my best but we were basically railroaded by Susan. I am happy to pass the mantle on to someone else next time. I feel I have basically produced nothing original or substantive of my own since this whole process started. I am at this moment, having to work on the ENV submission to the forthcoming UK Research Assessment exercise, again instead of actually doing some useful research! Anyway thanks again Mike.... really appreciated when it comes from you
> very best wishes
> Keith[23]

These two e-mails were written after the release of the Working Group I report of AR4 (IPCC, 2007e). Michael Mann writes an e-mail showing his approval of the final version of Chapter 6 ("Paleoclimate") of Working Group I report (Jansen et al., 2007) and to congratulate Briffa on the accomplishment. Keith Briffa responds to show his appreciation for Mann's e-mail; he explains some of the challenges and difficulties he encountered while finalizing the chapter and getting it through the ultimate stages of review. As stated in Section 2.2.2 (Background) and Response 2-16 above, Chapter 6 had two convening authors and 14 lead authors from 12 countries, 33 contributing authors from nine countries, and two review editors who oversaw the handling of more than 2,900 comments from the rounds of expert and governmental review. It is perfectly understandable and reasonable that Briffa, who was one of the 14 lead authors, would have been frustrated by some of the challenges in examining all of the available scientific literature on topics related to paleoclimate (whether or not it agrees with the dominant paradigms and whether or not it has yet stood the test of time compared to other studies that have considered the topic), putting that literature in context through a process of assessment, distilling the information into key messages that capture the state of knowledge at the time of the assessment, addressing all of the expert and government reviews, and developing key points for the summary for policymakers. Briffa's e-mail does not support the petitioner's allegation that he "felt pressured to present a unified front - and an agreed-upon narrative of global warming - even when there was not one." The petitioner is taking Briffa's statement that he "tried hard to balance the needs of the science and the IPCC, which were not always the same" completely out of context and making unsupported allegations. Although he describes some frustrations with the challenges of the IPCC's rigorous and robust report development procedures, Briffa's e-mail does not indicate that he was not satisfied with the final version, that he did not agree with the conclusions, nor that he felt pressured in any way to "present a unified front."

The e-mails in question also reveal that the process of scientific assessment is personally and professionally challenging because scientists who volunteer their time are taken away from their

[23] E-mail file 1177890796.txt, (April 29, 2007) page 1310, line 24 of PDF version entitled: CRU Emails 1996-2009.pdf

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own research and must sideline their own personal views of what should and should not be included in the reports. In fact, Michael Mann compliments Keith Briffa's objectivity and even-handedness in handling the challenges. Briffa also clearly expresses frustration with the time spent away from doing new science, which is not the primary job of an IPCC chapter author or of the IPCC in general. The primary role of the IPCC is to assess existing science already published in the literature, i.e., in Briffa's words, "the needs of the science and the IPCC" are not always the same. In context, it is clear that the needs of the IPCC in this case are the "formulaic way things had to be done" and the need to do assessments of existing literature rather than producing "original and substantive" work or "useful research." It appears original research would be what Briffa is referring to as the needs of the science. When the e-mails are read in their full context, it is clear that the authors of these e-mails sought to convey the science accurately and address all the controversies in a fair and even-handed way. Again, petitioners appear to have selectively picked excerpts from emails.

We note that the Landsea letter provided by the Coalition for Responsible Regulation is not new. As stated in the link of the letter provided by the petitioner (Taylor, 2005), Landsea wrote this letter in January 2005. Therefore, it was not impracticable to raise the objection during the public comment period and the reasons for the objection did not arise between June 24, 2009, and February 16, 2010. The petitioner could have raised this comment during the comment period on the proposed Endangerment Finding. The Coalition for Responsible Regulation has not shown why it would have been impracticable to do so, especially given the fact that the public has been aware that EPA might rely on the IPCC assessments since the July 2008 Advance Notice of Proposed Rulemaking.

Despite this, we will respond briefly to the petitioner's allegations. Christopher Landsea served as a contributing author for the IPCC Second and Third Assessment Reports (IPCC 1995, IPCC 2001), but chose not to participate in AR4. In the initial planning stages of the AR4, Landsea wrote this letter to the IPCC expressing his disapproval with IPCC procedures. Specifically, Landsea disapproved of the fact that Kevin Trenberth, an IPCC lead author for the TAR, purportedly used his position to "promulgate to the media and general public his own opinion that the busy 2004 hurricane season was caused by global warming, which is in direct opposition to research written in the field and is counter to conclusions in the TAR [Third Assessment Report]." Landsea went on to state that "As the IPCC leadership has seen no wrong in Dr. Trenberth's actions and have retained him as a Lead Author for the AR4, I have decided to no longer participate in the IPCC AR4." This letter shows that Landsea disagreed with Trenberth regarding a particular aspect of the attribution of hurricanes to climate change and that Landsea did not approve of Trenberth representing the IPCC when discussing his views about the issue.

This impact of climate change on hurricane activity is a very dynamic issue. There are still significant uncertainties in the underlying climate science, so it not surprising that two scientists would disagree regarding the attribution of the 2004 hurricane season to climate change effects. However, the contents of the letter do not "demonstrate that climate scientists felt pressured to present a unified front - and an agreed-upon narrative of global warming - even when there was not one," as alleged by the petitioner. Landsea was not taking issue with the content of the IPCC reports, but with how Trenberth discussed certain issues during the period between the Third and Fourth Assessment Reports. The fact that Landsea disapproved of how Trenberth represented

the IPCC in discussing a specific scientific issue at a press conference preceding development of the AR4 provides absolutely no support for petitioners' claim that the conclusions reached in AR4 are incorrect or biased, or that they were developed in a way that pressured scientists into presenting "a united front." The petitioners did not provide any evidence to support that conclusion.

We also note that the discussion in AR4 of uncertainties associated with the impact of climate change on hurricane activity reflected the ongoing debate and alternative views on the issues. EPA also clearly described the uncertainties related to hurricane activity and climate change in the TSD and again in Volumes 2 and 4 of the RTC document for the Endangerment Finding. Finally, our response to allegations involving the IPCC's characterization of climate change and disaster losses can be found in Subsection 2.1.4 of this volume of the RTP document.

2.2.4 Responses to Allegations Based on Information That Is Not New

The petitioners submitted four objections concerning: 1) the collaborations among IPCC authors, 2) the general IPCC peer review process, 3) the alleged manipulation of dates and deadlines for accepting literature, and 4) the IPCC's use of gray literature. EPA has reviewed the petitioners' submissions and finds that it was not impracticable to raise the objection during the public comment period and that the reasons for the objection did not arise between June 24, 2009, and February 16, 2010. The IPCC AR4 has been public since early 2007, and petitioners could have raised these comments during the comment period on the proposed Endangerment Finding. Although, in most cases, the petitioners provide excerpts from the CRU e-mails in support of their assertions, EPA's review has determined that this evidence does not support their allegations, and that the vast majority of the information submitted by petitioners on these topics was available well before the comment period for the Endangerment Finding. Petitioners have not shown why it would have been impracticable for them to raise these issues then, especially given the fact that the public has been aware that EPA relied, in part, on the IPCC assessments since the July 2008 ANPR. Indeed, some of these same points were already raised, and responded to, in the RTC.

Despite the fact that these objections fail to meet the criteria for a petition for reconsideration, we briefly explain why, contrary to petitioners' allegation, they fail to call into question the overall integrity or validity of the IPCC AR4. As noted above, very similar comments questioning the appropriateness of IPCC author and reviewer roles were submitted and responded to during the development of the Findings (see Volume 1 of the RTC document).

2.2.4.1 Allegations of Inappropriate Collaborations Among IPCC Authors

Comment (2-30):
The State of Texas, Peabody Energy, and the Coalition for Responsible Regulation contend that the CRU e-mails show that IPCC authors and reviewers are close associates who frequently collaborate on projects and studies, and claim that such collaborations create conflicts of interest (for example, when one person authors an IPCC chapter and another serves as an official reviewer). Peabody Energy argues that the Wegman Report, *Social Network Analysis of Authorship in Temperature Reconstruction*, confirms that IPCC scientists are closely networked

with each other and dominate their field. The petitioner references testimony given by Edward J. Wegman (George Mason University) to Congress (Wegman, 2006) in arguing that "the paleoclimate field is dominated by interlinked scientists who no longer produce research that has the desired degree of independence."

Based on this report, Peabody Energy provides a detailed example of the small paleoclimate research community and how these scientists frequently co-author papers together, review each other's papers, and collaborate in other ways that generate conflicts of interest. Specifically, the petitioner, in referring to Chapter 9 ("Understanding and Attributing Climate Change") of Working Group I's contribution to the AR4 (Hegerl et al., 2007), provides a series of statistics that were also provided to EPA during the public comment period (these statistics are provided below) and argues that EPA did not respond to these specific issues in the RTC document:

- Forty of the 53 authors of this chapter co-authored papers with each other.
- More than half of the contributing authors co-authored papers with lead authors or coordinating lead authors.
- The review editor of the chapter contributed to 13 papers cited in the chapter and had co-authored these papers with 10 other authors of Chapter 9.
- Of the published papers in Chapter 9:
    - 94 were authored by two or more of that chapter's authors.
    - One cited paper had six chapter authors.
    - Five cited papers had five chapter authors.
    - 26 papers had three chapter authors, including six papers written entirely by chapter authors.
    - 50 of the cited papers listed two chapter authors each, and 10 of these papers were written entirely by chapter authors.

Response (2-30):
Neither the facts nor the evidence provided support the petitioners' claim that the collaborations among climate researchers led to conflicts of interest and bias, or that these collaborations interfered with their ability to be objective and impartial. Some climate science fields (e.g., paleoclimatology) are highly specialized and are the focus of only a limited number of researchers. In such fields, scientists who have at one point in the past collaborated on work can be called on to review each other's work. This practice is common in a variety of scientific areas with a relatively limited number of researchers, not just these specific climate science fields. It is actually the most robust practice of ensuring scientific credibility, because the reviewing scientists are the true experts who know the material and are most capable of fulfilling the review role. Petitioners' conclusions of impropriety or bias are not supported by the mere fact that authors know each other and have collaborated.

We respond to Peabody Energy's statistics regarding Chapter 9 in Subsection 2.2.3.2 of this volume of the RTP document. Given the limited number of researchers in this particular area, the statistics regarding author and reviewer roles in Chapter 9 of Working Group I's contribution

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to the AR4 (Hegerl et al., 2007) are not surprising and do not indicate, as alleged by the petitioner, that there were "built-in conflicts of interest that had the potential for undermining the reliability of the reports." Rather, these statistics show that the most qualified and experienced authors and reviewers were involved in developing that particular chapter. EPA carefully reviewed and responded to these statistics regarding collaborations among IPCC authors in Volume 1 of the RTC document.

Furthermore, all scientific papers have to abide by strict ethical, conflict of interest, and scientific integrity/quality rules. The evidence provided by the petitioners does not show that these rules have been broken, that the peer-review system has been compromised, or that the assessment literature did not consider a range of perspectives in summarizing the state of the science. Essentially, the petitioners' argument can be boiled down to the view that if scientists work together and know each other, something improper is probably happening. This is an unwarranted and unjustified view of professional relationships, based on pure speculation.

Finally, we note that Peabody Energy does not provide any evidence to support its allegation that the past collaborations of these authors and reviewers actually led to "less than fully independent and rigorous" assessments of the science. The petitioner provided limited and unsubstantiated critiques of the science presented in Chapter 9, which we address in Volume 1 of this RTP document. Peabody Energy also provides no scientific argument or analysis indicating that the research produced by theses scientists or the IPCC chapter at issue was in any way biased or less than scientifically rigorous.

2.2.4.2 Allegations Regarding Insufficient Peer Review Processes for the IPCC

Comment (2-31):
Peabody Energy claims that the IPCC's peer review process is less robust and credible than the processes employed by scientific journals because IPCC lead and contributing authors are the ones who decide whether to accept or reject critical reviews. The petitioner argues that the IPCC's process is flawed because there is no neutral scientist, who was not involved in the writing, to ensure that the reviews are judged objectively.

Response (2-31):
First, we note that the petitioner provides no new information to substantiate their allegation, and that Peabody Energy's argument regarding the rigor of the IPCC's peer review does not accurately describe the actual review process used by the IPCC. As described above in Subsection 2.2.2 (Background) of this volume, lead and contributing authors are indeed tasked with initially responding to comments; however, independent and objective review editors (i.e., editors not involved in the writing of the chapter) are assigned to each chapter to ensure that each comment is addressed properly and accurately. Furthermore, the contributing authors are not allowed to simply reject critical reviews without documenting their rationale. The IPCC carefully documented all comments received on the first and second order drafts of each chapter of each working group. These comments and responses are, and have always been, publically available (IPCC, 2006a for Working Group I and IPCC, 2005 for Working Group II).

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In addition, it would be illogical and inappropriate for the IPCC, as suggested by the petitioner, to allow only unrelated parties to respond to comments on chapters that they did not write. What the petitioner seems to believe would be appropriate—allowing unrelated people to respond to comments on the draft documents, as opposed to having the authors respond and revise their drafts—makes absolutely no sense and is not common in any scientific discipline because the unrelated parties would not possess the experience and context necessary to properly understand and respond to the comments. We therefore disagree with the petitioner's argument that the IPCC's peer review procedures are less rigorous than the processes employed by scientific journals. Petitioners provide no evidence that the IPCC authors inappropriately influenced the response to comments process or that review editors failed to perform their role in ensuring that all comments were properly addressed. The mere allegations and conclusory claims made by the petitioner are insufficient to support the broad conclusion they draw. Finally, we note that the petitioner did not provide examples of other peer review processes that they deemed to be more robust and credible than those procedures employed by the IPCC.

2.2.4.3 Allegations That IPCC Authors Manipulated Deadlines for New Literature

Comment (2-32):
Peabody Energy argues that the IPCC manipulated dates and deadlines for receipt of new literature to provide additional evidence in substantiating its conclusions regarding 20th-century warming. Specifically, the petitioner provides an example of two papers (both by Caspar Ammann and Eugene Wahl) on long-term temperature reconstructions, one of which was allegedly allowed to be referenced by IPCC authors in the AR4 only because, the petitioners claim, the IPCC manipulated the deadline for receipt of literature.

Response (2-32):
The evidence provided by Peabody Energy does not demonstrate that the IPCC, specifically the lead author of Chapter 6 of Working Group I's contribution to the AR4 (Jansen et al., 2007), manipulated the deadline for receipt of new literature for the purpose of including the two papers by Ammann and Wahl (Ammann and Wahl, 2007; Wahl and Ammann, 2007). We note that the IPCC AR4 has been public since early 2007, and petitioners could have raised these objections during the comment period on the proposed Endangerment Finding. Petitioners have not shown why it would have been impractical for them to do so. The only part of their argument that is "new" (i.e., has arisen since the close of the comment period on June 23, 2009) is an e-mail between Wahl and Ammann, which is a very minor part of their overall interaction. The e-mail only shows that Wahl and Ammann were making final proofing edits in September 2007. The e-mail stated:

> Hi Phil:
> There were inevitably a few things that needed to be changed in the final version of the WA paper, such as the reference to the GRL paper that was not published (replaced by the AW paper here), two or three additional pointers to the AW paper, changed references of a Mann/Rutherford/Wahl/Ammann paper from 2005 to 2007, and a some other very minor grammatical/structural things. I tried to keep all of this to the barest minimum possible, while still providing a good reference structure. I imagine that MM [Ross McKitrick and Pat Michaels] will make the biggest issue about the very existence

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> of the AW paper, and then the referencing of it in WA; but that was simply something we could not do without, and indeed AW does a good job of contextualizing the whole matter. Steve Schneider seemed well satisfied with the entire matter, including its intellectual defensibility (sp?) and I think his confidence is warranted. That said, any other thoughts/musings you have are quite welcome.
> Peace, Gene[24]

As stated by the petitioner, the deadline for receipt of new literature was changed during the development of the Working Group I report. The deadline was originally December 2005 and was changed to July 24, 2006. When the coordinating lead authors for Working Group I extended the deadline for receipt of new literature, they provided the following justification (IPCC, 2006b):

> To ensure clarity and transparency in determining how such material might be included in the final Working Group I report, the following guidelines will be used by Lead Authors in considering such suggestions. In preparing the final draft of the IPCC Working Group I report, Lead Authors may include scientific papers published in 2006 where, in their judgment, doing so would advance the goal of achieving a balance of scientific views in addressing reviewer comments.

The authors of Chapter 6 followed this guidance and included the Wahl and Ammann (2007) study. We note that the Wahl and Ammann paper was accepted into *Climatic Change* on March 1, 2006, which means that at that point, the paper had passed peer review and the editor had agreed with the reviewers regarding its merit for publication. Thus, although the citation for the paper is in 2007, the acceptance date met the IPCC's revised deadline of July 24, 2006, for receipt of new literature that was established by AR4 lead authors. It appears that the same authors' other paper, Ammann and Wahl (2007), was not accepted for publication in time to meet the extended deadline for receipt of new literature, and we note that it is therefore not referenced in Chapter 6 of the AR4.

The petitioner alleges impropriety because the IPCC referenced Wahl and Ammann (2007), even though some of the underlying statistical analysis for that study, which was eventually published in Amman and Wahl (2007), had not been accepted for publication by the extended deadline. There are two flaws with petitioner's arguments. First, in the event that any of the expert reviewers for Chapter 6 expressed concern regarding the Wahl and Ammann (2007) paper, they would have had the opportunity to request any supplemental information necessary for reviewing the credibility of the Wahl and Ammann results. Second, the Ammann and Wahl paper went through peer review and was eventually published in *Climatic Change* in 2007, in the same issue as Wahl and Ammann (2007). The petitioners do not claim or demonstrate that the methods or results described in the Ammann and Wahl paper were incorrect or flawed. They simply allege that a decision to change deadlines slightly is "manipulation," even if no scientific flaw or challenge is raised against the literature affected by the date change.

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[24] E-mail file 1189722851.txt, (September 12, 2007), page 1357, line 6 of PDF version entitled: CRU Emails 1996-2009.pdf

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Moreover, contrary to the petitioner's argument, the evidence provided by the petitioner does not indicate that the deadline was inappropriately extended to accommodate the inclusion of these papers in AR4. On this issue, the Independent Climate Change E-mails Review found that:

> Taking into account the evidence of the Review Editor [for Chapter 6, i.e. John Mitchell], IPCC papers [documentation of IPCC responses to comments], the statement from the CLA [Jonathan Overpeck], and the importance of the issues raised by M&M2003 [McIntyre and McKitrick], we consider it to be reasonable that work that might throw further light on these issues and to ensure that assessments were as up to date as possible should be included. We do not consider therefore that these were exceptional unwarranted efforts to defend a particular position, but reasonable attempts to use up to date information that might resolve an issue. They appear to be consistent with IPCC principles and to reflect a concern for objectivity (Russell, 2010).

There was a general decision to allow extension of the deadline for the entire Working Group, and the chapter authors applied this guidance and extended the deadline for scientific studies relevant to that chapter. The fact that it was extended does not show it was extended because of these specific papers. In addition, petitioners have not shown that the extension altered the results of the report or the appropriateness of EPA's relying on it. First, inclusion of the peer-reviewed study represents one very small part in the deliberate preparation and review of a multi-volume assessment containing several thousands of pages of findings and conclusions. Second, Chapter 6 relied upon a number of long-term temperature reconstructions for its conclusions, including the findings of NRC's 2006 report (NRC, 2006) on surface temperature reconstructions. The NRC findings were fully consistent with the conclusions of the Ammann and Wahl papers. The papers in question provided additional, but not the only, evidence concerning the validity of using long-term proxy temperature reconstructions to compare historical and current climates. Indeed, and perhaps most importantly, the petitioner has provided no evidence showing that the conclusions of the Ammann and Wahl paper were mistaken or incorrect, or that the conclusions by themselves changed the findings of Chapter 6. Third, we note the statements that John Mitchell, one of two Chapter 6 review editors for Chapter 6, provided to the Independent Climate Change E-mails Review regarding how in-press material was handled and how decisions about the text of successive drafts were made. He commented as follows:

> I was not aware of the debate about whether the Wahl and Ammann paper had or had not met the deadline for the 2nd order draft for chapter 6, until after the event. The concentration on specific deadlines however misses the larger point. It must be recognized that if only published sources were used, the report would be two years old by the time of publication. In a fast-moving area such as climate change research, assessments could be significantly behind the times if important, but as yet unpublished, new results could not be used. The assessments for policymakers could also therefore be behind the times...
>
> In earlier assessments, there had been a relatively liberal regime in using unpublished material provided that there was a sound basis for regarding it as rigorous or reliable, although priority was always given to finding published sources. In AR4 however, the

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regime was tightened significantly, so that such material was only to be used under exceptional circumstances, but the use of unpublished material was not prohibited. Hockey-stick issues were regarded at the time as sufficiently important to justify using new data. The dilemma between using only published material and being out of date, or using more recent unpublished material was increased in AR4 as the latest publication date was about 12 months earlier than in the process than in the previous assessment (Russell, 2010).

2.2.4.4 Allegations Regarding the IPCC's Use of Gray Literature

Comment (2-33):
The Coalition for Responsible Regulation, Peabody Energy, the Southeastern Legal Foundation, and the State of Texas argue that the IPCC's use of non-peer-reviewed literature (e.g., reports they claim are developed by environmental advocacy groups) in the AR4 calls into question the quality and objectivity of these pieces of literature and contradicts EPA's assertion that the IPCC is based on peer-reviewed science. The petitioners provide examples of gray literature sources that were used by the IPCC in AR4.

Response (2-33):
First, we note that the petitioners provided no new information in support of their allegations. As stated above, the petitioners are simply rehashing a comment that was submitted and responded to in the development of the Findings. Therefore, we find that their allegations were not impracticable to raise the objection during the public comment period and the reasons for the objection did not arise between June 24, 2009, and February 16, 2010. The IPCC AR4 has been public since early 2007, and petitioners could have raised these comments during the comment period on the proposed Endangerment Finding. Petitioners have not shown why it would have been impracticable for them to raise these issues then, especially given the fact that the public has been aware that EPA relied, in part, on the IPCC assessments since the July 2008 ANPR.

The IPCC relied on and referenced a very limited number of non-peer-reviewed sources in developing AR4. The IPCC's report development procedures recognized and allowed for the limited use of non-peer-reviewed literature where this was necessary and appropriate. Indeed, neither the IPCC nor EPA ever stated that the assessment reports relied *exclusively* on peer-reviewed material. For EPA's responses showing how the limited use of gray literature documents did not undermine the IPCC's scientific findings and the technical support for endangerment, please see Section 2.1 of this volume, including Responses 2-8, 2-9, and 2-10.

Looking across the thousands of scientific studies reviewed, assessed, and referenced by the IPCC in the AR4, it is clear that the number of non-peer-reviewed documents was dwarfed by the number of peer-reviewed references (estimated by the IPCC to be approximately 18,000). The IPCC, as clearly described in Volume 1 of the RTC document, has specific procedures to ensure that any non-peer-reviewed materials are sufficiently robust and credible in the context in which they were cited. While there are a very few instances in which erroneous conclusions were developed from the gray literature sources (see Section 2.1 of this RTP document for more detail on our responses to these issues), the overall process is exceedingly robust. Furthermore,

the few errors in this regard are trivial when viewed against the backdrop of the IPCC's multi-volume assessment containing several thousand pages of findings and conclusions. The few errors do not affect the climate change science findings or have any material or meaningful implication for the determination of endangerment to public health and welfare in the United States. The examples of gray literature provided by the petitioners were not cited by EPA in describing the key IPCC conclusions that EPA relied on in developing the TSD (U.S. EPA, 2009). The examples provided by the petitioners are cited in chapters of the Working Group II and III AR4 reports when describing climate change impacts in other world regions, which was not a focus of the TSD.

Comment (2-34):
Peabody Energy claims that the IPCC Working Group II "frequently used a citation method that did not candidly reveal an underlying affiliation with an environmental advocacy group." For example, the petitioner claims that in many instances the IPCC report "referred only to the name of the author when the work was actually sponsored by an interest group" such as the World Wildlife Fund. Peabody concludes that "It is unclear whether these sponsored works provide independent, objective, and peer-reviewed science that should be the basis for AR4, or whether they advance the environmental agenda of their sponsor. It is also unclear whether these sources were independently verified by IPCC authors and contributors."

Response (2-34):
First, we note that the IPCC's citation method for the AR4 is not new and that this information has been known since the assessment report was released in 2007 (IPCC, 2007a). Therefore, the petitioner's arguments were not impracticable to raise during the public comment period and the reasons for the objection did not arise between June 24, 2009, and February 16, 2010. The petitioner could have raised this comment during the comment period on the proposed Endangerment Finding. Peabody Energy has not shown why it would have been impractical to do so. Despite this, we respond below to the merits of their argument.

The petitioner alleges that the IPCC employed a parenthetical citation method in the text of the chapters that hid information showing that references were developed by environmental non-government organizations. In fact, the IPCC employed a common citation method for the thousands of studies that are referenced among the more than 3,000 pages in AR4. This format consists of listing the author's names first for each entry in the references section, and mentioning the publisher and/or organization (e.g., World Wildlife Fund) toward the end of the reference. Parenthetical citations, for each reference in the text of a chapter, list the author(s)' name(s) and the year of publication. This citation methodology is consistent with many established citation guidelines, including those developed by the Modern Language Association, the American Psychological Association, and the University of Chicago.

The evidence provided by the petitioner does not show that the IPCC hid the fact that some of the reports it cited were developed by non-government organizations like the World Wildlife Fund. The petitioner seems to suggest that the IPCC should have included the names of the non-government organizations in the parenthetical citations for these literature sources. However, this practice is contrary to the well-established conventions and styles that are commonly used in all disciplines of science and literature. Special treatment for these literature sources would be

inappropriate and unreasonable, and the petitioner's only justification for such an approach is the speculation that this literature might have been created to "advance the environmental agenda of their sponsor." Again, the IPCC included the names of the organizations in the full reference for each report in the references section at the end of each chapter. The IPCC did not hide the publisher or sponsoring organization's name.

For our response to the petitioner's argument that "It is unclear whether these sponsored works provide independent, objective, and peer-reviewed science that should be the basis for AR4, or whether they advance the environmental agenda of their sponsor," please see Section 2.1 of this volume, including Responses 2-8, 2-9, and 2-10.

Finally, the procedures employed by the IPCC in evaluating sources of gray literature are described in Section 1 and Appendix A of Volume 1 of the RTC document. The petitioner has provided no evidence suggesting that the reports developed by environmental non-government organizations were not evaluated by AR4 authors according to the IPCC's procedures.

2.2.5 Summary

The evidence provided by the petitioners does not support their allegations that the IPCC's peer review and report development processes are designed inappropriately, or that they were inappropriately implemented in the development of the AR4. Specifically, the evidence provided by the petitioners and all of the information in the record for the Endangerment Finding shows that, contrary to the claims of the petitioners:

- It was proper to not list certain scientists as contributing authors as they did not contribute significantly to the writing and editorial decisions in developing any AR4 chapter, including Chapter 6 of Working Group I's contribution (Jansen et al., 2007), and therefore did not compromise their objectivity during the peer-review process.

- IPCC authors did not cite their own studies more frequently than what was acceptable and reasonable.

- IPCC authors were not directed to focus on policy-prescriptive conclusions, but rather implemented IPCC guidelines by presenting policy-relevant and neutral findings.

- IPCC authors did not alter the content of reports to eliminate suggestions of nonconsensus.

- Collaborations among IPCC authors and reviewers prior to the development of AR4 did not compromise objectivity or generate conflicts of interest.

- The IPCC's peer-review processes are appropriate and adequate, and were properly implemented.

- IPCC authors did not manipulate deadlines for receipt of new literature.

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- The IPCC's very limited use of gray literature does not call into question the quality and objectivity of the assessment reports.

Petitioners do not present scientific evidence or argument showing that the Chapters of assessment report at issue are inaccurate or that they do not appropriately reflect the range of scientific evidence and the degree of scientific consensus on the scientific issues discussed. The evidence they present does not support the broad assertion that this is the case. They do not present credible scientific evidence or arguments on the science itself to support their claims. Therefore, petitioners' evidence and arguments do not support changing our position, as stated in the Endangerment Finding, that the assessment literature, including the IPCC AR4, represents the "best reference materials for determining the general state of knowledge on the scientific and technical issues before the agency in making an endangerment decision."

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United States Environmental Protection Agency

EPA's Response to the Petitions to Reconsider the Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act

Volume 3: Process Issues Raised by Petitioners

U.S. Environmental Protection Agency
Office of Atmospheric Programs
Climate Change Division
Washington, D.C.

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ACRONYMS

AGU	American Geophysical Union
AIC	Akaike information criterion
ANPR	Advance Notice of Proposed Rulemaking
AOCGCM	atmosphere-ocean coupled general circulation model
APA	Administrative Procedure Act
AR	autoregressive
AR4	IPCC Fourth Assessment Report
BIC	Bayesian information criterion
CAA	Clean Air Act
CCSP	Climate Change Science Program
CO_2	carbon dioxide
CR	Climate Research
CRCES	Center for Research on the Changing Earth System
CRU	Climatic Research Unit
DCPS07	Douglass, Christy, Pearson, and Singer, 2007
E.O.	Executive Order
FCC	Federal Communications Commission
FOI	Freedom of Information
FOIA	Freedom of Information Act
GHG	greenhouse gas
GRL	Geophysical Research Letters
HadCRUT	Climatic Research Unit temperature record
ICO	Information Commissioner's Office
IJC	International Journal of Climatology
IPCC	Intergovernmental Panel on Climate Change
IQA	Information Quality Act
NRC	National Research Council
LIA	Little Ice Age
MBH	Mann, Bradley, and Hughes
MIT	Massachusetts Institute of Technology
MM	McIntyre and McKitrick
NASA	National Aeronautics and Space Administration
NH	Northern Hemisphere
QSR	Quaternary Science Reviews
RCS	regional curve standardized
RMS	Royal Meteorological Society
RSC	Royal Society of Chemistry
RSS	Royal Statistical Society
RTC	Response to Comments
RTP	Response to Petitions
SAB	Science Advisory Board
TSD	Technical Support Document
UEA	University of East Anglia
UHI	urban heat island

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USGCRP	U.S. Global Change Research Program
WMO	World Meteorological Organization

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3.0 Process Issues Raised by Petitioners

3.1 Approaches and Processes Used to Develop the Scientific Support for the Findings

3.1.1 Overview

Several petitioners (the Coalition for Responsible Regulation, the Commonwealth of Virginia, the Ohio Coal Association, Peabody Energy, the State of Texas, the Southeastern Legal Foundation, and Arthur Randol) take issue with the process and approach EPA used in developing the scientific support for the Endangerment Finding. Many of these arguments are a repetition of arguments submitted during the public comment period for the Proposed Findings. These include claims that EPA did not independently judge the underlying science, violated the Information Quality Act (IQA, also referred to as the Data Quality Act), violated the law by failing to post the underlying data and scientific studies in the docket, and did not convene a truly independent external peer review.

The sole arguably new argument made by some petitioners (the Ohio Coal Association, the Pacific Legal Foundation, and Peabody Energy) is the claim that EPA ignored public concerns about the implications of the e-mails involving scientists at the Climatic Research Unit (CRU) at the University of East Anglia in the United Kingdom. The petitioners claim that statements made in the CRU e-mails cast doubt on the validity of underlying data relied on by EPA's Endangerment Finding, and argue that EPA's response to this issue is inadequate in the record for the Endangerment Finding.

Based on our review, petitioners' claims regarding the implications of the CRU e-mails are wrong. In late 2009, EPA carefully reviewed many of the e-mails and responded to the issues that were presented to us shortly before the Endangerment Finding was completed. Since that time, we have reviewed all of the e-mails in light of additional issues raised by petitioners. Based on this review, we reaffirm that petitioners' claims and the information they submit do not change or undermine our understanding of how anthropogenic emissions of greenhouse gases cause climate change and how human-induced climate change generates risks and impacts to public health and welfare. The information provided by petitioners does not change any of the scientific conclusions that underlie the Administrator's Findings, nor do the petitions lower the degrees of confidence associated with each of these major scientific conclusions. The science issues raised by petitioners, which we respond to in Volume 1 of this document, do not undermine the core understanding of climate change, which is based on multiple lines of evidence from independent sources. For example, petitioners allege that the surface temperature record produced by CRU is flawed, but our review indicates that the surface data is sound and that the surface temperature record trends are corroborated by satellite temperature records and the impacts we see on the ground, such as glacier retreat and lengthening of the growing season.

With respect to the arguments already raised during the rulemaking leading to the Endangerment Finding, the petitioners do not provide any new information to bolster arguments previously submitted. For reasons elaborated below, we conclude that the responses provided in the Findings and the Response to Comments (RTC) document are still robust.

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In this section, we summarize and respond to the new argument being raised by the petitioners regarding EPA's initial response to comments about the implications of the CRU e-mails. We then review the petitioners' resubmitted arguments (originally addressed in Volume 1 of the RTC document) in light of any new evidence provided in the petitions for reconsideration.

3.1.2 Issues Regarding Consideration of the CRU E-mails

Comment (3-1):
A few petitioners (the Coalition for Responsible Regulation, the Ohio Coal Association, the Pacific Legal Foundation, and Peabody Energy) allege that EPA did not properly consider the implications of the CRU e-mails on the validity of the underlying data on which the Findings rest and that EPA did not provide an adequate response to the late comments that were raised concerning the e-mails. The Ohio Coal Association states that although allegations about problems with the CRU data had come to light prior to the Administrator signing the Findings, EPA did not consider the implications and instead "plowed ahead with compromised data, undermining its core conclusions in the process." The Pacific Legal Foundation and Peabody Energy state that EPA could not have thoroughly examined the thousands of e-mails and documents released from CRU in the five-day period between the Competitive Enterprise Institute's petition supplement and the signing of the Endangerment Finding. Peabody Energy concludes that EPA's brief discussion of the CRU material in its RTC document "cannot substitute for the searching re-analysis of the Endangerment Finding that the CRU material demands." The Pacific Legal Foundation states that "EPA has dismissed public concerns over the CRU e-mails and documents by its single, abbreviated response to a comment made by the Competitive Enterprise Institute." The Pacific Legal Foundation argues that because the CRU e-mails and documentation were not available to be included in the record during the public comment period, neither the general public nor the EPA Science Advisory Board (SAB) have had the opportunity to comment on the new information therein.

Response (3-1):
The petitioners identify several issues in the e-mails that they consider to be "smoking guns," evidence of scientific misconduct, and fatal blows to the "theory of anthropogenic global warming." Although petitioners claim that the e-mails introduce new information, they concern many of the same scientific issues on which the public commented during notice and comment for the proposed findings. Prior to finalizing the Endangerment Finding, EPA carefully reviewed many of the e-mails, and through this review, we determined that many of the issues raised therein had also been raised through the public comments and were responded to at the time (see, for example, Volume 2 of the RTC document). Based on that initial review, we concluded that the scientific conclusions of the assessment literature remained sound as to the state of the science on GHGs and climate change. We did not inappropriately "plow ahead," as one petitioner claims. Rather, we assessed the issues raised by commenters and the CRU e-mails in light of our comprehensive review of climate science, and in light of all of the objections to the science that were raised by commenters, and concluded that our review of the science and the conclusions based on it were sound. As explained in more detail in the other volumes of this Response to Petitions (RTP) document, the petitioners make unfounded leaps regarding implication of the CRU e-mails to the overall state of climate change science.

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Following issuance of the Endangerment Finding, petitioners raised more specific concerns with respect to the CRU e-mails. EPA has reviewed all of the e-mails in light of the petitioners' assertions, and our substantive responses on the science are provided in the Decision and the three volumes of the RTP document. On the basis of our analysis of the scientific issues raised, and our thorough review of the contents of the e-mails, we disagree with the petitioners' contention that additional "searching reanalysis" of the Endangerment Finding is required. Our examination of the CRU e-mails in light of the current science shows that the petitioners routinely misunderstand or mischaracterize the scientific issues they are raising, and draw faulty conclusions on the state of the science. We show throughout this RTP document multiple examples where petitioners have resorted to hyperbole, broadly impugned the ethics and scientific integrity of climate scientists in general, and characterized actions as "falsification" and "manipulation" with no basis or support. As we reviewed the many footnotes in their documents, we found an inordinate reliance on blogs, news stories, and literature that is neither peer-reviewed nor accurately summarized in their petitions.

Nothing has been presented that challenges the current understanding of climate change science and the causal linkage between human-caused GHG emissions and warming of the climate system. Indeed, EPA finds that petitioners most often rely on "cherry-picked" language from select e-mails that creates the suggestion or appearance of impropriety, without looking deeper into the issues or providing corroborating evidence that improper action actually occurred. Throughout the three volumes of this document, we have provided detailed and specific responses to petitioners' assertions based on the CRU e-mails.

3.1.3 Assessment of Issues Raised in Public Comments and Re-Raised in Petitions for Reconsideration

The Administrator Exercised Her Judgment in Reviewing the Science and Making the Findings

Comment (3-2):
Several petitioners (the Coalition for Responsible Regulation, the Commonwealth of Virginia, the Ohio Coal Association, Peabody Energy, the State of Texas, the Southeastern Legal Foundation, and Arthur Randol) argue that the Administrator did not independently judge the primary scientific literature and data. Instead, they claim that she improperly relied on summary scientific reports produced by third parties or "foreign entities." They argue this is a violation of Clean Air Act (CAA) Section 202(a)'s requirement that the Administrator exercise her own expert judgment. EPA responded to similar arguments during notice and comment on the Findings. More recently, petitioners re-raise this argument in light of new information that they claim calls into greater question EPA's reliance on the assessment literature. For example, the Southeastern Legal Foundation argues that "the Administrator cannot possibly exercise the form of 'judgment' required by the Clean Air Act based on data or procedures from other agencies that are potentially faulty, manipulated, contrived, or otherwise subject to the kinds of irregularities that have been alleged with respect to current climate information." The Coalition for Responsible Regulation and the Commonwealth of Virginia argue that in relying on the assessment reports of the IPCC, EPA ceded or sub-delegated its responsibility for independent judgment to the IPCC, which the petitioners characterize as "an international body not subject to

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U.S. data quality and transparency standards and whose reports were prepared in total disregard to those standards," and whose processes are politically motivated and advance "policy objectives masquerading as science."

Several petitioners (the Coalition for Responsible Regulation, the State of Texas, Arthur Randol, the Pacific Legal Foundation, and Peabody Energy) make the related argument that EPA violated the IQA and Administrative Procedure Act (APA) because it "did not independently investigate and confirm the quality and transparency of the information cited in the 'assessment literature,' relying instead on its review of the written procedures of the organizations preparing that literature to conclude that those organizations had ensured quality and transparency." Finally, the Coalition for Responsible Regulation and Peabody Energy argue that EPA cannot rely on the IPCC because the CRU e-mails demonstrate that influential IPCC scientists failed to meet EPA's data quality and transparency obligations under the IQA.

Response (3-2):
As noted previously, we find that these issues raised by petitioners are not new, and were, in fact, raised and responded to through the notice and comment process. Thus, objections based on EPA's general reliance on assessment reports, rather than EPA's undertaking a separate assessment itself, were not impracticable to raise during the public comment period and the reasons for the objection did not arise between June 24, 2009, and February 16, 2010.

To the extent petitioners argue that new information in the CRU e-mails calls into question the reasoning behind EPA's position on the use of assessment reports in the final Findings, the petitioners do not demonstrate that additional information has become available that merits reconsideration of the Findings, or EPA's use of the assessment literature. Nonetheless, we have carefully reviewed the new concerns raised regarding the implications of the CRU e-mails. Here, we focus specifically on the issue of whether information in the CRU e-mails requires us to undertake additional procedural steps with respect to the Endangerment Finding. Our response to each of the issues raised by petitioners follows. Note that we respond to petitioners' allegations on substantive science issues elsewhere in this RTP document.

With respect to the petitioners' claims that EPA should have conducted its own independent assessment of the primary scientific literature and not relied on scientific reports produced by third parties or "foreign entities," we note that the Administrator provided a detailed discussion of her position in Section III.A of the Findings (see "The Science on Which the Decisions Are Based"). In other sections of this RTP document, we have already explained why the CRU e-mails and the nature and number of reported errors in the IPCC report, as well as arguments or objections over the scientific conclusions EPA reached in the Findings, do not lead EPA to change its scientific conclusions and do not necessitate the reconsideration of the Findings. We find that the issues raised by petitioners do not lead us to change our decision regarding our approach and do not demonstrate that an additional or separate review is either required or appropriate.

For the same reasons, these claims do not warrant revisiting EPA's approach to analyzing that science. We note that the IPCC reports are a primary but not the only source of scientific information underlying the Findings. As is clearly stated in the Findings, the Administrator

relied on numerous other assessment reports prepared by the U.S. Global Change Research Program (USGCRP), the National Research Council (NRC), and others. In addition, the Administrator tested her approach and proposed conclusions by subjecting them to notice and comment, and in reaching final conclusions drew on the wealth of information submitted through public comments to inform her decision. Many commenters provided additional scientific literature, which we carefully reviewed, considered, and responded to. A cursory examination of the detailed discussions in the multi-volume RTC document demonstrates the care and rigor with which EPA approached the underlying science. Therefore, we reject Peabody Energy's allegation that EPA "used a rulemaking process that effectively permits no replies and no rebuttals" to the science that formed the technical basis for the Findings. In addition, in May 2010 the NRC issued another major climate change assessment report that further solidifies the science supporting the Administrator's decision and supports that decision. This recent NRC report is discussed further in the Denial and Volume 1 of the RTP document.

In responding to petitioners' objections that the Administrator failed to exercise her own judgment in reaching the Endangerment Finding, we note that this issue is not new and petitioners have not raised new arguments calling into question the process for the Endangerment Finding. Nonetheless, it is useful to describe the process EPA followed in compiling and analyzing the science to support the Administrator's Endangerment Finding. Contrary to petitioners' assertions, EPA did not passively accept a scientific judgment or conclusion supplied to it by outsiders. Instead, EPA evaluated all of the scientific information before it, and determined from this information the current state of the science on climate change and the degree of scientific consensus on this science. The Administrator then considered this information in light of the legal criteria for determining endangerment. This process included EPA presenting its scientific views and judgments for public comment and then evaluating and considering all such comments received. The Administrator properly and carefully exercised her judgment in all matters related to the Endangerment Finding.

The following is an outline of the actions taken that evidence EPA's comprehensive and in-depth exercise of judgment:

1. EPA has a strong scientific background and understanding in global climate change science. EPA scientists have worked for years in this area, and many EPA scientists have been part of the development of the Intergovernmental Panel on Climate Change (IPCC) and USGCRP assessment reports. EPA has strong in-house science expertise in this area, while recognizing that no one organization will have experts or expertise in all of the variety of areas involved. However, EPA has a solid grounding in the core areas of science involved in climate change. Many EPA scientists were part of the development of the various assessment reports.

2. EPA's goal was to evaluate the current state of the science for all of the relevant areas at issue for the Endangerment Finding, and to evaluate the degree of scientific consensus in these areas. EPA performed a detailed review of all elements of the various assessment reports as part of evaluating this.

3. EPA evaluated the assessment reports and their conclusions in several ways:

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- EPA reviewed the process employed to develop the reports, relying in part on its own experience and involvement in various parts of the process for the IPCC and USGCRP reports. EPA concluded that the lengthy, comprehensive process was very robust, with checks and steps included to produce high-quality, unbiased reports.

- EPA reviewed the content of the reports in light of its in-house science expertise. EPA found the reports' contents to be comprehensive, balanced, carefully caveated with respect to certainty, clearly identifying supporting as well as non-supporting evidence, with conclusions drawn based on the entire body of the evidence, not just one part of it.

- EPA took into consideration the depth of scientific consensus the reports represented. They reflect a very strong consensus of the scientific community across the world. EPA has never claimed that there is unanimity on all aspects of the science, but there is a very broad scientific consensus on the multiple lines of evidence on which the Findings are based (as described in Section III.B of the Denial). This consensus includes concurrence and clearance within the U.S. government science community, on many of the major assessment reports.

- EPA took into consideration the trends in the science. Over the last 30-plus years, as we study more, learn more, and advance our understanding, the general trend is toward more certainty that warming is occurring, that it is caused by anthropogenic emissions, and that we are currently on a path to future increases in warming.

4. After conducting this review of the state of the science, EPA reached an initial conclusion that the assessment reports provide a reliable and credible assessment of the current state of the science, reflecting the many areas of consensus across the science community, and also documenting those areas that are less settled and where uncertainty remains.

5. EPA then provided an opportunity for public comment on EPA's initial conclusions and judgments on the science and the question of endangerment, with a detailed explanation of the basis for these conclusions and judgments. The public and all of the petitioners had the opportunity to present their views, agreeing or disagreeing, and why. EPA did this twice—on the Advance Notice of Proposed Rulemaking (ANPR) and on the Proposed Findings.

   This public process was designed to provide a full opportunity to test EPA's initial conclusions and judgments and allow anyone to present scientific evidence or argument showing that EPA's judgments on the science were inaccurate.

6. EPA carefully reviewed all of the comments submitted on the science and its judgments.

   - In general, people who opposed EPA's initial conclusion presented evidence and argument on one side or one part of an issue, discussing a limited number of old or

- EPA reviewed the studies, arguments, and evidence presented by commenters, assessed them in light of the entire body of evidence, and responded to the comments. These responses can be found in the Findings and the 11 volumes of the RTC document.

- Commenters who opposed EPA's initial conclusion on the science did not provide a comprehensive peer-reviewed alternative assessment of the science showing how the body of evidence as a whole supports their conclusion and does not support EPA's initial conclusion. We note that some commenters (who are also petitioners) submitted a non-peer reviewed assessment report by the Nongovernmental International Panel on Climate Change during notice and comment and recommended it as an alternative to the assessment reports prepared by the IPCC, USGCRP, and NRC. Response 1-12 in Volume 1 of the RTC document explains that we reviewed the process for preparing this report, as well as its content, and found that it lacked the depth, breadth, and rigor of the assessment reports on which the Findings rely.

7. After reviewing and considering all of the comments and arguments, EPA reached final conclusions on the state of the science. EPA generally confirmed its initial view, while making a variety of changes and modifications in various places of the TSD where it was warranted.

8. The Administrator carefully evaluated the scope of her legal discretion under section 202(a) in making a decision on endangerment, after providing notice of her initial legal views and receiving comments on that initial view.

9. In making the decision on endangerment, the Administrator exercised her own judgment by applying the science to the legal framework provided in section 202(a).

The core of petitioners' objection is that they do not agree with important parts of the scientific information on which the Endangerment Finding is based. They frame this as a failure of EPA or the Administrator to exercise independent judgment, or as EPA ceding to an outside body its responsibility to exercise independent judgment. The above makes it clear that neither EPA nor the Administrator did such a thing. EPA exercised its own judgment when reviewing the assessment reports, and did not cede or sub-delegate its authority or judgment to anyone. The petitioners disagree with the information EPA relied on and the conclusions EPA drew, and EPA addresses those objections throughout this document and the record for the Endangerment Finding. However, a disagreement over whether a source of information is useful or credible is not evidence of a lack of exercise of discretion or judgment.

There has been considerable criticism of EPA's use of the IPCC as a source for the TSD (U.S. EPA, 2009a), with some petitioners going so far as to refer to it as "an overt scientific organization with a covert political agenda of making the science conform to the desired result." A high level of vitriol has been directed at the IPCC, and gross misstatements have been made

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regarding the quality and integrity of their processes and reports. We strongly disagree with these mischaracterizations. The Findings, Volume 1 of the RTC document, and Volume 2 of the RTP document rebut petitioners' allegations that the IPCC is a political, not scientific, organization and that it does not adhere to U.S. standards of transparency and data quality.

We respond to petitioners' argument regarding the existence of errors in the IPCC Fourth Assessment Report (AR4) in Volume 2, Section 2.1, of this document and find that the errors are minimal, mischaracterized and inconsequential to the Findings. We respond to petitioners' arguments that the IPCC is a biased organization that advances a policy agenda in Volume 2, Section 2.2 of this RTP document, and we find that petitioners provide no evidence to support their claims that IPCC authors supported or promoted a unified policy agenda. Throughout Volume 1 of this RTP document, we also respond to petitioners' scientific arguments that the IPCC and other assessment reports presented the body of science in a biased or incomplete manner or reached inappropriate scientific conclusions. On issue after issue, we review the scientific evidence provided by petitioners and find that they misunderstand or mischaracterize the issues and the evidence.

The petitioners' arguments that the Agency violated the IQA and APA are also not new, and EPA provided a detailed response in Volume 1 of the RTC document. Several commenters previously raised specific scientific concerns, which they claimed demonstrated that EPA violated the IQA and APA. These were addressed in both Volume 1 and the accompanying scientific volumes of the RTC. The petitioners now make essentially the same general argument that EPA's use of third-party assessment reports violates the IQA and APA. As noted in Volume 1 of the RTC, the IQA requires that an agency issue guidelines regarding data quality and ensure their implementation. EPA complied with the IQA by issuing its *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility and Integrity of Information Disseminated by the Environmental Protection Agency* (U.S. EPA, 2002) and has acted consistently with these guidelines in developing the Findings. As stated in Volume 1 of the RTC, EPA's use of the assessment literature as a basis for the Endangerment Finding "is consistent with these guidelines because we thoroughly reviewed and evaluated the author selection, report preparation, expert review, public review, information quality, and approval procedures of IPCC, USGCRP/CCSP, and NRC to ensure the information adhered to a basic standard of quality, including objectivity, utility, and integrity." The CRU e-mails do not undermine this view. Our detailed responses on the science issues raised by petitioners concerning these e-mails are provided in several other sections of this RTP document, and show that petitioners' science claims do not support the view that the IPCC or other assessment reports were biased, inaccurate, or scientifically incorrect. Likewise, the few scientific or technical errors identified by petitioners in the IPCC report, such as the amount of land in the Netherlands that is below sea level, are all minor errors that are irrelevant in the context of EPA's Endangerment Finding. See Volume 2 of this RTP document for more detail regarding our response to this specific issue. Given the vast number of factual and scientific issues addressed by these comprehensive assessment reports, the existence of only a very limited number of these kinds of errors does not show a failure to employ and implement a high degree of control on the scientific quality of the report.

Comment (3-3):

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In support of its argument to Comment 3-2, the Southeastern Legal Foundation provides the announcement that the InterAcademy Council would conduct an independent review of the IPCC and its assessment report development process. The petitioner argues that "the IPCC itself is reconsidering its own work," and claims that this investigation "impeach[es] the reporting" of the IPCC and undermines the science used in developing the Endangerment Finding.

Response (3-3):
On February 27, 2010, the IPCC announced that the InterAcademy Council is conducting an independent review of the policies and procedures of the IPCC (IPCC, 2010). Upon completion, the InterAcademy Council will issue a report with recommended measures and actions to strengthen the IPCC's processes and procedures to better respond to future challenges and ensure the ongoing quality of its reports (InterAcademy Council, 2010). The IPCC's (2010) announcement stated that:

> The IPCC strives to ensure that its procedures for use of published material in the preparation of its assessment reports are followed in all respects. But we recognize the criticism that has been leveled at us and the need to respond. While embarking on the preparation of its Fifth Assessment Report it was the intention of the IPCC that an independent committee of distinguished experts evaluate means by which IPCC procedures must be implemented fully and that they should also examine any changes in procedure that may be required.

The petitioner improperly assumes that the IPCC is discredited because it has announced an evaluation of its report development process. In fact, the IPCC's announcement also stated that:

> We stand firmly behind the rigour and robustness of the 4th Assessment Report's conclusions, and are encouraged by the support demonstrated recently by scientists and governments around the world. The 4th Assessment Report's key conclusions are based on an overwhelming body of evidence from thousands of peer-reviewed and independent scientific studies. Most significantly, they rest on multiple lines of analysis and datasets.

The evidence provided by the petitioner does not show that the InterAcademy Council's review was initiated based on a presumption of wrongdoing. EPA's review of available information clearly reveals that the petitioner is wrong to assert that the IPCC is "reconsidering" its conclusions. We have addressed the specific scientific arguments raised by the petitions in the RTP document and find that the scientific evidence supporting the Endangerment Finding remains strong. Thus, as stated in the Findings, these reports continue to "represent the best reference materials for determining the general state of knowledge on the scientific and technical issues before the agency in making an endangerment decision," and the petitioner has not provided evidence to suggest that EPA's judgment was anything less than credible, objective, and robust.

Comment (3-4):
As evidence to support its argument that EPA delegated its duty and instead relied on the flawed IPCC assessment reports, the State of Texas states that "Dr. William Sprigg, who oversaw the IPCC's first assessment report, recently commented at a climate change conference: 'The IPCC is biased, conflicted, [and] pushing political agendas. We need to stick to our scientific

principles. We need to improve our peer review process, and expand the stakeholders' role to keep us all honest.'"

Response (3-4):
See Response 3-2 for our conclusion that we did not delegate our duty and that the petitioners are incorrect in alleging that the Administrator failed to exercise her own judgment in reaching the Endangerment Finding.

In response to this specific evidence, the petitioner mischaracterizes who William Sprigg is and what his role was in the IPCC. The petitioner claims that Sprigg oversaw development of the IPCC's First Assessment Report. However, after reviewing the reports of these Working Groups, there is no indication that Sprigg was involved in overseeing the development of any part of the entire report. The following people oversaw the development of the report: John Houghton, Chair of Working Group I; Yuri A. Izrael, Chair of Working Group II; and Frederick Bernthal, Chair of Working Group III. Sprigg is only mentioned as having been a contributing author on Chapter 6 ("World Oceans and Coastal Zones") of the Working Group II report on impacts for the First Assessment, which was released in 1990. Clearly the petitioner did not take the time to determine Sprigg's actual role in developing the IPCC's First Assessment Report, and significantly overstated his involvement.

Although the petitioner did not provide a transcript of Sprigg's statement or a citation for it, the evidence provided indicates merely that Sprigg does not approve of the IPCC's report development process. The petitioner provides this conclusion but provides no details about the basis for Sprigg's concerns, nor any evidence to support them. Throughout this document and the overall record, we have responded to both general and specific comments and find that Sprigg's comments do not provide any new information or evidence. The conclusory, unsupported statements of one former IPCC author, who has not been involved with the organization for almost two decades, do not provide evidence that the IPCC does not develop objective, sound, and unbiased assessments of climate change science.

EPA Provided Sufficient Opportunities for Public Comment

Comment (3-5):
Peabody Energy describes that "a number of commenters sought an extension of the 60-day comment period for the Endangerment Finding, complaining that 60 days was insufficient to review and comment on the complex climatological and policy issues raised in the proposed finding." The petitioner goes on to argue that in the Technical Support Document (TSD), "EPA elected to rely on secondary sources for which it has had no real scientific testing of any kind. It has used a rulemaking process that effectively permits no replies and no rebuttals." Peabody Energy argues that "EPA's use of the public comment periods in the processes that led to development of the 'assessment literature' as justification for the short comment period here [of the proposed findings] is further evidence of EPA's near total reliance on that literature."

Response (3-5):
EPA received several requests to extend the 60-day public comment period for the Proposed Findings. The main justification for these requests was that the record for this rulemaking,

which was made up of the assessment literature that EPA relied on in developing the TSD, was extensive and that additional time was needed to fully review all of the materials. In its denial of these requests, EPA noted, among other things, that a large majority of the underlying information and analysis supporting the Proposed Findings, and EPA's intension of using this information, had been in the public domain for almost one year prior to publishing the Proposed Findings. This was because a very large part of the underlying information and analysis for the Proposed Findings were previously released for a public comment period of 120 days on July 11, 2008, as part of the *Advance Notice of Proposed Rulemaking: Regulating Greenhouse Gas Emissions under the Clean Air Act* (73 FR 44353). EPA also noted that the major recent scientific assessments on which the Agency relied all had their own public review processes, and had been publicly available for some time. Under these circumstances, EPA determined that the 60-day comment period provided adequate opportunity for the public to review and comment on the Proposed Findings. We maintain that the 60-day comment period was reasonable and we note that the petitioner is not asking that EPA reconsider the Findings based on the length of the comment period.

Instead, Peabody Energy alleges that EPA's justification for the length of the comment period on the Proposed Findings "is further evidence of EPA's total reliance on that literature," and that the Agency "did not independently judge the science and instead relied primarily on summary scientific reports produced by third parties." The fact that EPA acknowledged the prior opportunity for public comment on the assessment reports does not evidence that EPA did not exercise independent scientific judgment. Rather, the evidence shows, as clearly stated in the proposed and final Findings, that EPA reviewed the major assessments of the USGCRP, the IPCC, and the NRC as the primary scientific and technical basis for the Administrator's endangerment decision. As described in Response 3-2, EPA and the Administrator properly and carefully exercised our own judgment in all matters related to the Endangerment Finding.

Finally, we note that was not impracticable to raise the objection during the public comment period and the reasons for the objection did not arise between June 24, 2009, and February 16, 2010. In making their argument, the petitioners have provided no new evidence and have not shown why it would have been impracticable for them to raise this issue during the public comment period, especially given the fact that the public has been aware that EPA relied, in part, on the IPCC assessments since the July 2008 ANPR.

EPA Complied With the Information Quality Act

Comment (3-6):
The Coalition for Responsible Regulation, the State of Texas, and Peabody Energy allege that EPA violated the IQA and APA by failing to make underlying data and studies relied on by the assessment literature available for public review by placing them in the docket. Peabody Energy concludes that EPA's approach to the science meant "there could be no genuine interchange between an open-minded EPA and the public on what EPA's scientific judgment should be because the Agency did not intend to exercise any such judgment."

Response (3-6):

First, we note that the petitioners are re-raising this issue in the petitions for reconsideration because they believe that the CRU e-mails show that "IPCC authors deleted information and hid behind foreign laws to avoid disclosure of key data" (from petition of the Coalition for Responsible Regulation). EPA responds to allegations involving the behavior of CRU scientists, including the allegation that data were destroyed, in Volume 1 and also in Sections 3.3 and 3.4 of this Volume of the RTP document. As stated in these sections, the evidence submitted by the petitioners in the form of the CRU e-mails does not support their allegation that data were destroyed. Therefore, the "new" information presented by the petitioners does not call into question the overall integrity of the science, nor does it call into question the process EPA used in developing the Findings.

As noted in Volume 1 of the RTC document, EPA is required to docket the information on which it relies, and, as explained in Section III.A of the Findings and in Volume 1 of the RTC document, the Administrator reasonably relied on the major assessments of the USGCRP, the IPCC, and the NRC as the primary scientific and technical basis of her endangerment decision.[1] Where EPA used or described any data in the TSD, the source of the data is listed, including where it can be accessed and downloaded. Further, each report, study, or dataset we relied on was clearly identified in the TSD bibliography and was placed in the docket. Information regarding the underlying data, models, and studies used by the IPCC, the USGCRP, the U.S. Climate Change Science Program (CCSP), and the NRC in developing their assessment reports can be accessed by consulting these reports. EPA also made available all studies and other information submitted by commenters. Given that some of these reports relied on thousands of underlying studies, docketing every underlying study and the data that were used in their development would be unreasonable and unnecessary, and it is not required by the IQA or any other law.

Cases cited by the petitioner do not indicate otherwise. In *American Relay Radio League, Inc. v. FCC*, 524 F.3d 227 (D.C. Cir. 2008), the D.C. Circuit held that the Federal Communications Commission (FCC) did not provide appropriate notice and comment when it redacted FCC staff-produced data integral to the basis for the rule. That is not the case for the Findings. EPA has provided and made available all studies relied on by the agency. *American Relay Radio League* also indicates that failure to provide data must be "prejudicial" to the commenter (*American Relay Radio League*, 524 F.3d at 237-238). Petitioners have had multiple opportunities to engage in this process, and the Agency has fully addressed this issue throughout. The D.C. Circuit itself noted the "narrowness" of its holding in *American Relay Radio League*, indicating that agencies are free to choose which studies they credit, as long as the Agency itself does not "redact parts of those studies" necessary to support the Agency's conclusion. EPA has provided and made available for comment all studies relied on for its final conclusion.[2]

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[1] See, for example, *American Trucking Ass'n v. EPA*, 293 F.3d 355, 372 (D.C. Cir. 2002). (EPA is not required to obtain and publicize the data underlying all the studies on which it relies.); *Coalition of Battery Recyclers Assn. v. EPA*, 604 F.3d 613, 622-24 (D.C. Cir. 2010) (same).

[2] Petitioners cite a case, *Solite Corp. v. EPA*, 952 F.2d 473 (D.C. Cir. 1991), where the court *rejected* a claim that EPA did not appropriately disclose data. In fact, this case holds that courts will only strike down agency action based on lack of disclosure of data when the agency hides or disguises "the information it used, or otherwise conducted the rulemaking in bad faith" (*Solite Corp.*, 952 F.2d at 484). That is certainly not the case here.

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The public was able to review all documents used by EPA in developing the TSD, including copyrighted material, by requesting a copy or visiting EPA's Air Docket. There was a full opportunity to review and comment on every piece of data relied on by EPA.

EPA's Review Process for the TSD Was Appropriate

Comment (3-7):
Several petitioners (the Coalition for Responsible Regulation, the Pacific Legal Foundation, and Peabody Energy) make the overarching argument that EPA's TSD did not go through a truly independent peer-review process. The petitioners argue that past EPA peer review of the science is now insufficient in light of new information in the CRU e-mails, and that the SAB must be given an opportunity to conduct an independent review of the Findings. They argue that the "SAB has not been able to perform its statutory function as an independent scientific review panel." More specifically, one petitioner states that review by the SAB is required under 42 U.S.C. § 4365(c)(1), because the substantial uncertainty surrounding EPA's scientific determination warrants reopening of the comment period. The Pacific Legal Foundation states that Section 4365(c) requires EPA to submit relevant technical information and data to the SAB for their review whenever the public comment period is open.

Response (3-7):
The general issue raised by petitioners regarding review of the TSD is not new and, in fact, was raised and responded to through the public comment process (see Volume 1 of the RTC document). Thus, it was not impracticable to raise the objection during the public comment period and the reasons for the objection did not arise between June 24, 2009, and February 16, 2010. To the extent petitioners argue that new information in the CRU e-mails calls into question the reasoning behind EPA's position on this issue in the final Findings, the petitioners do not demonstrate that additional information has become available that merits reconsideration of the Findings. We have carefully reviewed the issue raised regarding the implications of the CRU e-mails, and considered whether information in the CRU e-mails calls for EPA to reconsider the procedural steps with respect to the scientific and technical information used as basis for the endangerment determination. We find nothing in the CRU e-mails that relates to EPA's decision regarding peer review of the TSD. Also, and as explained in detail elsewhere in this document and the Denial, the e-mails and other "new" information provided by petitioners do not call into question the underlying science of climate change, nor the validity of the assessment reports.

As stated in Volume 1 of the RTC document, the purpose of the federal expert review was to ensure that the TSD accurately summarized the conclusions and associated uncertainties from the assessment reports. This is reasonable given our approach to the scientific literature (described in Section III.A of the Findings and Volume 1 of the RTC document). We also note that the federal expert review was only one part of a much larger process of developing the TSD from 2007 until the present. In addition to the three rounds of technical review by the 12 federal experts, the TSD has also gone through two rounds of public comment. The scope and depth of the record on the Endangerment Finding—including an 11-volume RTC document responding to comments on all aspects of the science, law, and procedure—demonstrate both the volume of information the Administrator considered in developing the Findings and the seriousness with

which the task of assessing the science was approached. Based on this, EPA rejects the Pacific Legal Foundation's allegation that the peer-review process EPA employed was insufficient in light of new information in the CRU e-mails. See other sections of this RTP document for our response to petitioner arguments regarding the implications of the CRU e-mails.

The petitioner's argument regarding the SAB is somewhat unclear. To the extent the petitioner is claiming that EPA was required to submit the proposed Endangerment Finding to the SAB when it was proposed, the petitioner clearly could have raised this objection during the comment period, and thus this objection is not a basis for reconsideration of the Endangerment Finding. To the extent that the petitioner is claiming that EPA is required to submit the Endangerment Finding to the SAB for review at this time, because the various other grounds raised in the petitions to reconsider warrant reopening of the public comment period, EPA interprets this as a claim that SAB review will be required under this provision if EPA grants the petition to reconsider and reopens the comment period. For all of the reasons discussed elsewhere in the Decision and the RTP document, EPA is not granting the petitions to reconsider and is not reopening the comment period. Thus, there is no reopening of the comment period to trigger the SAB review claimed by the petitioner.

In addition, this statutory provision did not require EPA to submit the proposed Endangerment Finding to SAB for review. Under its terms, the provision calls for EPA to make a "proposed criteria document, standard, limitation, or regulation" available to the SAB for review. The proposed Endangerment Finding is not a criteria document, standard, limitation, or regulation, and is thus not in the scope of this provision. In addition, the requirement to submit the proposed document to the SAB applies when "any proposed criteria document, standard, limitation, or regulation … is provided to any other Federal agency for formal review and comment." It is not clear whether this includes the kind of informal interagency review conducted pursuant to Executive Order (E.O.) 12866, as compared to the more formal agency review envisioned in statutory provisions such as 49 U.S.C. 32902(j).

Finally, the objection does not provide substantial support for the argument that the Endangerment Finding should be revised. In the Endangerment Finding the Administrator determined that the body of scientific evidence compellingly supports a positive endangerment finding. The major assessments by the USGCRP, the IPCC, and the NRC (published before 2010) served as the primary scientific basis supporting the Administrator's Endangerment Finding. The objections raised by the various petitioners have not changed EPA's view of the science. In May 2010, the NRC of the U.S. National Academies published its comprehensive assessment, "Advancing the Science of Climate Change." It concluded that "climate change is occurring, is caused largely by human activities, and poses significant risks for—and in many cases is already affecting—a broad range of human and natural systems." Furthermore, the NRC stated that this conclusion is based on findings that are "consistent with the conclusions of recent assessments by the U.S. Global Change Research Program, the Intergovernmental Panel on Climate Change's Fourth Assessment Report, and other assessments of the state of scientific knowledge on climate change." These are the same assessments that served as the primary scientific references underlying the Administrator's Endangerment Finding. Importantly, this recent NRC assessment represents another independent and critical scientific inquiry into the state of climate change science, separate and apart from the previous IPCC and USGCRP

assessments. The NRC assessment is a clear affirmation that the scientific underpinnings of the Administrator's Endangerment Finding are robust, credible, and appropriately characterized by EPA. Petitioners provide no basis to suggest that lack of review by the SAB undermines this scientific basis in any way.

EPA Did Consider Positive Impacts of Elevated Carbon Dioxide Concentrations

Comment (3-8):
Peabody Energy argues that "EPA fails to come to grips with the fact that CO_2 [carbon dioxide] is a benign, naturally-occurring gas that is necessary for life on earth" and that the Administrator's finding of endangerment to public health fails to recognize this fact. The petitioner goes on to describe that in making the endangerment determination, EPA did not account for the "wide variety of positive impacts for plant life, including agricultural crops." Finally, referring to the IPCC reports, the petitioner argues that "EPA's attempt to transform the benign naturally-occurring substance into a danger air pollutant is based on evidence it should never have used in the first place."

Response (3-8):
First, we note that the issue raised by petitioner is not at all new and was raised and responded to at length through the public comment process after the Proposed Findings and very directly within the Endangerment Finding itself (see Sections I and IV of the Findings and Volume 1, Section 4, of the RTC document). Second, the petitioner is simply incorrect in claiming that EPA did not account for some of the beneficial effects of CO_2, such as the fertilization effect on agricultural crops; these issues have been addressed at length by EPA in the RTC document and in the Findings. Thus, it was not impracticable to raise the objection during the public comment period and the reasons for the objection did not arise between June 24, 2009, and February 16, 2010.

To the extent petitioners argue that new information in the CRU e-mails calls into question the reasoning behind EPA's position on this issue in the final Findings, the petitioners do not demonstrate that additional information has become available that merits reconsideration of the Findings. Based on our review of the CRU e-mails, we find that they do not contain information that should cause us to question the conclusions of the assessment literature as to the state of the science on GHGs, climate change, and the associated risks and impacts to public health and welfare. In the context of the allegation by Peabody Energy, the CRU e-mails also do not cause us to reconsider our consideration of net (adverse and beneficial) effects. We note that the petitioner did not provide any new information (e.g., peer-reviewed, published scientific studies) to support their argument regarding the CO_2 fertilization issue. Rather, the petitioner refers to the comments they submitted on the Proposed Findings, which, as stated above, we have already responded to at length in the RTC document.

3.1.4 Summary

After reviewing the petitioners' arguments, EPA finds that many of them are based on a either a mischaracterization of or a fundamental disagreement with our approach to the scientific literature in developing the TSD for the final Findings, or the Administrator's consideration of

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that science in her Findings. Almost all of their arguments are not new, and we responded to them in the Findings and RTC document. None of the petitioners' arguments regarding the approaches and processes EPA used to develop the scientific support for the Findings justifies reconsideration.

EPA reasonably chose to rely on the existing assessment reports of the USGCRP, the IPCC, and the NRC as the primary sources for determining the current state of the science relating to climate change, and for determining the degree of scientific consensus on these issues, based on: 1) the goals of these reports to provide such information, in the context of the broad scope and complexity of the climate science that would be considered in an Endangerment Finding; 2) EPA's review of the rigorous and transparent procedures for development of the various assessment reports; 3) EPA's review of the contents of these reports; and 4) EPA's use of the public comment process to test and evaluate its initial scientific conclusions and judgments based primarily on the assessment literature. It is our conclusion that by placing primary reliance on the major assessment reports, EPA ensured that the endangerment determinations are based on reports that have considered and weighed all views. Our review of the objections raised by petitioners to the process and the substance of the various assessment reports does not support changing this view. EPA fully exercised its judgment and discretion under section 202(a), as evidenced throughout the comprehensive and robust record supporting the Endangerment Finding.

The petitioners appear to believe that there is a substantial likelihood that EPA would have drawn different conclusions had it conducted its own separate assessment instead of relying on the conclusions of the assessment literature. They further claim that the CRU e-mails and other new information prove that such separate assessment is absolutely necessary. After examining the breadth and quality of the USGCRP, IPCC, and NRC assessments, as well as the new information provided by petitioners, we disagree. Overall scientific understanding is not shaped by any single study; one must look across a range of studies that together serve to advance scientific knowledge. These assessment reports already reflect significant input from EPA's scientists and the scientists of many other government agencies. They have been reviewed and formally accepted, commissioned, or in some cases authored by U.S. government agencies and individual government scientists. By relying on the assessment literature, EPA is benefitting from the confidence and strength of an entire federal research enterprise and a robust process involving the scientists from around the world, and we find no reason, for reasons described throughout this RTP document, to believe that these reports do not represent the best primary source material to determine the state of science on the issues central to making an Endangerment Finding for GHGs.

3.2 Response to Claims That the Assessments by the USGCRP and NRC Are Not Separate and Independent Assessments

3.2.1 Overview

Two petitioners (the Competitive Enterprise Institute and the State of Texas) argue that EPA misled the public into thinking that the Agency relied on three separate and independent assessment reports when in reality, they contend, the assessment reports developed by two of the

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groups (USGCRP and NRC) are not separate and independent assessments of the available science because the USGCRP and NRC "regularly cite and rely on data, resources and conclusions in the IPCC reports." These petitioners further argue that since the IPCC reports are unreliable, the USGCRP and NRC reports are also unreliable, and thus all of the assessment literature EPA relied on is flawed. Following this logic, the petitioners argue that the Endangerment Finding must thus be reconsidered.

First, as explained in detail in this document and the Denial, the IPCC reports are not unreliable, and continue to provide a robust foundation for the Findings. Moreover, the IPCC, USGCRP, and NRC assessments are separate and independent of each other. The organizational and personnel differences, and the detailed and robust report development procedures employed by the IPCC, USGCRP, and NRC, demonstrate that these assessment reports are separate and independent, and petitioners' claims to the contrary are insufficient and unsubstantiated. EPA's reliance on these three sets of assessment reports was and is reasonable. The fact that different assessments, developed by different organizations using different report development procedures, refer to each other's work and arrive at similar conclusions does not imply flawed work. To the contrary, when multiple independent sources arrive at similar conclusions, those findings are strengthened.

3.2.2 EPA's Response to Petitioners' Arguments

Comment (3-9):
Both the Competitive Enterprise Institute and the State of Texas note that EPA relied on the findings of the assessment literature to serve as a basis for the Endangerment Finding. They argue that EPA misled the public into believing that the Agency relied on assessments from three independent climate science entities, when in fact the TSD discusses and references findings from IPCC assessment reports far more frequently and in greater depth than those of the USGCRP and NRC. For example, the State of Texas argues that "the Administrator attempts to justify outsourcing her scientific assessment by purporting to rely on three outside organizations – which creates the appearance of a more thorough review." In discussing this issue, the Competitive Enterprise Institute claims that the USGCRP and NRC assessments "are actually extensions of the IPCC findings, incorporating its faults and errors. Contrary to EPA claims, they do not provide any independent scientific support whatsoever." The petitioners argue that the Endangerment Finding must be reconsidered because the USGCRP and NRC assessments are as flawed as the IPCC reports because they are not separate and independent from the IPCC reports.

Response (3-9):
The issues of EPA's reliance on the assessment literature and whether the assessments by IPCC, USGCRP, and NRC are independent are not new and not only could have been, but were, the subject of comment during the public comment period. Thus, it was not impracticable to raise the objection during the public comment period and the reasons for the objection did not arise between June 24, 2009, and February 16, 2010. As such, they do not justify reconsideration of the Findings. The Administrator's rationale for relying on the major assessments of the USGCRP, IPCC, and NRC as the primary scientific and technical basis for making the endangerment decision is explained in detail in the Findings, and our responses on this issue are

included in Section 1.1 of Volume 1 of the RTC document, as well as Section 3.1 of this volume and Section 2.2 of Volume 2 of this RTP document.

To the extent petitioners are arguing that new evidence casts further doubt on a practice they already criticized during the public comment period, we disagree. As discussed in Volume 2 and the Denial, it is abundantly clear that the issues raised in the CRU e-mails and errors found in the IPCC report do not cast doubt on the EPA's reliance on the IPCC and other assessment literature relied for the Endangerment Finding.

Moreover, contrary to the arguments of the petitioners, the USGCRP, IPCC, and NRC are separate and independent of each other. Although we thoroughly addressed this issue previously in Volume 1 of the RTC document, we will respond again here.

There can be no doubt that the USGCRP, the IPCC, and the NRC are distinct organizations, with separate report development procedures. Below, we summarize the differences in the organizations, the groups of scientists who developed the assessments, and scope of the assessments produced by each body.

- The IPCC, created in 1988 by the United Nations Environment Programme and the World Meteorological Organization (WMO), is open to all member countries of the United Nations and the WMO. At regular intervals, the IPCC prepares comprehensive assessments of scientific, technical, and socio-economic information relevant for the understanding of human induced climate change, potential impacts of climate change, and options for mitigation and adaptation all at global and regional scales. The most recent assessment—the AR4—included thousands of scientists from all over the world, who participated on a voluntary basis as authors, contributors, and reviewers (IPCC, 2007a). While many federal and nonfederal scientists from the United States were involved in the development of the AR4, the United States is just one of 194 countries that contribute to the assessments.

- The USGCRP is part of the United States Executive Branch. Thirteen departments and agencies participate in the USGCRP, including EPA. A critical role of the interagency program is to coordinate research and integrate and synthesize information to achieve results that no single agency, or small group of agencies, could attain. Between 2004 and 2009, the USGCRP produced 21 synthesis and assessment reports on a wide range of topics (e.g., temperature trends in the lower atmosphere; weather and climate extremes in a changing climate; and the effects of climate change on agriculture, land resources, water resources, and biodiversity). The USGCRP assessment reports are developed to enhance understanding of natural and human-induced changes in the Earth's global environmental system; to monitor, understand, and predict global change in the United States; and to provide a sound scientific basis for national and international decision-making. Each of these reports had a unique team of authors, drawn from relevant disciplines. Many authors were federal scientists, and in some cases, nonfederal scientists contribute their expertise to the process. While some of the USGCRP authors participated in the development of the IPCC AR4, most did not.

- The NRC is an independent scientific organization that is not affiliated with either the IPCC or USGCRP. As described in Appendix C of Volume 1 of the RTC document, the NRC:

> "enlist(s) the nation's foremost scientists, engineers, health professionals, and other experts to address the scientific and technical aspects of society's most pressing problems. Each year, more than 6,000 of these experts are selected to serve on hundreds of study committees that are convened to answer specific sets of questions. All serve without pay. Federal agencies are the primary financial sponsors of the Academies' work. Additional studies are funded by state agencies, foundations, other private sponsors, and the National Academies endowment. The Academies provide independent advice; the external sponsors have no control over the conduct of a study once the statement of task and budget are finalized. Study committees gather information from many sources in public meetings but they carry out their deliberations in private in order to avoid political, special interest, and sponsor influence."

  Ten NRC reports are cited in the Endangerment Finding and TSD. Each of these reports has a unique author committee, selected based on their areas of expertise. While some of the NRC study committee members have participated in either the IPCC or USGCRP report development processes, many have not.

With this background on the three organizations and their report development processes, the flaws of the petitioners' allegations become clear. Not only are the three organizations separate and distinct, but there is additional independence among the multiple reports that they each produce. Within the IPCC, each chapter has a unique, dedicated team of authors, and the same is true for each NRC and USGCRP report. It should be no surprise that some scientists participate in reports produced by more than one organization, but petitioners have provided no evidence that any scientists exerted influence on a number of the reports produced by these three organizations. Moreover, there is no overlap in the personnel at the IPCC, NRC, and USGCRP who supervised the review and preparation of the final reports.

Finally, the petitioners state that EPA cited and referenced the IPCC AR4 more frequently and in more depth than the USGCRP and NRC assessment reports in the Findings and the TSD. While this is accurate, the TSD also references many of the USGCRP and NRC assessment conclusions. For example, the Chapter 15 of the TSD on "U.S. Regional Climate Change Impacts" primarily cited and referenced the USGCRP's 2009 assessment (Karl et al., 2009) for its focus on impacts in the United States. Regardless, counting references is a misguided and trivial criterion to apply. As described in the Endangerment Finding, we relied on the IPCC AR4 because it is a comprehensive synthesis of the latest science on: "(1) the amount of greenhouse gases being emitted by human activities; (2) how greenhouse gases have been and continue to accumulate in the atmosphere as a result of human activities; (3) changes to the Earth's energy balance as a result of the buildup of atmospheric greenhouse gases; (4) observed temperature and other climatic changes at the global and regional scales; (5) observed changes in other climate-sensitive sectors and systems of the human and natural environment; (6) the extent to which observed climate change and other changes in climate-sensitive systems can be attributed to the human-induced buildup of atmospheric greenhouse gases; (7) future projected climate change under a range of different scenarios of changing greenhouse gas emission rates; and (8) the

projected risks and impacts to human health, society and the environment." As discussed throughout this document, this statement still holds true.

Our reliance on the IPCC is entirely reasonable given the breadth of the issues covered and the credibility and quality of the information presented in the AR4. As discussed in Volume 2 of this RTP document, the recent revelations about a small number of specific factual errors in the IPCC AR4 do not call into question the overall credibility of the report such that it would render EPA's reliance on it unreasonable. Nor do the CRU e-mails call into question the scientific integrity of the IPCC report or the underlying studies considered therein. Importantly, during the public comment period, we received many comments on specific scientific issues and conclusions of the IPCC AR4 and the other reports on which we relied. These comments were fully responded to in the multiple volumes of the RTC document, and insights from the comments were reflected in the Administrator's final determination. The scope and depth of the record on the Endangerment Finding—including an 11-volume RTC document responding to comments on all aspects of the science, law, and procedure—demonstrates both the volume of information the Administrator considered in developing the Findings and the seriousness with which EPA approached the task of assessing the science. The general claims by the petitioners that the IPCC is "unreliable" or "flawed" are not valid because, as discussed in Volume 2, Section 2.1, of the RTP document, they are not backed by specific evidence or credible scientific studies that support their views.

Comment (3-10):
The Competitive Enterprise Institute and the State of Texas argue that EPA misled the public into believing that the Agency relied on assessments from three independent climate science entities, when in fact the USGCRP and NRC reports regularly cite and rely on data, resources, and conclusions in the IPCC reports, thereby contradicting arguments that all three of the assessments are separate and independent.

Response (3-10):
These allegations are not new and not only could have been, but were, the subject of comment during the public comment period. It was not impracticable to raise the objection during the public comment period and the reasons for the objection did not arise between June 24, 2009, and February 16, 2010.

In their recent assessment reports, the USGCRP and NRC relied on and referenced many conclusions from the IPCC AR4 chapters. All three bodies are tasked with identifying the best available scientific information on which to base their assessments. Therefore it is reasonable and expected that the NRC and USGCRP would cite the IPCC; this is a reflection of the confidence that the NRC and USGCRP place in the work of the IPCC, not evidence that there is a lack of separation and independence. We disagree with the petitioners' conclusion that since the reports produced by the different organizations referenced many of the same studies, or each other, or arrived at consistent conclusions this means that these reports are not independent assessments of the available science related to climate change. Given the clear separation and independence in the organizations, the personnel performing supervision and review, and the differences in the groups of scientists working on the assessment, the appropriate conclusion to

draw is that the consistency in the conclusions reached by multiple reports of the three organizations provides more, not less, weight and confidence in these conclusions.

Petitioners appear to believe that EPA should conclude, from the fact that subsequent assessments of climate change science have reaffirmed and strengthened the core conclusions of previous reports, that the assessments are not separate and independent. However, the test of separation and independence is not whether one reaches a different result or conclusion, but rather whether independent discretion and judgment was exercised. For example, it is routine in science for different researchers to perform similar or related analyses or assessments. Reaching a similar result provides increased confidence in the entire set of results. The similarity in results does not prove, nor should it even suggest, that the researchers failed to be separate and independent. Petitioners' logic fails, as it is driven by an inappropriate results-oriented criterion. The fact that each successive assessment report, performed by a different organization and group of scientists and reviewers, reexamines the work of previous reports in light of new scientific information, and in many cases cites them, results in greater confidence in the reliability and objectivity of the scientific conclusions on which the Endangerment Finding relies. In this manner, the USGCRP, the IPCC, and the NRC have all taken a fresh look at the literature and existing assessments and reached similar, consistent, and compelling conclusions regarding the threat of climate change.

It is also reasonable and scientifically credible that the USGCRP and NRC would reference the IPCC AR4. Despite the allegations of petitioners, we have found no evidence that the IPCC processes do not produce credible reports or that the IPCC has reached flawed conclusions on specific scientific issues. Our response to petitioners' claims regarding the IPCC processes are detailed in Volume 2, and our response on the science issues are in Volume 1 of this RTP document. Petitioners' evidence does not support their claim that the USGCRP and NRC blindly accept the conclusions and assessments reports of the IPCC. To the contrary, the evidence shows that they independently reviewed the conclusions of the assessment reports, including in some cases the literature underlying the assessments, and also reviewed the more recent literature to determine the current state of the science. In some cases, USGCRP reviewed the underlying science and referenced the IPCC where they agreed with the conclusions and how they were developed. For example, in their assessments the USGCRP referenced IPCC findings for many context-setting issues such as global observations, attribution, and radiative forcing. In other cases, USGCRP reviewed the available literature, including any studies reviewed or referenced in the AR4, and made their own key conclusions regarding the state of the science. The USGCRP predominantly employed this approach in describing observed and projected impacts in the United States (Karl et al., 2009). A very similar approach was used by the NRC in their assessments (NRC, 2008). As a result, USGCRP's and NRC's assessments contain both references for the AR4 chapters and individual studies.

The USCGRP and NRC also give the public opportunities to provide input and comment during report development (see Volume 1 of the RTC document for more information on USGCRP's and NRC's report development processes). Specifically, the USGCRP holds public comment periods when developing the prospectus for each assessment and again once the report has been drafted. The NRC employs a different, yet entirely robust and reasonable process. Information-gathering meetings of the NRC study committees are open to the public, and any written

materials provided to the committee by individuals are maintained in a public access file that is available for examination. In developing the draft findings and recommendations for each report, the study committees deliberate in meetings closed to the public in order to maintain independence from outside influences. Finally, the NRC reports undergo a rigorous, independent external review by experts whose comments are provided anonymously to the committee members.

Comment (3-11):
Peabody Energy contends that the principal authority for EPA's central conclusion that anthropogenic GHG emissions are causing deleterious climate change is the IPCC, rather than other "assessment literature" or any other studies. They note that of the 67 citations in the attribution section of the TSD (Section 5) that discusses the linkage between observed climate change and GHGs, 47 are from the IPCC. Additionally, Peabody Energy is critical of the fact that "only eight pages" of the TSD are devoted to this issue.

Response (3-11):
Section 5 of the TSD addresses attributing observed changes in climate to anthropogenic GHGs, and the IPCC does serve as a core reference to the assessment literature for Section 5. The IPCC's findings on attribution, as summarized in the TSD, draw from modeling experiments using 14 atmosphere-ocean general circulation models and scores of simulations, as well as literally hundreds of studies. The IPCC's chapter on attribution is 80 pages long. It is therefore the most comprehensive resource on attribution available in the scientific literature on this subject. Peabody Energy provides no substantive comment on its content.

While we reference the IPCC for large parts of our discussion of attribution, we also reviewed and cited several USGCRP assessments that cover attribution issues. These include:

- CCSP 1.3: Reanalysis of Historical Climate Data for Key Atmospheric Features: Implications for Attribution of Causes of Observed Change (CCSP, 2008a)
- Subsections on attribution in CCSP 3.3: Weather and Climate Extremes in a Changing Climate (CCSP, 2008b)
- Global Change Impacts in the United States (Karl et al., 2009)

While Peabody Energy's points to the length in pages of the TSD discussion, it does not identify any general or specific issues that were omitted or inappropriately handled. Peabody Energy's focus on counting references and pages is not a credible, science-based argument against the scientific information that supports the Endangerment Finding. We did receive many public comments on attribution, and our responses are provided in Volume 3 of the RTC document. Furthermore, the National Academy of Sciences recent report "Advancing the Science of Climate Change" (NRC, 2010) supports and reaffirms the conclusions from the earlier assessment literature synthesized in the TSD pertaining to attribution as mentioned in Section 1.1.2.4 of this RTP document.

EPA's evaluation of the attribution issue relies on appropriate assessment literature, as well as any information or studies provided in the public comment process. EPA's evaluation, and it's

responses to comments on the issue of attribution, provide a comprehensive and appropriate evaluation of this issue. Peabody Energy's comment on citations and pages provides no scientific basis to believe otherwise.

3.2.3 Summary

The evidence provided by the petitioners does not support their allegations that the IPCC, USGCRP, and NRC assessments are not separate and independent, and the alleged flaws with the IPCC attach to the USGCRP and NRC reports as well. The organizational and personnel differences, and the detailed and robust report development procedures employed by the IPCC, USGCRP, and NRC, demonstrate that these assessment reports are separate and independent, and petitioners' claims to the contrary are insufficient and unsubstantiated. Thus, the petitioners' claims that EPA misled the public regarding the breadth and independence of the information relied on by the Administrator are unfounded. Contrary to petitioners' allegation, the USGCRP and NRC are independent and separate assessments. Furthermore, the similarity of the conclusions among the assessment reports from the three bodies provides evidence of the strength of the underlying science and does not represent a lack of independence, as alleged by the petitioners. The evidence does not support changing EPA's use of those assessments, or justify the reconsideration of the Findings.

Separate and apart from the issue of the independence of these assessment reports, the petitioners provide no information to demonstrate that the scientific conclusions of the IPCC, USGCRP, and NRC are wrong or that EPA erred in relying on them. The specific science issues raised by petitioners are discussed in Volumes 1 and 2. Thus, whether or not the various assessment reports are separate and independent, EPA reasonably relied on them as reflecting the current state of the science and the degree of broad consensus within the science community on these issues.

3.3 Issues Concerning the Integrity of Peer-Reviewed Literature

3.3.1 Overview

Several petitioners (the Coalition for Responsible Regulation, the Ohio Coal Association, the Pacific Legal Foundation, Peabody Energy, the Southeastern Legal Foundation, the State of Texas) argue that leading climate scientists associated with the CRU e-mails conspired to keep dissenting views of anthropogenic climate change out of the peer-reviewed literature. Specifically, petitioners claim that these scientists unfairly gave favorable reviews of each other's manuscripts while providing negative reviews of manuscripts authored by those with opposing views, made efforts to unfairly expedite publication of their responses to papers by with opposing views, conspired to remove editors of prominent journals that had published dissenting views of climate change, and boycotted certain journals in reprisal for publication of articles with which they disagreed. The petitioners conclude that all of these actions advantaged the positions of the climate scientists associated with the CRU e-mails in getting their views published and legitimized, while making it very difficult if not impossible for dissenting views to

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be published. Thus, petitioners argue that the peer-reviewed climate change literature is unbalanced and reflects an artificial consensus about anthropogenic climate change.

Our review of the petitioners' claims and the evidence they rely upon shows many cases in which the petitioners make overly broad generalizations based on suggestions of inappropriate actions that are not supported by the information they provided. Most of the quotes from the e-mails that petitioners allege shows impropriety are taken out of context from the e-mails. Further, petitioners do not provide corroborating evidence that improper action actually occurred, let alone evidence that any alleged improper action led to biased or inaccurate science that was ultimately used by EPA to support the Findings. In addition, the petitioners make broad leaps in logic to impugn the overall integrity of the peer-reviewed climate change literature based on very limited examples and largely speculative assertions. Based on our review, the e-mails do not contain information that causes us to question the integrity of the assessment literature or its conclusions as to the state of the science on GHGs, climate change, and the associated risks and impacts to public health and welfare.

The following sections provide our responses to the arguments made by petitioners regarding the integrity of peer-reviewed literature. Section 3.3.2 responds to allegations regarding reviews of manuscripts. Section 3.3.3 responds to allegations of unfair journal publications practices. Section 3.3.4 responds to allegations of efforts to remove editors and boycott journals. Section 3.3.5 responds to allegations of intimidating junior scientists and those with opposing views. Finally, Section 3.3.6 summarizes our responses.

3.3.2 Allegations Regarding Reviews of Manuscripts

Comment (3-12):
Peabody Energy cites one example from the CRU e-mails that it claims demonstrates that the scientists "bent the rules to ensure publication of papers that supported their position regardless of quality." Specifically, the petitioner argues that Michael Mann (a professor at Pennsylvania State University and former editor for the *Journal of Climate*) inappropriately recommended that Phil Jones of CRU should review a manuscript submitted for publication by Ben Santer of Lawrence Livermore National Laboratory and Tom Wigley of the University Corporation for Atmospheric Research. Peabody Energy argues that Jones' close association with the authors limited his ability to act as an impartial reviewer. In addition, Peabody Energy cites an e-mail written by Tom Wigley from September 22, 2000, on which Jones was copied and which shows Santer and Wigley discussing their submitted manuscript:

> Ben (or, really, everybody else),
>
> I don't know whether you have all seen the paper analyzing the observed data that Ben and I sent to J. Climate ?? This is where the JGR [*Journal of Geophysical Research*] paper began, and it is useful to compare both papers. In the J. Climate paper we assessed the best fits using a subjective balance of raw and lowpass filtered results. The reason for this was because of the difficulty of setting up an automated procedure -- which is the problem that Ben is currently having to deal with. In the next iteration of the JGR paper, the reason for moving to a more automated procedure will be explained. Both the subjective and automated procedures have their advantages and disadvantages. The latter

> procedure, of course, is in no way 'objective'. Many subjective choices have to be made in setting up the procedure. This is why the word 'automated' is used above, rather than 'objective'.
>
> If you have not seen the J. Climate paper, let me know and I will send you a copy. There is a companion paper that has been accepted by GRL [*Geophysical Research Letters*] that I will send at the same time.[3]

Peabody Energy argues that this e-mail gave Jones advance knowledge of the paper's content and thus limited his ability to act as an impartial reviewer of their manuscript. The petitioner states that on October 24, 2000, Jones wrote a positive review with minimal comments:

> Dear Brendaw,
> My review of the paper JCL [*Journal of Climate*] 3435 is attached. My recommendation is to accept the paper subject to minor changes. I don't wish to see it again. If there are any problems with the attachment, let me know and I can fax the 2 pages.[4]

Peabody Energy asserts that Jones did not act as an impartial, objective reviewer because he clearly had problems with the manuscript, but recommended the paper for publication anyway. As evidence of Jones' problems with the manuscript, the petitioner cites the following excerpt of an e-mail written by Jones on October 25, 2000, to Santer:

> Also just sent back comments to Mike Mann on the paper by Tom and you factoring out ENSO [the El Niño Southern Oscillation] and Volcanoes. Felt like writing red ink all over it, but sent back a short publish subject to minor revision to Mike.[5]

Peabody Energy concludes that this exchange is evidence that "peer-review publication rules" were manipulated, and that "the peer-review process was tainted in favor of desired papers." Peabody Energy argues that the Endangerment Finding should be reconsidered because it relies on biased peer-reviewed literature that published papers supporting anthropogenic climate change regardless of their scientific quality.

Response (3-12):
The emails do not support the petitioner's arguments because the petitioner provides no evidence to support its claim that past collaborations among these climate researchers led Jones to skew his review. The petitioner makes much of Jones' statement that he "felt like writing red ink all over it," but the meaning of this statement is unclear from the e-mail. Jones does not say that he disagreed with the paper's conclusions, and it is equally plausible the he thought the paper was poorly written or that he believed the conclusions could have been improved. The fact that he wanted to edit the paper (for an unknown reason) does not support the view that he should have rejected it for publication.

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[3] E-mail file 969652057.txt, (September 22, 2000), page 285, line 42 of PDF version entitled: CRU Emails 1996-2009.pdf
[4] E-mail file 972415204.txt, (October 24, 2000), page 295, line 33 of PDF version entitled: CRU Emails 1996-2009.pdf
[5] E-mail file 972499087.txt, (October 25, 2000), page 296, line 9 of PDF version entitled: CRU Emails 1996-2009.pdf

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Petitioner alleges that Mann inappropriately asked Jones to review the paper and that Jones should have declined because he knew the authors and may have had prior knowledge of the paper's content. Neither of these events is uncommon in scientific publishing; however, in a small field like paleoclimate research, there is often substantial interaction of this type. In order to demonstrate manipulation, petitioners need to prove that the paper was flawed, which they fail to do. In fact, they do not provide any discussion of the scientific merits of the paper. In addition, all peer-reviewed publications have multiple reviewers, so Jones was not in position to determine whether or not it would be approved for publication.

In addition, this incident, even if it supported the claim petitioner alleges, does not support petitioners allegations of broad ranging efforts by multiple scientists to manipulate the entire spectrum of peer-reviewed literature. All this incident could possibly prove, if the petitioner's claims were substantiated (which they are not) is that Phil Jones gave a favorable review to one paper published by people he interacted with professionally.

These e-mails do not support the claim that Jones or others "bent the rules" on the peer review process for this specific paper, and they present no other evidence to support the petitioner's claim of a broader effort by many scientists that affected an unknown number of other journal articles. Even if the allegations were corroborated for this one paper, they deal with only one of thousands of papers that make up the body of scientific literature on climate change. To claim, as the petitioner does, that one paper or the actions of one scientist could somehow bias the vast wealth of climate change studies or call into question the overall conclusions reached from those thousands of papers is unwarranted and unsupported. Finally, the petitioner fails to make any arguments as to why the paper at issue was scientifically flawed and should have been rejected for publication. Instead of arguing about the scientific merits of the paper, the petitioner relies upon speculation.

Comment (3-13):

Petitioners claim that the CRU e-mails indicate that certain scientists unfairly wrote negative reviews of manuscripts authored by "climate skeptics" in order to keep opposing views out of the peer-reviewed literature. Peabody Energy argues that:

> As leading scientists in the climate field, several of the authors involved in AR4 were in a position to affect the types of papers that were published in the peer-reviewed literature…They abused their positions of influence, however, by manipulating the peer-review publication process to prevent publication of papers at odds with their own views and even to oust editors who had published such papers.

More specifically, Peabody Energy claims that Tom Wigley of the University Corporation for Atmospheric Research unfairly reviewed and recommended rejecting a manuscript by Patrick Michaels of the University of Virginia. The petitioner suggests that Wigley was motivated by a desire to keep dissenting views out of the peer-reviewed climate change literature because "other peer reviewers not connected with the Jones et al. group had accepted it in the normal course and the refereeing process had been more rigorous than usual." The petitioner cites an e-mail from Wigley in which he discusses his rejection of the manuscript:

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> Danny Harvey [of the University of Toronto] and I refereed this and said it should be rejected. We questioned the editor (deFreitas again!) and he responded, saying… "The [manuscript] was reviewed initially by five referees…The other three referees, all reputable atmospheric scientists, agreed it should be published subject to minor revision. Even then I used a sixth person to help me decide. I took his advice and that of the three other referees and sent the [manuscript] back for revision. It was later accepted for publication. The refereeing process was more rigorous than usual."
>
> On the surface this looks to be above board—although, as referees who advised rejection, it is clear that Danny and I should have been kept in the loop and seen how our criticisms were responded to.[6]

In a related example, Peabody Energy and the State of Texas quote an excerpt of an e-mail from Phil Jones to Michael Mann on March 31, 2004, in which he discusses his unfavorable reviews of two papers for *Geophysical Research Letters* and the *Journal of Geophysical Research*:

> Recently rejected two papers (one for JGR and for GRL) from people saying CRU has it wrong over Siberia. Went to town in both reviews, hopefully successfully. If either appears I will be very surprised, but you never know with GRL.[7]

The petitioners claim that Jones' negative reviews attempted to "prevent a manuscript from being published that questioned the CRU's research" and were motivated by a desire to keep dissenting views out of the peer-reviewed literature. The petitioner concludes that these examples provide evidence that "peer-review publication rules" were manipulated to suppress dissenting views of anthropogenic climate change. The petitioners argue that the Endangerment Finding should be reconsidered because it relied on biased peer-reviewed literature that does not reflect the true breadth of the science.

Response (3-13):
As part of the peer-review process, scientists are justified in recommending that any given manuscript not be published if, based on their expert scientific judgment, they determine that the manuscript does not meet a certain standard of methodological rigor or its conclusions are questionable, given the evidence presented. The petitioners assume that the papers at issue received *unjustified* unfavorable reviews by Wigley, Harvey, and Jones, and assume the unjustified views were motivated by a desire to suppress dissenting views about climate change. Regarding the paper reviewed by Wigley and Harvey, petitioners neither entertain nor address the most straightforward possibility: that these scientists, based on their expert judgment, concluded that the paper was not up to standards for publication, while the other reviewers simply came to a different conclusion. Disagreement among reviewers is extremely common in scientific publishing. This issue was examined by the Independent Climate-Change E-mail Review, which stated, "There is always the risk of group-think among experts which resists alternative perspectives. Editors try to reduce the risk of group-think by sending papers to

[6] E-mail file 1051156418.txt, (April 23, 2003), page 486, line 27 of PDF version entitled: CRU Emails 1996-2009.pdf
[7] E-mail file 1051156418.txt, (March 31, 2004), page 664, line 1 of PDF version entitled: CRU Emails 1996-2009.pdf

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different and widely dispersed reviewers, deliberately seeking or even provoking critical reviews" (Russell, 2010).

Regarding the Jones review, the petitioners provide no evidence to support their claim that Jones' actions were inappropriate or that his reviews of these two particular papers were not scientifically justified. In addition, all peer-reviewed publications have multiple reviewers, so Jones was not in position to determine whether or not these papers would be approved for publication. Thus, we find that the reviews by Wigley, Harvey, and Jones were completely within the norms of scientific practice.

Beyond these e-mails, Peabody Energy provides no evidence to support their claim that these scientists "bent the rules" of the peer-review process to bias the peer-reviewed process for these papers or for the literature as a whole. Petitioners also provide no evidence that the papers were not in fact published, which would seem to be an important fact if they are concerned that the goals was to "keep opposing views out of the peer-reviewed literature." It appears that at least one paper was published, and there is no information on the other two. So, petitioners fail to show any actual bias in the literature that might have occurred. Even if the allegations were supported for these papers, which they are not, the petitioner's allegations involve only three out of thousands of papers that make up the body of scientific literature on climate change. To claim, as the petitioner does, that a few papers or the actions of a few scientists could somehow bias the vast wealth of climate change studies or call into question the overall conclusions reached from those many papers is unwarranted and unsupported.

Comment (3-14):

In another example, Peabody Energy claims that on June 4, 2003, Keith Briffa of CRU asked Edward Cook of the Lamont-Doherty Earth Observatory at Columbia University to provide evidence for rejecting a manuscript because Briffa disagreed with its authors' views on climate change. According to the petitioner, in making his request, Briffa apparently inappropriately disclosed the identity and recommendation of the other reviewer, Dave Stahle.

> I am really sorry but I have to nag about that review - Confidentially I now need a hard and if required extensive case for rejecting - to support Dave Stahle's and really as soon as you can. Please [8]

According to the petitioner, Cook replied to Briffa the same day to ask for help regarding a manuscript review for the *Journal of Agricultural, Biological, and Environmental Sciences*. Peabody Energy states that rather than providing his own independent analysis of the paper's suitability for publication, Cook enlisted Briffa's help to write an unfavorable review for the paper. The petitioner concludes that this provides evidence that "peer-review publication rules" were manipulated to suppress dissenting views of anthropogenic climate change. Peabody Energy argues that the Endangerment Finding should be reconsidered because it relies on biased peer-reviewed literature that did not reflect the true breadth of the science.

[8] E-mail file 1054748574.txt, (June 4, 2003), page 514, line 1 of PDF version entitled: CRU Emails 1996-2009.pdf

Response (3-14):
The Independent Climate-Change E-mail Review examined in detail the claims regarding the manuscript review Keith Briffa requested from Edward Cook. Based on the CRU e-mails and additional evidence submitted to the Independent Climate-Change E-mail Review panel, they concluded the following:

> Although much has been made of the e-mail in paragraph 15 as evidence of an unprincipled approach to the role of editor, we see nothing in these exchanges that supports the interpretations of subverting the peer review process that have been placed upon it. It appears to reflect an Editor with a strongly negative review in hand, and who presumably has read the paper, asking for confirmation that the paper should be rejected, possibly to reduce one of the many complications that assail an editor; and in view of the delay in communicating to authors, hoping for a strong decision from the referee. On receiving a second, more equivocal review, he offers the authors the opportunity to re-submit. These exchanges illustrate some of the complications of an Editor's life … They do not provide evidence of subversion of process in rejecting contradictory ideas as has been alleged. (Russell, 2010)

Regarding the claim that Cook enlisted Briffa's help in reviewing a manuscript, the petitioner does not quote Cook's e-mail in its entirety. The full text of the e-mail provides important context:

> Hi Keith,
> Okay, today. Promise! Now something to ask from you. Actually somewhat important too. I got a paper to review (submitted to the Journal of Agricultural, Biological, and Environmental Sciences), written by a Korean guy and someone from Berkeley, that claims that the method of reconstruction that we use in dendroclimatology (reverse regression) is wrong, biased, lousy, horrible, etc. They use your Tornetrask recon as the main whipping boy. I have a file that you gave me in 1993 that comes from your 1992 paper. Below is part of that file. Is this the right one? Also, is it possible to resurrect the column headings? I would like to play with it in an effort to refute their claims. If published as is, this paper could really do some damage. It is also an ugly paper to review because it is rather mathematical, with a lot of Box-Jenkins stuff in it. It won't be easy to dismiss out of hand as the math appears to be correct theoretically, but it suffers from the classic problem of pointing out theoretical deficiencies, without showing that their improved inverse regression method is actually better in a practical sense. So they do lots of monte carlo stuff that shows the superiority of their method and the deficiencies of our way of doing things, but NEVER actually show how their method would change the Tornetrask reconstruction from what you produced. Your assistance here is greatly appreciated. Otherwise, I will let Tornetrask sink into the melting permafrost of northern Sweden (just kidding of course).
> Cheers, Ed [9]

As is clearly stated in the e-mail, Cook only asks Briffa to confirm if a specific dataset was the same as the one Briffa used in an early paper (and which was the focus of the paper Cook was being asked to review) and to provide column headings for the data. Cook does not ask Briffa to

[9] E-mail file 1054756929.txt, (June 4, 2003), page 514, line 44 of PDF version entitled: CRU Emails 1996-2009.pdf

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read the manuscript, nor does he ask for Briffa's help in writing the review. These examples do not support the petitioner's arguments that the peer-review process was manipulated.

Comment (3-15):
In another example, Peabody Energy claims that Jones influenced the editor of the *International Journal of Climatology* (IJC) to select reviewers who would be biased against a paper submitted by Stephen McIntyre, editor of the blog ClimateAudit, and Ross McKitrick of the University of Guelph. Peabody cites the following e-mail Jones wrote to Ben Santer on January 29, 2009:

> I've just seen that M+M [McIntyre and McKitrick] have submitted a paper to IJC on your H2 statistic - using more years, up to 2007… Anyway you'll likely get this for review, or poor Francis will. Best if both Francis and Myles did this. If I get an email from Glenn I'll suggest this.[10]

In a related example, the Coalition for Responsible Regulation claims that Jones encouraged his co-authors on a paper "to submit the names of five scientists as recommended peer reviewers because they 'know the sort of things to say'.[11]" The petitioner provides no additional context about the title or content of paper, but asserts that true scientific scrutiny and close review "cannot be expected from hand-picked, wholly-supportive reviewers." The petitioner argues that Jones' actions bias the peer review process and "endors[e] findings that may prove to be scientifically erroneous or unsubstantiated." The petitioners conclude that Jones acted unethically to manipulate the normal peer-review process in order to keep dissenting views out of the peer-reviewed literature, and that the Endangerment Finding should be reconsidered because it relies on biased peer-reviewed literature that did not reflect the true state of the science.

Response (3-15):
It is customary for scientific journal editors to ask authors or associates to provide names of recommended reviewers during the process of submitting a manuscript. Thus, Jones' actions do not appear inappropriate and there is no explanation how this could have biased the peer reviewed literature, as alleged by the petitioners. Regarding the first example, it is clear from the e-mail that Jones had not yet been asked to provide any recommendations; rather, he was simply stating his intentions if the editor decided to contact him. The petitioner does not provide any evidence that Jones was ever contacted by the editor, or if he was, how he responded. Similarly, in the second example, petitioners again provide no evidence that Jones' co-authors submitted names of peer-reviewers, or if they did, that the scientists they suggested were asked to peer review and that they then said "the sorts of things" Jones wanted.

In both examples, the petitioners make an unsubstantiated assumption that the reviewers suggested by Jones would be biased, either against the McIntyre and McKitrick paper, or biased in favor of the paper Jones wrote with his co-authors. There is no evidence to support the petitioners' claims that any reviewers suggested by Jones and selected by the editor would be

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[10] E-mail file 1233249393.txt, (January 29, 2009), page 1626, line 33 of PDF version entitled: CRU Emails 1996-2009.pdf
[11] E-mail file 1249503274.txt, (August 5, 2009), page 1722, line 32 of PDF version entitled: CRU Emails 1996-2009.pdf

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unable or unwilling to provide objective critique of a manuscript. In addition, Jones was not in a position to "hand-pick" any reviewers because any decisions regarding the selection of peer reviewers are solely the purview of the journal editor. In sum, these examples do not support the petitioner's arguments that the journal publication process was manipulated.

In summary, the various claims by petitioners of biased peer review processes or bending of rules to achieve this result are not supported by the evidence they present. Their evidence shows only the typical peer review process being followed, with reviewers presenting their views pro or con. There is no evidence that any papers were not published and, if they were not, that the basis was any reason other than scientific inadequacy. There is no evidence or scientific argument that the literature is biased, even for the specific papers at issue, just unsupported allegations of an improper process. Petitioners' claims and evidence do not provide a basis for EPA to question or change its view that the science supporting the Endangerment Finding is robust, is compelling, and has been appropriately characterized by EPA.

3.3.3 Allegations Regarding Journal Publication Practices

Comment (3-16):
Peabody Energy argues that the CRU materials reveal that Ben Santer of Lawrence Livermore National Laboratory and various colleagues exerted improper influence to pressure IJC to delay publication of a paper by David Douglass of University of Rochester and his colleagues—Douglass et al. (2007)—and to expedite publication of their response—Santer et al. (2008). According to Peabody Energy, the overall effect of these actions was to give Santer et al. the "last word" and prevent Douglass et al. from responding according to "customary conventions." Peabody Energy asserts that a number of e-mails[12] reveal inappropriate conduct on the part of the authors and journal editors, including:

> (a) unusual cooperation between authors and editor that undermined the independence of each, (b) misstatement of known facts, (c) outright character assassination, (d) avoidance of traditional scientific give-and-take, (e) use of confidential information, (f) misrepresentation, or at a minimum misunderstanding, of the scientific question posed by Douglass et al. (2007), [and] (g) withholding of material data.

The Southeastern Legal Foundation also argues that the CRU e-mail authors engaged in improper actions with regard to the Douglass et al. paper, quoting an opinion article by David Douglass of the University of Rochester and John Christy of the University of Alabama published in the daily Internet publication *American Thinker*: "The CRU e-mails have revealed how the normal conventions of the peer review process appear to have been compromised by a

[12] E-mail file 1196795844.txt, (December 4, 2007), page 1360, line 4; e-mail file 1196877845.txt, (December 5, 2007), page 1365, line 7; e-mail file 1196956362.txt, (December 6, 2007) page 1370, line 36; e-mail file 1196964260.txt, (December 6, 2007) page 1371, line 22; e-mail file 1197325034.txt, (December 10, 2007) page 1374, line 13; e-mail file 1197507092.txt, (December 12, 2007) page 1376, line 8; e-mail file 1199988028.txt, (January 10, 2008) page 1424, line 3; e-mail file 1199999668.txt, (January 10, 2008), page 1426, line 43 of PDF version entitled: CRU Emails 1996-2009.pdf; e-mail file 1200059003.txt, (January 11, 2008) page 1432, line 8; e-mail file 1200076878.txt, (January 11, 2008) page 1432, line 46; and e-mail file 1215712600.txt, (July 10, 2008),page 1531, line 29 of PDF version entitled: CRU Emails 1996-2009.pdf)

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team of global warming scientists, with the willing cooperation of the editor of the IJC, Glenn McGregor" (Douglass and Christy, 2009).

Prior to submitting the Santer et al. article to IJC, Peabody Energy asserts, Santer strategized to get the study published "in a way that customary conventions are ignored and the authors are prevented from responding." Peabody Energy refers to an e-mail from Santer to Peter Thorne, a climate scientist working at the UK Met Office, on December 5, 2007:

> Peter, I think you've done a nice job capturing some of my concerns about the Douglass et al. paper … I don't think it's a good strategy to submit a response to the Douglass et al. paper to the International Journal of Climatology (IJC). As Phil [Jones] pointed out, IJC has a large backlog, so it might take some time to get a response published. Furthermore, Douglass et al. probably would be given the final word.[13]

Peabody Energy then describes how Tim Osborn, part of IJC's editorial board , "inserted himself into the process" by recommending that Santer submit to the journal and by contacting IJC editor Glenn McGregor to "see what he can do" to ensure a quick turnaround in publishing the Santer et al. submission. Peabody Energy states that McGregor was "clearly not unbiased, and the journal was persuaded to disregard proper peer-review procedures in order to hurry the team's [Santer et al.'s] response into print." Peabody Energy quotes an e-mail from Tim Osborn to Santer and Phil Jones on January 10, 2008:

> I just contacted the editor, Glenn McGregor, to see what he can do. He promises to do everything he can to achieve a quick turn-around time (he didn't quantify this) and he will also "ask (the publishers) for priority in terms of getting the paper online asap after the authors have received proofs." He genuinely seems keen to correct the scientific record as quickly as possible.
>
> He also said (and please treat this in confidence, which is why I e-mailed to you and Phil only) that he may be able to hold back the hardcopy (i.e. the print/paper version) appearance of Douglass et al., possibly so that any accepted Santer et al. comment could appear alongside it. Presumably depends on speed of the review process.
>
> If this does persuade you to go with IJC, Glenn suggested that I could help (because he is in Kathmandu at present) with achieving the quick turn-around time by identifying in advance reviewers who are both suitable and available. Obviously one reviewer could be someone who is already familiar with this discussion, because that would enable a fast review - i.e., someone on the e-mail list you've been using - though I don't know which of these people you will be asking to be co-authors and hence which won't be available as possible reviewers… [14]

[13] E-mail file 11968778451..txt, (December 5, 2007), page 1365, line 23 of PDF version entitled: CRU Emails 1996-2009.pdf

[14] E-mail file 1199999668.txt, (January 10, 2008), page 1426, line 43 of the PDF version entitled: CRU Emails 1996-2009.pdf

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Peabody Energy then cites the following e-mail in which Santer states his conditions for submitting to IJC to Tim Osborn (copying Phil Jones), also in an e-mail from January 10, 2008:

> 1) Our paper should be regarded as an independent contribution, not as a comment on Douglass et al. ...
>
> 2) If IJC agrees to 1), then Douglass et al. should have the opportunity to respond to our contribution, and we should be given the chance to reply. Any response and reply should be published side-by-side, in the same issue of IJC.
>
> I'd be grateful if you and Phil could provide me with some guidance on 1) and 2), and on whether you think we should submit to IJC. Feel free to forward my email to Glenn McGregor.[15]

Peabody Energy subsequently states:

> The final approval of the strategy (Santer's conditions) to deny Douglass and his collaborators an opportunity to respond in the normal way was acknowledged by Osborn to Santer and Jones in that Osborn wrote that McGregor, as editor, is "prepared to treat it as a new submission rather than a comment on Douglass et al." and "[McGregor's] offer of a quick turn around time etc still stands."[16]

Peabody Energy concludes by arguing that the Santer et al. paper was published in print only 36 days after it was published online, while Douglass et al. had waited more than 11 months for their print publication. In addition, the petitioner argues that Douglass and his co-authors were never informed of Santer's intention to publish a response, nor were they contacted for an explanation at any point in the process regarding Santer et al.'s concerns with their paper. Peabody Energy concludes that "The strategy of preventing Douglass and his collaborators from having any opportunity for a simultaneous response to Santer et al. had been achieved. The gamesmanship behind this strategy diverted the process of scientific inquiry from its proper path and tainted the materials on which the Agency now seeks to rely." Peabody Energy concludes that the CRU e-mail authors' improper conduct places Santer et al.'s work on questionable footing and casts doubt on the credibility of their critique of Douglass et al. (2007).

Response (3-16):
As discussed in Volume 1, Section 1.2.1.2 , the petitioners' complaint focuses on the timing of the hardcopy publication of the Douglass et al. (2007) paper (which was previously published on-line), and does not provide any substantive evaluation or analysis of the scientific content of Santer et al. (2008). Petitioner does not explain why the findings presented in Douglass et al. (2007) are correct despite the findings presented in Santer et al. (2008). Peabody Energy also offers no substantive evaluation of any of the assessment literature (i.e., Karl et al., 2009) or other studies relied on by EPA that provide evidence for an anthropogenic fingerprint in the

[15] E-mail file 1200076878.txt, (January 11, 2008), page 1433, line 41 of the PDF version entitled: CRU Emails 1996-2009.pdf
[16] E-mail file 1200076878.txt, (January 11, 2008), page 1433, line 9 of the PDF version entitled: CRU Emails 1996-2009.pdf

tropics. In addition, Douglass and the other authors of the 2007 study have not provided a scientific response or rebuttal to the scientific position presented in the Santer et al. (2008) paper.

In addition to the petitioner's focus on the timing of the hard copy publication rather than scientific content, we note that Peabody Energy extensively quotes from an article entitled "A Climate Conspiracy" (Douglass and Christy, 2009), published in the daily Internet publication *American Thinker*. In this article, two authors of Douglass et al. (2007) (Douglass and University of Alabama–Huntsville scientist John Christy) discuss the CRU e-mails pertinent to the Santer et al. and Douglass et al. studies, and pose the following challenge to readers:

> We will let the reader judge whether this team effort [of Santer and colleagues], revealed in dozens of e-mails and taking nearly a year, involves inappropriate behavior, including (a) unusual cooperation between authors and editor, (b) misstatement of known facts, (c) character assassination, (d) avoidance of traditional scientific give-and-take, (e) using confidential information, (f) misrepresentation (or misunderstanding) of the scientific question posed by DCPS [the authors of Douglass et al. (2007): Douglass, David; Christy, John; Pearson, Benjamin; Singer, Fred], (g) withholding data, and more. (Douglass and Christy, 2009)

Peabody Energy's allegations of misconduct on the part of Santer and colleagues identically match the examples of "inappropriate behavior" put forward by Douglass and Christy in the *American Thinker* article though Peabody Energy does not cite this article as the underlying source. Peabody Energy has no independent basis for their allegations; they are uncritically repeating the objections of Douglass and Christy.

In February (2010), Santer published lengthy counterarguments to Douglass and Christy (2009) on the blog *RealClimate* (Santer, 2010a) and, separately, in an open letter to the scientific community (Santer, 2010b). The following excerpt from Santer (2010a) describes his counterarguments to the allegations set out in Douglass and Christy (2009) and an article by Fred Pearce in the *Guardian* (Pearce, 2010):

> In December 2009, shortly after the public release of the stolen emails from the University of East Anglia's Climatic Research Unit, Professors David Douglass and John Christy accused me of leading a conspiracy to delay publication of the print version of the Douglass et al. paper. This accusation was based on a selective analysis of the stolen emails. It is false.
>
> In Mr. Pearce's account of this issue, he states that "There is no doubt the (sic) Santer and his colleagues sought to use the power they held to the utmost…" So what are the facts of this matter? What is the "power" Fred Pearce is referring to?
>
> - **Fact 1:** The only "power" that I had was the power to choose which scientific journal to submit our paper to. I chose the International Journal of Climatology. I did this because the International Journal of Climatology had published (in their online edition) the seriously flawed Douglass et al. paper. I wanted to give the journal the opportunity to set the scientific record straight.
> - **Fact 2:** I had never previously submitted a paper to the International Journal of Climatology. I had never met the editor of the journal (Professor Glenn McGregor).

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- **Fact 3:** Prior to submitting our paper, I wrote an email to Dr. Tim Osborn on January 10, 2008. Tim Osborn was on the editorial board of the International Journal of Climatology. I told Dr. Osborn that, before deciding whether we would submit our paper to the International Journal of Climatology, I wanted to have some assurance that our paper would "be regarded as an independent contribution, not as a comment on Douglass et al." This request was entirely reasonable in view of the substantial amount of new work that we had done. I have described this new work above.
- **Fact 4:** I did not want to submit our paper to the International Journal of Climatology if there was a possibility that our submission would be regarded as a mere "comment" on Douglass et al. Under this scenario, Douglass et al. would have received the last word. Given the extraordinary claims they had made, I thought it unlikely that their "last word" would have acknowledged the serious statistical error in their original paper. As subsequent events showed, I was right to be concerned – they have not admitted any error in their work.
- **Fact 5:** As I clearly stated in my email of January 10 to Dr. Tim Osborn, if the International Journal of Climatology agreed to classify our paper as an independent contribution, "Douglass et al. should have the opportunity to respond to our contribution, and we should be given the chance to reply. Any response and reply should be published side-by-side…"
- **Fact 6:** The decision to hold back the print version of the Douglass et al. paper was not mine. It was the editor's decision. I had no "power" over the publishing decisions of the International Journal of Climatology.

This whole episode should be filed under the category "No good deed goes unpunished". My colleagues and I were simply trying to set the scientific record straight. There was no conspiracy to subvert the peer-review process. Unfortunately, conspiracy theories are easy to disseminate. Many are willing to accept these theories at face value. The distribution of facts on complex scientific issues is a slower, more difficult process.

Peabody Energy provides numerous quotations from the CRU e-mails and narrates its interpretations of events, but its examples do not materially change the narrow and limited nature of its overall argument, which is that the Santer et al. paper was improperly published in print at the same time as the Douglass et al. paper. Peabody makes no claims or arguments as to the validity of the science in the Santer et al. (2008) paper, just that its hard-copy publication date was advanced by the editor, and another paper's was delayed. Decisions regarding the selection of peer reviewers, the timing of peer review, and whether and when a paper is published are solely the responsibility of the journal editor, not the study authors.

Crucially, we also note that the Douglass et al. paper was freely available online for almost a year before it came out in print. Online publications are considered to be official records of publication and generally attract the majority of the scientific and media attention. At the point of online publication, the Douglass et al. paper was considered to be a legitimate contribution to the literature, which is why the year of citation is 2007 while the year of citation for the Santer et al. paper is 2008. Thus, Peabody Energy's argument that the Douglass et al. paper was "improperly delayed" and Southeastern Legal Foundation's argument that "the normal conventions of the peer review process appear to have been compromised" are without merit;

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when it was published online, Douglass et al. were "on the record" as part of the peer-reviewed academic literature.

The decision of IJC editor Glenn McGregor to delay the print publication of Douglass et al. and expedite the review of Santer et al. so that they would be published simultaneously was motivated by McGregor's desire to "correct the scientific record[17]" after the editor became aware of problems with the Douglass et al. paper. Santer had made the case for doing so when he e-mailed Tim Osborne at IJC stating his conditions for submittal on January 10, 2008—which the petitioner did not include in its summary of events:

> IJC published a paper with egregious statistical errors. Douglass et al. was essentially a commentary on work by myself and colleagues—work that had been previously published in Science in 2005 and in Chapter 5 of the first U.S. CCSP Report in 2006. To my knowledge, none of the authors or co-authors of the Santer et al. Science paper or of CCSP 1.1 Chapter 5 were used as reviewers of Douglass et al. I am assuming that, when he submitted his paper to IJC, Douglass specifically requested that certain scientists should be excluded from the review process. Such an approach is not defensible for a paper which is largely a comment on previously-published work.
>
> It would be fair and reasonable to give IJC the opportunity to "set the record straight", and correct the harm they have done by publication of Douglass et al. I use the word "harm" advisedly. The author and coauthors of the Douglass et al. IJC paper are using this paper to argue that "Nature, not CO2, rules the climate", and that the findings of Douglass et al. invalidate the "discernible human influence" conclusions of previous national and international scientific assessments.
>
> Quick publication of a response to Douglass et al. in IJC would go some way towards setting the record straight. I am troubled, however, by the very real possibility that Douglass et al. will have the last word on this subject. In my opinion (based on many years of interaction with these guys), neither Douglass, Christy or Singer are capable of admitting that their paper contained serious scientific errors. Their "last word" will be an attempt to obfuscate rather than illuminate. They are not interested in improving our scientific understanding of the nature and causes of recent changes in atmospheric temperature. They are solely interested in advancing their own agendas. It is telling and troubling that Douglass et al. ignored radiosonde data showing substantial warming of the tropical troposphere—data that were in accord with model results—even though such data were in their possession. Such behaviour constitutes intellectual dishonesty. I strongly believe that leaving these guys the last word is inherently unfair.[18]

Given Santer's serious scientific concerns about the substance of the Douglass et al. paper, as well as the process for publishing it, McGregor clearly felt it was his prerogative as the journal editor to accept Santer's request for a quick turn-around and inclusion as a new submission. This is demonstrated by the e-mail cited by the petitioner in which Osborne says to Santer on January 11, 2008:

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[17] E-mail file 1199999668.txt, (January 10, 2008), page 1427, line 43 of the PDF version entitled: CRU Emails 1996-2009.pdf

[18] E-mail file 1200076878.txt, (January 11, 2008), page 1433, line 18 of the PDF version entitled: CRU Emails 1996-2009.pdf

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> just heard back from Glenn. He's prepared to treat it as a new submission rather than a comment on Douglass et al. and he also reiterates that "Needless to say my offer of a quick turn around time etc still stands."[19]

The petitioner is correct that the publication of Santer as a new submission, rather than a comment gave Santer the last word on the subject in that particular issue of the journal. However, as stated above, Santer had made clear to IJC "Douglass et al. should have the opportunity to respond to our contribution." As discussed in Volume 1, Section 1.2.1.2, we note that to date, Douglass et al. have not published a peer reviewed rebuttal to Santer et al.'s study or other literature on the issue, although they have had ample time to do so.

In summary, the evidence does not suggest and no logical conclusion can be drawn that two papers being printed simultaneously "tainted the materials on which the Agency now seeks to rely" or challenges the key conclusions of the totality of scientific literature on the issue of an anthropogenic fingerprint in the tropics—as discussed in Volume 1, Section 1.2.1.2. Peabody Energy makes no arguments that the scientific reasoning or conclusions in the Santer et al. (2008) paper were inappropriate in any way, and instead draws broad, unsupported conclusions solely based on the timing of the various articles, which is irrelevant to their scientific merit.

Various additional allegations of misconduct on the part of Santer and colleagues from Peabody Energy are discussed in several subsequent responses in this section.

Comment (3-17):
Peabody Energy states that Glenn McGregor, editor of IJC, intended to:

> ….identify in "advance reviewers who are both suitable and available [to review the Santer et al. submission]," perhaps including "someone on the email list you've been using." [20]

It concludes "this appears to be a flagrant abuse of the review process, where reviewers are not permitted to be close associates of the author."

Response (3-17):
It is standard practice when submitting a journal article for journal editors to request from authors a list of appropriate reviewers. Reviewers should not be directly contributing to the research of the authors, but may be colleagues who are experts on matters related to the subject and/or have published on related work.

As a matter of fact, Tim Osborn, an editor at IJC, stated criteria for suggesting co-authors in an e-mail (partially cited by Peabody Energy):

> Obviously one reviewer could be someone who is already familiar with this discussion, because that would enable a fast review - i.e., someone on the email list you've been using - though I don't know which of these people you will be asking to be co-authors

[19] E-mail file 1200076878.txt, (January 11, 2008), page 1433, line 9 of the PDF version entitled: CRU Emails 1996-2009.pdf
[20] E-mail file 1200076878.txt, (January 11, 2008), page 1434, line 25 of the PDF version entitled: CRU Emails 1996-2009.pdf

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> and hence which won't be available as possible reviewers. For objectivity the other reviewer would need to be independent, but you could still suggest suitable names.[21]

And, in fact, on January 11, 2008, Santer submitted a list of names to Tim Osborn, with the following preface:

> Here are some suggestions for potential reviewers of a Santer et al. IJoC submission on issues related to the consistency between modeled and observed atmospheric temperature trends. None of the suggested reviewers have been involved in the recent "focus group" that has discussed problems with the Douglass et al. IJoC paper.[22]

Thus, Peabody Energy's allegation of "flagrant abuse of the review process" is not supported.

Comment (3-18):
Peabody Energy states:

> On January 10, 2008, Jones told the team [i.e. many of the scientists Santer and his colleagues corresponded with on this issue] (Wigley, K. Taylor, Lanzante, Mears, Bader, Zwiers, Wentz, Haimberger, Free, MacCracken, Jones, Sherwood, Klein, Solomon, Thorne, Osborn, Schmidt, and Hack) a "secret" he had learned from Osborn: that one of the recipients on the Santer e-mail list was one of the original reviewers of Douglass et al. (2007) who did not reject the article.
>
> > The problem !! The person who said they would leave it to the editor's discretion is on your email list! I don't know who it is - Tim does - maybe they have told you? I don't want to put pressure on Tim. He doesn't know I'm sending this. It isn't me by the way - nor Tim ! Tim said it was someone who hasn't contributed to the discussion - which does narrow the possibilities down![23]

Response (3-18):
The petitioner excerpts this e-mail with no comment as it to its significance or implications. It appears to be simply an example of scientists, in a private communication, trying to determine who among them might have approved publication of a paper (i.e., Douglass et al.) that many of them felt was substandard. It has no demonstrated relevance to the integrity of the publication of the Santer et al. paper or the underlying science.

Comment (3-19):
Peabody Energy claims that this statement in an e-mail from Osborn to Santer and Jones on January 11, 2008 demonstrates "the impropriety of the situation" in which the Douglass et al. paper publication is delayed:

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[21] E-mail file 1199999668.txt, (January 10, 2008), page 1428, line 4 of the PDF version entitled: CRU Emails 1996-2009.pdf
[22] E-mail file 1200059003.txt, (January 11, 2008), page 1432, line 17 of the PDF version entitled: CRU Emails 1996-2009.pdf
[23] E-mail file 1199999668.txt, (January 10, 2008), page 1427, line 9 of the PDF version entitled: CRU Emails 1996-2009.pdf

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> the only thing I didn't want to make more generally known was the suggestion that print publication of Douglass et al. might be delayed ... all other aspects of this discussion are unrestricted.[24]

Response (3-19):
The petitioner does not explain why it is improper or of any scientific relevance that Osborn, an editor of IJC, would want to keep quiet the possibility that the print publication of Douglass et al. might be delayed. It is also not clear why Osborn wanted to keep it quiet. Instead of arguing the merits of the science, the petitioner relies instead on speculation of motivations. There is not material evidence of "impropriety."

As stated in our response (3-16) above, the electronic version of Douglass et al.—an official record of the publication—had been available to the public for months

Comment (3-20):
Peabody Energy ends its narrative discussion of this issue by referencing a series of e-mails composed during the Santer et al. paper review process, suggesting the journal editor, McGregor, had made efforts to "accommodate" Santer:

> McGregor informed Santer that he had received one set of comments and though he "... would normally wait for all comments to come in before providing them to you, I thought in this case I would give you a head start in your preparation of revisions."[25] Later, Santer wrote to Jones on July 10, 2008, that the two subsequent reviews were in, but reviewer number two was "somewhat crankier."[26] Santer indicated that McGregor had told him that he would not resend the coming revised manuscript to the "crankier" reviewer in another apparent effort by McGregor to accommodate Santer.[27]

Response (3-20):
The petitioner does not explain why or how McGregor's actions are relevant to the scientific legitimacy of Santer et al.'s study. First, the petitioner does not demonstrate how McGregor providing Santer et al. with one reviewer's comments before the other two has any effect on the substance of Santer's study or the legitimacy of the review process. The following e-mail from Santer to his co-authors on April 24, 2008, details how seriously Santer considered the comments from this first reviewer and discusses at length Santer's initial thoughts on how to be responsive:

> Dear folks,
>
> I'm forwarding an email from Prof. Glenn McGregor, the IJoC editor who is handling our paper. The email contains the comments of Reviewer #1, and notes that comments from two additional

[24] E-mail file 1200076878.txt, (January 11, 2008), page 1433, line 13 of the PDF version entitled: CRU Emails 1996-2009.pdf
[25] E-mail file 1209080077.txt, (April 24, 2008), page 1484, line 23 of the PDF version entitled: CRU Emails 1996-2009.pdf
[26] E-mail file 1215712600.txt, (July 10, 2008), page 1536, line 12 of the PDF version entitled: CRU Emails 1996-2009.pdf
[27] E-mail file 1215712600.txt, (July 10, 2008), page 1536, line 12 of the PDF version entitled: CRU Emails 1996-2009.pdf

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Reviewers will be available shortly. Reviewer #1 read the paper very thoroughly, and makes a number of useful comments. The Reviewer also makes some comments that I disagree with.

The good news is that Reviewer #1 begins his review (I use this personal pronoun because I'm pretty sure I know the Reviewer's identity!) by affirming the existence of serious statistical errors in DCPS07 [Douglass, Christy, Pearson, and Singer, 2007]

"I've read the paper under review, and also DCPS07, and I think the present authors are entirely correct in their main point. DCPS07 failed to account for the sampling variability in the individual model trends and, especially, in the observational trend. This was, as I see it, a clear-cut statistical error, and the authors deserve the opportunity to present their counter-argument in print."

Reviewer #1 has two major concerns about our statistical analysis. Here is my initial reaction to these concerns.

CONCERN #1: Assumption of an AR-1 [autoregressive] model for regression residuals.

In calculating our "adjusted" standard errors, we assume that the persistence of the regression residuals is well-described by an AR-1 model. This assumption is not unique to our analysis, and has been made in a number of other investigations. The Reviewer would "like to see at least some sensitivity check of the standard error formula against alternative model assumptions." Effectively, the Reviewer is asking whether a more complex time series model is required to describe the persistence.

Estimating the order of a more complex AR model is a tricky business. Typically, something like the BIC (Bayesian Information Criterion) or AIC (Akaike Information Criterion) is used to do this. We could, of course, use the BIC or AIC to estimate the order of the AR model that best fits the regression residuals. This would be a non-trivial undertaking. I think we would find that, for different time series, we would obtain different estimates of the "best-fit" AR model. For example, 20c3m runs without volcanic forcing might yield a different AR model order than 20c3m runs with volcanic forcing. It's also entirely likely (based on Rick 'Katz's experience with such AR model-fitting exercises) that the AIC- and BIC-based estimates of the AR model order could differ in some cases.

As the Reviewer himself points out, DCPS07 "didn't make any attempt to calculate the standard error of individual trend estimates and this remains the major difference between the two papers." In other words, our paired trends test incorporates statistical uncertainties for both simulated and observed trends. In estimating these uncertainties, we account for non-independence of the regression residuals. In contrast, the DCPS07 trend "consistency test" does not incorporate ANY statistical uncertainties in either observed or simulated trends. This difference in treatment of trend uncertainties is the primary issue. The issue of whether an AR-1 model is the most appropriate model to use for the purpose of calculating adjusted standard errors is really a subsidiary issue. My concern is that we could waste a lot of time looking at this issue, without really enlightening the reader about key differences between our significance testing procedure and the DCPS07 approach.

One solution is to calculate (for each model and observational time series used in our paper) the parameters of an AR(K) model, where K is the total number of time lags, and then apply equation 8.39 in Wilks (1995) to estimate the effective sample size. We could do this for several different

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K values (e.g., K=2, K=3, and K=4; we've already done the K=1 case). We could then very briefly mention the sensitivity of our "paired trend" test results to choice of order K of the AR model. This would involve some work, but would be easier to explain than use of the AIC and BIC to determine, for each time series, the best-estimate of the order of the AR model.

CONCERN #2: No "attempt to combine data across model runs"

The Reviewer is claiming that none of our model-vs-observed trend tests made use of data that had been combined (averaged) across model runs. This is incorrect. In fact, our two modified versions of the DCPS07 test (page 29, equation 12, and page 30, equation 13) both make use of the multi-model ensemble-mean trend.

The Reviewer argues that our paired trends test should involve the ensemble-mean trends for each model (something which we have not done) rather than the trends for each of 49 individual 20c3m realizations. I'm not sure whether the rationale for doing this is as "clear-cut" as the Reviewer contends.

Furthermore, there are at least two different ways of performing the paired trends tests with the ensemble-mean model trends. One way (which seems to be what the Reviewer is advocating) involves replacing in our equation (3) the standard error of the trend for an individual realization performed with model A with model A's intra-ensemble standard deviation of trends. I'm a little concerned about mixing an estimate of the statistical uncertainty of the observed trend with an estimate of the sampling uncertainty of model A's trend.

Alternately, one could use the average (over different realizations) of model A's adjusted standard errors, or the adjusted standard error calculated from the ensemble-mean model A time series. I'm willing to try some of these things, but I'm not sure how much they will enlighten the reader. And they will not help to make an already-lengthy manuscript any shorter.

The Reviewer seems to be arguing that the main advantage of his approach #2 (use of ensemble-mean model trends in significance testing) relative to our paired trends test (his approach #1) is that non-independence of tests is less of an issue with approach #2. I'm not sure whether I agree. Are results from tests involving GFDL CM2.0 and GFDL CM2.0 temperature data truly "independent" given that both models were forced with the same historical changes in anthropogenic and natural external forcings? The same concerns apply to the high- and low-resolution versions of the MIROC model, the GISS models, etc.

I am puzzled by some of the comments the Reviewer has made at the top of page 3 of his review. I guess the Reviewer is making these comments in the context of the pair-wise tests described on page 2. Crucially, the comment that we should use "...the standard error if testing the average model trend" (and by "standard error" he means 'DCPS07's sigma{SE}) IS INCONSISTENT with the Reviewer's approach #3, which involves use of the inter-model standard deviation in testing the average model trend.

And I disagree with the Reviewer's comments regarding the superfluous nature of Section 6. The Reviewer states that, "when simulating from a known (statistical) model... the test statistics should by definition give the correct answer. The whole point of Section 6 is that the DCPS07 consistency test does NOT give the correct answer when applied to randomly-generated data!

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> In order to satisfy the Reviewer's curiosity, I'm perfectly willing to repeat the simulations described in Section 6 with a higher-order AR model. However, I don't like the idea of simulation of synthetic volcanoes, etc. This would be a huge time sink, and would not help to illustrate or clarify the statistical mistakes in DCPS07.
>
> It's obvious that Reviewer #1 has put a substantial amount of effort into reading and commenting on our paper (and even performing some simple simulations). I'm grateful for the effort and the constructive comments, but feel that a number of comments are off-base. Am I misinterpreting the Reviewer's comments?
>
> With best regards,
> Ben[28]

As evidenced by this detailed and substantive scientific discussion of the reviewers comments, Santer treated the peer review process seriously and focused carefully on the scientific merits of the reviewer's comments. Petitioners, however, have raised no scientific arguments or objections, and instead rely solely on speculation concerning motivations.

Concerning the second review, the petitioner does not discuss why McGregor's decision not to send Santer's revised manuscript back to the second reviewer is an accommodation or somehow irregular. Santer's e-mail to his co-authors about the second reviewer's comments simply indicates that McGregor—as journal editor—had communicated to Santer that he was not sending the next draft of the manuscript back to this reviewer. The CRU e-mails do not explain McGregor's reasoning, and the petitioner relies on speculation.

Although Santer was told the second reviewer would not see the manuscript again, he was diligent in describing to McGregor why one of the second reviewer's criticisms was not of central relevance. Santer wrote to McGregor on July 10, 2008:

> Dear Glenn,
>
> I thought you might be interested in this email exchange with Francis Zwiers [one of Santer's co-authors]. It's directly relevant to the third criticism raised by Reviewer 2.
>
> With best regards,
> Ben[29]

Santer attached a detailed, highly technical discussion from Zwiers pertaining to this third criticism and his response to Zwiers in which he stated his agreement.

> Thanks - this information will be extremely helpful in responding to Reviewer 2. I really do feel that the Reviewer is getting overly exercised about a relatively minor technical point.[30]

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[28] E-mail file 1209080077.txt, (April 24, 2008), page 1482, line 1 of the PDF version entitled: CRU Emails 1996-2009.pdf

[29] E-mail file 1215713915.txt, (July 10, 2008), page 1537, line 25 of the PDF version entitled: CRU Emails 1996-2009.pdf

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To summarize, the petitioner does not substantiate any improper procedures on the part of either Santer or McGregor in this process, nor does the petitioner present any scientific basis to question the scientific validity of the analysis and conclusions contained in the Santer et al. (2008) paper.

Comment (3-21):
Peabody Energy states that it appears that Glenn McGregor, editor of IJC, breached confidentiality obligations by disclosing the page proofs of Douglass et al. (2007) to New York Times reporter Andrew Revkin, who then disclosed them to Santer and two other unnamed scientists a week before initial publication online. The petitioner makes a general claim that "use of confidential information" should cause EPA to question Santer et al.'s work. Peabody Energy quotes Revkin's e-mail: "Sorry to take your time up, but really do need a scrub of singer/christy/etc effort."[31]

Response (3-21):
It is customary for journals to provide embargoed versions of articles to journalists prior to publication. Thus, it does not appear that confidentiality was breached by McGregor. Furthermore, the petitioner does not discuss how the alleged breach of confidentiality bears on the legitimacy of the publication process of either the Douglass et al. or Santer et al. papers, or on the scientific validity of the analyses and concussion in either paper. Our evaluation of the scientific issues involved with the Douglass and Santer papers is provided in Volume 1, Section 1.2.1.2 of this RTP document.

Petitioners' evidence does not support their claim that the journal publication process was manipulated or improper, nor do the petitioners provide any other evidence that would cause EPA to question the conclusions drawn about the scientific merits of the issues involved in these papers.

Comment (3-22):
Peabody Energy argues that Michael Mann and Kevin Trenberth (of the National Center for Atmospheric Research) improperly sought special treatment to get their comment (Foster et al. 2010) on a paper by McLean et al. (2009) published immediately in the *Journal of Geophysical Research*. According to the petitioner, their improper actions included violating the journal's policy that reviewers recommended by the authors could not be their close associates, and giving a copy of their manuscript to Michael McPhaden, president of the American Geophysical Union (AGU), which publishes the journal. The petitioner concludes that these examples provide evidence that "peer-review publication rules" were manipulated in an attempt to favor publication of supporting views of anthropogenic climate change. Peabody Energy argues that the Endangerment Finding should be reconsidered because it relied on biased peer-reviewed literature that does not reflect the true breadth of the science.

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[30] E-mail file 1215713915.txt, (July 10, 2008), page 1538, line 18 of the PDF version entitled: CRU Emails 1996-2009.pdf
[31] E-mail file 1196795844.txt, (December 4, 2007). page 1360, line 4 of the PDF version entitled: CRU Emails 1996-2009.pdf

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Response (3-22):
First, we note that McLean et al. (2009) was published on July 23, 2009, and Foster et al. (2010) was published about 10 months later on May 14, 2010. This fact alone refutes the petitioner's claim that there was any "special treatment" that resulted in immediate publication of Foster et al. (2010). Furthermore, the petitioner's argument does not discuss the merits of the science in either paper, or any alleged harm to the McLean et al. (2009) paper resulting from the publication of Foster et al. (2010). It is well within the norms of the scientific community to write and attempt to publish rebuttals to published journal articles if one can demonstrate that there are scientific insufficiencies. Responses can be submitted either as separate manuscripts or as "comments" on a given paper. There is no credible evidence to suggest that the authors of Foster et al. (2010) overstepped the bounds of common practice in submitting their response and asking that it be reviewed expeditiously. In addition, the petitioner makes an unsubstantiated assumption that the reviewers suggested by the authors of Foster et al. (2010) would be biased in favor of the paper. There is no evidence to support the petitioner's claim that these recommended reviewers would be unable or unwilling to provide objective critique of a manuscript. Ultimately, any decisions as to the timing of review, the selection of peer reviewers, and whether and when a paper is published are solely the responsibility of the journal editor.

This example does not support the petitioner's argument that the journal publication process was manipulated, nor does the petitioner provide any other evidence that would cause EPA to change its view on the scientific issues involved in these papers. Petitioner has failed to provide any arguments based on the science.

To summarize Section 3.3.3, petitioners argue that the scientific record for the Endangerment Finding is biased because of improper practices in publication of certain journal articles. Their evidence is limited to only a few articles. They focus on claims of when the hard copy of one article was published, as well as changes in the editorial board at one journal. Their claims of improper practices are broad and sweeping, but are not supported by the evidence they present. Their claims are based largely on speculation, and they fail to provide any scientific argument to contest the scientific analysis or conclusions of the articles they object to. They fail to show improper action, whether for the articles at issue or more broadly. They fail provide a basis to question EPA's views on the scientific issues involved in the papers.

3.3.4 Allegations Regarding Efforts to Remove Editors and Boycott Journals

Comment (3-23):
The Coalition for Responsible Regulation, the Ohio Coal Association, Peabody Energy, the Southeastern Legal Foundation, and the State of Texas argue that the CRU e-mail authors threatened to boycott the journal *Climate Research* and endeavored to have one of its editors, Chris de Freitas, removed because the journal had published a paper by Soon and Balinus (2003) with which that they did not agree. The Southeastern Legal Foundation asserts that "After Messrs. Jones and Mann threatened a boycott of publications and reviews, half of the editorial board of *Climate Research* resigned." Peabody Energy claims that "[i]n response to these protests, wholesale changes were made in the editorial staff at Climate Research." The State of Texas argues that when "the group learned that Climate Research planned to publish so-called

skeptical literature, the climatologists responded less like objective scientists eager to let the science determine the answer, and more like activists working to advance their preferred result." The Southeastern Legal Foundation claims that this is an example of "a concerted effort to purge dissenting views from the scientific literature." The Pacific Legal Foundation also references this example, stating that the CRU e-mails "…appear to show attempts to 'discipline' scientists and journalists who published skeptical information." The petitioners quote a number of CRU e-mails in support of their arguments.

More specifically, the Ohio Coal Association and Peabody Energy quote a statement from Phil Jones: "I will be e-mailing the journal to tell them I'm having nothing more to do with it until they rid themselves of this troublesome editor.[32]" The Southeastern Legal Foundation and Peabody Energy quote the following e-mail from Michael Mann:

> I think we have to stop considering 'Climate Research' as a legitimate peer-reviewed journal. We would also need to consider what we tell or request of our more reasonable colleagues who currently sit on the editorial board. Perhaps we should encourage our colleagues in the climate research community to no longer submit to, or cite papers in, this journal.[33]

Peabody Energy quotes an e-mail from Tom Wigley, characterizing his words as "urging a full-scale assault on the editorial board":

> PS Re CR [Climate Research], I do not know the best way to handle the specifics of the editoring [sic]. Hans von Storch [another editor at *Climate Research*] is partly to blame -- he encourages the publication of crap science 'in order to stimulate debate'. One approach is to go direct to the publishers and point out the fact that their journal is perceived as being a medium for disseminating misinformation under the guise of refereed work. I use the word 'perceived' here, since whether it is true or not is not what the publishers care about -- it is how the journal is seen by the community that counts.
>
> I think we could get a large group of highly credentialed scientists to sign such a letter -- 50+ people. Note that I am copying this view only to Mike Hulme and Phil Jones. Mike's idea to get editorial board members to resign will probably not work -- must get rid of von Storch too, otherwise holes will eventually fill up with people like Legates, Balling, Lindzen, Michaels, Singer, etc. I have heard that the publishers are not happy with von Storch, so the above approach might remove that hurdle too[34]."

Peabody Energy then quotes a statement from the publisher of *Climate Research*, Otto Kinne, which attempts to defend de Freitas' decision to publish the Soon and Balinus paper:

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[32] E-mail file 1047388489.txt, (March 11, 2003), page 456, line 30 of the PDF version entitled: CRU Emails 1996-2009.pdf

[33] E-mail file 1047388489.txt, (March 11, 2003), page 457, line 13 of the PDF version entitled: CRU Emails 1996-2009.pdf

[34] E-mail file 1051190249.txt, (April 24, 2003), page 488, line 11 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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> Dear colleagues, In my [June, 20 2003] e-mail to you I stated, among other things, that I would ask C[limate] R[esearch] editor Chris de Freitas to present to me copies of the reviewers' evaluations for the 2 Soon et al. papers. I have received and studied the material requested. Conclusions: 1) The reviewers consulted (4 for each ms) by the editor presented detailed, critical and helpful evaluations. 2) The editor properly analyzed the evaluations and requested appropriate revisions. 3) The authors revised their manuscripts accordingly. Summary: Chris de Freitas has done a good and correct job as editor.[35]

As further evidence of the CRU e-mail authors' protests against this editor and journal, Peabody Energy quotes Mann's response that Kinne's words were "disingenuous" and said "I think that the community should, as previously suggested in this eventuality, terminate its involvement with this journal at all levels--reviewing, editing, and submitting, and leave it to wither way into oblivion and disrepute."[36]

Peabody Energy then quotes Wigley's response: "I agree that Kinne seems like he could be a deFreitas clone. However, what would be our legal position if we were to openly and extensively tell people to avoid the journal?"[37] The petitioner also quotes Santer's response: "Based on Kinne's editorial, I see little hope for more enlightened editorial decision making at Climate Research. Tom, Richard Smith and I will eventually publish a rebuttal to the Douglass et al. paper. We'll publish this rebuttal in JGR - not in Climate Research."[38]

The petitioner concludes that these e-mails provide evidence that the e-mail authors interfered with journal editorial boards in an attempt to suppress publication of dissenting views about anthropogenic climate change. Peabody Energy argues that the Endangerment Finding should be reconsidered because it relied on biased peer-reviewed literature that does not reflect the true breadth of the science.

Response (3-23):
The context to the petitioners' arguments is the Soon and Balinus (2003) paper published in the journal *Climate Research*. This paper was subsequently heavily and broadly criticized by the scientific community in peer-reviewed journals. A scientific rebuttal to Soon and Balinus (2003) was published in the AGU journal *Eos* (Mann et al., 2003).

The publication of this paper revealed problems with the peer review process at *Climate Research*, which eventually resulted in the resignation of three people on the editorial board when they could not come to an agreement with the publisher on how to revamp the peer-review process in the wake of the controversy (Kinne, 2003). Petitioners assume that because the resignations occurred after the CRU e-mail authors threatened to boycott the journal, the

[35] E-mail file 1057941657.txt, (July 11, 2003), page 546, line 13 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[36] E-mail file 1057941657.txt (July 11, 2003), page 547, line 18 of the PDF version entitled: CRU Emails 1996-2009.pdf
[37] E-mail file 1057941657.txt (July 11, 2003), page 547, line 12 of the PDF version entitled: CRU Emails 1996-2009.pdf
[38] E-mail file 1057941657.txt (July 11, 2003), page 547, line 1 of the PDF version entitled: CRU Emails 1996-2009.pdf

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resignations must be a result of that threat. However, *Climate Research* publisher Otto Kinne later admitted in a statement published in the journal that the Soon and Balinus paper was flawed and should not have been published, expressed regret that the journal had lost three editors due to the controversy, and promised to strengthen the journals' peer review policies (Kinne, 2003). Thus, the petitioners' claims that it was the actions of the CRU e-mail authors that resulted in changes to the editorial board of *Climate Research* are without merit.

It is clear from the quoted e-mails that the CRU scientists and their colleagues believed that there was a failure of the peer review process at *Climate Research* that allowed a scientifically flawed paper to be published. Subsequent events have demonstrated that their views were justified; as shown by the publication of Mann et al.'s (2003) scientific rebuttal. It is not inappropriate or uncommon for scientists to challenge the validity of each 'others work. It is well within the norms of the scientific community to write and publish comments or responses and otherwise challenge published journal articles if one can demonstrate that there are scientific insufficiencies. Such challenges are indeed essential to the progress of science. The critical issue is that such challenges should be focused on scientific and factual grounds. The scientists reacted reasonably by publishing a rebuttal to the Soon and Balinus paper in a different peer-reviewed journal (Mann et al., 2003).

Science is a community-based professional enterprise in which it is expected and appropriate that researchers choose in which journals to publish, as well as recommend to their peers journals in which to publish or not publish. In this case, the bottom line is that the underlying science at issue has been shown to be flawed. The scientists' actions were focused on this lack of scientific merit and the process that lead to it, and not an attempt to distort the science or the scientific literature. We disagree with the petitioner's claim that the CRU e-mail authors acted like "activists" and not like scientists. Their focus was clearly on the scientific merits of the study at issue and the scientific integrity of the peer review process. There is no evidence to suggest that the CRU e-mail authors were attempting to manipulate the peer-reviewed literature. If anything, their actions aimed to police the peer review process and rectify a problem that threatened its scientific integrity.

We also note that the e-mails cited by the petitioner are simply statements of displeasure, not indications that any actions were undertaken. It is legitimate and entirely reasonable that these scientists expressed their opinions about a situation that concerned them. There is no evidence that the CRU e-mail authors engaged in any actions that were unethical, or otherwise outside the norms of scientific practice. Moreover, there are hundreds of journals relevant to climate science and many editors at each, so to claim that any change in the editorial board at one journal somehow biased the vast wealth of climate change studies or called into question the overall conclusions reached from those thousands of papers is unwarranted and unsupported.

Comment (3-24):
The State of Texas and the Coalition for Responsible Regulation claim that the CRU e-mail authors sought to remove an editor from *Geophysical Research Letters* (GRL) because they did not agree with his views on climate science. They quote the following e-mail from Tom Wigley:

> This is truly awful. GRL has gone downhill rapidly in recent years…Proving bad behavior here is very difficult. If you think that [the objectionable editor] is in the

> greenhouse skeptics camp, then, if we can find documentary evidence of this, we could go through official AGU channels to get him ousted.[39]

The Pacific Legal Foundation also references this example, stating that the CRU e-mails "…appear to show attempts to 'discipline' scientists and journalists who published skeptical information." The State of Texas argues that the CRU e-mail authors' language reflects an "us versus them" attitude more commonly associated with legal advocacy or team sports than the scientific method. The petitioner quotes an e-mail from Michael Mann: "What a shame that would be. It's one thing to lose 'Climate Research' [sic]. We can't afford to lose GRL."

The State of Texas states that "Wigley's goal of removing the editor" was successful, quoting a statement from Pat Michaels of the Cato Institute, who said that the departure of the GRL editor, James Saiers, "coincided with Mann, Wigley, and Dr. Jones's plan to 'get him ousted'" [Michaels, 2009a]. The State of Texas and the Coalition for Responsible Regulation also quote an e-mail from Michael Mann: "the GRL leak may have been plugged up now w/ new editorial leadership there."[40]

The petitioners conclude that these e-mails provide evidence that their authors interfered with journal editorial boards in an attempt to suppress publication of dissenting views about anthropogenic climate change. The petitioners argue that the Endangerment Finding should be reconsidered because it relied on biased peer-reviewed literature that does not reflect the true state of the science.

Response (3-24):
First, we note that there is no evidence that any actions by the CRU e-mail authors were taken or they resulted in the dismissal or replacement of the editor, and there is also no evidence that they took inappropriate actions. The e-mails show the scientists discussing plans to record evidence of potential political bias by one of the journal's editors. Michael Mann states, "If there is a clear body of evidence that something is amiss, it could be taken through the proper channels" [41] The e-mails depict scientists' reaction to what they believed was bias within the peer review process.

Again, petitioners assume that because the resignation occurred after the CRU e-mail authors talked among themselves, it must be a result of actions by the e-mail authors. This claim is unsupported by any evidence provided by the petitioners, however, and they do not show that the scientists engaged in improper behavior or claimed sabotage of the journal or its editors. There is also no evidence that any action by the scientists resulted in the replacement of the journal editor. To the contrary, we note that the GRL editor in question was James Saiers, who was quoted in an article in the *Guardian* newspaper saying simply that "his three-year term was up" (Pearce, 2010). Saiers also stated, "My departure had nothing to do with attempts by Wigley or

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[39] E-mail file 1106322460.txt (January 20, 2005), page 809, line 14 of the PDF version entitled: CRU Emails 1996-2009.pdf

[40] E-mail file 1132094873.txt, (November 15, 2005), page 989, line 25 of the PDF version entitled: CRU Emails 1996-2009.pdf

[41] E-mail file 1106322460.txt, (January 20, 2005), page 809, line 7 of the PDF version entitled: CRU Emails 1996-2009.pdf

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anyone else to have me sacked…nor was I censured, as I have seen suggested on a blog posting written by McKitrick." Thus, it appears that Saiers left voluntarily when his term ended, and that his departure was unrelated to any actions of the CRU e-mail authors.

As stated in our previous response (3-23), it is not unethical or inappropriate for scientists to challenge or oppose—on scientific and factual grounds—the actions of a journal editor that approved the publication of research that they believe is flawed. Just as they were concerned for editorial integrity at *Climate Research*, the CRU scientists and their colleagues were concerned about what they viewed as a failure of the peer review process at GRL. The evidence does not suggest that the CRU e-mail authors were attempting to manipulate the peer-reviewed literature, nor that they engaged in any actions that were unethical or otherwise outside the norms of scientific practice. Moreover, there are hundreds of journals relevant to climate science and many editors at each, so to claim that any change in the editorial board at one journal somehow biased the vast wealth of climate change studies or called into question the overall conclusions reached from those thousands of papers is unwarranted and unsupported.

Comment (3-25):
The Coalition for Responsible Regulation claims that the CRU e-mails show that Phil Jones and Ben Santer "went over the head of the editor of *Weather*, with Jones threatening the Royal Meteorological Society [RMS] Chief Executive that he would no longer submit information to Royal Meteorological Society journals if the *Weather* editor refused to 'back down' [1237496573.txt]." The Coalition for Responsible Regulation provides no additional context for this exchange, but claims that it is another example of the CRU scientists and their colleagues interfering with the editorial boards of scientific journals in order to publish only those papers that agreed with their positions.

The petitioners conclude that these e-mails provide evidence that their authors interfered with journal editorial boards in an attempt to favor publication of papers that supported their views about anthropogenic climate change. The petitioners argue that the Endangerment Finding should be reconsidered because it relied on biased peer-reviewed literature that does not reflect the true breadth of the science.

Response (3-25):
From our review of the CRU e-mails, the context for the petitioner's quote is that Phil Jones submitted a paper with fellow CRU scientist David Lister on urban heat islands (UHI) to the journal *Weather*—i.e., Jones and Lister (2009). Contrary to what the petitioner implies, Ben Santer was not involved with the paper; he simply received an e-mail about it from Jones. It appears that Jones received comments back from the editor at *Weather* with which he did not agree. Jones states:

> I've written up the London paper for the RMS journal Weather, but having trouble with their new editor. He's coming up with the same naive comments that these responders are. He can't understand that London has a UHI of X, but that X has got no bigger since 1900.[42]

[42] E-mail file 1237474374.txt, (March 19, 2009), page 1647, line 37 of the PDF version entitled: CRU Emails 1996-2009.pdf

In another e-mail, Jones states:

> In my 2 slides worth at Bethesda I will be showing London's UHI and the effect that it hasn't got any bigger since 1900. It's easy to do with 3 long time series. It is only one urban site (St James Park), but that is where the measurements are from. Heathrow has a bit of a UHI and it has go[t] bigger. I'm having a dispute with the new editor of Weather. I've complained about him to the RMS Chief Exec. If I don't get him to back down, I won't be sending any more papers to any RMS journals and I'll be resigning from the RMS. The paper is about London and its UHI![43]

First, we note that the science of UHIs and their relationship to climate change is addressed in Volume 1, Section 1.3.4 of this RTP document. However, the petitioner does not argue based on the scientific information presented in the manuscript in question, which was eventually accepted and published in *Weather* (Jones and Lister, 2009). Rather, the petitioner takes issue with the fact that Jones complained about the editor and made statements about boycotting the journal in the future, which the petitioner claims is evidence that Jones inappropriately interfered with the peer review and publication process at *Weather*. Phil Jones is within his rights as a scientist and author to choose the journals to which he submits his papers. We disagree with the petitioner that Jones' statements constitute "interference" or inappropriate action.

The Independent Climate Change E-mails Review examined this general issue and reached a similar conclusion:

> In conclusion, it is common for editors to have multiple, intense, and sometimes sharp and passionate interactions with authors and reviewers. The tone of their exchanges and communications with editors can be attacking, accusatory, aggressive, and even personal. If a research paper is especially controversial and word of it is circulating in a particular scientific community, third-party scientists or critics with an interest in the work may get to hear of it and decide to contact the journal. They might wish to warn or encourage editors. This kind of intervention is entirely normal. It is the task of editors to weigh up the passionate opinions of authors and reviewers, and to reflect on the comments (and motivations) of third parties.

This example does not support the petitioner's arguments that the journal publication process was manipulated.

To summarize Section 3.3.4, petitioners' evidence does not support their claims that the journal publication process was improperly influenced. Their evidence shows scientists with strong scientific opinions on the scientific merits of various papers, and opinions about the scientific integrity of the peer review process at certain journals. It appears that in one case the journal determined that mistakes had been made in publishing a flawed paper. In another case an editor resigned and publicly stated it had nothing to do with the scientists that petitioners point to.

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[43] E-mail file 1237496573.txt, (March 19, 2009), page 1649, line 21 of the PDF version entitled: CRU Emails 1996-2009.pdf

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Petitioners' broad, sweeping conclusions about improper actions by the scientists are speculative and not supported by the evidence.

As in other claims discussed above, petitioners do not base their claims on scientific arguments. They do not argue that the scientists at issue here were wrong in their scientific analyses or conclusions, or in their critiques of other studies. They do not provide evidence of any scientific paper or research that was not but should have been published. Their broad claim that EPA relied upon a body of peer reviewed literature that was biased and did not reflect the true breadth of the science is not supported by the evidence they present. Their assertions are not based on any scientific arguments or evidence, but instead rely upon unwarranted speculation.

3.3.5 Allegations Regarding Objectivity of the Peer-Reviewed Literature

Comment (3-26):
Peabody Energy argues that "Michael Mann and his collaborators engaged in a decade-long campaign of preventing dissenting scientific voices from being heard." Peabody Energy states that one of Mann's former collaborators, Raymond Bradley, disassociated himself from comments made to the editor of the journal *Science* after it published a paper with which Mann disagreed. Peabody Energy quotes part of an e-mail written by Bradley on April 19, 1999 to the editor at *Science*:

> As for thinking that it is "Better that nothing appear, than something unacceptable to us"…as though we are the gatekeepers of all that is acceptable in the world of paleoclimatology seems amazingly arrogant. Science moves forward whether we agree with individual articles or not.[44]

Peabody Energy asserts that in the end, Mann and his colleagues acted as gatekeepers to the peer-reviewed literature, in marked contrast to Mann's stance in his 2009 letter to the editor of The Wall Street Journal. Peabody Energy provides the following excerpt from the letter:

> Society relies upon the integrity of the scientific literature to inform sound policy. It is thus a serious offense to compromise the peer-review system in such a way as to allow anyone—including proponents of climate change science—to promote unsubstantiated claims and distortions [Mann, 2009].

Peabody Energy argues that the Endangerment Finding should be reconsidered because it relied on peer-reviewed literature that is biased in favor of views supporting anthropogenic climate change and does not reflect the true breadth of the science.

Response (3-26):
The petitioner quotes only one part of one e-mail from Bradley, and fails to provide the context for the incident they are describing, which occurred more than 10 years ago. In context, it appears Mann is referring to specific language he objected to in a draft article he was reviewing for the journal *Science*. This drafting issue was later resolved to the satisfaction of the author of

[44] E-mail file 0924532891.txt (April 19, 1999), page 155, line 16 of the PDF version entitled: CRU Emails 1996-2009.pdf

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the article, and does not indicate any attempt to suppress opposing views or some "decades long" attempt to do so. To understand Mann's statement in context, we include three relevant e-mails below, in full. The first is the full text of Bradley's e-mail to the editor at *Science*, sent April 19, 1999. The second is an e-mail from Phil Jones to Michael Mann regarding Mann's reaction to the draft article in *Science*, sent May 6, 1999. The third is an e-mail from Mann to Jones and others involved in writing, reviewing, or editing the draft article in *Science*, sent on May 12, 1999.

> Date: Mon, 19 Apr 1999 10:06:52 -0400
> To: juppenbrink@science-int.co.uk [editor at *Science*]
> From: "Raymond S. Bradley" rbradley@geo.umass.edu
> Subject: Climate warming prespctives article
> Cc: mann@snow.geo.umass.edu, mhughes@ltrr.arizona.edu
>
> I have just returned from Finland and have now read all the correspondence regarding the Science perspectives article you asked Keith Briffa & Tim Osborn to write. I've sent Tim Osborn & Keith Briffa a few suggestions re their perspectives article. If you would like to see them, let me know. I would like to diasassociate myself from Mike Mann's view that "xxxxxxxxxxx" [*original text x'ed out in released e-mails*] and that they "xxxxxxxxxxxxx" [*original text x'ed out in released e-mails*]. I find this notion quite absurd. I have worked with the UEA [University of East Anglia] group for 20+ years and have great respect for them and for their work. Of course, I don't agree with everything they write, and we often have long (but cordial) arguments about what they think versus my views, but that is life. Indeed, I know that they have broad disagreements among themselves, so to refer to them as "the UEA group", as though they all march in lock-step seems bizarre. As for thinking that it is "Better that nothing appear, than something unnacceptable to us" .....as though we are the gatekeepers of all that is acceptable in the world of paleoclimatology seems amazingly arrogant. Science moves forward whether we agree with individiual articles or not.... Sincerely, Raymond S. Bradley[45]

> From: Phil Jones <p.jones@xxxxxxxxx.xxx>
> To: mann@xxxxxxxxx.xxx
> Subject: Straight to the Point
> Date: Thu, 06 May 1999 17:37:34 +0100
> Cc: k.briffa@xxxxxxxxx.xxx,t.osborn@xxxxxxxxx.xxx,mhughes@xxxxxxxxx.xxx, rbradley@xxxxxxxxx.xxx
>
> Mike,
> Just back from two weeks away and from discussions with Keith and Tim and some e-mails you seem quite pissed off with us all in CRU. I am somewhat at a loss to understand why. It is clear from the e-mails that this relates to the emphasis placed on a few words/phrases in Keith/Tim's Science piece. These may not be fully resolved but the piece comes out tomorrow. I don't want to open more wounds but I might by the end of the e-mail. I've not seen the censored e-mail that Ray has mentioned but this doesn't, to my way of working, seem to be the way you should be responding - ie slanging us all off

[45] E-mail file 0924532891.txt (April 19, 1999), page 155, line 16 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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to Science. We are all trying to work together for the good of the 'Science'. We have disagreements - Ray, Malcolm, Keith and me have in the past, but they get aired and eventually forgotten. We have never resorted to slanging one another off to a journal (as in this case) or in reviewing papers or proposals. You may think Keith or I have reviewed some of your papers but we haven't. I've reviewed Ray's and Malcolm's - constructively I hope where I thought something could have been done better. I also know you've reviewed my paper with Gabi very constructively.

So why all the beef now? Maybe it started with my Science piece last summer. When asked to do this it was stressed to that I should discuss how your Nature paper fitted in to the current issues in paleoclimatology. This is what I thought I was doing. Julia Uppenbrink asked me to do the same with your GRL paper but I was too busy and passed it on to Keith. Again it seems a very reasoned comment.

I would suspect that you've been unhappy about us coming out with a paper going back 1000 years only a few months after your Nature paper (back to 1400). Ray knew all about this as he was one of the reviewers. Then the second Science comment has come out with a tentative series going back 2000 years. Both Science pieces give us a chance to discuss issues highly relevant to the 'science', which is what we have both tried to do. Anyway that's enough for now - I'll see how you'll respond, if at all. There are two things I'm going to say though:

1) Keith didn't mention in his Science piece but both of us think that you're on very dodgy ground with this long-term decline in temperatures on the 1000 year timescale. What the real world has done over the last 6000 years and what it ought to have done given our understanding of Milankovic forcing are two very different things. I don't think the world was much warmer 6000 years ago - in a global sense compared to the average of the last 1000 years, but this is my opinion and I may change it given more evidence.

2) The errors don't include all the possible factors. Even though the tree-ring chronologies used have robust rbar statistics for the whole 1000 years (ie they lose nothing because core numbers stay high throughout), they have lost low frequency because of standardization. We've all tried with RCS [regional curve standardized]/very stiff splines/hardly any detrending to keep this to a minimum, but until we know it is minimal it is still worth mentioning. It is better we (I mean all of us here) put the caveats in ourselves than let others put them in for us.

3) None of us here are trying to get material into IPCC. I've given you my input through the review of the chapter in Asheville. I may get a chance to see the whole thing again at some stage, but I won't be worried if I don't.

I can't think of a good ending, but hoping for a favourable response, so we can still work together. Cheers, Phil[46]

From: mann@xxxxxxxxx.xxx
Date: Wed, 12 May 1999 13:00:09 -0400 (EDT)
To: juppenbrink@xxxxxxxxx.xxx, k.briffa@xxxxxxxxx.xxx, t.osborn@xxxxxxxxx.xxx
Cc: mann@xxxxxxxxx.xxx, mhughes@xxxxxxxxx.xxx, p.jones@xxxxxxxxx.xxx, rbradley@xxxxxxxxx.xxx

[46] E-mail file 0926026654.txt (May 6, 1999), page 164, line 18 of the PDF version entitled: CRU Emails 1996-2009.pdf.

Dear all,

Thanks for working so hard to insure a final product that was acceptable to all. I think that Keith and Tim are to be commended on a fine job w/ the final version of the Perspectives piece that appeared, and I thank Julia for her especially difficult editorial task. I appreciate having had the opportunity to respond to the original draft. I think this opportunity is very important in such cases (ie, where a particular author/groups work is the focus of a commentary by someone else), and hope that this would be considered standard procedure in the future in such instances.

I think we have some honest disagreements amonst us about some of the underlying issues, but these were fairly treated in the piece and that's what is important (The choice of wording in the final version was much better too. Wording matters!). Thanks all for the hard work and a job well done. I like to think that may feedback helped here--so I take some pride here as well.

best regards,
mike[47]

We first note that the statement attributed to Michael Mann—"Better that nothing appear, than something unacceptable to us"—is actually just inferred from Raymond Bradley's email, which does not specifically identify Mann as the source of the quote. Regardless of its origin, however, the petitioner mischaracterizes and misinterprets this statement attributed to Michael Mann by Bradley. The petitioner mistakenly assumes that Mann was arguing that it would be better that nothing was published in the peer-reviewed literature, rather than dissenting viewpoints that differed from his own. In actuality, Mann was specifically commenting on a draft article written by Keith Briffa and Tim Osborn (Briffa and Osborn, 1999) for the journal *Science*. The Briffa and Osborn article was commissioned by an editor at *Science* and represents a review or synthesis, not original research. As the e-mails make clear, the background for their disagreement stems from a negative review of the Briffa and Osborn article that Mann sent to an editor at *Science*. We do not have access to the review Mann sent to the editor at *Science* because it was not included in the released CRU e-mails, but it can be observed from other CRU e-mails that Mann disagreed with some of the language and descriptions used in the article.[48] For example, in one of his comments to Briffa and Osborn, Mann states, "One additional new comment: 0) 1st page, 'In attemping [sic] to do this...Mann at al...exemplifies' is unacceptable language to us. We confront the very problems that are being discussed here, so it is a disservice to us to say our paper 'exemplifies' these problems. It 'exposes' or 'confronts' would be fair language, but 'exmemplifies'[sic] is unacceptable." [49]

The e-mails also make it clear that the disagreements were amicably resolved; in the final e-mail, Mann states, "Thanks for working so hard to insure a final product that was acceptable to all."[50]

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[47] E-mail file 0924532891.txt (April 20, 1999), page 155, line 46 of the PDF version entitled: CRU Emails 1996-2009.pdf

[48] e.g., E-mail file 0924030302.txt (April 13, 1999), page 146, line 45, e-mail file 0924120405.txt (April 14, 1999), page 153, line 15, and e-mail file 0924613924.txt (April 20, 1999), page 155, line 46 of the PDF version entitled: CRU Emails 1996-2009.pdf.

[49] E-mail file 0924120405.txt (April 14, 1999), page 153, line 15 of the PDF version entitled: CRU Emails 1996-2009.pdf.

[50] E-mail file 0926681134.txt (May 14, 1999), page 166, line 45 of the PDF version entitled: CRU Emails 1996-2009.pdf

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The most reasonable conclusion is that the statement "Better that nothing appear, than something unacceptable to us" apparently referred to specific language in the paper with which Mann strongly disagreed. We find no evidence to suggest that the statement had anything to do with suppressing dissenting scientific views on climate change or their publication, much less a "decade-long campaign" to keep them out of the peer-reviewed literature.

The petitioner's evidence does not show that Mann's actions were inconsistent with his views on the peer review process, as described in his letter to the editor of The Wall Street Journal. Although the petitioner only quotes part of the letter, we provide it here in full:

> In his Dec. 18 op-ed "How to Manufacture a Climate Consensus," Patrick J. Michaels of the Cato Institute falsely claims that work by him (and other fossil-fuel-funded climate change contrarians) has been unfairly blocked by me and others from appearing in mainstream science journals because the peer review process is supposedly biased against climate science deniers.
>
> In truth, the only bias that exists at such publications is for well-reasoned writing that is buttressed by facts.
>
> That is why climate skeptics such as Richard Lindzen of MIT [Massachusetts Institute of Technology] or John Christy of the University of Alabama—who are widely regarded as credible and whose work contributes meaningfully to the scientific discourse—have no problem publishing their work in mainstream scientific journals.
>
> And what about those who are not being published? Every scientist dealing with a major public issue must decide if he or she is going to be a scientist or a de facto politician.
>
> Mr. Michaels and many climate science deniers have opted for the latter course of action. For example, presidential science adviser John Holdren notes that Mr. Michaels "has published little if anything of distinction . . . being noted rather for his shrill op-ed pieces and indiscriminate denunciations of virtually every finding of mainstream climate science." This makes Mr. Michaels a perfect candidate for a Wall Street Journal op-ed and a decidedly poor submitter to a serious scientific journal.
>
> Society relies upon the integrity of the scientific literature to inform sound policy. It is thus a serious offense to compromise the peer-review system in such a way as to allow anyone—including proponents of climate change science—to promote unsubstantiated claims and distortions.
>
> The good news is that it is not happening today in relation to either climate scientists or the deniers of climate science. Men and women who have dedicated their lives to advancing science need not apologize for keeping their rigorous professional journals free of the pollution of what is purely politics.

Thus, we conclude that the petitioner leaps from the Bradley quote to an unsupported conclusions regarding Mann's actions with respect to the specific issue in the e-mails and in general. The petitioner's claim that Mann wanted to suppress the article is unsupported by the

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text they reference, and their claim that these e-mails somehow prove that Mann had a "decades-long agenda" to suppress dissenting views is baseless. Mann's letter to the editor of The Wall Street Journal further clarifies that he supports ensuring high standards of rigor and quality in the peer-reviewed literature. This example does not support the petitioner's arguments that the journal publication process was manipulated. The claim of a "gatekeeper" to the peer-reviewed literature is not supported by their evidence, and the petitioner provides no evidence of any paper that it believes was not, but should have been, published as a result of the claimed "gatekeeping." They make no arguments based on science, and instead rely on unwarranted speculation.

Comment (3-27):
The Coalition for Responsible Regulation and the Southeastern Legal Foundation argue that various actions by the CRU e-mail authors made it difficult or impossible for scientists with differing views to successfully publish their research in peer-reviewed journals. The Coalition for Responsible Regulation claims that the CRU e-mail authors "tried mightily to allow only one perspective on the global warming debate to be published and legitimized." In support of this argument, petitioners repeat their allegations regarding reviews of manuscripts, journal publication practices, and efforts to remove editors and boycott journals that are discussed in sections 3.3.2, 3.3.3, and 3.3.4 of this Volume. In addition, the Coalition for Responsible Regulation quotes part of an e-mail written by Roger Pielke, Sr., of Colorado State University on November 19, 2004:

> There has been, however, in my view an unfortunate change over time where reviewers who disagree with already published work recommend rejection of subsequent work rather than letting the community view and assess the different perspectives on a science issue.[51]

The Coalition for Responsible Regulation claims that "[t]his systemic suppression of differing viewpoints, in turn, has dissuaded prominent scientists from seeking publication in peer-reviewed journals," quoting as evidence an e-mail from Phil Jones: "Even here they [climate change skeptics] don't seem to be bothering with journals at all recently."[52] The Southeastern Legal Foundation provides a quote supporting this argument from Pat Michaels:

> Mr. Wigley repeatedly tells news reporters not to listen to 'skeptics' (or even nonskeptics like me), because they didn't publish enough in the peer-reviewed literature— even as he and his friends sought to make it difficult or impossible to do so. [Michaels, 2009]

Thus, the petitioners argue, scientists with dissenting views were only able to publish their work in formats other than peer-reviewed journals, which both EPA and the IPCC ignored or downplayed. On this basis, the petitioners argue that the Endangerment Finding should be reconsidered because it relies on peer-reviewed literature, which is biased in favor of views supporting anthropogenic climate change and does not reflect the true state of the science.

Response (3-27):

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[51] E-mail file 1101133749.txt (November 18, 2004), page 752 lines 30-46 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[52] E-mail file 1256765544.txt (October 28, 2009), page 1837 , lines 28-29 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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We respond to petitioners' allegations regarding reviews of manuscripts, journal publication practices, and efforts to remove editors and boycott journals in sections 3.3.2, 3.3.3, and 3.3.4 of this volume. As discussed there, the petitioners' broad, sweeping conclusions about improper actions by the scientists are speculative and not supported by the evidence. The petitioners jump to the conclusion that papers with opposing views were systematically suppressed but do not provide any evidence of actions taken to prevent publication of otherwise acceptable research.

The petitioners quote the opinions of Roger Pielke, Sr., and Pat Michaels as support for the proposition that research with opposing views of anthropogenic climate change cannot get published. The petitioners assume that such research should have been or would have been published in peer-reviewed literature if not for the opposition of the CRU e-mail authors, without providing any science-based analysis to support this argument. The petitioners assume, with no basis, that the CRU e-mail authors had the power both to influence the peer-review process for the many journals that publish research related to climate-change, and to prevent publication of manuscripts with opposing views of anthropogenic climate change.

The petitioner's characterization of the scientific literature as biased and one-sided is incorrect. The Coalition for Responsible Regulation argues that it has been "difficult or impossible" for climate "skeptics" to get their research published in professional journals. However, EPA reviewed numerous publications representing a wide range of views on climate change, both here in the RTP document and in the RTC document for the Endangerment Finding. As Michael Mann stated in his letter to the editor of The Wall Street Journal (reproduced in full in response 3-26 above): "[C]limate skeptics such as Richard Lindzen of MIT or John Christy of the University of Alabama—who are widely regarded as credible and whose work contributes meaningfully to the scientific discourse—have no problem publishing their work in mainstream scientific journals." Petitioners' evidence does not support their claims of "systematic suppression of differing viewpoints" in the literature.

EPA disagrees with the petitioners' argument that the Findings were based on a false consensus regarding anthropogenic global warming, and that the IPCC (and by extension EPA) disregarded contrary views or evidence because they were not represented in the peer-reviewed literature. Contrary to the petitioners' implication, there are many perspectives on climate change present in the peer-reviewed literature. In reality, many diverging viewpoints and a vast array of findings are represented in the scientific literature on climate change. There is no single view in the literature as petitioners seem to claim, instead there are myriad examples in the literature of the robust back and forth process of scientific research for the broad range of scientific issues have been explored by many different scientists around the world. It is precisely this diversity in research results that the IPCC describes in its assessment reports when it provides uncertainty ranges for its major conclusions. The assessment reports synthesize literally thousands of individual studies and look at the range of conclusions across multiple disciplines. The assessment reports comprehensively reviewed the science; their scientific conclusions routinely identified the degree of certainty around any conclusion, driven by the degree of consistency and the depth of the science. These conclusions reflected a broad consensus of the scientific community, and recognized the existence of ongoing debate within the scientific community on all of these issues, as is the norm in all science endeavors. We thoroughly address issues related to the use of consensus literature and the major assessment reports in Volume 1 of the RTC

document for the Endangerment Finding and again in Volume 2, Section 2.2 of this RTP document. Thus we find no merit in the argument that the Endangerment Finding did not fully consider scientific evidence representing a full range of views.

The Endangerment Finding was based on a careful consideration of the full weight of scientific evidence and a thorough review of hundreds of thousands of public comments. The major scientific conclusions that support the Endangerment Finding are themselves the product of decades of research, reflected in thousands of studies by numerous scientists, with varying opinions about how best to interpret the results. EPA relied on these assessment reports precisely to avoid an over-reliance on and narrow consideration of individual studies from a limited subset of scientific disciplines or perspectives and to ensure that the Administrator's decision would be based on a comprehensive assessment of the scientific literature. Even if something was missed in an assessment report, our notice and comment on the Endangerment Finding was designed to ensure that EPA received information from all points of view. We received over 380,000 comments, including hundreds of references to literature and reports for our consideration. This material was reviewed and responded to in the 11 volumes of the RTC document for the Endangerment Finding. The notion that EPA did not consider the full range of scientific views is thus simply incorrect. We find that the objections raised by the petitioner have not changed EPA's conclusion that the science supporting the Endangerment Finding is robust, is compelling, and has been appropriately characterized by EPA.

Comment (3-28):
Petitioners question the credibility of the peer review process and the validity of the scientific consensus regarding anthropogenic climate change. The Southeastern Legal Foundation claims that the numerous examples (discussed in sections 3.3.2–3.3.4 above) of "persecution and black-balling of journals, editors, and reviewers" by the CRU e-mail authors provide evidence that "the normal processes of peer review and objective scientific evaluation that might ordinarily lead to 'consensus' have been shown to be so fundamentally degraded by collusion, intimidation, and deception that no one can seriously contend that any consensus [about anthropogenic climate change] exists at this time."

The Southeastern Legal Foundation argues that the CRU e-mail authors' intimidation tactics have caused other journal editors to be concerned about the risk to their careers from allowing publication of anything contrary to the views of these scientists. The Southeastern Legal Foundation states that "it can be difficult to distinguish 'consensus' from enforced doctrinal orthodoxy," quoting John Christy of the University of Alabama:

> These people act in concert to diminish, reject, and otherwise denigrate findings with which they do not agree -- and they are able to do so because of their "establishment" positions. This is the preservation of "group think" at its most serious level.... The group represented by the bulk of these e-mails does indeed have a message to defend. Those of us who see problems with that message are aware of how the data are manufactured and interpreted to support that message -- and worse, how these establishment scientists act as gatekeepers for the "consensus" reports to suppress alternative findings. [Hake, 2009]

The Southeastern Legal Foundation asserts that the CRU e-mail authors "manipulated the scientific literature to purge any and all contrary opinions" and that this suppression of contrary

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opinions has resulted in bias in the type of papers cited in the IPCC reports and other major assessments, and which were relied upon by EPA in making the Endangerment Finding. The petitioner quotes Pat Michaels in support of this argument:

> When scientists make putative compendia of that literature, such as is done by the U.N. climate change panel every six years, the writers assume that the peer-reviewed literature is a true and unbiased sample of the state of climate science. That can no longer be the case. The alliance of scientists at East Anglia, Penn State, and the University Corporation for Atmospheric Research (in Boulder, Colo.) has done its best to bias it. [Michaels, 2009]

The Pacific Legal Foundation claims that the CRU e-mails "appear to call into question the credibility of the peer review process" and argues that that EPA's Scientific Advisory Board should be given the opportunity to examine the CRU e-mails and determine if there was scientific misconduct that would undermine the science on which the Endangerment Finding was based. The Competitive Enterprise Institute claims that "the IPCC scientific review process has a systematic bias of an unknowable magnitude in favor of human-induced warming. Consequently, the EPA Endangerment Finding is severely undermined by a systematic bias of an unknowable magnitude in favor of human-induced warming."

The petitioners argue that the Endangerment Finding should be reconsidered because the peer-reviewed literature on which it relies has been biased in favor of views supporting anthropogenic climate change and does not reflect a true consensus regarding anthropogenic climate change.

Response (3-28):
We respond to petitioners' specific arguments regarding the peer review process, journal editors, and journal publication practices in Sections 3.3.2–3.3.4 of this Volume of the RTP document. In our responses, we discuss the fact the evidence relied upon by petitioner is limited in nature, involves at most a few articles and the journals involved, that this evidence is often taken out of context and does not support the claims made by petitioners of unethical, or inappropriate actions taken against journals or their editors, or an attempt to prevent contrary opinions from entering the literature. Petitioners do not identify papers that were not, but should have been, published because of their scientific merit, and petitioners do not make any scientific arguments about the limited number of papers at issue. Southeastern Legal Foundation's claim that journal editors would be concerned about the risk to their careers from publishing opposing science is not substantiated by the evidence. Southeastern Legal Foundation's sole support for this allegation is the personal opinions of Pat Michaels and John Christy. These statements of opinion, however, do not demonstrate or substantiate the petitioner's claim that CRU scientists "manipulated the scientific literature." In addition, as discussed in the preceding response (3-27), the scientific literature is not one-sided and includes a wide variety of perspectives about climate change.

The evidence presented by petitioners does not support the claims that the CRU e-mail authors acted as "gatekeepers" to the literature to advance their views or were motivated by an activist agenda. As discussed in detail in our previous response (3-23), the CRU scientists identified what they believed was flawed science in specific papers, and responded by publishing peer-

reviewed, scientific rebuttals in professional journals. This is standard practice in the scientific community and in no way constitutes bias in the literature. The evidence does not support the claims that the content and substance of the body of peer-reviewed literature on climate change was manipulated by the CRU email authors.

The statement from John Christy provided by the Southeastern Legal Foundation (that "data are manufactured and interpreted to support [a] message [of anthropogenic climate change]") is an assertion; it contains no evidence of the claimed data manipulation. We respond to similar arguments that question the accuracy and credibility of the science in Volume 1 of this RTP document. The scientific issues petitioners claim were hidden or presented in a biased manner were in fact fully and comprehensively discussed in the assessment reports. Our responses to the science issues contained in Volume 1 make this clear. The evidence we have examined does not call into question any of the fundamental conclusions of climate science research.

Finally, our notice and comment process on the Endangerment Finding was designed to ensure that EPA received information from all points of view. We received over 380,000 comments, including hundreds of references to literature and reports for our consideration. This material was reviewed and responded to in the 11 volumes of the RTC document for the Endangerment Finding. The notion that EPA did not consider the full range of scientific views is thus simply incorrect. The objections raised by the petitioner do not support changing EPA's conclusion that the science supporting the Endangerment Finding is robust, is compelling, and has been appropriately characterized by EPA.

Comment (3-29):
The State of Texas claims that the CRU e-mails "reveal a cadre of activist scientists colluding and scheming to advance what they *want* the science to be, even where the empirical data suggest a different outcome." The State of Texas concludes that the CRU e-mails "reflect a concerted effort to advance a specific scientific theory—or perhaps more appropriately a scientific cause—rather than to reach the objective truth. That is, the e-mails that have been released indicate that the scientists were more concerned with advancing their agenda than with obtaining the objective results required by the OMB and EPA guidelines."

The State of Texas also claims that the CRU e-mail authors were opposed to the publication of dissenting views because they "had long maligned their skeptical opponents' positions by arguing that the opposition's research had not been published by a peer-reviewed journal and could therefore not be trusted." The State of Texas argues that the CRU e-mail authors were worried that any publication of dissenting views gave support to "skeptics", quoting as evidence an e-mail from Phil Jones: "I think the skeptics will use this paper to their own ends and it will set paleo [climate science] back a number of years if it goes unchallenged.[53]" The petitioner argues that the Endangerment Finding should be reconsidered because it relies on peer-reviewed literature, which is biased in favor of views supporting anthropogenic climate change and does not reflect the true state of the science.

[53] E-mail file 1047388489.txt (March 11, 2003), page 456, line 30 of the PDF version entitled: CRU Emails 1996-2009.pdf.

Response (3-29):
The State of Texas claims that the CRU e-mail authors' scientific judgments regarding anthropogenic climate change are unsupported by "empirical data." We respond to similar arguments that question the accuracy and credibility of the science in Volume 1 of this RTP document. The scientific issues petitioners claim were hidden or presented in a biased manner were in fact fully and comprehensively discussed in the assessment reports, and include appropriate characterization of the degree of certainty around any conclusion. The evidence EPA has examined does not call into question any of the fundamental conclusions of climate science research.

The State of Texas argues that the CRU scientists were opposed to certain publications solely on ideological grounds, but the evidence does not support the petitioner's claim. The petitioner quotes an e-mail from Phil Jones that refers to the controversial Soon and Balinus (2003) paper published in the journal *Climate Research*. As described in our response (3-23) above, the publication of this paper revealed problems with the journal's peer review process, which eventually resulted in the resignation of three people on the editorial board. The publisher of *Climate Research* later admitted that the Soon and Balinus paper was flawed and should not have been published (Kinne, 2003). Scientists, including Jones, did no more than challenge the scientific validity of the Soon and Balinus (2003) paper, which is an appropriate response within the scientific community and appears scientifically warranted in this case. Petitioners make no arguments that the scientific challenges were incorrect.

As stated in the above responses (3-23 and 3-24), scientists are justified in challenging or opposing—on scientific and factual grounds—any research that they believe is flawed. This is true regardless of whether the research had been published in a peer-reviewed journal, but is particularly so if a scientist has reason to believe that flawed science made it through the peer review process, which exists for the express purpose of ensuring scientific integrity of published research. It is well within the norms of the scientific community to write comments or responses and otherwise challenge published journal articles if one can demonstrate that there are scientific insufficiencies. The State of Texas implies that the CRU e-mail authors did not have scientific and factual grounds on which to oppose the publication of dissenting views; however, the petitioner does not provide evidence or even attempt to show that the critiques of "skeptics'" research were scientifically unjustified. In addition, the State of Texas implies that "skeptics'" research should have been or would have been published in peer-reviewed literature if not for the opposition of the CRU e-mail authors, but it does not provide any evidence or science-based analysis to support this argument.

In sum, the petitioners' evidence does not support their claim of actions to manipulate the content and substance of the peer-reviewed literature on climate change, nor does the evidence provided by the petitioner warrant EPA to question the conclusion that the science supporting the Endangerment Finding is robust, is compelling, and has been appropriately characterized by EPA.

Comment (3-30):

The Coalition for Responsible Regulation argues that "[p]rominent scientists have stated for years that their efforts to publish contrary science have been stifled and that they have seen their grant money dry up and research positions become unavailable to them. These same scientists claim they have been publicly ridiculed and their reputations made to suffer if they take issue with the supposed 'consensus' on the science (Carter, 2008)." The petitioner argues that because certain researchers have been unable to publish their research, the peer-reviewed literature is biased in favor of views supporting anthropogenic climate change and does not reflect the true state of the science.

Response (3-30):
The petitioner's evidence does not support its claim of broad, concerted efforts to exclude dissenting viewpoints that would in any way change our understanding of key climate change science. The petitioner makes accusations of "public ridicule" and harm to "skeptics'" professional reputations, citing an article by Robert Carter, an Australian professor at James Cook University, in which he argues against the evidence for anthropogenic climate change. It appears that the petitioner bases its claim on the following statement in Carter's article: "At the same time, unsolicited ad hominem attacks are made on qualified persons who espouse different views, and who are often disparaged as 'sceptics', 'deniers', or worse." Carter does not elaborate beyond this one statement, and there is no evidence presented to substantiate either Carter's or the Coalition for Responsible Regulation's claims.

The petitioner claims that scientists with opposing views of anthropogenic climate change faced difficulties securing grant money and research positions; however, these are common challenges faced by research scientists in all disciplines of scientific research. The existence of such challenges does not mean the body of scientific literature on climate change, which spans multiple scientific disciplines and reflects the research of thousands of scientists worldwide, is flawed or biased. The evidence does not support the petitioner's broad and sweeping conclusions about the merits of the broader body of scientific literature, and the arguments do not support changing EPA's conclusion that the science supporting the Endangerment Finding is robust, is compelling, and has been appropriately characterized by EPA.

3.3.6 Allegations of Intimidating Scientists and Those With Dissenting Views

Comment (3-31):
Peabody Energy claims that "The politics of climate research was enough to make at least one scientist contemplate leaving the field completely." The petitioner claims that Mann and other CRU colleagues engaged in "constant haranguing" about a manuscript submitted by Ed Cook regarding the Medieval Warm Period. The petitioner quotes part of an e-mail from Ed Cook to Keith Briffa, sent on September 10, 2001:

> I never wanted to get involved in this quixotic game of producing the next great NH [Northern Hemisphere] temperature reconstruction because of the professional politics and sensitivities involved. … This all reinforces my determination to leave this NH/global temperature reconstruction junk behind

> me once I get this paper submitted. It's not worth the aggravation. However, the paper is something that I need to do for Jan. And I still think it is a good paper.[54]

Peabody Energy concludes that the goal of the CRU e-mail authors' "intimidation/bad-mouthing [was] to influence scientific development" and effectively prevent "dissenting scientific voices from being heard" in the climate science literature. Peabody Energy argues that the Endangerment Finding should be reconsidered because it relies on peer-reviewed literature, which is biased in favor of views supporting anthropogenic climate change and does not reflect the true breadth of the science.

Response (3-31):

We disagree with the petitioner's interpretation of this e-mail. Our review indicates that the context for this e-mail, which is not discussed by petitioner, was an e-mail discussion between Cook and Michael Mann and Keith Briffa, in which Mann and Briffa provided scientific feedback on a paper Cook was completing. The e-mails are provided below, and do not support the petitioner's charge that Cook suffered "constant haranguing." To the contrary, the e-mails reflect a professional exchange on how best to characterize a complex scientific issue:[55]

> Ed
> I still believe you are not showing sufficient comparisons with series besides the MBH [Mann, Bradley, and Hughes]; necessary to demonstrate the true extent of "new" information in this work. At the very least this needs to acknowledge that other (and other tree-ring-based) series are out there , that use at least some of the data you employ , and use the RCS method to process may of their constituent series - i.e. the Northern chronology series shown in my QSR [*Quaternary Science Reviews*] paper. What is similar and what is different in your series and this one? You give the impression here that you are using the RCS and new data to demonstrate the possibility of getting more low frequency signal from tree-ring data - but then you base this on a comparison with MBH only. Surely what is needed here is to establish WHY MBH don't get as much LIA [Little Ice Age]for example. By not showing that other tree-ring data that have also shown a LIA , and not exploring why MBH does not (despite using some of the same - and note -already RCS standardised data) is perhaps confusing rather than clarifying the issue. When we discussed this here, I also suggested the need to show separate "north" and more "south" curves ,separated in your data set, to try to get at least some handle on the independent expression of the centennial trends in a region south of the over-exploited northern network. At the very least it should be clearly stated that many of the site data used here and in previous work (see our Science perspectives piece) are common and other series already produce more low-frequency signal than is implied in MBH. Sorry for this rushed comment but I wanted to get this point over as we had talked about it before but you don't seem to have taken it on board.
> Cheers Keith [56]

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[54] E-mail file 1000154718.txt (September 10, 2001), page 389, line 17 of the PDF version entitled: CRU Emails 1996-2009.pdf.

[55] e.g., E-mail file 1000132513.txt (September 10, 2001), page 386, line 15, e-mail file 1000140042.txt (September 10, 2001), page 388, line 45, and e-mail file 1000168453.txt (September 10, 2001), page 390, line 26 of the PDF version entitled: CRU Emails 1996-2009.pdf.

[56] E-mail file 1000168453.txt (September 10, 2001), page 390, line 26 of the PDF version entitled: CRU Emails 1996-2009.pdf

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Hi Ed,
Just to reiterate one more key point---Superimposing the two series and their uncertainties is not the whole story (although it is a definite improvement over just showing the two reconstructions on top of each other w/ know assessment of uncertainty). However, doing the above still only poses the question: apple +/- [uncertainty in apple] =? orange +/- [uncertainty in orange]

As we discussed in a previous e-mail exchange (based on the correlations you calculated between instrumental series w/ the trend removed) , the two reconstructions should probably only share about 60% or so variance in common in the best case scenario, where there is no uncertainty at all, owing simply to the differing target regions/season... So we need to be very careful w/ the following statement which you made in your previous e-mail: "If so, this would not mean that the series are not significantly different from each other. One can't dismiss the highly systematic differences at multi-centennial timescales quite so easily." I'm not sure you can justify that statement based on sound statistical reasoning! I agree w/ your following statement "Why these differences are there is the crux question."

However, I hope the discussion will accurately reflect the fact that the leading hypotheses to be rejected in answering that question are 1) random uncertainty in the two series owing to differing data quality and sampling, etc. can explain the difference and 2) systematic differences owing to differing target region and seasonality can explain any residual differences after (1). That may be a tough standard to beat, but it *is* the approach that Tom, Phil, Keith, and I have all been taking in addressing the issue of whether our different reconstructions are or are not inconsistent and the conclusion has in general been (see e.g. IPCC which was really a consensus of many of us, though admittedly only I was a lead author) that, despite notable differences in the low-frequency variability, the different reconstructions probably cannot be considered inconsistent given the uncertainties and differences in seasonality/spatial sampling. I have a hard time understanding why the same standard should not be applied to comparisons w/ your current reconstruction? Does your RCS reconstruction really not fall in the mix of all the other reconstructions? Is it truly an outlier w/ respect to Phil's, Tom's, MBH, and other existing N. hem reconstructions that are based on different seasonality and regional sampling???

We've probably had enough discussion now on this point, so I'll leave it to you to discuss the results in the way you see most fit, but I really hope you take the above points into account, in fairness to the previous work... I look forward to seeing the final manuscript in one form or another, in any case,
cheers,
mike[57]

These e-mails provide no basis for the petitioner's charges of intimidation, bad mouthing, and constant haranguing, or that these drove Cook out of this area of research. Cook has not left the field; he currently serves as the director of the Tree-Ring Laboratory at the Lamont-Doherty Earth Observatory at Columbia University. Although Cook may no longer work on this

[57] E-mail file 1000132513.txt (September 10, 2001), page 386, line 15 of the PDF version entitled: CRU Emails 1996-2009.pdf

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particular type of temperature reconstruction, there is no basis for the petitioner's assertion that this was because of improper actions by Mann and Briffa.

We disagree that the comments and critiques from Keith Briffa, Michael Mann, and others constitute "haranguing" or indicate that politics were tainting climate research. It is evident from the e-mails that the CRU scientists and their colleagues were providing detailed, science-based critiques of Cook's manuscript in an attempt to improve it. There is no indication that they were pressuring or threatening Cook. In fact, Mann clearly tells Cook, "I'll leave it to you to discuss the results in the way you see most fit".[58] We respond to the petitioner's scientific arguments regarding the paleoclimate reconstructions in the RTC document for the Endangerment Finding and in Volume 1 of this RTP document.

Comment (3-32):
Peabody Energy claims that "[d]iverging opinions were also left out of conferences and professional events" and that Michael Mann and Phil Jones acted to exclude "skeptic" scientists from such events. Peabody Energy quotes an e-mail sent by Mann to Jones on August 25, 2005, in which he refers to a conference invitee list that he has been sent, saying, "The last two on the list (w/ question marks) would be unwise choices because they are likely to cause conflict than to contribute to consensus and progress," to which Phil Jones responds, "I agree with Mike that the last two names on the list should be removed".[59] Peabody Energy then quotes another e-mail from Mann describing why he did not want to invite Zorita:

> I'm afraid I don't agree on Zorita. He has engaged in some very nasty, and in my opinion unprofessional e-mail exchanges with some close colleagues of mine who have established some fundamental undisclosed errors in work he co-published with von Storch. Given this, I don't believe he can be involved in constructive dialogue of the sort we're looking for at this workshop. There are some similarly problematic issues w/ Cubasch, who like von Storch, who has engaged in inflammatory and ad hominem public commentary. There is no room for that on any side of the debate.[60]

Peabody Energy concludes that the goal of the CRU e-mail authors' "intimidation/bad-mouthing [was] to influence scientific development" and effectively prevent "dissenting scientific voices from being heard" at conferences or in the climate science literature. Peabody Energy argues that the Endangerment Finding should be reconsidered because it relies on peer-reviewed literature, which is biased in favor of views supporting anthropogenic climate change and does not reflect the true breadth of the science.

Response (3-32):

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[58] E-mail file 1000132513.txt (September 10, 2001), page 386, line 15 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[59] E-mail file 1124994521.txt (August 25, 2005), page 980, line 23 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[60] E-mail file 1125067952.txt (August 26, 2005), page 981, line 19 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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Peabody Energy's claim that there is a pattern of behavior of excluding "skeptic" scientists from conferences and professional events is based on a speculative interpretation of one e-mail chain involving one apparently by-invitation-only workshop. As conveners of the workshop, Mann, Jones, and the other workshop planners have every right to decide who to invite and why, based on their goals for the workshop. Peabody Energy claims that Zorita and Cubasch were not invited because they were "skeptic scientists," but Mann and Jones do not characterize them as such. Rather, the e-mail from Mann clearly indicates that he had concerns regarding the quality of their scientific work and their professional behavior. Mann makes a substantive comment that Zorita had "fundamental undisclosed errors" in a paper he co-authored, and that he was concerned neither of them would be constructive at the workshop.

The petitioner does not make any arguments based on the science, but projects a claim of bias to the breadth of the scientific literature based on one e-mail involving one invitation-only workshop. There is no discussion of the validity of the scientific work of the individuals at issue, or whether their work is reflected in the peer reviewed literature, or whether their work shows that the body of scientific evidence, when viewed as a whole, does not support the conclusions reached by EPA. Instead of basing arguments on the science, the petitioner relies on very limited evidence of one workshop to draw an unwarranted assumption of bias across the body of the scientific literature.

Comment (3-33):
Peabody Energy argues that Michael Mann engaged in "a pattern of scholarly intimidation" against those whose research challenged his own, and that this affected the way other researchers presented their results in journal articles. Peabody Energy quotes an e-mail sent on November 30, 2001, from Keith Briffa to an editor at the journal *Science* regarding a manuscript he reviewed:

> You will see that I think the work is genuinely interesting and potentially of wide significance. The bottom line is that you should publish this but the way the authors have chosen to present their results smacks of a lack of clarity of thought (and a lot of fudging!). I believe that they are more concerned with trying to temper their ideas so as not to "offend" Mann et al.[61]

The petitioner describes an e-mail exchange between Briffa and the authors of the manuscript, which Peabody Energy characterizes as "some less established paleoclimate researchers." Briffa states in this e-mail, "I think you will start a minor explosion - but that is what science needs.[62]" The researchers wrote back to offer Briffa a co-authorship on the paper; Peabody Energy asserts that they made this offer for protection from Mann, because Briffa, as a more well-established scientist, "could better shield them from" any backlash from Mann. Peabody Energy argues that this example demonstrates that scientists felt a "fear of reprisal from Mann."

[61] E-mail file 1014240346.txt (February 20, 2002), page 398, line 17 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[62] E-mail file 1066075033.txt (October 13, 2003), page 603, line 25 of the PDF version entitled: CRU Emails 1996-2009.pdf.

ED_001612_00028344-00070

Peabody Energy concludes that the goal of the CRU e-mail authors' "intimidation/bad-mouthing [was] to influence scientific development" and effectively prevent "dissenting scientific voices from being heard" in the climate science literature. Peabody Energy argues that the Endangerment Finding should be reconsidered because it relies on peer-reviewed literature which is biased in favor of views supporting anthropogenic climate change and does not reflect the true breadth of the science.

Response (3-33):
This is another instance of the petitioner claiming that there is a pattern of behavior based on speculation and innuendo. The first e-mail offers one scientist's opinion on a manuscript, which he concludes has scientific merit and ought to be published. He offers his opinion that the research results could have been presented differently, but it is clear from the e-mail that he is not questioning the validity of the research findings themselves. The petitioner provides no analysis of the scientific content in the manuscript in question or evidence that Michael Mann played a material role in the decision to present the research findings any particular way. In fact, there is no evidence whatsoever that Mann had anything to do with the paper either before or after it was published. The petitioner quote parts of the e-mail exchange between Briffa and the authors of the manuscript in question (Jan Esper of the Swiss Federal Research Institute and Rob Wilson of the University of St. Andrews), but here we provide the e-mails in full to provide important context:

> Date: Mon, 13 Oct 2003 15:21:03 +0200
> To: Keith Briffa <k.briffa@xxxxxxxxx.xxx>
> From: Jan Esper <esper@xxxxxxxxx.xxx>
> Subject: minor explosion
> Cc: Wilson Rob <rjwilson_dendro@xxxxxxxxx.xxx>
> Hi Keith
> thank you for the message and the comments to the Siberia draft. We are intending to finalize a draft when Rob is coming over and we go on a sampling trip to the Bavarian Forest and E-Germany. We will then also discuss of data-overlap issue again and might include some extra figure with our record re-calculated (without Tornetraesk and Polar Ural). However, I (Jan) an not sure that we should have another figure with only the Mann and the (reduced) Esper series. Second, it seems that Mann used the density records from these two sites only (not ring width). Lets see. We would really like to send you the final draft, and ask you to become the fourth author? We ask this not only because of the "minor explosion" that might happen, but also because some of the arguments in the draft were made earlier by you anyway. What do you think?
> Take care
> Jan and Dave
>
> Jan
> with respect to the overlap problem we could agree to differ for now -I think the problem is much more in the earlier period anyway but I suggest you go ahead and submit it anyway. There are some minor wording points but nothing that affects the meaning. You know that in my opinion the recent similarity in the records is driven by instrumental data inclusion (or calibration against instrumental data) and that Mann's earlier data are strongly biased towards summer and northern land signals. I think you will start a minor explosion - but that is what science needs. I looked at your tree-line data and thought them very interesting. In my opinion the way you directed the interpretation was what

drew your criticisms. For a climate journal you should have been pointing out the complicated regional responses (to the temperature record) rather than trying to state a simple overall response. The data are clearly important and you should have no trouble publishing them if you rethink the approach to the description (no work needed). I think Boreas or Arctic and Alpine Res. are better targets though. I enjoyed the discussions also and it is frustrating not to be able to get up to speed with your other projects. I will get back to you when I have looked more at the idea of the big review paper.
the very best to you and all
Keith

At 09:55 AM 10/8/03 +0200, Jan Esper wrote:

Hi Keith
with respect to our EOS draft, I am still thinking about the data overlap argument you made.
1. I still believe that the overlap is not that significant, and that the significance is changing dramatically with time (less in more recent centuries).
2. With respect to the aim of the paper, we do NOT intend to explain the similarity between the records. We rather address that the recons differ in the lower frequency domains AND are much more similar in the higher frequency domains. I believe that this is crucial. (One could also say that we only address the dissimilarity, and the arguments related to that.)
I appreciated the discussions we had very, very much (especially the one in the night before the official meeting).
Take care
Jan[63]

This e-mail exchange clearly shows that Briffa made substantive contributions to the manuscript, which would warrant the courtesy of offering co-authorship. As the petitioner acknowledges, Briffa did not accept the co-authorship, the paper was published, and there is no evidence of any "backlash" from Mann. These subsequent events demonstrate that the petitioner's speculative claim of "fear of reprisal" was unfounded.

Beyond these e-mails, Peabody Energy provides no evidence to support their claim that Mann engaged in a "pattern of scholarly intimidation," implying that an unknown number of journal articles may have been affected by one scientist's purported actions. This allegation is not supported by evidence, but relies on unwarranted speculation and assumptions based on this e-mail exchange involving only one of thousands of papers that compose the body of scientific literature on climate change, and for this one paper there was publication and no apparent reprisal or other activity. To claim, as the petitioner does, that concerns raised concerning this one paper could somehow bias the vast wealth of climate change studies or call into question the overall conclusions reached from those thousands of papers is unwarranted speculation and unsupported. This example and the objections raised by the petitioner provide no basis for changing EPA's conclusion that the science supporting the Endangerment Finding is robust, is compelling, and has been appropriately characterized by EPA.

[63] E-mail file 1066075033.txt (October 13, 2003), page 603, line 25 of the PDF version entitled: CRU Emails 1996-2009.pdf.

Comment (3-34):
Peabody Energy claims that Michael Mann and Tom Wigley in particular "resorted to admonishment of those they disagreed with." Peabody Energy cites the example of Mexican climate researcher Jorge Sánchez-Sesma, who, in an e-mail to Phil Jones sent December 3, 2004, said that he met Mann at a conference. According to Peabody Energy, "at first Mann was 'very kind,' but when Mann found out Sánchez-Sesma's work ran counter to some of Mann's conclusions, Mann 'changed his attitude.'"[64]

In addition, Peabody Energy claims that Michael Mann "continued his battle" against climate change "skeptics" like Stephen McIntyre and Ross McKitrick in the press, quoting an e-mail from Mann to New York Times reporter Andy Revkin, sent on February 8, 2005:

> The McIntyre and McKitrick paper is pure scientific fraud. I think you'll find this reinforced by just about any legitimate scientist in our field you discuss this with. To recap, I hope you don't mention MM [McIntyre and McKitrick] at all. It really doesn't deserve any additional publicity.[65]

Peabody Energy also claims that Tom Wigley engaged in character assassination of two highly credentialed scientists—John Christy and Chris de Freitas—in an attempt to ruin their careers. As evidence, Peabody Energy quotes the following e-mail from Wigley, sent on August 19, 2003:

> Jim Titus mentioned to me that in the legal profession here people are disbarred for behavior like that of De Freitas (and even John Christy -- although this is a more subtle case). We cannot do that of course, but we can alert the community of honest scientists to such behavior and formally discredit these people.[66]

Peabody Energy concludes that the goal of the CRU e-mail authors' "intimidation/bad-mouthing [was] to influence scientific development" and effectively prevent "dissenting scientific voices from being heard" at conferences or in the climate science literature. Peabody Energy argues that the Endangerment Finding should be reconsidered because it relies on peer-reviewed literature, which is biased in favor of views supporting anthropogenic climate change and does not reflect the true breadth of the science.

Response (3-34):
The petitioner uses language such as "admonished," "battled," "engaged in character assassination," and "intimidation/bad mouthing" in an attempt to demonstrate that two scientists, Michael Mann and Tom Wigley, improperly biased the peer reviewed literature, making the body of peer reviewed literature unreliable. Examination of the petitioner's argument does not support their claims. With respect to interaction between Mann and Jorge Sánchez-Sesma, we

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[64] E-mail file 1079384474.txt (March 15, 2004), page 661, line 45 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[65] E-mail file 1107899057.txt (February 8, 2005), page 825, line 31 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[66] E-mail file 1061298033.txt (August 19, 2003), page 566, line 15 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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provide the full e-mail that Sánchez-Sesma sent to Phil Jones, in which he described his interaction with Michael Mann:

> Dear Dr. Jones: I am very happy because I went to a Workshop in Kona Hawaii (with support of NASA-CRCES [National Aeronautics and Space Administration–Center for Research on the Changing Earth System] after to gain a contest with a review paper about global temperature reconstructions, it was a different version of the paper that you have read). There I met with Dr. Michael Mann. Mann was very kind with me, however when he did know my work he changed his attitude. I met there also Dr. Hans von Starch who presented a global temperature reconstructions with a AOCGCM [atmosphere-ocean coupled general circulation model] with natural and anthropogenic forcings. His results agree more or less with ECS, and my results. i am in contact with the GKSS group in order to compare and share information. However, the key point of my studies, as you have pointed out, is to justify that the background Ice Acidity (without volcanic activity) from polar caps could be considered as a proxy. I have contacted Dr. Hammer and Dr. Crowley to have information and advice. In order continue this kind of studies I would like to propose you again (as we have tried last year) to ask support the AMC (Mexican Academy of Sciences) to support a visit to CRU UEA next year to continue my work, with your help and advice, about global temperature for the Holocene. I will need only an official invitation for my visit. It would be in March 2005 for 3 or 4 weeks. Also, I am asking support to travel to Japan this year (this fall), however I would like to stop in England a week, in order to visit CRU-UEA and to continue our collaboration. I would like to know your opinion, cheers, Jorge[67]

The quote from Sánchez-Sesma"Jorge—"he changed his attitude"—is unclear; there is no substantive information in the e-mail to determine what it means. Assuming Mann did change his attitude to some degree, the petitioners' evidence does not show that he acted in a way that had any negative consequences for Sánchez-Sesma. In fact, it is clear from the full e-mail that Sánchez-Sesma was "very happy" with the workshop, and it appears that his brief contact with Mann did not adversely affect his experience there.

Regarding the e-mail from Michael Mann to Andy Revkin, Mann's statements reflect his scientific judgment that the McIntyre and McKitrick (2005) paper was flawed. As discussed thoroughly in our previous responses (e.g., 3-23), it is entirely acceptable and appropriate for scientists to express their opinions and challenge papers that they believe are scientifically flawed. It was on this basis that Mann recommended that McIntyre and McKitrick were not worth interviewing because their paper was flawed. In any case this e-mail concerns discussions with a journalist, and have no bearing on the publication of peer-reviewed literature in journals. We note that we have responded to the scientific arguments presented in McIntyre and McKitrick (2005) as well as numerous other issues related to paleoclimatic reconstructions, both in the RTC document for the Endangerment Finding and in Volume 1 of this RTP document.

Regarding the allegations of "character assassination," the full e-mail sent on August 19, 2003, by Tom Wigley provides context for his statements:

[67] E-mail file 1079384474.txt (March 15, 2004), page 661, line 45 of the PDF version entitled: CRU Emails 1996-2009.pdf.

ED_001612_00028344-00074

> Andre,I have been closely involved in the CR [Climate Research] fiasco. I have had papers that I refereed (and soundly rejected), under De Freitas's editorship, appear later in the journal -- without me seeing any response from the authors. As I have said before to others, his strategy is first to use mainly referees that are in the anti-greenhouse community, and second, if a paper is rejected, to ignore that review and seek another more 'sympathic' reviewer. In the second case he can then (with enough reviews) claim that the honest review was an outlier. I agree that an ethics committee is needed and I would be happy to serve on such a committee. It would have to have endorsement by international societies, like Roy. Soc., US Nat. Acad., Acad. Europ., plus RMS, AMS [American Meteorological Society], AGU, etc. Jim Titus mentioned to me that in the legal profession here people are disbarred for behavior like that of De Freitas (and even John Christy -- although this is a more subtle case). We cannot do that of course, but we can alert the community of honest scientists to such behavior and formally discredit these people. The Danish Acad. did something like this recently, but were not entirely successful. In the meantime, I urge people to dissociate themselves from Climate Research. The residual 'editorial' (a word I use almost tongue in cheek) board is looking like a rogues' gallery of skeptics. Those remaining who are credible scientists should resign.
> Tom.[68]

Wigely's e-mail refers to the decision by an editor at *Climate Research*, Chris de Freitas, to publish the controversial Soon and Balinus (2003) paper. As described in our response (3-23) above, the publication of this paper revealed problems with the journal's peer review process. The publisher of *Climate Research* later admitted that the Soon and Balinus paper was flawed and should not have been published (Kinne, 2003). Clearly, scientists, including Wigley, were justified in challenging the scientific merit of the Soon and Balinus (2003) paper and to question the process that enabled such a paper to be published. It is clear from the e-mail that Wigley believed that Chris de Freitas acted in a way that was contrary to the practice of good science. Like anyone else, Wigley is entitled to speak his mind in personal communications to colleagues. To raise legitimate questions of scientific validity is not "character assassination," nor are such actions unethical, or otherwise outside the norms of scientific practice. In sum, the evidence presented does not support the arguments and broad conclusions drawn by petitioners.

3.3.7 Summary

The petitioners rely upon a small number of papers and other circumstances to claim that leading climate scientists successfully conspired to keep dissenting views of climate change out of the broad body of peer-reviewed literature and create an artificial consensus about anthropogenic climate change. They claim these e-mails show the broad body of scientific literature is biased and can not credibly be relied upon to make an Endangerment Finding. The examples proved by petitioners are extremely limited, and involve a small number of papers and a few specific situations. In all cases it appears the scientists involved were basically making their scientific objections known, and were basing their objections on the science and not on assumptions or speculation. The evidence presented by petitioners does not support their claims of bias, either

[68] E-mail file 1061298033.txt (August 19, 2003), page 566, line 15 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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for the specific papers and individuals at issue, or for the much broader and sweeping challenges made concerning the integrity of all peer-reviewed climate literature.
The arguments made of a biased peer review process relies on speculation and subjective interpretations of quotes from the CRU e-mails, which are typically taken out of context, and involve a very small number of papers and situations. The e-mails themselves do not support the claims and conclusions drawn by petitioners, either for those specific papers and situations, or for the broader peer reviewed literature petitioners contest. Petitioners' claims are not based on scientific analysis or arguments, and their evidence does not support changing or revising EPA's use of the major assessments of peer-reviewed literature or the overall scientific conclusions about climate change reached from the thousands of papers considered in the assessments. The objections raised by the petitioner have not called into question or changed EPA's conclusion that the science supporting the Endangerment Finding is robust, is compelling, and has been appropriately characterized by EPA.

3.4 Issues Concerning Freedom of Information Act Requests

3.4.1 Overview

Several petitioners (the Coalition for Responsible Regulation, the Ohio Coal Association, the Pacific Legal Foundation, Peabody Energy, the Southeastern Legal Foundation, the State of Texas) claim that the CRU e-mails provide evidence that leading climate scientists did not conduct their research in a fully transparent manner and did not appropriately respond to UK Freedom of Information (FOI) and U.S. Freedom of Information Act (FOIA) requests. Specifically, the petitioners argue that these scientists deliberately withheld key data and computer programming codes and attempted to obstruct or avoid FOI/FOIA requests from "climate skeptics."

Our review of the CRU emails indicates that in many cases, the data at issue were released by the scientists, including data concerning a human "fingerprint" in the tropics, data underlying the HadCRUT temperature record, and data concerning historic temperature reconstructions. In addition, significant data were also publicly available. Petitioners have not explained or shown why the amount of data and other information that was available was not adequate for researchers to replicate or otherwise evaluate key findings, or to conduct other research. In addition, there was a robust and public process to submit, review, and publicly respond to comments on the scientific issues involved in all parts of the IPCC AR4. Petitioners do not rely on science or science based arguments to support their claim that the assessment report resulting from this robust process should not be relied upon by EPA. Instead, they rely on unsupported conclusions drawn from e-mails concerning a FOI request for personal communications between various scientists, where it appears that the appropriate University FOI officers had determined that these emails were exempt from release. This evidence does not support petitioners' claims that the IPCC AR4 should not be considered as part of the scientific basis for the Endangerment Finding.

EPA agrees with the results of the various investigations, which found that the scientists at issue conducted their research with scientific integrity and rigor, the research utilized methods which are fair and satisfactory, and that their actions were consistent with the common practice in

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climate research at that time. EPA also agrees with the recommendations of the Independent Climate Change E-mails Review supporting greater transparency in the future in this area of climate research. Petitioners' evidence, however, does not support their conclusions that the research produced by these scientists was suspect, flawed, or biased, or that the AR4 or other assessment reports were suspect, flawed, or biased. Their evidence does not support the conclusion that the science at issue should not be relied upon by EPA. Greater transparency in the future will facilitate scientific research; however, concluding that greater transparency would be helpful for a particular element of climate change science is not the equivalent of providing evidence that the scientific basis for EPA's Endangerment Finding is flawed.

The following sections provide our response to petitioners' specific arguments. Section 3.4.2 deals with claims that the CRU e-mail authors refused requests to make their data, computer programming codes, and other information on which some of their research was based publicly available, and inappropriately limited other researchers' ability to replicate and verify results. Section 3.4.3 addresses claims of improper conduct with regard to UK FOI and U.S. FOIA laws, including general non-compliance allegations, allegations regarding a specific FOI request related to the IPCC, and allegations of improperly influencing University FOI officials. Finally, Section 3.4.4 summarizes our response to these issues.

3.4.2 Allegations of Withholding Key Data and Information

Comment (3-35):
The Southeastern Legal Foundation claims that "three prominent British scientific organizations have condemned the practices of top IPCC climate scientists as revealed by the Climategate documents [i.e., the CRU e-mails]." The group provides quotes from the Institute of Physics, the Royal Society of Chemistry (RSC), and the Royal Statistical Society (RSS) taken from statements submitted to the UK House of Commons Science and Technology Committee (2010a) during its investigation of the CRU e-mails. The Southeastern Legal Foundation states that these three organizations "concluded that the refusal of the CRU researchers to disclose their data and methods was contrary to the scientific method and cast doubt on the integrity of their research." In addition, the petitioner highlights the organizations' statements regarding data availability, stating that they call for the "data and methods of climate research to be made freely available as required by the canons of the scientific method." On the basis of these statements, the Southeastern Legal Foundation concludes that the CRU e-mails have "grave implications for the integrity of the science upon which the IPCC's reporting is based" and that "EPA cannot dismiss the conclusions of institutions having the prestige and reputation of the Institute of Physics, the Royal Society of Chemistry, and the Royal Statistical Society."

Response (3-35):
During the UK House of Commons Science and Technology Committee's investigation of the CRU e-mails, it accepted written evidence regarding the following questions:

1. What are the implications of the disclosures for the integrity of scientific research?
2. Are the terms of reference and scope of the Independent Review announced on 3 December 2009 by UEA adequate?
3. How independent are the other two international datasets?

In addition, the UK House of Commons Science and Technology Committee held one oral evidence session to take information from the following five panels:

1. The Right Honourable Lord Lawson of Blaby, Chairman, and Dr. Benny Peiser, Director, Global Warming Policy Foundation.
2. Richard Thomas Commander of the Order of the British Empire, former Information Commissioner.
3. Professor Edward Acton, Vice-Chancellor at UEA, and Professor Phil Jones, Director of CRU.
4. Sir Muir Russell, Head of the Independent Climate Change E-Mails Review.
5. Professor John Beddington, Government Chief Scientific Adviser; Professor Julia Slingo Officer of the Order of the British Empire, Chief Scientist, UK Met Office; and Professor Bob Watson, Chief Scientist, Department for Environment, Food and Rural Affairs.

The Committee received 57 submissions of written evidence (see UK House of Commons Science and Technology Committee, 2010a). The petitioner cites selective quotes from only three of these submissions. The full transcripts of the three statements discussed by the petitioner are provided in the reference document entitled, "Memoranda Submitted to the UK House of Commons Science and Technology Committee Investigation" in the docket (http://www.regulations.gov, Docket ID EPA-HQ-OAR-2009-0171). We respond to the petitioner's allegations with regard to the three submissions below.

First, the petitioner mischaracterizes or exaggerates the statements from the Institute of Physics, the RSC, and the RSS to claim that they "condemned the practices of top IPCC climate scientists." The Institute of Physics states that there is "reason for concern" as well as "a need for a review of [the] adequacy and objectivity" of the peer-review process (Institute of Physics, 2010). The institute also states its opinion that further inquiry into the implications of the CRU e-mails on scientific integrity is warranted. Contrary to the petitioner's claims, however, the institute does not assume misconduct or wrongdoing on the part of the CRU e-mail authors, nor does it "condemn" their work.

The RSC states that the CRU e-mails have been "widely portrayed as an indication of a lack of integrity in scientific research," but the RSC itself does not state or conclude that there has been lack of integrity in climate science research (RSC, 2010). The RSC statement does not have language that represents a condemnation of IPCC climate scientists. Similarly, the RSS discusses in detail its arguments for placing climate change data, analysis methods, and models in the public domain, but does not condemn the work of IPCC scientists nor allege a lack of integrity in climate science research.

Second, the petitioner exaggerates the organizations' statements when it states that the organizations agree that the CRU e-mails "cast doubt on the integrity of their research." The Institute of Physics states that questions have been raised about the integrity of some historic temperature reconstructions and the way in which they have been graphically represented by entities such as the IPCC. It is misleading and inaccurate to interpret this statement—which states that "questions have been raised" but does not take a position on the merits of the issue—as casting doubt on all of the research conducted throughout the years by the CRU e-mail authors.

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The RSC describes the implications of "[a] lack of willingness to disseminate scientific information" in general or hypothetical terms, without making claims or drawing conclusions about CRU researchers or their work. In addition, in part of the statement not quoted by the petitioner, the RSC highlights the importance of transparency and valid science on both sides of the climate change debate (point 10 in their submission):

> 10. The issue of misinformation in the public domain must also be tackled. Just as the scientific community must be open with regard to their evidence base, those who disagree must also provide a clear and verifiable backing for their argument, if they wish their opinions to be given weight. When disagreements occur, the validity of the analysis must be established before credence can be given to any opinion. Increased understanding of the process of scientific research, firstly in the government, but also within the media and general public, is vital in order to foster a more open sharing of information.

Similarly, the RSS makes broad statements and recommendations about the importance of open access to data without making claims or drawing conclusions about CRU researchers or their work. In part of the statement not quoted by the petitioner, the RSS also discusses important caveats to its position that raw data and associated metadata used for scientific analyses should be publicly available within reason (point 8 in their statement):

> 8. It is also clearly unreasonable to require that any given scientist having published some research is then condemned to answer each and every question that might possibly arise from it. For example, requests under the Freedom of Information act or the Environmental Information Regulations could overwhelm small groups of scientists. To avoid this it is best if data are stored in data centres that are professionally run and properly funded.

These statements from the Institute of Physics, RSC, or RSS do not constitute agreement that the integrity of CRU e-mail authors' research is now in question. We note that the Institute of Physics, the RSC, and the RSS are offering their opinions on the questions posed to them by the UK House of Commons Science and Technology Committee. Neither the Institute of Physics, the RSC, nor the RSS have been involved in the three recent inquiries and investigations into the CRU e-mails that carefully examined the full body of evidence with regard to the allegations against CRU: 1) the UK House of Commons Science and Technology Committee investigation; 2) the Scientific Appraisal Panel review; and 3) the Independent Climate Change E-mails Review.

Beyond reading the text of the e-mails, none of the organizations indicated that they had conducted any detailed review of the broader context for the events described in the CRU e-mails. These organizations' statements were written in February 2010, before the conclusions of any of the three recent investigations were published. The petitioner claims that the statements from the Institute of Physics, RSC, and RSS challenge the scientific research advanced by CRU scientists and by extension the science on which EPA relied, but does not cite any of the conclusions of the independent investigations that carefully examined the full body of evidence.

In contrast to the general statements from the Institute of Physics, RSC, and RSS, the UK House of Commons Science and Technology Committee investigation examined written and oral

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evidence from numerous witnesses on both sides of the issue and examined the facts of the issues. Their report made the following broad conclusions:

- The focus on Professor Jones and CRU has been largely misplaced. On the accusations relating to Professor Jones's refusal to share raw data and computer codes, we consider that his actions were in line with common practice in the climate science community. We have suggested that the community consider becoming more transparent by publishing raw data and detailed methodologies. On accusations relating to Freedom of Information, we consider that much of the responsibility should lie with UEA, not CRU.
- In addition, insofar as we have been able to consider accusations of dishonesty—for example, Professor Jones's alleged attempt to "hide the decline"—we consider that there is no case to answer. Within our limited inquiry and the evidence we took, the scientific reputation of Professor Jones and CRU remains intact. We have found no reason in this unfortunate episode to challenge the scientific consensus as expressed by Professor Beddington, that "global warming is happening [and] that it is induced by human activity". It was not our purpose to examine, nor did we seek evidence on, the science produced by CRU. It will be for the Scientific Appraisal Panel to look in detail into all the evidence to determine whether or not the consensus view remains valid (UK House of Commons Science Technology Committee, 2010b).

The Scientific Appraisal Panel conducted a review of the science, examining criticism of CRU that "climatic data had been dishonestly selected, manipulated and/or presented to arrive at pre-determined conclusions that were not compatible with a fair interpretation of the original data." The inquiry involved an international panel of experts headed by Lord Oxburgh, and drew the following key conclusions:

- We saw no evidence of any deliberate scientific malpractice in any of the work of the Climatic Research Unit and had it been there we believe that it is likely that we would have detected it. Rather we found a small group of dedicated if slightly disorganised researchers who were ill-prepared for being the focus of public attention. As with many small research groups their internal procedures were rather informal.
- After reading publications and interviewing the senior staff of CRU in depth, we are satisfied that the CRU tree-ring work has been carried out with integrity, and that allegations of deliberate misrepresentation and unjustified selection of data are not valid. In the event CRU scientists were able to give convincing answers to our detailed questions about data choice, data handling and statistical methodology. The Unit freely admits that many data analyses they made in the past are superseded and they would not do things that way today.
- Like the work on tree rings, this work [temperatures from historical instrumental records] is strongly dependent on statistical analysis and our comments are essentially the same. Although there are certainly different ways of handling the data, some of which might be superior, as far as we can judge the methods which CRU has employed are fair and satisfactory. Particular attention was given to records that seemed anomalous and to establishing whether the anomaly was an artefact or the result of some natural process. There was also the challenge of dealing with gaps in otherwise high quality data series. In detailed discussion with the researchers we found them to be objective and dispassionate in their view of the data and their results, and there was no hint of tailoring results to a particular agenda. Their sole aim was to establish as robust a record of temperatures in recent centuries

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In addition, the Independent Climate Change E-mails Review found:

> Climate science is a matter of such global importance, that the highest standards of honesty, rigour and openness are needed in its conduct. On the specific allegations made against the behaviour of CRU scientists, we find that their rigour and honesty as scientists are not in doubt. In addition, we do not find that their behaviour has prejudiced the balance of advice given to policy makers. In particular, we did not find any evidence of behaviour that might undermine the conclusions of the IPCC assessments (Russell, 2010).

The three general statements selected by the petitioner do not support what they claim, and do not undermine the conclusions of the independent investigations quoted above that weighed substantially more information and evidence. We find that evidence provided by the petitioner does not contradict the conclusions of these investigations, which found that the CRU research was conducted with integrity and scientific rigor, without dishonesty, and their release of data was consistent with the common practices of the scientific community at that time.

Comment (3-36):
The State of Texas and Peabody Energy reference an article in *The Times* newspaper discussing the reaction of Professor John Beddington (Chief Scientific Advisor to the British Government) to the CRU e-mails. The State of Texas provides the following quote from Beddington: "I don't think it's healthy to dismiss proper skepticism. Science grows and improves in the light of criticism. There is a fundamental uncertainty about climate change prediction that can't be changed" (Webster, 2010). Peabody Energy provides the following quote from Beddington: "I think, wherever possible, we should try to ensure there is openness and that source material is available for the whole scientific community" (Webster, 2010). The petitioners use these quotes to substantiate their claim that the CRU e-mail authors obstructed the normal process of scientific inquiry by withholding information necessary for replicating key studies, so that by extension, the science on which EPA relied for the Endangerment Findings has been called into question.

Response (3-36):
Professor John Beddington's opinions as quoted from a newspaper article do not provide evidence that supports the petitioner's allegation that the CRU e-mail authors withheld data necessary for replicating key studies. Beddington is simply stating his view that the climate scientists, in addition to the whole scientific community, should make more concerted efforts to ensure data availability. The petitioners' evidence does not show that the CRU e-mail authors engaged in any actions that were unethical or outside of the norms of scientific practice. As discussed in our response (3-35) above, the CRU e-mail authors acted in line with common practice in the climate science community.

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In addition, we note that Professor Beddington elaborated more fully on his views in his written evidence to the UK House of Commons Science and Technology Committee investigating the CRU e-mails. The relevant portion of his submission stated:

> Not withstanding the need for scientists to maintain a competitive position amongst their peers, protect intellectual property and in some cases protect confidentiality, scientists should, as a general principle, aim to ensure openness and transparency of their data, methods and results at the point of peer-reviewed publication. This allows independent expert scrutiny, challenge and repetition to confirm the validity of findings, all of which are fundamental to furthering scientific understanding. Equally, scientists should feel free to openly debate their work, as this process is also essential for the furthering of robust research (UK House of Commons Science and Technology Committee, 2010b).

In another relevant portion of Professor Beddington's written evidence, he states that the CRU e-mails have not altered our understanding of the basic science and the human contribution to climate change:

> It is important to emphasise that the evidence that the world is warming and that human activities are driving this change does not rest on the robustness or otherwise of a single temperature record. Basic physics shows that greenhouse gases absorb and re-emit long wave radiation emitted by the Earth, which warms the surface and lower atmosphere. The science underpinning this knowledge was performed over a century ago. We also know that human activities are releasing billions of tonnes of greenhouse gases - including carbon dioxide, methane, nitrous oxide and halocarbons - each year, which is increasing their concentration in the atmosphere.

The petitioners' evidence does not support their claim that the CRU scientists and their colleagues obstructed the normal process of scientific inquiry, nor does the article relied upon by the petitioners provide any other evidence that would cause EPA to question the scientific merits of these scientists' work. The evidence indicates that scientists commonly weigh several policies in deciding issues of release of data, such as the need for transparency, protection of intellectual property, and protection of confidentiality. As discussed below, in many cases data were already publicly available or were released by the scientists, and the scientific issues involved were the subject of robust and serious scientific debate, as explained in Volume 1 of the RTP document. Petitioners' evidence does not show that the scientific research produced by these scientists is in any way flawed or unreliable, and they make no science-based arguments to that effect.

Comment (3-37):
The Ohio Coal Association, Peabody Energy, and the Southeastern Legal Foundation point to CRU scientists' attempts to refuse an FOI request by scientist Willis Eschenbach to obtain land station data for the HadCRUT3 dataset (Eschenbach, 2009), which is a global surface temperature dataset based on measurements from both land stations and ships. The petitioners state that the request was first met with evasion, and only later it was eventually revealed that the CRU no longer had access to the raw data for their dataset. The Southeastern Legal Foundation goes one step further, claiming that the CRU e-mails "prove that the conspiracy to obstruct his requests went to the highest levels of climate science."

Response (3-37):

The petitioners claim that the CRU scientists stonewalled FOI requests in order to prevent public access to critical climate information like the HadCRUT dataset. An extensive discussion of the availability of HadCRUT data was provided in Volume 2 of EPA's RTC document for the Endangerment Findings, and this issue is also discussed in Volume 1, Section 1.3.3.1 of this RTP document. As stated in those discussions, a limited amount of raw data from the HadCRUT dataset is no longer in CRU's possession; however, this does not impede the ability to check if the publically available data give the same results as the HadCRUT analysis, or that it changes the scientific validity of the analyses performed by the CRU. The HadCRUT dataset is publicly available as a value-added (i.e., quality-controlled and homogenized) dataset of global surface temperature data. Regarding the availability of the HadCRUT data, the Independent Climate Change E-mails Review (Russell, 2010) found that:

> On the allegation of withholding temperature data, we find that CRU was not in a position to withhold access to such data or tamper with it. We demonstrated that any independent researcher can download station data directly from primary sources and undertake their own temperature trend analysis.

The Independent Climate Change E-mails Review also noted that CRU eventually provided a list of station identifiers pursuant to the FOI request referenced by petitioners. Although the review notes this could have been accomplished in a more timely manner, the evidence does not support the argument of a "conspiracy to obstruct [Eschenbach's] requests." Petitioners' evidence provides no basis to question the reliability or integrity of the scientific research involving the HadCRUT dataset.

Comment (3-38):
Peabody Energy claims that Benjamin Santer of Lawrence Livermore National Laboratory attempted to avoid repeated informal requests for data as well as a formal U.S. FOIA request by Stephen McIntyre for data that were used in one of his papers. The data in question depicted evidence for a human "fingerprint" in the tropics, essentially showing that the tropical troposphere was warming as predicted by models. The petitioner claims that the lack of access to this data hampered efforts by other researchers to replicate and verify Santer's work, which was a key attribution study used in the IPCC AR4. Peabody Energy states that the data were eventually made public, but questions why "Santer could not have just released his data when McIntyre first requested it rather than attempting to stonewall it."

Response (3-38):
We respond to comments on the scientific validity of Santer's study regarding a human "fingerprint" in the tropics and the existence of multiple lines of evidence for human attribution of climate change in Section 1.2.1 of this RTP document.

The petitioner acknowledges that Santer subsequently provided the requested datasets and information, as well as additional information. In an e-mail written in December 2008 and sent to various colleagues, Santer states:

> …Over the past several weeks, I've had a number of discussions about the "FOIA issue" with PCMDI's [Program for Climate Model Diagnosis and Intercomparison] Director (Dave Bader), with other LLNL [Lawrence Livermore National Laboratory] colleagues,

> and with colleagues outside of the Lab. Based on these discussions, I have decided to "publish" all of the climate model surface temperature time series and synthetic MSU time series (for the tropical lower troposphere [T2LT] and the tropical mid- to upper-troposphere [T2]) that we used in our International Journal of Climatology (IJoC) paper. This will involve putting these datasets through an internal "Review and Release" procedure, and then placing the datasets on PCMDI's publicly-accessible website. The website will also provide information on how synthetic Microwave Sounding Unit (MSU) temperatures were calculated, anomaly definition, analysis periods, etc. After publication of the model data, we will inform the "FOIA Point of Contact" that the information requested by McIntyre is publicly available for bona fide scientific research. Unfortunately, we cannot guard against intentional or unintentional misuse of these datasets by McIntyre or others. By publishing the T2, T2LT, and surface temperature data, we will be providing far more than the "Monthly average T2LT values" mentioned in McIntyre's FOIA request to DOE. This will make it difficult for McIntyre to continue making the bogus claim that he is being denied access to the climate model data necessary to evaluate the validity of our findings. All of the raw model output used in our IJoC paper are already available to Mr. McIntyre (as I informed him several months ago), as are the algorithms required to calculate synthetic MSU temperatures from raw model temperature data. I hope that "publication" of the synthetic MSU temperatures resolves this matter to the satisfaction of NNSA [National Nuclear Security Administration], DOE Headquarters, and LLNL. With best regards, Ben [69]

Petitioner makes no argument based on the science that Santer's analysis was incorrect scientifically. They do not claim that there has been any inability to use the released information for their research. Their sole argument concerns the timing of the release, and not the merits of the science. The petitioners' evidence does not provide any reason to question the scientific merits of these scientists' work.

Comment (3-39):
Peabody Energy argues that CRU scientists and their colleagues "hid from public view" information pertaining to key studies used in the IPCC AR4. The petitioner describes four examples in which it claims that authors of CRU e-mails refused to release requested information because they feared scientific criticism of their work. Two of the examples—the data underlying the HadCRUT temperature record and the data regarding a human "fingerprint" in the tropics—are discussed and responded to in the preceding comments (3-37 and 3-38). The two other examples are discussed below.

According to the petitioner, the first example of "stonewalling" requests for data occurred in the spring of 2003, when Michael Mann, professor at Pennsylvania State University, allegedly provided Stephen McIntyre, editor of the blog "Climate Audit," with an incorrect or incomplete dataset of the information used in Mann's "hockey stick" temperature reconstruction paper. McIntyre used the dataset to publish a paper in October 2003 with Ross McKitrick, professor at University of Guelph, which described errors in Mann's analysis. According to Peabody Energy, Mann responded in a tone that was "harshly negative" and accused McIntyre and McKitrick of making numerous errors and using some data other than what was used in the original analysis.

[69] E-mail file 1229468467.txt (December 16, 2008), page 1598, line 38 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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Peabody Energy quotes an e-mail from November 12, 2003, in which Tim Osborn, academic fellow at CRU, writes to Keith Briffa and Phil Jones of CRU and states that he wished Mann had waited to respond to the McIntyre and McKitrick paper by submitting a formal comment to a peer-reviewed journal.

Peabody Energy states that McIntyre and McKitrick then requested Mann's original source code, but their request was not granted. Peabody Energy notes that Mann referred to their requests as "intimidation tactics" in a February 14, 2005, *Wall Street Journal* article (Regalado, 2005). The petitioner also highlights a series of e-mails from Phil Jones to multiple colleagues, from which Peabody Energy draws the conclusion that Jones and his colleagues discussed providing "information that could not be used or not providing any information at all." In one of the e-mails quoted by Peabody Energy, Jones writes his opinions about the request from McIntyre and McKitrick:

> If the code is sent, there needs to be conditions. We don't want MM [McIntyre and McKitrick] to come out and say he can't get it to work after a few days. So, it is far some simple. I'm still against the code being given out. Mike has made the data available. That is all they should need. The method is detailed in the original paper - in the online (methods) and also in several other papers Mike has written.[70]

The petitioner cites a second example of "stonewalling" requests for data in the winter of 2004, when Stephen McIntyre made a request to Phil Jones for data underlying the Jones and Mann (2003) paper, which created a proxy temperature reconstruction that was cited in Chapter 6 of the IPCC AR4 (Jansen et al., 2007). Peabody Energy describes Jones as refusing the request despite obtaining approval from a colleague, Tas van Ommen of the Australian Arctic Division, to release his part of the dataset. The petitioner also cites an e-mail exchange between Jones and Mann about McIntyre's request, in which Mann stated that he would not provide information to McIntyre and encouraged Jones to do the same. Peabody Energy also quotes an e-mail from Jones to Mann from about a year later:

> I got this e-mail from McIntyre a few days ago. As far as I'm concerned he has the data — sent ages ago. I'll tell him this, but that's all — no code. If I can find it, it is likely to be hundreds of lines of uncommented fortran! I recall the program did a lot more that just average the series. I know why he can't replicate the results early on — it is because there was a variance correction for fewer series.[71]

The petitioner argues that these examples of ignoring data requests, in addition to other statements made by CRU scientists and their colleagues, are indicative of a pattern or typical practice of refusing to provide access to their data. Peabody Energy cites the following e-mail from Phil Jones to Tas van Ommen on February 9, 2004 as further evidence:

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[70] E-mail file 1076083097.txt, (February 6, 2004), page 650, line 42 of the PDF version entitled: CRU Emails 1996-2009.pdf.

[71] E-mail file 1114607213.txt, (April 27, 2005), page 866, line 31 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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> I had some e-mails with him a few years ago when he wanted to get all the station temperature data we use here in CRU. At that time, I hid behind the fact that some of the data had been received from individuals and not directly from Met Services through the Global Telecommunications Service (GTS) or through GCOS [Global Climate Observing System]… I'll just sit tight here and do nothing. Mike will likely do the same, but we'll expect another publication in the nearish future.[72]

Peabody Energy also cites the following e-mail from Phil Jones to Tas van Ommen and Caspar Ammann on May 7, 2004:

> Many of us in the paleo field get requests from skeptics (mainly a guy called Steve McIntyre in Canada) asking us for series. Mike and I are not sending anything, partly because we don't have some of the series he wants, also partly as we've got the data through contacts like you, but mostly because he'll distort and misuse them.[73]

Peabody Energy asserts that "the reason why these scientists refused to divulge underlying information was to avoid criticism of their work" and "Jones and Mann and their colleagues were obviously hostile to McIntyre and other 'skeptics' because of their disagreement with the conclusions those 'skeptics' might draw, saying the 'skeptics' would 'misuse' and 'distort' the data." As evidence, the petitioner quotes a comment Phil Jones made to Janice Lough of the Australian Institute of Marine Science: "Mike Mann refuses to talk to these people and I can understand why. They are just trying to find if we've done anything wrong." As further evidence, Peabody Energy also quotes two e-mails from Mann to Osborn as examples of CRU scientists' "acute hostility" to anyone associated with ClimateAudit:

> I'm saddened to hear that this bozo is bothering you too, in addition to NCAR [National Center for Atmospheric Research], NSF [National Science Foundation], NAS [National Academies of Science], IPCC and everyone else. Rest assured that I won't ever respond to McIntyre should he ever contact me, but I will forward you any e-mail he sends related to this. I assume Scott feels the same way... [74]
>
> hi tim. personally, I don't see why you should make any concessions for this moron.[75]

Peabody Energy states that "[T]his attitude is not consistent with good science…Research, particularly research of this immense importance, should be amenable to replication by anyone, regardless of whether they will draw different conclusions from the research than those producing the research would like." In support of this argument, Peabody Energy references the conclusions of a report commissioned by the U.S. House Committee on Energy and Commerce,

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[72] E-mail file 1076336623.txt, (February 9, 2004), page 652, line 6 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[73] E-mail file 1083962601.txt, (May 7, 2004), page 665, line 12 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[74] E-mail file 1146062963.txt, (April 26, 2006), page 1126, line 8 of the PDF version entitled: CRU Emails 1996-2009.pdf
[75] E-mail file 1147435800.txt, (May 12, 2006), page 1129, line 27 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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known as the "Wegman Report" (Wegman et al., 2006). Peabody quotes the following conclusion from the report:

> Sharing of research materials, data, and results is haphazard and often grudgingly done. We were especially struck by Dr. Mann's insistence that the code he developed was his intellectual property and that he could legally hold it personally without disclosing it to peers. When code and data are not shared and methodology is not disclosed, peers do not have the ability to replicate the work and thus independent verification is impossible.

Response (3-39):
First, the petitioner describes at length four interactions between the CRU e-mail authors and people requesting information. On the basis of these four examples, the petitioner concludes that CRU scientists and their colleagues repeatedly and consistently ignored data requests because they feared scientific review and critiques of their work. For two of these examples—the raw CRU temperature data and the tropical "fingerprint" data—we address the petitioner's concerns on this issue in responses 3-37 and 3-38 above, which shows that these information requests were not ignored and data was made or was available to the requestors. Regarding the other two examples—claims that Mike Mann and Phil Jones withheld paleoclimate data—we address the petitioner's concerns here.

The e-mails cited by the petitioner indicate that the scientists believed they had already provided enough data and information for others to be able to replicate their work by making the basic data publicly available and publishing the methodology for replicating a particular study in the literature. For example, Phil Jones states that "Mike [Mann] has made the data available. That is all they should need. The method is detailed in the original paper - in the online (methods) and also in several other papers Mike has written"[76]. The UK House of Commons Science and Technology Committee inquiry (2010b) found that this type of approach was considered common practice at the time. They stated:

> The focus on Professor Jones and CRU has been largely misplaced. On the accusations relating to Professor Jones's refusal to share raw data and computer codes, we consider that his actions were in line with common practice in the climate science community. We have suggested that the community consider becoming more transparent by publishing raw data and detailed methodologies.

From our review of the e-mails, it is clear that the scientists expressed significant frustration at repeated requests for specific explanations and computer codes, and that their attitudes toward some requestors were not always complimentary. This is consistent with the findings of the Independent Climate Change E-mails Review, which stated that the CRU scientists had an "overly defensive approach" and a tendency to provide unhelpful responses to requests for information (Russell, 2010). This is regrettable, and EPA agrees with the recommendations of the UK House of Commons Science and Technology Committee investigation and the Independent Climate Change E-mails Review that both CRU and the greater scientific

[76] E-mail file 1076083097.txt, (February 6, 2004), page 650, line 42 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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community should make more of an effort to provide public access to raw data and detailed methodologies.

However, we also find that the petitioner greatly exaggerates the implications of the alleged conduct of two scientists. The evidence they point to does not support their claims that the ability of other researchers to independently review or replicate paleoclimate studies has been limited, that their scientific conclusions are unsupported, or that these specific incidents are a sound basis on which to characterize the practices of hundreds, if not thousands, of scientists across the much broader body of climate science. These leaps of logic are not supported by sound reasoning or evidence. The evidence indicates the exercise of scientific rigor and honesty, and the release of information in accord with then common scientific practice. The petitioner has not explained why the data and methodology that was released or was otherwise available was inadequate for further research, and have not provided scientific arguments to support their claims. In addition, the "hockey stick" papers are more than a decade old. Since their publication, numerous studies have been published that improved on the original methodology and that include newer and different sources of data. Given this body of newer work, petitioner's concern over the construction of a decade old figure are of little if any scientific relevance. As discussed in Volume 1 of the RTP and elsewhere, there has been significant research and debate in the scientific community over a variety of proxy temperature reconstructions, and petitioner has not argued or shown here that this research was in error or that research opposing it was not performed or could not be performed because of data or coding allegedly withheld.

EPA agrees with the Independent Climate Change E-mails Review's recommendation of greater transparency in the future in this area of scientific research, but the evidence presented by the petitioner does not support the view that the scientific research in this area and the conclusions drawn from it, including conclusions about the uncertainty involved in areas of research such as proxy temperature reconstructions, was flawed or improperly characterized by EPA in the Endangerment Finding.

In addition, the body of paleoclimate research—that is, the specific research at issue in the e-mails related to these two examples cited by the petitioner—underwent extensive scientific review and scrutiny by the NRC in 2006 in response to a request from the U.S. House of Representatives Committee on Science. The NRC committee was tasked with assessing "the state of scientific efforts to reconstruct surface temperature records for the Earth over approximately the last 2,000 years and the implications of these efforts for our understanding of global climate change" (NRC, 2006). A key conclusion from the NRC report supported the methods and general conclusions of the paleoclimate community, stating:

> It can be said with a high level of confidence that global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period during the preceding four centuries. This statement is justified by the consistency of the evidence from a wide variety of geographically diverse proxies.

Thus, we find that the petitioner's evidence does not support their conclusion that paleoclimate studies could not be replicated and results verified, nor any reason to question the fundamental conclusions of the climate change research conducted by the CRU researchers.

Comment (3-40):
Peabody Energy claims that in response to a HadCRUT data request from Warwick Hughes, an Australian scientist, Phil Jones replied on February 8, 2005, "We have 25 years or so invested in the work. Why should I make the data available to you, when your aim is to try and find something wrong with it?" (Jones, 2005). On this basis, the petitioner argues that the Endangerment Finding should be reconsidered because lack of data sharing and accessibility prevented key climate science studies from being replicated and critiqued.

Response (3-40):
Although Jones denies Hughes' request, we note that he points Hughes to another expert (Hans Teunisson) to assist with his request, as well as to various sources of data while describing that some countries restrict access to data. Jones' full response to Hughes' email is as follows (Jones, 2005):

> Warwick,
> Hans Teunisson will reply. 'He'll tell you which other people should reply. Hans is "Hans Teunissen" <HTeunissen@wmo.int> . I should warn you that some data we have we are not supposed top pass on to others. We can pass on the gridded data - which we do. Even if WMO [the World Meteorological Organization] agrees, I will still not pass on the data. We have 25 or so years invested in the work. Why should I make the data available to you, when your aim is to try and find something wrong with it. There is IPR to consider.
>
> You can get similar data from GHCN at NCDC. Australia 'isn't restricted there. Several European countries are. Basically because, for example, France 'doesn't want the French picking up data on France from Asheville. Meteo France wants to supply data to the French on France. Same story in most of the others.
> Cheers
> Phil

The petitioners exaggerate the implications of this one unfulfilled data request for the validity of the science. We note that the methods used to generate the HadCRUT temperature record are well described in the literature and the data necessary to replicate the HadCRUT record are publically available, as described in Volume 1, Section 1.3.3.1. Working with publically accessible data, the Independent Climate Change E-mails Review (Russell, 2010) was able to write computer code from scratch in a space of two days that produced results similar to the HadCRUT and other independent analyses. Furthermore, Volume 1 demonstrates that temperature reconstructions from publically available data such as NOAA's temperature record, the Global Historical Climatology Network (GHCN), look very similar to temperature reconstructions from HadCRUT. Therefore, the petitioner's allegation that key climate science studies could not be replicated and critiqued is not accurate. It remains the case that the HadCRUT temperature record is legitimized by peer reviewed methodology, its replicability, and its similarity with other global temperature records.

As noted in our response (3-39) above, the Independent Climate Change E-mails Review found a tendency to provide unhelpful responses to requests for information and the need for a culture

shift to emphasize the importance of transparency. EPA agrees with the recommendations of the UK House of Commons Science and Technology Committee investigation and the Independent Climate Change E-mails Review that both CRU and the greater scientific community should make more of an effort to provide public access to raw data and detailed methodologies. However, the petitioners' broad and sweeping claims are not warranted given the data that was clearly available and the ready ability to do research using the publicly available data and methodology provided by the CRU.

Comment (3-41):
The petitioners draw various conclusions about the effect of the scientists' alleged actions discussed in the e-mails. Peabody Energy argues that leading climate scientists have worked under a "veil of secrecy" and that their actions "[do] not comport with U.S. scientific norms." Peabody Energy asserts that this is suggestive that they may have been "hiding" something. Peabody Energy also claims that without the underlying data and related information, CRU and associated scientists' studies "could not be replicated or critiqued," which calls into question their validity. The Coalition for Responsible Regulation goes one step further, alleging that "It is doubtful EPA can disclose the technical studies and data upon which it so heavily relies, not only because Phil Jones and his colleagues at CRU deliberately withheld data from both EPA's and the public's review, but also because some of that raw data has now been destroyed."

Response (3-41):
Our responses to the specific e-mails petitioners rely upon in reaching these conclusions are addressed above. Responses 3-37 through 3-40 address claims regarding availability of data, including data concerning a human "fingerprint" in the tropics, data underlying the HadCRUT temperature record, and data concerning historic temperature reconstructions. Volume 1 of this RTP document addresses claims regarding the scientific validity and other scientific aspects of these data. As we have explained, based on our review of the e-mails, the evidence does not support the broad claims of misfeasance or poor science, or of attempts to hide any such science. Instead the scientists at issue performed their research honestly and with scientific rigour, and they released information in accord with the common scientific practice at that time.

Further, the e-mails show that the scientists believed that enough data and information were available for independent review, replication, and verification, while also expressing frustration with the ongoing inquiries from certain individuals. It is clear that the e-mail authors were particularly frustrated by repeated requests for specific explanations and computer programming codes when the base data had already been made available and the methodology for replicating a particular study had already been published in the literature. As we note in our previous responses (e.g., 3-35), this view of the e-mail authors represented the common approach toward data release at the time. Petitioners do not explain why the data that was available was inadequate for the purposes of such research.

The petitioners claim that the CRU scientists and their colleagues ignored requests for data in order to avoid revealing their biased or flawed science, implying that they did not operate according to good scientific practice. However petitioner's evidence does not support their suggestion that the scientists manipulated their analyses to reach desired results, withheld data with an aim of hiding the alleged manipulation, and ultimately

reached flawed their scientific conclusions are flawed.

EPA is not alone in reaching these conclusions. As stated in our response (3-35) above, the UK House of Commons Science and Technology Committee investigation concluded that "On the accusations relating to Professor Jones's refusal to share raw data and computer codes, we consider that his actions were in line with common practice in the climate science community." The Scientific Appraisal Panel review examined criticism toward CRU and found "no evidence of any deliberate scientific malpractice in any of the work of the Climatic Research Unit and had it been there we believe that it is likely that we would have detected it" (Oxburgh, 2010). In addition, the Independent Climate Change E-mails Review concluded, "On the specific allegations made against the behaviour of CRU scientists, we find that their rigour and honesty as scientists are not in doubt" (Russell, 2010). We find that the petitioner's evidence does not suggest otherwise or show that the CRU scientists and their colleagues utilized methods other than those which are "fair and satisfactory" according to the Scientific Appraisal Panel, and conducted their research with integrity and rigor.

Comment (3-42):
Peabody Energy states that the CRU e-mails provide evidence that top climate scientists refused to provide access to key data underlying their studies, and that this practice is "especially alarming both because many of these scientists were either government employees or government-funded and because they were so highly influential in the IPCC." Peabody Energy quotes the following conclusion from the "Wegman Report" (Wegman et al., 2006).

> Federally funded work including code should be made available to other researchers upon reasonable request, especially if the intellectual property has no commercial value. Some consideration should be granted to data collectors to have exclusive use of their data for one or two years, prior to publication. But data collected under federal support should be made publicly available.

Response (3-42):
The petitioner's quote from the Wegman Report does not support the petitioner's allegation that the CRU e-mail authors refused to share key data underlying their studies. It is simply a statement of the opinion of Dr. Wegman, author of the referenced report. We have already addressed public comments regarding the Wegman Report in Volume 2 of the RTC document supporting the Endangerment Findings. We address the petitioners' claims regarding the alleged withholding of data—including data concerning a human "fingerprint" in the tropics, data underlying the HadCRUT temperature record, and data concerning historic temperature reconstructions—in Responses 3-37 through 3-40 above.

Comment (3-43):
Peabody Energy states that the CRU e-mail authors finally acknowledged the importance of public disclosure of their data for maintaining good scientific practices only after they were forced to admit they had made mistakes in their research. According to Peabody Energy, the authors of a paper published in *Science* were forced to admit that they had flipped a dataset upside down as a result of Stephen McIntyre's requests for data. Peabody Energy quotes the

following e-mail from Jonathan Overpeck, professor at University of Arizona, sent to multiple colleagues on September 5, 2009:

> D [Darrell Kaufman, professor at Northern Arizona University] et al.—
> Please write all e-mails as though they will be made public. I would not rush and I would not respond to any of them until the best strategy is developed—don't want to waste anyone's time, including yours or Mc's [Stephen McIntyre's]. Since the recon in Science has an error, I think you do need to publish a correction in Science…I don't think you have a choice here…
>
> # 5 is tricky. Giving him the data would be good, but only if it is yours to give. You can't give him data that you got from others and are not allowed to share. But it would be nice if he could have access to all the data that we used—that's the way science is supposed to work.[77]

Peabody Energy also states that Tom Wigley of the University Corporation for Atmospheric Research was forced to admit there were problems with datasets used in proxy temperature reconstructions by Keith Briffa of CRU, when Stephen McIntyre raised questions about them. According to the petitioner, Briffa, at least initially, "declined to respond to McIntyre's requests for information." The petitioner quotes the following e-mail excerpt from Tom Wigley to Phil Jones on October 5, 2009:

> …Keith does seem to have got himself into a mess…And the issue of with-holding data is still a hot potato, one that affects both you and Keith (and Mann). Yes, there are reasons— but many *good* scientists appear to be unsympathetic to these. The trouble here is that with-holding data looks like hiding something, and hiding means (in some eyes) that it is bogus science that is being hidden.[78]

<u>Response (3-43)</u>:
Peabody Energy implies that because of Stephen McIntyre's requests for data, mistakes were found in a paper published in *Science*, which the petitioner did not identify but that we believe to be Kaufman et al. (2009) based on context given in the e-mails. However, the evidence does not show what the catalyst was for the authors' decision to publish a correction. In the "corrections and clarifications" update written by Kaufman et al. responding to critiques of their original paper, they thanked "H. McCulloch and others who have pointed out errors and have offered suggestions" (Kaufman et al. 2010). To the extent that Peabody Energy is arguing that the results of Kaufman et al. (2009) are invalid given the errors that necessitated publishing a correction, we respond in Volume 1, Section 1.1.3 of the RTP document to the allegation about "flipping datasets" (1-10) and related paleoclimate temperature reconstruction issues.

Peabody Energy also implies that Wigley admitted there were problems with Keith

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[77] E-mail file 1252164302.txt, (September 5, 2009), page 1734, line 12 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[78] E-mail file 1254756944.txt, (October 5, 2009), page 1782, line 6 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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Briffa's proxy temperature reconstructions after Stephen McIntyre questioned their validity. The e-mail does not support this allegation. The text of the e-mails says nothing that would indicate that Wigley "admitted" or believed there were errors in Briffa's work, or that any errors were being "hidden." To the contrary, Wigley states that there can be valid reasons for not publishing data, but voices concern that others would misinterpret such actions as trying to hide poor science.

As before, the petitioner claims that these incidents are proof that the science was flawed and unreliable. Through our review of the scientific issues, in response to petitioners' arguments and throughout the notice and comment period on the Endangerment Findings, EPA has determined that the paleoclimate science is appropriately characterized and weighed in the Administrator's decision. Our review of the issues related to the release of data indicates that the scientists did make data and information available, even if sometime later and sometimes not to the satisfaction of requestors, that raw data was also publicly available, that the scientists at issue conducted their work with scientific integrity and rigour, and their actions in releasing data was consistent with common and accepted scientific practice. While EPA supports increased transparency in this area of research, petitioners arguments are not based on science and do not support their claims that the research at issue was flawed. Their claim is based on concerns over data availability, and they do not show why the data that was available was not adequate for the research purposes claimed. The evidence they present does not support the broad scientific and other conclusions they draw.

3.4.3 Allegations of Improper Conduct With Regard to UK FOI and U.S. FOIA Laws

3.4.3.1 General Allegations

Comment (3-44):
The Coalition for Responsible Regulation, the Pacific Legal Foundation, Peabody Energy, and the State of Texas claim that a quote from the Deputy Information Commissioner of the UK Information Commissioner's Office (ICO)—"Requests under the Freedom of Information Act were not dealt with as they should have been under the legislation"—provides evidence that CRU scientists violated the law by refusing to comply with requests for data. Peabody Energy states that "these efforts by CRU to evade FOIA have now been determined to have been illegal." Peabody Energy further opines that "Destruction of public records to avoid disclosure under FOIA unquestionably violates U.S. and U.K. law." The State of Texas quotes a newspaper article (Kinver, 2010) that states that the UK ICO is reviewing whether the UK FOI law needs to be revised in light of the CRU's refusal to disclose public information.

Response (3-44):
The petitioners base their allegations that CRU violated the UK FOI law solely on a statement to the press made by Deputy Information Commissioner Graham Smith, which suggested that at least some of the requested information should have been disclosed. Contrary to the petitioners' claims, this statement was not an official finding of the UK ICO. The recent inquiry by the UK House of Commons Science and Technology Committee (2010b) puts Smith's statement into proper context:

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88. On 29 January there was an exchange between UEA [University of East Anglia] and Mr. Smith, the Deputy Commissioner. Brian Summers, the Registrar and Secretary of UEA responded forcibly to Mr Smith's 22 January press statement, which asserted that UEA had not dealt with FOIA requests "as they should have been under the legislation". He did not consider it was "acceptable that such a statement which has led to an extremely damaging commentary on the University [was] first communicated to the University by a journalist". His letter goes on to defend UEA's actions in detail and to ask that, if the Information Commissioner's Office (ICO) cannot retract the 22 January statement, it issue a clarification regarding the alleged breaches of the FOIA. A response from the ICO was issued the same day. It did not retract the original statement but offered clarification:

1. [No] decision notice has yet been issued and no alleged breaches have yet been put to the University for comment. That matter has yet to be addressed, but it will be over coming months.
2. The fact that the elements of a section 77 offence may have been found here, but cannot be acted on because of the elapsed time, is a very serious matter. The ICO is not resiling from its position on this.
3. The ICO's position is as stated in point 2 above. The statement may be read to indicate that. Under section 77, an offence may be committed by an individual, not necessarily the public authority itself.
4. Errors like this are frequently made in press reports and the ICO cannot be expected to correct them, particularly when the ICO has not itself referred to penalties or sanctions in its own statement.

89. UEA responded on 1 February thanking the ICO for the clarification but setting out its concerns relating to the press coverage of the ICO's original statement:

> Your clarification that the press cannot infer from your statement to the Sunday Times that it has been established that the University (or indeed any individual associated with the University) has breached the terms of the Freedom of Information Act is welcome. [UEA's] reputation which has been subjected to these damaging and incorrect assertions claiming to be based on your statement and we must take some steps to put this right. We will be writing to the media which carried reports based on your statement, pointing out the inaccuracies and asking them to rectify the position.

90. In his oral evidence Professor Acton [Vice-Chancellor at UEA] questioned the ICO statement of 22 January:

> Our principle is that prima facie evidence is evidence which on the face of it and without investigation suggests that there is a case to answer. To my mind if there is prima facie evidence; why did I set up the Muir Russell independent review? Prima facie evidence is not the same as, you have been found to breach. [...] If it is sub judice, if, as we had in the letter ten days ago from the ICO, the investigation has not even begun, I am puzzled how we could have been found to breach if there has been no investigation.

91. The ICO's most recent letter, dated 3 March, in UEA's view, "makes plain that there is no assumption by the ICO, prior to investigation, that UEA has breached the Act; and that no investigation has yet been completed." The ICO's letter confirmed that the "ICO is not pursuing any investigation under section 77 of the Act. That matter is closed as far as the ICO is concerned, given the statutory time limits for action". It added that:

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> The ICO acknowledges your concern about the statement made and the subsequent media and blog reports. Given that the Deputy Commissioner has already been publicly associated with the matter, any Decision Notice will be reviewed and signed off by another authorised signatory.

The UK House of Commons Science and Technology Committee (2010b) concluded the following:

> We regret that the ICO made a statement to the press that went beyond that which it could substantiate and that it took over a month for the ICO properly to put the record straight. We recommend that the ICO develop procedures to ensure that its public comments are checked and that mechanisms exist to swiftly correct any mis-statements or misinterpretations of such statements.

Based on the evidence submitted to the UK House of Commons Science and Technology by UEA and the UK ICO, it is clear that Deputy Information Commissioner Smith's January 22nd press statement was not based on the results of a formal investigation and his opinions about CRU do not represent the conclusions of a comprehensive government investigation. The statement from Smith does not support the petitioner's allegations that CRU scientists acted illegally. In addition, regarding the comment from the State of Texas that the UK ICO is reviewing whether the UK FOI law needs to be revised, we note that the existence of a possible review of the law does not provide evidence that CRU scientists acted illegally or inappropriately.

For all of the above reasons, the petitioners evidence does not show whether there was a violation of UK law, and does not contradict the conclusions of the three independent investigations into the CRU e-mails. These investigations found that the CRU e-mail authors conducted their research in accordance with common practice in the climate science community at the time, utilized methods which are "fair and satisfactory" according to the Scientific Appraisal Panel (Oxburgh, 2010), and maintained scientific integrity and rigor in their work. EPA supports the recommendations for greater transparency in this area of climate research; however petitioners' evidence does not support their claim that the science underlying the Endangerment Finding was suspect or flawed, or that it was mischaracterized in any way in the Endangerment Finding. Petitioners' arguments are not based on an analysis of the science, but on unsupported assertions of inadequate science.

Comment (3-45):
The Coalition for Responsible Regulation, Peabody Energy, and the Southeastern Legal Foundation claim that the CRU e-mail authors, particularly Phil Jones and Michael Mann, avoided compliance with FOI laws. Peabody Energy argues that the CRU e-mail authors concealed information as a means to frustrate the work of researchers like Stephen McIntyre and Ross McKitrick who might criticize their work. Peabody Energy states that the paleoclimate community "decided that McIntyre and anyone associated with him was essentially their enemy and that they would refuse to cooperate entirely with any effort to provide him with information, including under the U.S. and British FOIAs." Peabody Energy further claims that CRU scientists and their associates "accelerated their highly-contentious

struggle against so-called 'skeptics'" by creating the RealClimate website in order to "counter" Stephen McIntyre's ClimateAudit website.

The petitioners highlight numerous statements taken from the CRU e-mails in support of their arguments that CRU scientists and their colleagues withheld data and ignored FOI requests. In one example, Coalition for Responsible Regulation and Peabody Energy quote an e-mail from Phil Jones to Tom Wigley and Ben Santer on January 21, 2005:

> As for FOIA Sarah isn't technically employed by UEA and she will likely be paid by Manchester Metropolitan University. I wouldn't worry about the code. If FOIA does ever get used by anyone, there is also IPR [intellectual property rights] to consider as well. Data is covered by all the agreements we sign with people, so I will be hiding behind them. I'll be passing any requests onto the person at UEA who has been given a post to deal with them.[79]

In another example, Peabody Energy, the Southeastern Legal Foundation, and the Coalition for Responsible Regulation quote the following e-mail excerpt from Jones to Mann on February 3, 2005:

> Just sent loads of station data to Scott. Make sure he documents everything better this time! And don't leave stuff lying around on ftp sites — you never know who is trawling them. The two MMs [Stephen McIntyre and Ross McKitrick] have been after the CRU station data for years. If they ever hear there is a Freedom of Information Act now in the UK, I think I'll delete the file rather than send to anyone. Does your similar act in the US force you to respond to enquiries within 20 days? — our does ! The UK works on precedents, so the first request will test it. We also have a data protection act, which I will hide behind. Tom Wigley has sent me a worried e-mail when he heard about it — thought people could ask him for his model code. He has retired officially from UEA so he can hide behind that. IPR [intellectual property rights] should be relevant here, but I can see me getting into an argument with someone at UEA who'll say we must adhere to it!…[80]

Peabody Energy and Southeastern Legal Foundation quote Mann's response (the Southeastern Legal Foundation erroneously attributes this quote to Phil Jones):

> Yes, we've learned out [sic] lesson about FTP. We're going to be very careful in the future what gets put there. Scott really screwed up big time when he established that directory so that Tim could access the data. Yeah, there is a freedom of information act in the U.S., and the contrarians are going to try to use it for all its worth. But there are also intellectual property rights issues, so it isn't clear how these sorts of things will play out ultimately in the U.S.[81]

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[79] E-mail file 1106338806.txt, (January 21, 2005), page 810, line 38 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[80] E-mail file 1107454306.txt, (February 3, 2005), page 821, line 22 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[81] E-mail file 1107454306.txt, (February 3, 2005) page 821, line 12 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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Peabody Energy quotes another e-mail excerpt from Phil Jones to Michael Mann, Raymond Bradley, and Malcolm Hughes on February 21, 2005:

> PS I'm getting hassled by a couple of people to release the CRU station temperature data. Don't any of you three tell anybody that the UK has a Freedom of Information Act !"[82]

Peabody Energy quotes another e-mail excerpt from Phil Jones to Ben Santer that was forwarded on December 4, 2008:

> In response to FOI and EIR [Environmental Information Regulations] requests, we've put up some data - mainly paleo data. Each request generally leads to more — to explain what we've put up. Every time, so far, that hasn't led to anything being added — instead just statements saying read what is in the papers and what is on the web site! Tim Osborn sent one such response (via the FOI person) earlier this week. We've never sent programs, any codes and manuals.[83]

Response (3-45):
The quoted e-mails show the authors' opinions and questions about the applicability of the FOI law to their various datasets. As discussed in our previous responses in this Volume, scientists can and do state their opinions and express frustration in personal communications with colleagues. Although Jones makes sometimes flippant statements regarding FOI laws, this does not show that he deleted files, destroyed data, or otherwise attempted to obstruct FOI requests.

In addition, the petitioner's claim that the paleoclimate community refused to cooperate entirely with McIntyre and anyone associated with him is without merit. Two of the e-mails quoted by Peabody Energy [84] clearly indicate that Jones and other CRU scientists provided data in response to FOI requests. As discussed throughout this section, our review of the issues related to the release of data indicates that in many cases the data were already publicly available or were released by the scientists, and that the scientists conducted their work with scientific rigor and honesty and consistent with common and accepted scientific practice.

Regarding Peabody Energy's claims that the CRU scientists perpetuated a "highly-contentious struggle" against "climate skeptics," we find that the petitioner's assertions concerning the RealClimate blog of no relevance. The reasons for creating the site are irrelevant to the issues of whether the scientists were complying with FOI laws, and to the issue of the scientific validity of their research.

Comment (3-46):
Peabody Energy quotes the following e-mail excerpt written by Phil Jones to Kevin Trenberth of the University Corporation for Atmospheric Research on June 20, 2007, claiming that it provides evidence that CRU scientists and their colleagues withheld data and ignored FOI requests:

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[82] E-mail file 1109021312.txt, (February 21, 2005), page 834, line 25 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[83] E-mail file 1228412429.txt, (December 4, 2008), page 1593, line 22 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[84] E-mail file 1182346299.txt, (June 20, 2007), page 1335, line 9 and e-mail file 1228412429.txt, (December 4, 2008), page 1593, line 22 of the PDF version entitled: CRU Emails 1996-2009.pdf.

> I won't be replying to either of the e-mails below, nor to any of the accusations on the Climate Audit website. I've sent them on to someone here at UEA to see if we should be discussing anything with our legal staff. The second letter seems an attempt to be nice to me, and somehow split up the original author team. I do now wish I'd never sent them the data after their FOIA request [85]

Peabody Energy cites this example as further evidence of the CRU e-mail authors ignored FOI requests as part of their "highly-contentious struggle" against anyone affiliated with Stephen McIntyre or the Climate Audit blog.

Response (3-46):
The petitioner selectively quotes part of an e-mail chain to support its argument and does not provide larger context for Jones' statement. The e-mail chain at issue here was sent in response to the following e-mail from Douglas Keenan (private UK citizen) to Stephen McIntyre (editor of the blog Climate Audit). The subject of the e-mail relates to a paper on urban heat islands that Jones co-authored with Wei-Chyung Wang of the University at Albany in New York (i.e., Jones et al., 1990).

> From: "D.J. Keenan" doug.keenan@informath.org
> To: "Steve McIntyre" stephen.mcintyre@utoronto.ca
> Cc: "Phil Jones" p.jones@uea.ac.uk
> Subject: Wang fabrications
> Date: Tue, 19 Jun 2007 20:45:15 +0100
>
> Steve,
> I thought that I should summarize what has happened with the Wang case First, I concluded that the claims made about Chinese stations by Jones et al. [Nature, 1990] and Wang et al. [GRL, 1990] were very probably fabricated. (You very likely came to the same conclusion.) Second, some investigation showed that Phil Jones was wholly blameless and that responsibility almost certainly lay with Wang. Third, I contacted Wang, told him that I had caught him, and asked him to retract his fabricated claims. My e-mails were addressed to him only, and I told no one about them. In 'Wang's reply, though, Jones, Karl, Zeng, etc. were Cc'd. Fourth, I explained to Wang that I would publicly accuse him of fraud if he did not retract. Wang seemed to not take me seriously. So I drafted what would be the text of a formal accusation and sent it to him. Wang replied that if I wanted to make the accusation, that was up to me. Fifth, I put a draft on my web site-- http://www.informath.org/apprise/a5620.htm-- and e-mailed a few people, asking if they had any recommendations for improvement.
>
> I intend to send the final version to Wang's university, and to demand a formal investigation into fraud. I will also notify the media. Separately, I have had a preliminary discussion with the FBI--because Wang likely used government funds to commit his fraud; it seems that it might be possible to prosecute Wang under the same statute as was used in the Eric Poehlman case. The simplicity of the case makes this

[85] E-mail file 1182346299.txt, (June 20, 2007). page 1335, line 9 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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easier--no scientific knowledge is required to understand things. I saw that you have now e-mailed Phil (Cc'd above), asking Phil to publish a retraction of Wang's claims: http://www.climateaudit.org/?p=1741#comment-115879 There could be a couple problems with that. One problem is that it would be difficult for Phil to publish anything without the agreement of Wang and the other co-authors (Nature would simply say "no"). Another problem is that your e-mail says that you presume Phil was "unaware of the incorrectness" of Wang's work. I do not see how that could be true. Although the evidence that Phil was innocent in 1990 seems entirely conclusive, there is also the paper of Yan et al. [Advances in Atmospheric Sciences, 18: 309 (2001)], which is cited on my web page. Phil is a co-author of that paper. Phil, this proves that you knew there were serious problems with Wang's claims back in 2001; yet some of your work since then has continued to rely on those claims, most notably in the latest report from the IPCC. It would be nice to hear the explanation for this. Phil?
Kind wishes,
Doug[86]

This e-mail shows Douglas Keenan making serious accusations of fraud and data fabrication against Wei-Chyung Wang, and accusing Jones of knowingly using Wang's alleged faulty data in his research. Keenan goes even further, stating that he contacted the Federal Bureau of Investigation about prosecuting Wang for fraud, and threatening that if Wang does not publish a retraction, Keenan will make formal accusations of fraud to Wang's university and the media.

We respond to the petitioners' claims that Jones and Wang committed fraud and knowingly used faulty Chinese weather station data in Volume 1, Section 1.3.4 of the RTP document. There, we show that the claims of Keenan and McIntyre are groundless and that Wang was cleared of any misconduct. Given this larger context, Jones' statement, "I do now wish I'd never sent them the data after their FOIA request," is more understandable. Rather than being an indication of Jones' reluctance to comply with FOIA requests, it appears that he is reacting to the fact that CRU data were misused to make aggressive and personal attacks on one of his colleagues. In addition, his e-mail basically says he is referring the request to the UEA, instead of making decisions himself on this issue. As the UK House of Commons Science and Technology Committee investigation found, "The focus on Professor Jones and CRU has been largely misplaced. On the accusations relating to Professor Jones's refusal to share raw data and computer codes, we consider that his actions were in line with common practice in the climate science community. We have suggested that the community consider becoming more transparent by publishing raw data and detailed methodologies. On accusations relating to Freedom of Information, we consider that much of the responsibility should lie with UEA, not CRU" (UK House of Commons Science and Technology Committee, 2010b).

Our review of the larger context for the CRU e-mails in question, as well as issues related to the release of data in general, indicates that the scientists did make data and information available, and conducted their work consistent with common and accepted scientific practice.

Comment (3-47):

[86] E-mail file 1182346299.txt, (June 29, 2007), page 1336, line 22 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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The Southeastern Legal Foundation argues that "E-mails were apparently altered or deleted to cover up wrongdoing." The petitioner quotes part of an e-mail from Phil Jones of CRU to Eugene Wahl of NOAA and Caspar Amman of the National Center for Atmospheric Research: "[T]ry and change the Received date. Don't give those skeptics something to amuse themselves with." The Southeastern Legal Foundation argues that even if there is no evidence that e-mails were tampered with in response to the request from Jones, the apparent willingness of these parties to engage in such actions should cause EPA to question its reliance on their work.

Response (3-47):
Petitioner makes a number of unsubstantiated assumptions in their argument. First, the petitioner assumes that Jones was asking Wahl and Ammann to alter their e-mail records. Although the petitioner only quotes part of the e-mail, we provide the full text to provide important context:

> Gene/Caspar,
> Good to see these two out. Wahl/Ammann doesn't appear to be in 'CC's [the journal *Climatic Change*] online first, but comes up if you search. You likely know that McIntyre will check this one to make sure it hasn't changed since the IPCC close-off date July 2006! Hard copies of the WG1 [IPCC Working Group 1] report from CUP have arrived here today. Ammann/Wahl - try and change the Received date! Don't give those skeptics something to amuse themselves with.
> Cheers
> Phil [87]

Based on our review of the issue, we note that in his e-mail, Jones is referring to two distinct journal articles written by the same authors, Wahl and Ammann (2007) and Ammann and Wahl (2007), both published in the journal *Climatic Change*. The rationale for Jones' statement, "Ammann/Wahl - try and change the Received date! Don't give those skeptics something to amuse themselves with," is that the journal *Climatic Change* had made an error in listing a received date of August 2000, which was several years earlier than the paper was written (Ammann and Wahl, 2007). Therefore, Phil Jones was apparently suggesting that they should try to get the journal to correct its website to list the actual date the Ammann and Wahl paper was received, rather than an obviously incorrect date of August 2000. There is no evidence that Ammann and Wahl followed up on Jones' suggestion, but even if they had, this would not be an inappropriate action.

Second, the petitioner assumes Jones' statement was part of some kind of "cover up" of "wrong-doing," without specifying what that means or providing any further context for their allegation. It is unclear on what basis the petitioner concludes that there was "apparent willingness of these parties" to tamper with e-mails. Jones suggestion is benign when the context is considered and receiving this e-mail in no way implies "willingness" on the part of Wahl and Amman to engage in inappropriate action. Subsequent replies from Wahl and Amman in the same e-mail chain[88] discuss only their papers and provide no indication that they engaged in any inappropriate

[87] E-mail file 1189722851.txt, (September 12, 2007), page 1357, line 18 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[88] E-mail file 1189722851.txt, (September 12, 2007). page 1356, line 33 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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actions. The petitioners' evidence does not support their claim that the CRU scientists and their colleagues altered e-mail information or withheld key data needed for replicating key climate change studies, nor do the petitioners provide any other evidence that would cause EPA to question the scientific merits of these scientists' work.

Comment (3-48):
The Pacific Legal Foundation and the State of Texas claim that the CRU e-mails demonstrate that EPA was incorrect in asserting that the science on which the Administrator has based her endangerment determinations has been fully open and transparent. The Pacific Legal Foundation and the State of Texas state that a separate inquiry funded by the University of East Anglia will investigate CRU's policies and practices for "disseminating data and research findings" to see if any of their actions were "at odds with acceptable scientific practice" or "call into question any of the research outcomes." The Pacific Legal Foundation argues that this lack of transparency evident in the CRU e-mails casts doubt on the reliability of CRU's work, and that EPA's Scientific Advisory Board should be granted an opportunity to review and comment on whether the CRU data can be relied on by EPA.

Peabody Energy argues that in a January 23, 2009, memorandum to EPA employees (U.S. EPA, 2009b) and in a March 9, 2009, Presidential Memorandum for the Heads of Executive Departments (U.S. EPA, 2009c), Administrator Jackson stated her commitment that the EPA will rely on open and transparent science. Peabody Energy states that the CRU scientists and their colleagues, which includes "government-funded scientists involved in hugely important scientific research," were not "fully willing to make available for public scrutiny all of the information they use and produce, no matter the political, policy or scientific consequence." Peabody Energy concludes that:

> [S]cience advances only when research is exposed to critical analysis; that is the entire purpose of the scientific process. The practice of science in the shadows as reflected in the CRU material is directly contrary to the Administrator's undertaking that science relied on by EPA will be subject to the highest standards of transparency and openness. The Administrator cannot, consistent with these undertakings, rely on the AR4 material prepared by these authors.

In other words, the petitioner concludes that the work of the CRU e-mail authors, including their contributions to the IPCC AR4, violates EPA's commitment to transparency and thus cannot be relied upon for the Endangerment Findings.

Response (3-48):
The Pacific Legal Foundation and the State of Texas reference the existence of the Independent Climate Change E-mails Review as evidence to call into question the reliability and validity of CRU's work. In so doing, the petitioners inappropriately assume wrongdoing based solely on the existence—not the conclusions—of an investigation. With regard to the CRU scientists' actions involving research and science, the Independent Climate Change E-mails Review issued its report on July 7, 2010. This report concluded:

> Climate science is a matter of such global importance, that the highest standards of honesty, rigour and openness are needed in its conduct. On the specific allegations made against the behaviour of CRU scientists, we find that their rigour and honesty as scientists

> are not in doubt. In addition, we do not find that their behaviour has prejudiced the balance of advice given to policy makers. In particular, we did not find any evidence of behaviour that might undermine the conclusions of the IPCC assessments.

Regarding CRU's data management policies and practices, the Independent Climate Change E-mails Review identified issues with the way the CRU has handled requests for information in the past and the need for more transparency. As stated in our responses (e.g., 3-39) above, we agree with the recommendations of the UK House of Commons Science and Technology Committee and the Independent Climate Change E-mails Review that both CRU and the greater climate science community can improve its efforts in terms of transparency. However, we also find that the petitioners greatly exaggerate the implications of the e-mails concerning the release of certain data on the validity of the specific science issues they addressed, not to mention the petitioners' much more expansive claim that the e-mails raise questions about the credibility of unrelated scientific issues not addressed in the materials they cite. Our review of the issues related to the release of data indicates that the scientists did make data and information available, that they conducted their work with scientific rigor and integrity, and that they acted in a manner consistent with common and accepted scientific practice. Data were also publicly available for use by researchers. We reiterate that we have found no evidence that other researchers were not able to access adequate data in order to replicate key findings or conduct their research. Petitioners have not explained why the data that was available was inadequate for these purposes. The petitioners' evidence does not support their claim that the CRU scientists and their colleagues withheld key data needed for replicating key climate change studies, nor do the petitioners provide any other evidence that would cause EPA to question the scientific merits of these scientists' work.

The petitioners' claim that the assessment reports can not be relied upon are not based on arguments or analysis of the scientific merits of the research at issue. Their arguments do not support a conclusion that the body of scientific research on climate change or the scientific basis for the Endangerment Finding is scientifically inappropriate or flawed.

3.4.3.2 Specific FOI Request Regarding the IPCC's Fourth Assessment Report

The following comments and responses in this section address the petitioners' specific allegation that the CRU e-mail authors obstructed one particular FOI request for e-mails and information pertaining to the creation of the IPCC's AR4.

Comment (3-49):
The State of Texas alleges that the CRU e-mail authors ignored legal requirements when discussing how to respond to a FOI request for their e-mails relating to the drafting of the IPCC AR4. The petitioner argues that "At no time in the exchange did any of them suggest what state or federal laws might have governed how the request needed to be treated." The State of Texas first quotes an e-mail from Bryan Lynch (private UK citizen) to Caspar Ammann of the National Center for Atmospheric Research on June 23, 2008, which references an FOI request submitted by David Holland of the UK-based think tank Global Warming Policy Foundation:

> I have read correspondence on web about your letter to the in relation [sic] to expert comments on IPCC chapter 6 sent directly by you to Keith Briffa, sent

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> outside the formal review process. The refusal to give these documents tends to discredit you and the IPCC in the eyes of the public.[89]

Ammann apparently forwarded Lynch's e-mail to Keith Briffa, Phil Jones, and Tim Osborn, and the State of Texas quotes their replies. Phil Jones states, "It doesn't discredit IPCC!".[90] Tim Osborn states:

> I'd ignore this guy's request anyway. If we aren't consistent in keeping our discussions out of the public domain, then it might be argued that none of them can be kept private. Apparently, consistency of our actions is important[91]

Keith Briffa states:

> I have been of the opinion right from the start of these FOI requests, that our private, inter-collegial discussion is just that PRIVATE. Your communication with individual colleagues was on the same basis as that for any other person and it discredits the IPCC process not one iota not to reveal the details. On the contrary, submitting to these "demands" undermines the wider scientific expectation of personal confidentiality. It is for this reason, and not because we have or have not got anything to hide, that I believe none of us should submit to these "requests."[92]

As a second example, the State of Texas alleges that Jones "…destroyed information in order to avoid the possibility of having to produce it." As evidence, the petitioner quotes an e-mail in which Phil Jones states, "About 2 months ago I deleted loads of e-mails, so have very little - if anything at all".[93]

In a third example, the State of Texas cites one e-mail in which Gavin Schmidt of NASA compares the actions of global warming "skeptics" requesting information under FOI or FOIA laws to "Somali pirates".[94] The petitioner claims that this remark "took the climate scientists' disdain for citizens who file open records requests to a whole new level." The State of Texas concludes from these examples that the CRU e-mail authors "have been the antithesis of transparent," displaying not only "a total disregard for open government-but worse, affirmative disdain for transparency and utter contempt for citizens who exercise their right to obtain public information."

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[89] E-mail file 1214228874.txt, (June 23, 2008) page 1533, line 5 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[90] E-mail file 1214228874.txt, (June 23, 2008) page 1533, line 5 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[91] E-mail file 1214228874.txt, (June 23, 2008) page 1533, line 25 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[92] E-mail file 1214228874.txt, (June 23, 2008) page 1533, line 13 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[93] E-mail file 1228412429.txt, (December 4, 2008), page 1593, line 22 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[94] E-mail file 1228258714.txt, (December 2, 2008), page 1590, line 44 of the PDF version entitled: CRU Emails 1996-2009.pdf.

ED_001612_00028344-00103

Response (3-49):
We have reviewed the e-mails at issue in the petitioner's objection and disagree that they are evidence that the scientists ignored legal requests or that they "have been the antithesis of transparent." We address each issue below.

From our review of the e-mails related to the quote from Bryan Lynch, it appears that the subject of the FOI request was for personal communications between authors of IPCC Chapter 6 ("Palaeoclimate") regarding expert review comments on chapter 6.[95] The request appears to be for e-mails that were not part of the formal review process—in other words, for personal conversations written privately between colleagues. This type of information is tangential at best to the scientific assessment of the AR4 or the workings of the IPCC as a whole, or for this one chapter. The IPCC maintains an open and transparent formal process by which expert comments are responded to and incorporated into the IPCC reports. The public can access drafts, expert and government review comments, and author responses used to prepare the Working Group I report (IPCC, 2007b), which includes chapter 6 on paleoclimate, on the Internet (IPCC, 2006). We provide further discussion of the transparency of IPCC review processes in Volume 2, Section 2.2. The petitioners' evidence does not show that this formal, public process was hindered or disrupted in any way, or that the opinions expressed on how to respond to this FOI request produced any less robust or scientifically valid comment review process for the assessment report.

Regarding the second example, we note that Phil Jones' statement is taken out of context from the e-mails. We provide the following supporting context excerpted from the e-mail:

> The inadvertent email I sent last month has led to a Data Protection Act request sent by a certain Canadian, saying that the email maligned his scientific credibility with his peers! If he pays 10 pounds (which he hasn't yet) I am supposed to go through my emails and he can get anything I've written about him. About 2 months ago I deleted loads of emails, so have very little - if anything at all. This legislation is different from the FOI - it is supposed to be used to find put [sic] why you might have a poor credit rating![96]

Phil Jones does not discuss, as the petitioners have asserted, deleting e-mails to "avoid the possibility of having to produce it." He also does not discuss deleting e-mails to avoid complying with requests (whether Data Protection Act or FOI); he simply states that he happened to delete a portion of his e-mails two months prior to receiving this request. The evidence does not support their conclusion that any information was deliberately deleted to avoid making it public.

Regarding the third example, it is clear that the authors of the e-mails voiced significant frustration about the increasing numbers of FOI requests, which they viewed as frivolous and which were taking significant time away from their research. EPA does not agree that these examples or any statements in the quoted e-mails are indicative of "affirmative disdain" or "utter contempt" for transparency. As stated in our responses above, in many cases large amounts of data were in fact released or were publicly available. Although we agree that there is room for

[95] E-mail file 1214228874.txt, (June 23, 2008), page 1533, line 13 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[96] E-mail file 1228412429.txt, (December 4, 2008), page 1594, line 6 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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improvement in terms of transparency, we also find that the petitioners greatly exaggerate the implications of these process issues for the validity of the science in this area. Petitioners have not explained why the data available was not adequate data in order for researchers to replicate or otherwise evaluate key findings, or to conduct other research. We find that the CRU e-mail authors conducted their research in accordance with common practice in the climate science community at the time, utilized methods which are "fair and satisfactory" according to the Scientific Appraisal Panel, and maintained scientific integrity and rigor in their work.

Comment (3-50):
Peabody Energy, the Southeastern Legal Foundation, the Coalition for Responsible Regulation, the Pacific Legal Foundation, and the State of Texas allege that the CRU scientists and their colleagues deleted or otherwise attempted to avoid disclosing information pertaining to the drafting of the IPCC AR4, which was the subject of an active FOI request. Peabody Energy, the Southeastern Legal Foundation, and the State of Texas quote the following e-mail from Jones to Tom Wigley of the University Corporation for Atmospheric Research on December 4, 2008:

> You can delete this attachment if you want. Keep this quiet also, but this is the person who is putting in FOI requests for all emails Keith and Tim have written and received re Ch 6 of AR4. We think 'we've found a way around this...This message will self destruct in 10 seconds![97]

Peabody Energy, the Southeastern Legal Foundation, and the Coalition for Responsible Regulation quote the following e-mail from Jones to Michael Mann on May 29, 2008:

> Can you delete any emails you may have had with Keith re AR4? Keith will do likewise. He's not in at the moment – minor family crisis. Can you also email Gene and get him to do the same? I don't have his new email address. We will be getting Caspar to do likewise. I see that CA [Climate Audit blog] claim they discovered the 1945 problem in the Nature paper!![98]

Peabody Energy describes an e-mail exchange from May 27, 2008 between Tim Osborn of CRU and Caspar Amman of the National Center for Atmospheric Research about whether Amman viewed e-mails related to the IPCC AR4 as "confidential".[99] From these e-mails, Peabody Energy concludes that Osborn "was not looking for a good faith statement from Amman"; rather, he was "clearly seeking an excuse for refusing to disclose information that was being sought."

As further evidence that CRU scientists deleted information pertaining to the IPCC AR4, Peabody Energy cites the following e-mail excerpt from Phil Jones to Tom Wigley on March 12, 2008:

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[97] E-mail file 1210341221.txt, (May 9, 2008), page 1494, line 1 of PDF version entitled: CRU Emails 1996-2009.pdf).
[98] E-mail file 1212063122.txt, (May 29, 2008), page 1514, line 45 of PDF version entitled: CRU Emails 1996-2009.pdf).
[99] E-mail file 1211924186.txt, (May 27, 2008), page 1509, line 22, e-mail file 1212156886.txt, page 1519, line 12, and e-mail file 1212166714.txt, (May 30, 2008), page 1520, line 3 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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> The inadvertent e-mail I sent last month has led to a Data Protection Act request sent by a certain Canadian, saying that the e-mail maligned his scientific credibility with his peers! If he pays 10 pounds (which he hasn't yet) I am supposed to go through my e-mails and he can get anything I've written about him. About 2 months ago I deleted loads of e-mails, so have very little — if anything at all. This legislation is different from the FOI — it is supposed to be used to find put why you might have a poor credit rating![100]

Peabody Energy also cites the following e-mail excerpt from Phil Jones to Ben Santer of Lawrence Livermore National Laboratory on December 10, 2008:

> Haven't got a reply from the FOI person here at UEA. So I'm not entirely confident the numbers are correct. One way of checking would be to look on CA [Climate Audit], but I'm not doing that. I did get an e-mail from the FOI person here early yesterday to tell me I shouldn't be deleting e-mails – unless this was 'normal' deleting to keep e-mails manageable![101]

Peabody Energy claims that "the material that they [the CRU e-mail authors] destroyed pertained directly to their work for the IPCC…" and that the "scientists' concern about what they communicated with each other about preparation of AR4 was so serious that they undertook to delete the e-mails rather than have them subject to public scrutiny." Peabody Energy contends that the refusal to provide information about the process of writing the IPCC reports contradicts EPA's view of the transparency of that process. The Southeastern Legal Foundation argues that even if there is no evidence that e-mails were deleted in response to the request from Jones, the apparent willingness of the CRU scientists and their colleagues to destroy evidence should cause EPA to question its reliance on their work.

Response (3-50):
We note that the petitioner ascribes negative motives to CRU e-mail author Tim Osborn—e.g., "not looking for a good faith statement," "clearly seeking an excuse"—which are based on conjecture and innuendo. We find that the petitioner bases its argument on a speculative interpretation of the following e-mail from Osborn to Caspar Amman:

> I don't think it is necessary for you to dig through any e-mails you may have sent us to determine your answer. Our question is a more general one, which is whether you generally consider e-mails that you sent us to have been sent in confidence. If you do, then we will use this as a reason to decline the request.[102]

The petitioner does not provide evidence or reasons why EPA should not interpret this statement at face value—that Osborn was sincere in asking for only a general answer as to whether or not Amman considered their private communications to be confidential. It is reasonable for Osborn to tell Amman not to waste time digging through his e-mails, as he

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[100] E-mail file 1228412429.txt, (March 12, 2008), page 1594, line 6 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[101] E-mail file 1228922050.txt, (December 10, 2008), page 1596, line 20 of the PDF version entitled: CRU Emails 1996-2009.pdf
[102] E-mail file 1212166714.txt, (May 30, 2008), page 1520, line 3 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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meant for his question to be a general one. We find that the petitioner has no basis for its negative characterization of Osborn's intentions.

We also note that the second e-mail quoting Phil Jones [1228412429.txt], in which Jones discusses deleting some e-mails, does not pertain to the FOI request for IPCC AR4 information. Contrary to the petitioner's assertions that Jones deliberately deleted information to avoid complying with the FOI request, the first sentence of the quoted e-mail [1228412429.txt] clearly refers to a Data Protection Act request, not an FOI request, for Jones' personal communications about a specific person (i.e., "a certain Canadian," presumably Stephen McIntyre). We also note that Phil Jones does not discuss, as the petitioners have asserted, deleting e-mails to avoid revealing something "serious" about preparation of AR4. In fact, he does not state any intentions whatsoever to avoid complying with any requests (whether Data Protection Act or FOI) by deleting e-mails; he simply states that he happened to delete a portion of his e-mails two months ago prior to receiving the Data Protection Act request. These e-mails may or may not have had anything to do with the drafting of the AR4; it is not clear from the e-mails themselves.

The petitioners exaggerate the importance of the requested information pertaining to the IPCC AR4, implying that the information requested was central to the workings of the IPCC report writing process. We respond to this issue in our response (3-49) above. We provide further discussion of the transparency of IPCC review processes in Volume 2, Section 2.2. As described above, the petitioners' evidence does not show that the formal, public process for submissions and review of comments was not fully robust or was hindered or disrupted, or that the opinions expressed in the e-mails produced any less robust or scientifically valid public comment review process on the science for the assessment report.

As described above, the investigations of the CRU scientists found that they conducted their research with scientific integrity and rigor, and with no indications of scientific malpractice. Although we agree that there is room for improvement in terms of transparency, we also find that the petitioners greatly exaggerate the implications of these process issues for the validity of the science in this area. We find that the CRU e-mail authors conducted their research in accordance with common practice in the climate science community at the time and utilized methods which are "fair and satisfactory" according to the Scientific Appraisal Panel. Petitioners' evidence concerning a request for information on e-mails considered to be informal communications does not change this conclusion.

Comment (3-51):
The Coalition for Responsible Regulation, Peabody Energy, and the State of Texas cite e-mails allegedly showing scientists attempting to avoid complying with a FOI request by saying that the IPCC, as an international institution, was not subject to the UK FOI law. As evidence, the Coalition for Responsible Regulation, the State of Texas, and Peabody Energy quote the following e-mail from Phil Jones:

> The skeptics will try to hang on to something, but I don't want to give them something clearly tangible. Keith/Tim still getting FOI requests as well as MOHC [Met Office Hadley Center] and Reading. All our FOI officers have been in discussions and are now using the same exceptions not to respond — advice they got from the Information Commissioner. As an aside and just between us,

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> it seems that Brian Hoskins has withdrawn himself from the WG1 Lead nominations. It seems he doesn't want to have to deal with this hassle. The FOI line we're all using is this. IPCC is exempt from any countries FOI – the skeptics have been told this. Even though we (MOHC, CRU/UEA) possibly hold relevant info the IPCC is not part our remit (mission statement, aims etc) therefore we don't have an obligation to pass it on.[103]

Response (3-51):
Regarding this argument, we find that the same e-mail quoted by the petitioner indicates that Phil Jones believed that CRU/UEA received advice from the Information Commissioner that the IPCC, as an international organization, was excepted from the UK FOI. Jones makes a similar statement in another e-mail: "According to the FOI Commissioner's Office, IPCC is an international organization, so is above any national FOI. Even if UEA holds anything about IPCC, we are not obliged to pass it on, unless it has anything to do with our core business - and it doesn't!"[104] We disagree, therefore, that the CRU e-mails show any attempt by the CRU scientists to avoid compliance with FOI; if anything, it shows that the scientists consulting with and following the advice of the UK ICO.

Comment (3-52):
The Coalition for Responsible Regulation argues that the CRU e-mail authors deliberately concealed information pertaining to the IPCC AR4. The petitioner claims that Gavin Schmidt, a manager of the National Aeronautics and Space Administration's (NASA's) temperature database and who participated in the review of EPA's Technical Support Document (TSD) for the Endangerment Finding, was aware that data supporting EPA's conclusions were being hidden from the Agency. The petitioner concludes that "EPA's Findings therefore rely on the input of at least one scientist who knew data were being withheld from review by EPA and the public." As evidence of his involvement, the Coalition for Responsible Regulation quotes an e-mail from Phil Jones to Schmidt:

> The FOI line we're all using is this. IPCC is exempt from any countries FOI - the skeptics have been told this. Even though we (MOHC [Met Office Hadley Center], CRU/UEA) possibly hold relevant info the IPCC is not part our remit (mission statement, aims etc) therefore we don't have an obligation to pass it on.[105]

Response (3-52):
The petitioner's claim that Gavin Schmidt was aware of a "cover up" and deliberate withholding of "data supporting EPA's conclusions" is unsupported." As stated in our response above, it appears that the subject of the FOI request was for personal e-mail communications between authors of IPCC chapter 6 (paleoclimate) regarding expert review comments. There is no mention within the e-mail exchange on this issue, nor does the petitioner present evidence, that

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[103] E-mail file 1219239172.txt, (August 20, 2008), page 1547, line 31 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[104] E-mail file 1228922050.txt, (December 10, 2008), page 1596, line 34 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[105] E-mail file 1219239172.txt, (August 20, 2008), page 1547, line 18 of the PDF version entitled: CRU Emails 1996-2009.pdf. See also 1210341221.txt, (May 9, 2008), page 1493, line 14; and 1228330629.txt, (December 3, 2008), page 1591, line 41.

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the request involved any type of "data" that was withheld form EPA or would affect EPA's review of the science in its Endangerment Finding. As noted above, the e-mail refers to advice received from their respective FOI office as the exemption from FOI, not to any cover-up.

In sum, petitioners' evidence concerning a FOI on communications related to the AR4 does not support their claims concerning the validity of the science underlying the AR4. The evidence indicates that personal communications were at issue, and that it appears that the respective FOI office determined that these were exempt from release. There was a robust and public process for review of comments on the science for the IPCC AR4, and petitioners' claims are not based on scientific arguments or studies showing that this public process failed to achieve its goal, or that the resulting AR4 was scientifically inappropriate or flawed in any way. EPA agrees with the Independent Climate Change E-mails Review's recommendation of greater transparency in the future in this area of research, but petitioners' evidence does not support a conclusion that the science underlying the AR4 and the Endangerment Finding was flawed or mischaracterized.

3.4.3.3 Allegations of Improperly Influencing University FOIA Officials

Comment (3-53):
The State of Texas and Peabody Energy cite an e-mail from Phil Jones of the CRU indicating his hope that university officials and potential requestors might be unaware of UK FOI laws. The State of Texas, the Southeastern Legal Foundation, and Peabody Energy claim that Phil Jones encouraged university officials to ignore FOI requests from people affiliated with the blog ClimateAudit. They quote the following e-mail:

> When the FOI requests began here, the FOI person said we had to abide by the requests. It took a couple of half hour sessions — one at a screen, to convince them otherwise showing them what CA was all about. Once they became aware of the types of people we were dealing with, everyone at UEA (in the registry and in the Environmental Sciences school — the head of school and a few others) became very supportive. I've got to know the FOI person quite well and the Chief Librarian — who deals with appeals. The VC [Vice-Chancellor] is also aware of what is going on — at least for one of the requests, but probably doesn't know the number we're dealing with. We are in double figures.[106]

In a second example, the State of Texas and Peabody Energy quote the following e-mail from Jones as proof that Jones and his colleagues convinced University of East Anglia officials to agree to ignore requests for information from anyone associated with the ClimateAudit blog. The State of Texas claims that the second sentence in the e-mail shows that Jones urged a colleague in Australia to disregard requests for information.

> Nothing much else to say except:
>
> 1. Think I've managed to persuade UEA to ignore all further FOIA requests if the people have anything to do with Climate Audit [CA].
> 2. Had an e-mail from David Jones of BMRC [Bureau of Meteorology Research Centre], Melbourne. He said they are ignoring anybody who has dealings with CA, as

[106] E-mail file 1228412429.txt, (December 4, 2008), page 1593, line 39 of the PDF version entitled: CRU Emails 1996-2009.pdf.

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there are threads on it about Australian sites.

3. CA is in dispute with IPCC (Susan Solomon and Martin Manning) about the availability of the responses to reviewer's [sic] at the various stages of the AR4 drafts. They are most interested here re Ch 6 on paleo.[107]

Response (3-53):
First, we note that in the first example the petitioners quote only part of the e-mail and that later in the same e-mail, Phil Jones states:

> In response to FOI and EIR [Environmental Information Regulations] requests, we've put up some data - mainly paleo data. Each request generally leads to more - to explain what we've put up. Every time, so far, that hasn't led to anything being added - instead just statements saying read what is in the papers and what is on the web site! Tim Osborn sent one such response (via the FOI person) earlier this week. We've never sent programs, any codes and manuals.[108]

The e-mails demonstrate that Phil Jones was not obstructing FOI requests; rather, he clearly indicates that he and his CRU colleagues made data available in response to FOI and other requests. He and others were working with the FOI officer and other university officials to determine the appropriate way to respond to these requests. As noted in our previous responses (e.g., 3-39) above, at the time it was not typical in climate science for authors to publish computer codes or detailed explanations beyond that which was described in the literature. Given this context, Jones' statement—"We've never sent programs, any codes and manuals"[109]—demonstrates his belief that having the raw data is sufficient to be able to replicate CRU's work because the methodologies are freely available in the published literature.

Regarding the second example, the e-mail is written in factual terms, it does not indicate the basis for the BMRC's interactions with persons affiliated with the CA. We also note that the Independent Climate Change E-mails Review spoke to these issues, as described in our previous responses (e.g., 3-39) in this volume. As discussed above, EPA agrees with their recommendation of greater transparency, but disagrees that the evidence presented by petitioners warrants any less reliance on the scientific assessment provided by the AR4.

3.4.4 Summary

Volumes 1 and 2 of this RTP document respond to scientific issues raised by petitioners in these e-mails and affirm that the science and assessment literature on which the Findings are based is sound. As noted in many places in this RTP document, the petitioners' arguments are not based on the body of the scientific evidence and include only a limited discussion of the science itself.

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[107] E-mail file 1182255717.txt, (June 19, 2007), page 1330, line 34 of the PDF version entitled: CRU Emails 1996-2009.pdf.
[108] E-mail file 1228412429.txt, (December 4, 2008), page 1594, line 11 of the PDF version entitled: CRU Emails 1996-2009.pdf
[109] E-mail file 1228412429.txt, (December 4, 2008), page 1594, line 15 of the PDF version entitled: CRU Emails 1996-2009.pdf

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Instead, the petitioners' arguments rely on broad claims based on the e-mails and jump to conclusions about implications for the science that are not supported by evidence.

Petitioners do not rely on science or science based arguments to support their claim that the assessment report resulting from this robust process should not be relied upon by EPA. Instead, petitioners claim that key climate data were withheld from the public when, in fact, our review of the CRU emails indicates that in many cases, the data were already publicly available or were released by the scientists. Petitioners have not explained or shown why the amount of data and other information that was available was not adequate for researchers to replicate or otherwise evaluate key findings, or to conduct other research. They also rely on unsupported conclusions drawn from e-mails concerning a FOI request for personal communications between various scientists, where it appears that the appropriate University FOI officers had determined that these emails were exempt from release. This evidence does not support petitioners' claims that the IPCC AR4 should not be considered as part of the scientific basis for the Endangerment Finding.

EPA agrees with the results of the various independent investigations into the CRU e-mails, which found that the scientists at issue conducted their research with scientific integrity and rigor, the research utilized methods which are fair and satisfactory, and that their actions were consistent with the common practice in climate research at that time. EPA also agrees with the recommendations of the Independent Climate Change E-mails Review supporting greater transparency in the future in this area of climate research; however, concluding that greater transparency would be helpful for a particular element of climate change science is not the equivalent of providing evidence that the scientific basis for EPA's Endangerment Finding is flawed. Petitioners' claims and evidence do not provide a basis for EPA to question or change its view that the science supporting the Endangerment Findings is robust, compelling, and has been appropriately characterized by EPA.

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To: Schnare, David[schnare.david@epa.gov]
From: DWSschnare
Sent: Wed 2/22/2017 12:49:17 AM
Subject: Fwd: Endangerment finding process
RM-response.GHG Endangerment Finding Redux.docx

Sent from my iPad

Begin forwarded message:

From: Ross McKitrick Personal Email/Ex. 6
Date: February 21, 2017 at 11:53:23 AM EST
To: David Schnare Personal Email/Ex. 6 Marlo Lewis <Mlewis@cei.org>
Subject: Re: Endangerment finding process

Please see attached.
Ross

On 2017-02-20 3:53 PM, David Schnare wrote:

I'd like your private comments on the attached. Please do not forward this to anyone and please do not discuss it with others.
David

--
David W. Schnare, Esq. Ph.D.

SOME NOTES (Interspersed comments follow)

Identifying the questions
There are three distinct questions here. (1) Is there a case for the EF to be reconsidered? (2) If a reconsideration is undertaken, can it be shown that key evidence on which it was originally based has weakened or changed? (3) If a new EF were considered, would a finding of non-endangerment be a likely outcome?

In my view the answers are as follows.

(1) Yes, the document sets out ample reasons to reconsider, including the receipt of petitions, Administrative direction, Congressional requests and the failure to deal with the IG findings.

(2) Yes, this would be straightforward. Some key lines of evidence in the TSD have been overturned. Three come immediately to mind: The absence of the tropical hotspot, evidence of contamination of the surface temperature record, and new evidence of low climate sensitivity. Regarding the first two, EPA staff ignored relevant evidence available at the time, and since even then more has been published that undermines the position taken in the TSD. Regarding the third, there is ample new evidence that points to materially lower climate sensitivity than that assumed in climate models and this directly affects Social Cost of Carbon calculations in such a way that calls into question whether the SCC is even a positive number. On this point, my paper with Kevin Dayaratna and David Kreutzer, which we presented at Heritage last week, has just been accepted for publication at the peer-reviewed journal *Climate Change Economics*. The IWG has completely ignored this issue so their work can't be cited in response, and likewise the NAS panel didn't deal with this issue.

(3) In my view yes, it would be straightforward to pass the reasonableness test, and to do so while avoiding any appearance of arbitrary or capricious action. The document you have provided sets forth a procedure that appears adequate to withstand judicial challenge. However, even if a court were to remand a finding of non-endangerment, I believe that Sct 202(b) would allow the Administrator to suspend action indefinitely, based on the following point.

Inconsistency between the alleged harm and the proposed remedy
The greens exploited the looseness of the phrase "cause or contribute" to their advantage, but Sct. 202(b) might be used to turn the looseness against them. They exploited the wording to say that while CO_2 is not itself harmful, there is harm connected to future warming. But their own models show that reducing CO_2 emissions will not alleviate this harm. Sct 202(b) requires the Administrator to await development and application of the "appropriate" technology, and to give appropriate consideration to the cost of compliance. On this basis, Sct. 202(b) seems to forbid current action. To wit:
(a) The Endangerment finding did not apply to CO_2 directly as an inhalant per se, since CO_2 at ambient concentrations, and even many multiples of same, are harmless to humans and beneficial to plants. Instead the Endangerment finding was entirely premised on its indirect effects on climate. Therefore the remedy imposed by the Administrator must be expressed in terms of amelioration of indirect effects on climate, not on the reduction of CO_2 emissions themselves.
(b) The same models that were cited in the TSD also show that full implementation of Kyoto, Paris, CPP and all related measures authorized under the CAA would have no material effect on the climate. Consequently the requisite technology does not currently exist to address the alleged Endangerment.
(c) Additionally, consideration of the cost will reasonably weigh the compliance costs against the effectiveness of the remedy. Since the proposed remedy does not reliably or materially alleviate the

alleged harm, any cost is unreasonable. This is especially the case when the cost is as steep as it is in the case of compliance with climate rules.

I have interspersed further comments in red below.

GHG Endangerment Finding Redux

Why reconsider the GHG Endangerment Finding?

- The President has no faith in the 2009 finding, believes regulation under that finding is inappropriate, has directed reconsideration as a primary element in his EPA Action Plan, is expected to direct reconsideration in his forthcoming executive orders on climate, and is expected to direct EPA to grant any petitions seeking reconsideration.
- Letters from House and Senate leadership are being prepared and will ask the Administrator to reconsider the finding.
- EPA has already received two petitions for reconsideration. **These considerations seem more than adequate for the matter.**
- If the reconsideration finds no endangerment, it automatically provides the authority needed to withdraw several high-cost, low-value rules (which we will need in order to meet the 2:1 reg and 1:1 cost requirements in the regulatory reform executive order), something that will save enormous amounts of time and effort in place of reconsidering each of those rules under notice and comment rulemaking.
- The Inspector General held that the 2009 finding was improperly done, a finding the Obama administration simply ignored. **This point needs to be highlighted in the public documentation of the decision to reconsider. Also, the fact that the EPA did not deem the TSD a HISA ought to have prevented Agency staff from promulgating expensive rules.**
- Climate science completed since the 2009 finding significantly undercuts the finding. **Yes, specifically with regards to the premises upon which the TSD was based. It will be important to focus attention on the narrow grounds upon which the original decision was made. Agency staff and their academic allies will try to move the goal posts, in effect saying "yes you're right, those argument are overturned, but now we have new arguments." This is a typical IPCC procedure. As soon as the evidence upon which the last Assessment gets debunked, they trot out a new line of evidence, so that the conclusions never change. By the time we have debunked the new line of evidence, they move on again. So at the point in the process where the original Endangerment finding is being examined, the entire focus must be on the evidence that was put forward in the 2009 finding, and Agency staff must not be permitted to trot out new lines of evidence or argumentation. New evidence can be considered when a new Endangerment review is undertaken, but then it calls into question the credibility of the proponents of Endangerment if they abandon evidence that they previously deemed pivotal now that it goes against their preferred position, and they try instead to rely on evidence that emerged only after they had already declared the science was "settled."**
- The Clean Air Act §202(a)(1) specifically authorizes revision of the finding.
- EPA has concluded that the rules emerging from the finding will have no significant effect on

climate (as measured by average global temperature) and thus do not significantly contribute to the GHG pollution needed to cause or contribute to endangerment. **This is awkwardly worded. The point is that the rules do not significantly contribute to alleviating the alleged endangerment. It is a situation akin to a proposal for regulating the color of men's shoes in the hopes of reducing urban NOx levels. Even if it could be shown that the regulation would not cost too much to implement, it must surely be a principle acceptable to the courts that if the proposed rule would have no effect on the alleged problem, then it can be blocked as an unreasonable action.**

- EPA currently expends approximately $100 million a year on climate activities grounded on the finding, funds that otherwise could be used to ameliorate traditional environmental harms. **Or simply cut from the budget. Presumably there is already funding in place to deal with criterion air and water contaminants, including in state-level budgets.**

How would EPA go about the reconsideration?

- In conducting its reconsideration of the finding, EPA will follow the procedures established under CAA § 307.
- EPA can only survive legal challenges to a new finding if it has a reasonable basis for its decision. The Agency's decision will be rejected and remanded if any of the following are found:
    - EPA offered no reasons for its finding; **Not a problem**
    - EPA offered an explanation for its decision that runs counter to the evidence before the agency; **Not a problem, as long as focus is placed on the evidence cited in the 2009 decision**
    - EPA used an explanation that is so implausible that it could not be ascribed to a difference in view or the product of agency expertise; **Not a problem**
    - There is inadequate data upon which EPA could make a decision; **Not a problem**
    - The finding is based upon scientific study's conclusions which are more limited than the finding and which cannot be validly extended to support the finding; **Not a problem. If anything this is a problem for the original decision. When it is time to make new arguments, we can, for instance, point to the evidence from IAMs that the SCC may not even be a positive number, per the new paper by Dayaratna et al. The other side will try to bring out some new and very shaky evidence on the effect of GHG on long term economic growth, but these studies can be shown to be very problematic.**
    - EPA used procedures to reach a final determination that reflect arbitrary and capricious action. **Not a problem**
- EPA must build a record of its decision-making process that can withstand judicial review and create public confidence in the process and its outcome.
- EPA has the tools to apply a 100 percent transparent process through "e-regulation" and use of available internet communication opportunities.
    - The process of making a finding consists of multiple decision points. EPA would seek comment on each decision point in appropriate sequential order through both a web page and the e-regulation system, allowing those making comments on the web page to also enter their comments into the official administrative record.

- EPA would use the Federal Register to notify the public of each new decision point on which it seeks comment. **It seems to me a challenge is going to be whether you can rely on Agency staff. There will be a heavy burden of responding to comments and developing effective counter-arguments. Agency staff may try to throw the fight in this process. Will you be relying on external contractors to oversee the staff?**

- EPA would identify the new endangerment finding as a "Highly Influential Scientific Assessment" which requires the Agency to rigorously apply its Information Quality Act guidelines, and conduct its own peer review. **This is an important point. It would be a good idea to enshrine in the rules that IPCC reports do not qualify under the HISA requirements. I have written extensively on problems in the IPCC peer review process. The Inter-Academy Council conducted a review in 2010 and recommended procedural changes to strengthen the IPCC, but they subsequently ignored or subverted them and nothing was fixed. It would serve the right at this point if US lawmakers disqualified IPCC reports for rulemaking purposes.**

- EPA would only rely on information, data and studies where the original data upon which assessment is based is available to the public and in the administrative record. EPA would not rely on any study whose authors refuse to provide the underlying data, including computer code used to evaluate and analyze the data. **It is high time for a rule like this. A long list of paleoclimate studies could be disqualified. And there are other areas besides climate where such a rule would lead to papers being disqualified from consideration, including some of the air pollution/epidemiology literature, CDC obesity studies, etc. I did a paper for the Fraser Institute on this with Bruce McCullough of Drexel University a few years ago. See**

http://www.rossmckitrick.com/uploads/4/8/0/8/4808045/thecaseforduediligence_fiedition.pdf

- EPA would rely exclusively on data and not on opinion or conclusions, regardless of how authoritative the source. **Be careful with this, it's a tricky one in climate. There's no "climate data" to speak of since no one can measure the climate; they don't even agree on what the definition of climate (as opposed to weather) is. All we have are weather observations of uneven quality that get processed based on assumptions and ad hoc reasoning. You can certainly insist that appeals to authority will have no weight, including surveys of scientific opinion, expert society statements etc.**

  Regarding society statements, you should always take the position that you will not pay any attention to statements from expert societies unless they are accompanied by the signatures of all the individual members of the society who specifically endorsed the statement, as well as a listing of all the members who declined to endorse it, with the endorsements representing such an overwhelming majority that the statement can, in fact, be deemed to be a consensus position. The number of statements that currently meet this requirement is precisely zero.

- EPA would begin by examining and taking comment on the meaning of the phrase "which in his [the Administrator's] judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare." **I argue that if the conditions of alleged danger are, in fact, indistinguishable from conditions in which large numbers of the public routinely choose to live and even prefer to alternative conditions in which the alleged dangers are absent, then endangerment cannot be said to exist. Then I'd point to the migration patterns within the US over the past 50 years in which people have proportionately left the inland Northeast and Midwest regions and moved to the stormy Atlantic coast, arid Southwest desert and hot, coastal California. In this way they have voluntarily, and indeed at**

great cost, left behind the climate conditions associated with the pre-industrial Northern Hemisphere average and sought out the climate conditions identified in climate models as the "dangerous" future, namely hotter, more susceptible to extremes and closer to rising sea levels.

- The Agency would then seek information necessary to apply the phrase as parsed, building lines of evidence with regard to each phrase and strictly applying the Information Quality Act guidance and Peer Review process to vet all data and determine the scientific basis for data summarizations and proposed findings. **Here I would again point to the evidence of low climate sensitivity and the fact that mainstream science & economics can't even establish a positive SCC. From there we can invoke many other lines of argumentation, including the poor forecast performance of climate models and the fact that the strongest warming patterns appear in the crappiest data sets, including the NOAA and GISS surface compilations. The best data (buoys and satellites) show the least warming.**
- The Agency would obtain contractor support to help develop the scientific lines of evidence and would either rely on an existing FACA panel or create one or more new ones to ensure adequate independent peer review. The open public process (crowd sourcing) would also serve to provide independent peer review. **Here you will need to be careful to prevent hostile Agency staff from deliberately flubbing the process so as to create a comment/response record that appears to concede to the alarmists.**
- The Agency would regularly brief the Administrator and Congressional committees on the progress of the reconsideration and invite scientific groups to fully participate in the findings process. **Subject to the requirement that statements will only be taken from individuals, and "Society" statements will have no weight unless accompanied by signatures of all individual members who endorse it, and a listing of all who declined to do so.**
- Upon completion of its analyses and data summarization, and pursuant to § 307(d) of the Clean Air Act, the Agency would prepare a proposed finding, take further comment and make a final finding.
- Because of the highly influential nature of the finding and its ramifications world-wide, EPA will build its technical support document and respond to comments made on each section of the document during development of the finding, thus minimizing the need to further respond to comments at the proposal stage.

To: Schnare, David[schnare.david@epa.gov]
From: David Schnare
Sent: Mon 2/20/2017 8:54:18 PM
Subject: Redux
GHG Endangerment Finding Redux.docx
Virelli criteria applied to Endangerment Finding.docx

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David W. Schnare, Esq. Ph.D.

GHG Endangerment Finding Redux

Why reconsider the GHG Endangerment Finding?

- The President has no faith in the 2009 finding, believes regulation under that finding is inappropriate, has directed reconsideration as a primary element in his EPA Action Plan, is expected to direct reconsideration in his forthcoming executive orders on climate, and is expected to direct EPA to grant any petitions seeking reconsideration.
- Letters from House and Senate leadership are being prepared and will ask the Administrator to reconsider the finding.
- EPA has already received two petitions for reconsideration.
- If the reconsideration finds no endangerment, it automatically provides the authority needed to withdraw several high-cost, low-value rules (which we will need in order to meet the 2:1 reg and 1:1 cost requirements in the regulatory reform executive order), something that will save enormous amounts of time and effort in place of reconsidering each of those rules under notice and comment rulemaking.
- The Inspector General held that the 2009 finding was improperly done, a finding the Obama administration simply ignored.
- Climate science completed since the 2009 finding significantly undercuts the finding.
- The Clean Air Act §202(a)(1) specifically authorizes revision of the finding.
- EPA has concluded that the rules emerging from the finding will have no significant effect on climate (as measured by average global temperature) and thus do not significantly contribute to the GHG pollution needed to cause or contribute to endangerment.
- EPA currently expends approximately $100 million a year on climate activities grounded on the finding, funds that otherwise could be used to ameliorate traditional environmental harms.

How would EPA go about the reconsideration?

- In conducting its reconsideration of the finding, EPA will follow the procedures established under CAA § 307.
- EPA can only survive legal challenges to a new finding if it has a reasonable basis for its decision. The Agency's decision will be rejected and remanded if any of the following are found:
    - EPA offered no reasons for its finding;
    - EPA offered an explanation for its decision that runs counter to the evidence before the agency;
    - EPA used an explanation that is so implausible that it could not be ascribed to a difference in view or the product of agency expertise;
    - There is inadequate data upon which EPA could make a decision;
    - The finding is based upon scientific study's conclusions which are more limited than the finding and which cannot be validly extended to support the finding;
    - EPA used procedures to reach a final determination that reflect arbitrary and capricious

action.

- EPA must build a record of its decision-making process that can withstand judicial review and create public confidence in the process and its outcome.
- EPA has the tools to apply a 100 percent transparent process through "e-regulation" and use of available internet communication opportunities.
    - The process of making a finding consists of multiple decision points. EPA would seek comment on each decision point in appropriate sequential order through both a web page and the e-regulation system, allowing those making comments on the web page to also enter their comments into the official administrative record.
    - EPA would use the Federal Register to notify the public of each new decision point on which it seeks comment.
- EPA would identify the new endangerment finding as a "Highly Influential Scientific Assessment" which requires the Agency to rigorously apply its Information Quality Act guidelines, and conduct its own peer review.
- EPA would only rely on information, data and studies where the original data upon which assessment is based is available to the public and in the administrative record. EPA would not rely on any study whose authors refuse to provide the underlying data, including computer code used to evaluate and analyze the data.
- EPA would rely exclusively on data and not on opinion or conclusions, regardless of how authoritative the source.
- EPA would begin by examining and taking comment on the meaning of the phrase "which in his [the Administrator's] judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare."
- The Agency would then seek information necessary to apply the phrase as parsed, building lines of evidence with regard to each phrase and strictly applying the Information Quality Act guidance and Peer Review process to vet all data and determine the scientific basis for data summarizations and proposed findings.
- The Agency would obtain contractor support to help develop the scientific lines of evidence and would either rely on an existing FACA panel or create one or more new ones to ensure adequate independent peer review. The open public process (crowd sourcing) would also serve to provide independent peer review.
- The Agency would regularly brief the Administrator and Congressional committees on the progress of the reconsideration and invite scientific groups to fully participate in the findings process.
- Upon completion of its analyses and data summarization, and pursuant to § 307(d) of the Clean Air Act, the Agency would prepare a proposed finding, take further comment and make a final finding.
- Because of the highly influential nature of the finding and its ramifications world-wide, EPA will build its technical support document and respond to comments made on each section of the document during development of the finding, thus minimizing the need to further respond to comments at the proposal stage.

Cross-check of Finding with the Virelli Deconstruction

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In examining the endangerment findings, and comparing the basis for them with new information that has since become available, it is critical to note where EPA's 2009 decisions failed to meet the requirements of the Administrative Procedures Act ("APA"). By correcting those failings through consideration of new information or information not previously considered

EPA may, and we argue will, come to the inevitable finding that known and predicted increases in levels of greenhouse gases did not and will not endanger human health and the environment. The keystone to evaluating EPA's 2009 decisions under the APA is a determination as to whether an agency considered the "relevant factors" before making its policy decision.[1] Whether it considered the existence and quality of the administrative record supporting the agency's decision,[2] the presence and persuasiveness of the agency's explanation for that decision,[3] and the "rational connection" between the agency's explanation and its ultimate policy position in determining arbitrariness.[4]

> "In all cases agency action must be set aside if the action was 'arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law' or if the action failed to meet statutory, procedural, or constitutional requirements. 5 U. S. C. §§ 706 (2)(A), (B), (C), (D). [Fundamentally,] the agency action is to be set aside if the action was not supported by "substantial evidence." And in other equally narrow circumstances the reviewing court is to engage in a de novo review of the action and set it aside if it was 'unwarranted by the facts.'"

Citizens to Preserve Overton Park, Inc. v. Volpe, 401 U.S. 402, 414 (U.S. 1971).

In layman's terms, the question is whether EPA[5] took a "hard look" at the facts and arguments supporting its decision and whether there is a rational linkage from those facts to the ultimate decision. In looking at this question, the courts apply different standards of review depending on the step within the decision process that is being examined. Virelli "deconstructed" the decision-making process and identified the standard of review the courts have used for each step in that process.[6] We use the Virelli deconstruction to organize this examination of EPA's 2009 decisions and to identify they gaps in the process that, once filled, would result in a likely different set of findings.

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[1] State Farm Mutual Automobile Insurance Company, 463 U.S. 29, 43 (1983) (citing Bowman Transp. Inc. v. Arkansas-Best Freight Sys., 419 U.S. 281, 285 (1974)).

[2] Citizens to Preserve Overton Park, Inc. v. Volpe, 401 U.S. 402, 420 (U.S. 1971).

[3] *State Farm*, 463 U.S. at 52.

[4] *Id*. at 43.

[5] *Sierra Club v. Hodel*, 848 F.2d 1068, 1093 (10th Cir. Utah 1988) ("The Supreme Court has emphasized that it is the agency, not the district court, which is to take that hard look:

> "Neither the statute nor its legislative history contemplates that a court should substitute its judgment for that of the agency as to the environmental consequences of its actions. The only role for a court is to insure that the agency has taken a 'hard look' at environmental consequences; it cannot 'interject itself within the area of discretion of the executive as to the choice of the action to be taken.'"

Kleppe v. Sierra Club, 427 U.S. 390, 410, 49 L. Ed. 2d 576, 96 S. Ct. 2718 n.21 (1976) (citations omitted)).

[6] Virelli, Louis J., "*Deconstructing Arbitrary and Capricious Review*," 92 N.C.L. Rev. 721 (2014).

I. BUILDING THE RECORD

There are two records an agency builds. One is the basis for their decision. The other is the record they place before the court. The courts find two record building acts arbitrary and capricious, (i) where the basis for the decision is deficient or incomplete; (ii) where the public was not given notice and an opportunity to comment on the record used in decision-making; and, (iii) where the record placed before the court is incomplete.

A. The Standard of Review

Adequate basis for decision-making: [P4] [S2] [S3?]

Motor Vehicle Mfrs. Ass'n of the U.S. v. State Farm Mut. Auto. Ins. Co., 463 U.S. 29, 46 (1983) (finding arbitrariness because the Agency failed to develop an adequate record *i.e.* "apparently gave no consideration whatever" to the viability of an airbags-only requirement).

First Girl, Inc. v Regional Manpower Adm'r of United States Dep't of Labor (1973, ND Ill) 361 F Supp 1339, affd (1974, CA7 Ill) 499 F2d 122.Where there was no evidence in record supporting Labor Department determination denying employment certification to alien stenographers seeking to enter United States, reviewing officer abused his authority in denying plaintiff's application therefor.

Montessori Children's House & School, Inc. v Secretary of Labor (1977, ND Tex) 443 F Supp 599.Secretary of Labor abuses discretion in failing to issue employment certificate for alien teacher under § 212(a)(14)(B) of Immigration and Nationality Act (8 USCS § 1182(a)(14)(B)), and case would be remanded to Secretary with instructions to grant certification without delay (5 USCS § 706), where in four hearings Secretary had failed to demonstrate that potentially there were qualified American employees available for jobs in question, and therefore Secretary should have issued employment certification for alien to teach at Montessori school.

Lobsters, Inc. v Evans (2004, DC Mass) 346 F Supp 2d 340. National Marine Fishery Service imposition of civil penalties and license revocation based on its determination that fishermen unlawfully fished in closed area on two occasions was arbitrary, capricious, and not supported by substantial evidence, as required by Administrative Procedure Act, 5 USCS § 706(2)(A), because agency considered prior offenses by fishermen that were more than five years old, contrary to agency's policy to not do so.

Walter O. Boswell Memorial Hospital v Heckler (1984, App DC) 242 US App DC 110, 749 F2d 788. Reliance by agency upon single study criticized extensively by its authors in its particular application may be arbitrary and capricious in absence of agency explanation for its actions contrary to evidence before it.

National Citizens Committee for Broadcasting v FCC (1977, App DC) 181 US App DC 1, 555 F2d 938, 2 Media L R 1405, affd in part and revd in part on other grounds *(1978) 436 US 775, 56 L Ed 2d 697, 98 S Ct 2096, 3 Media L R 2409.* Decision must be considered arbitrary and capricious if facts on which it is purportedly based are not supported by the record; however, factual certainty is not necessary; agency may regulate even though facts do not illuminate clear path.

Adequate basis for public comment: [P3]

United States v. Nova Scotia Food Prods. Corp., 568 F.2d 240, 252 (2d Cir. 1977) ("When the basis for a proposed rule is a scientific decision, the scientific material which is believed to support the rule should be exposed to the view of interested parties for their comment.").

Adequate record for judicial review: [P1]

Overton Park, 401 U.S. at 420; *Pension Benefit Guar. Corp. v. LTV Corp.*, 496 U.S. 633, 654 (1990) ("At most, *Overton Park* suggests that [the APA's arbitrary and capricious standard] imposes a general 'procedural' requirement of sorts by mandating that an agency take whatever steps it needs to provide an explanation that will enable the court to evaluate the agency's rationale . . . .")

Bowman Transportation, Inc. v. Arkansas-Best Freight System, Inc., 419 U.S. 281, 294-300 (1974) (five-year time lapse between the close of the ICC's evidentiary hearings and the Agency's final decision; holding "that there is sound basis for adhering to our practice of declining to require reopening of the record, except in the most extraordinary circumstances")

National Welfare Rights Organization v Mathews (1976, App DC) 174 US App DC 410, 533 F2d 637.Judicial review is meaningless where administrative record is insufficient to determine whether action is arbitrary and capricious, and, even within narrow scope of review mandated in evaluation of rulemaking procedures, support for agencies actions must appear in record.

Walter O. Boswell Memorial Hospital v Heckler (1984, App DC) 242 US App DC 110, 749 F2d 788. Reliance by agency upon single study criticized extensively by its authors in its particular application may be arbitrary and capricious in absence of agency explanation for its actions contrary to evidence before it.

St. Joseph's Hospital v Heckler (1984, DC Ariz) 583 F Supp 1545, remanded without op (1986, CA9 Ariz) 796 F2d 479.Agency reliance upon empirical study validity of which was questioned by authors is error; agency failure to consider numerous negative responses before taking final action based solely upon questionable empirical study is arbitrary and capricious.

Fund for Animals v Norton (2003, DC Dist Col) 294 F Supp 2d 92, 58 Envt Rep Cas 1208, 34

ELR 20010, stay den, injunction den (2004, App DC)reversal of agency's views in two years without reasoned explanation was arbitrary and capricious.

Atlantic, Ltd. v Hudson (1983, ED Va) 574 F Supp 1381Grounds upon which agency acted must be clearly disclosed in and sustained by record; rationalization of agency action by counsel in brief and in argument does not cure noncompliance by agency.

Ratnayake v Mack (1974, CA8 Minn) 499 F2d 1207. It was reviewable abuse of discretion by Secretary of Labor to deny labor certification under 8 USCS § 1182 where Secretary failed to determine if unemployed and underemployed American teachers in United States were willing and as capable, because of specialized training, as petitioner to teach in Montessori schools.

National Welfare Rights Organization v Mathews (1976, App DC) 174 US App DC 410, 533 F2d 637. Judicial review is meaningless where administrative record is insufficient to determine whether action is arbitrary and capricious, and, even within narrow scope of review mandated in evaluation of rulemaking procedures, support for agencies actions must appear in record.

Seo v U. S. Dep't of Labor (1975, CA9 Cal) 523 F2d 10. Secretary of Labor abused his discretion in denying nonimmigrant visitor alien employment certificate where refusal was based solely on state agency employment listings without further investigation.

B. To what this standard applies in the findings process

II. THE BASIS AND PURPOSE OF THE DECISION [S4]

An agency must act within the confines of the statute under which it regulates and is required to provide to the public an explanation regarding both the authority for its discretion and the purpose for its action. Administrative Procedure Act, 5 U.S.C. § 553(c) (2012). The court reviews this only with regard to ensuring the agency has operated within those boundaries.

A. The Standard of Review

Explained basis and purpose:

Hoving Corp. v Federal Trade Com. (1961, CA2) 290 F2d 803.Regulations will not be declared void merely because of purely technical flaw in failing to include within rules themselves concise general statement of **basis and purpose** as required under 5 USCS § 553 where both **basis and purpose** are obvious from specific governing legislation and entire trade was fairly apprised of **basis and purpose** by procedure followed.

Failure to include statement of statutory authority renders rulemaking unauthorized. Global Van Lines, Inc. v Interstate Commerce Com. (1983, CA5) 714 F2d 1290.

Regulations with no statement of purpose may be upheld where agency's purpose is considered obvious and unmistakable. Citizens to Save Spencer County v United States EPA (1979, App DC) 195 US App DC 30, 600 F2d 844, 12 Envt Rep Cas 1961, 9 ELR 20194.

Failure to incorporate in rule adopted concise general statement of **basis and purpose** renders agency action invalid; post hoc issuance of **basis and purpose** statement is unacceptable substitute for contemporaneous statement. Action on Smoking & Health v Civil Aeronautics Bd. (1983, App DC) 230 US App DC 1, 713 F2d 795.

Even when **basis and purpose** statement is cursory or nonexistent, rule may be upheld when agency's path may reasonably be discerned.Mobil Oil Corp. v Department of Energy (1983, Em Ct App) 728 F2d 1477, cert den (1984) 467 US 1255, 82 L Ed 2d 849, 104 S Ct 3545.

Found operating within the legislative mandate:

it is duty of courts to interpret statute under which agency functions and to determine whether agency is acting within congressional purpose. *Frank Irey, Jr., Inc. v OSHRC (1974, CA3) 519 F2d 1200, 2 BNA OSHC 1283, 3 BNA OSHC 1329,* affd *(1977) 430 US 442, 97 S Ct 1261, 51 L Ed 2d 464* (superseded by statute on other grounds as stated in *In re United Mo. Bank, N.A. (1990, CA8 Mo) 901 F2d 1449, 20 BCD 644, 22 CBC2d 1400, CCH Bankr L Rptr P 73344, 18 FR Serv 3d 621).*

It is exclusive province of agency to make findings of fact, to draw legitimate inferences therefrom and to evaluate and determine weight to be given conflicting evidence; however, it is duty of reviewing court to determine whether course followed by agency is consistent with its mandate from Congress: agency must set forth clearly grounds on which it acted and justify and explain any departure from prior norms. *Scott Paper Co. v United States (1974, ED Pa) 372 F Supp 721,* affd *(1974) 419 US 807, 42 L Ed 2d 38, 95 S Ct 26.*

Strycker's Bay Neighborhood Council, Inc. v. Karlen, 444 U.S. 223, 227 (U.S. 1980) ("once an agency has made a decision subject to NEPA's procedural requirements, the only role for a court is to insure that the agency has considered the environmental consequences").

Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 351 (U.S. 1989) ("it would not have violated NEPA if the Forest Service, after complying with the Act's procedural prerequisites, had decided that the benefits to be derived from downhill skiing at Sandy Butte justified the issuance of a special use permit, notwithstanding the loss of 15 percent, 50 percent, or even 100 percent of the mule deer herd.").

State Farm, 463 U.S. at 43 ("the agency has relied on factors which Congress has not intended it to consider").

North Carolina v. Federal Aviation Admin., 957 F.2d 1125, 1130 (4th Cir. N.C. 1992) ("At the

time it issued its final rule, the FAA had not revised its Handbook to comply with the CEQ's regulations about adoption of another federal agency's environmental documentation. Nevertheless, we conclude that the FAA's acquiescence in the CEQ regulations, its independent review and adoption of the Navy's supplemental environmental assessment, and the issuance of its own FONSI, were sufficient to comply with NEPA and the CEQ regulations.”).

Texas Committee on Natural Resources v. Marsh, 736 F.2d 262, 268 (5th Cir. Tex. 1984) (“The Corps considered the recommendations of the USFWS and articulated its reasons for rejecting those recommendations. In doing so, it fulfilled its statutory obligations.”).

Sierra Club v. Hodel, 848 F.2d 1068, 1091 (10th Cir. Utah 1988) (identifying the boundaries of permissible statutory authorities and the lack of arbitrary and capricious behavior when operating within those boundaries.)

Outside the bounds of the statute

Soler v G & U (1985, SD NY) 615 F Supp 736, 27 BNA WH Cas 435, 105 CCH LC P 34846, revd on other grounds, remanded (1987, CA2 NY) *833 F2d 1104, 28 BNA WH Cas 593, 107 CCH LC P 34995,* cert den *(1988) 488 US 832, 109 S Ct 88, 102 L Ed 2d 64, 1 BNA WH Cas 2d 168* and affd in part and set aside in part (1991, SD NY) *768 F Supp 452, 119 CCH LC P 35507.* Although administrative decision must be given due deference, decision cannot stand if it is inconsistent with intent of Congress or would defeat purpose of relevant statute.

B. To what this standard applies in the findings process

III. THE INPUT QUALITY UNDERLYING THE DECISION

In decisions involving scientific or technical information, an agency must have processes in place to ensure the reliability or veracity of the informational inputs to its policy decisions and must use them. This is not to be confused with inadequate agency reasoning. Rather, it goes to the heart of an agency knowing it has bad data, also has good data, but uses the bad data, either to dilute the persuasiveness of the good data or to replace good with bad.

A. The Standard of Review

Lack of factual support and Obtaining the unobtainable

FCC v. Fox Television Stations, Inc., 556 U.S. 502, 519 (2009) (“There are some propositions for which scant empirical evidence can be marshaled . . . . It is one thing to set aside agency action . . . because of failure to adduce empirical data that can readily be obtained. It is something else to insist upon obtaining the unobtainable.” (internal citation omitted)).

Brae Corp. v United States (1984, App DC) 238 US App DC 352, 740 F2d 1023, cert den *(1985) 471 US 1069, 85 L Ed 2d 505, 105 S Ct 2149.* Although court does not require complete factual support in record for agency judgment or prediction where it is not possible, when facts relied upon by commission are insufficient by themselves to support ultimate conclusion with certainty, commission must identify uncertainties, explain why it acted prior to engaging in search for further evidence, and state what considerations led it to resolve uncertainties as it did.

Super Deference

Deference to agencies on scientific matters is routine, but there is no case using the term "super deference" in the federal courts. Further, courts address challenges to information quality under the relevant factors test, or consideration on if the agency entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or [an explanation that] is so implausible that it could not be ascribed to a difference in view or the product of agency expertise, all per *State Farm*.

Greater Yellowstone Coalition, Inc. v. Servheen, 665 F.3d 1015, 1028 (9th Cir. Mont. 2011) ("We recognize that scientific uncertainty generally calls for deference to agency expertise. See Lands Council v. McNair, 537 F.3d 981, 993 (9th Cir. 2008) (en banc) ("We are to be most deferential when the agency is making predictions, within its area of special expertise, at the frontiers of science." (internal quotation marks and brackets omitted)). But we nonetheless have a responsibility to ensure that an agency's decision is not arbitrary. See id. It is not enough for the Service to simply invoke "scientific uncertainty" to justify its action. As the Supreme Court has explained, "[r]ecognizing that policymaking in a complex society must account for uncertainty . . . does not imply that it is sufficient for an agency to merely recite the terms 'substantial uncertainty' as a justification for its actions." *State Farm*, 463 U.S. at 52. The Service must rationally explain why the uncertainty regarding the impact of whitebark pine loss on the grizzly counsels in favor of delisting now, rather than, for example, more study. See id. Otherwise, we might as well be deferring to a coin flip.

Lands Council v. McNair, 537 F.3d 981, 992-993 (9th Cir. Idaho 2008) we defer to the Forest Service as to what evidence is, or is not, necessary to support wildlife viability analyses.

Were we to grant less deference to the agency, we would be ignoring the APA's arbitrary and capricious standard of review. Ecology Center illustrates the consequences of failing to grant appropriate deference to an agency. In *Ecology Center*, [993] we rejected reports establishing

that soil analysis was conducted in the project area as "too few and of poor quality." See 430 F.3d at 1073 (McKeown, J., dissenting). We stated, "[t]he record provides little information that enables us to assess the reliability or significance of these reports; for example, we do not know the qualifications of the person conducting the field review, the methodology utilized, or whether the field observations confirmed or contradicted the Service's estimates." Id. at 1070 (majority opinion). Essentially, we assessed the quality and detail of on-site analysis and made "fine-grained judgments of its worth." Id. at 1077 (McKeown, J., dissenting). It is not our proper role to conduct such an assessment.

Instead, our proper role is simply to ensure that the Forest Service made no "clear error of judgment" [29] that would render its action "arbitrary and capricious." See *Marsh v. Or. Natural Res. Council*, 490 U.S. 360, 378, 109 S. Ct. 1851, 104 L. Ed. 2d 377 (1989); see also Ecology Ctr., 430 F.3d at 1075 (McKeown, J., dissenting) (noting that Lands Council I did not demand that we "assess the sufficiency of the Forest Service's on-site soil quality analysis beyond the traditional arbitrary and capricious standard; it only asks us to verify that there is such an on-site sampling"). To do so, we look to the evidence the Forest Service has provided to support its conclusions, along with other materials in the record, to ensure that the Service has not, for instance, "**relied on factors which Congress has not intended it to consider, entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or [an explanation that] is so implausible that it could not be ascribed to a difference in view or the product of agency expertise**." *Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29, 43, 103 S. Ct. 2856, 77 L. Ed. 2d 443 (1983); see Lands Council I, 395 F.3d at 1026.

Compare Kumho Tire Co., Ltd. v. Carmichael, 526 U.S. 137, 149–50 (1999). (courts can evaluate (at least in meaningful part) the reliability of nonscientific agency inputs without claiming to share the agency's expertise.)

Petry v Block (1984, App DC) 238 US App DC 46, 737 F2d 1193. Where agency squarely addresses criticisms leveled at data relied upon in interim rule stage and sets forth responsive views with respect to other points raised by comments, rule is not arbitrary and capricious.

Suntex Dairy v Block (1982, CA5 Tex) 666 F2d 158, reh den (1982, CA5 Tex) *670 F2d 181* and cert den *(1982) 459 US 826, 74 L Ed 2d 62, 103 S Ct 59.* If evidence of record is such that it supports inconsistent inferences and conclusions, courts must defer to administrative choice.

Qualification and independence of the information source

Where limited access scheme of "tilefish" fishery management plan adopted under Magnuson-

Stevens Fishery Conservation and Management Act, *16 USCS §§ 1801* et seq., was not based on scientific evidence, but born of political compromise between two powerful industry groups, regulation was clearly arbitrary under *5 USCS § 706(2)(A)* and was set aside. *Hadaja, Inc. v Evans (2003, DC RI) 263 F Supp 2d 346.*

Failed to employ methodological protections

Michigan v. EPA slip op No. 14-46 (2014) (benefit cost analysis require for all major decisions)

Using outdated information

Lobsters, Inc. v Evans (2004, DC Mass) 346 F Supp 2d 340.National Marine Fishery Service imposition of civil penalties and license revocation based on its determination that fishermen unlawfully fished in closed area on two occasions was arbitrary, capricious, and not supported by substantial evidence, as required by Administrative Procedure Act, 5 USCS § 706(2)(A), because agency considered prior offenses by fishermen that were more than five years old, contrary to agency's policy to not do so.

Fund for Animals v Norton (2003, DC Dist Col) 294 F Supp 2d 92, 58 Envt Rep Cas 1208, 34 ELR 20010, stay den, injunction den (2004, App DC) reversal of agency's views in two years without reasoned explanation was arbitrary and capricious.

Inadequate quality data

High Sierra Hikers Ass'n v Weingardt (2007, ND Cal) 521 F Supp 2d 1065, motion to strike gr, motion to strike gr, in part, motion to strike den, in part (2007, ND Cal) *2007 US Dist LEXIS 84746,* injunction gr (2008, ND Cal) *561 F Supp 2d 1107.* Hikers association was entitled to summary judgment in its action challenging Forest Service's Final Environmental Impact Statement and 2005 Record of Decision which allowed special use permits for commercial pack stock operations in Ansel Adams and John Muir Wilderness areas; Forest Service's reliance on flawed survey to calculate need under *16 USCS § 1133(d)(5)* was arbitrary and capricious under *5 USCS § 706*.

Bethesda Hospital v Heckler (1985, SD Ohio) 609 F Supp 1360, affd in part and revd in part on other grounds, remanded (1987, CA6 Ohio) *810 F2d 558,* revd on other grounds, en banc, remanded *(1988) 485 US 399, 99 L Ed 2d 460, 108 S Ct 1255.* Reliance on flawed data is properly considered clear error in judgment, at least where flaws are known to agency prior to promulgation of final rule.

Burd v United States (1990) 19 Cl Ct 515. Substantial evidence standard for court reviewing agency adjudications under *5 USCS § 706* requires court to inquire as to whether inadmissible evidence in question influenced decision of agency; thus, inquiry is not whether there was enough to support result, but, even if so, whether error itself had substantial influence.

B. To what this standard applies in the findings process

IV. THE SCOPE OF THE RESEARCH

An agency should have included in the record and considered enough relevant information to ensure it conducted due diligence and did not miss information that would have altered the decision. This is not a "relevant factors" question, but one of whether within a relevant factor the agency sought sufficient evidence to ensure it had fully considered the relevant factor. The scope could also be insufficient where the full range of data sources are collected for one of the relevant factors, but not for others.

A. The Standard of Review (see cites supra on the record)

FCC v. Fox Television Stations, Inc., 556 U.S. 502, 517–18 (2009) (the effect of broadcast profanity on children is not something that lends itself to direct empirical study, and thus the other information available to the Agency—such as children's propensity to mimic observed behavior—constituted a sufficient knowledge base to support the new policy).

B. To what this standard applies in the findings process

V. THE RELEVANT FACTORS

Agencies are bound by what factors they must, can and cannot consider when making decisions.

A. The Standard of Review

Changes in prior norms:

An agency must set forth clearly grounds on which it acted and justify and explain any departure from prior norms. *Scott Paper Co. v United States* (1974, ED Pa) 372 F Supp 721, affd (1974) 419 US 807, 42 L Ed 2d 38, 95 S Ct 26; *but see* *FCC v. Fox Television Stations, Inc.*, 556 U.S. 502, 541 (2009) (Stevens, J., *dissenting*) ("It . . . makes eminent sense to

require the Commission to justify why its prior policy is no longer sound before allowing it to change course [something the FCC did not do].”).

Illinois v Interstate Commerce Com. (1983, CA7) 722 F2d 1341. Interstate Commerce Commission may not change long established policy by pure fiat, with no explanation of why change is consistent with statute; failure to give reason for change of course renders administrative behavior arbitrary and capricious.

Food Marketing Institute v Interstate Commerce Com. (1978, App DC) 190 US App DC 388, 587 F2d 1285. Although agencies may not be bound under doctrine of stare decisis to same degree as courts, it is at least incumbent upon agency carefully to spell out basis of its decision when departing from prior norms, and in review under *5 USCS § 706(2)(A)* court might accord somewhat greater degree of scrutiny than might otherwise be appropriate where agency order under review (order of Interstate Commerce Commission ruling that motor carriers of loose and carcass meats were not required to offer unloading service) reaffirmed decision that itself departed drastically from Commission's earlier order requiring these carriers to provide unloading services.

National Audubon Soc. v Hester (1986, App DC) 16 ELR 20940. Environmental organization was not entitled to injunction against Wildlife Service's change in condor recovery program where Service thoroughly surveyed competing factors and examined 7 alternatives; agencies are entitled to alter their policies with or without change in circumstances so long as they satisfactorily explain why they have done so.

Failed to consider comments

[*State Farm* “factors”] *Motor Vehicle Mfrs. Ass’n of the U.S. v. State Farm Mut. Auto. Ins.*, 463 U.S. 29, 43 (1983) (“In reviewing [an agency’s] explanation, we must ‘consider whether the decision was based on a consideration of the relevant factors . . . .’ ” (quoting *Bowman Transp., Inc. v. Arkansas-Best Freight Sys., Inc.*, 419 U.S. 281, 285 (1974)).

Did consider relevant factors

Ozbirman v Regional Manpower Admr., United States Dep't of Labor (1971, SD NY) 335 F Supp 467. Matter should be remanded for reconsideration where Secretary of Labor, in denying auto mechanic certification for alien employment, did so solely because pay of proposed job was below "prevailing wage" in area of intended employment, even though such decision is to large extent discretionary and therefore subject to very limited judicial review, where only per hour pay was considered in determining wage, and Secretary failed to recognize or consider that all forms of compensation do not take form of money, and, in addition, wage which was offered was one reached by union negotiation and equivalent of co-workers salary.

American Paper Institute, Inc. v. American Electric Power Service Corp., 461 U.S. 402, 417–18 (1983) (concluding that the Federal Energy Regulatory Commission’s decision incorporated all of the relevant statutory factors).

Nat'l Cable & Telecomms. Ass'n v. Brand X Internet Servs., 545 U.S. 967, 1001 n.4 (2005) (distinguishing between step two of *Chevron* and hard look review by noting that an agency's "inconsistency bears on whether the Commission has given a reasoned explanation for its current position, not on whether its interpretation is consistent with the statute" under *Chevron*).

FCC v. National Citizens Committee for Broadcasting, 436 U.S. 775 (1978) (factors not stated in law but were consistent with FCC's purposes).

Entergy Corp. v. Riverkeeper, Inc., 556 U.S. 208, 222 (2009) (holding that the EPA was permitted to consider costs as a relevant factor in its regulation of cooling water intake structures at existing power plants).

Considered factors not allowed to be considered

Whitman v. American Trucking Ass'ns, 531 U.S. 457, 468, (2001) (prohibiting the EPA from considering costs in its air quality standard setting because doing so was deemed precluded from consideration by section 109(b) of the Clean Air Act).

Judulang v. Holder, 132 S. Ct. 476 (2011) (at 488, describing the legal sources for determining the relevant factors as existing in a "text-free zone"; at 485, Court instead based its arbitrariness ruling on its own determination of the relevant factors, holding that the BIA's "action must be based on non-arbitrary, 'relevant factors,' which here means that the BIA's approach must be tied, even if loosely, to the purposes of the immigration laws or the appropriate operation of the immigration system.")

Where limited access scheme of "tilefish" fishery management plan adopted under Magnuson-Stevens Fishery Conservation and Management Act, *16 USCS §§ 1801* et seq., was not based on scientific evidence, but born of political compromise between two powerful industry groups, regulation was clearly arbitrary under *5 USCS § 706(2)(A)* and was set aside. *Hadaja, Inc. v Evans (2003, DC RI) 263 F Supp 2d 346.*

Entirely failed to consider an important aspect of the problem

Arkansas v. Oklahoma, 503 U.S. 91, 113 (1992) (holding that the EPA was not arbitrary and capricious, noting that the court of appeals erred in identifying the EPA's omission of consideration of the river's degraded nature as a relevant factor).

Motor Vehicle Mfrs. Ass'n of the U.S. v. State Farm Mut. Auto. Ins. Co., 463 U.S. 29, 48, 55 (1983) (concluding, inter alia, that the Department of Transportation's decision to rescind a passive restraint regulation for automobiles was arbitrary and capricious because it failed to

consider two "alternative way[s] of achieving the [safety] objectives of the

Act").

W. Ala. Quality of Life Coalition v United States FHA (2004, SD Tex) 302 F Supp 2d 672. Although coalition argued that defendants failed to comply with National Environmental Policy Act (NEPA), *42 USCS §§ 4321-4370f*, and National Historic Preservation Act (NHPA), *16 USCS §§ 470-470x-6*, by failing to fully analyze all impacts of traffic control plan on neighboring communities and failing to involve public in formation of construction plan, defendants fully complied with NEPA and NHPA and their actions were not arbitrary, capricious, abuse of discretion, or otherwise not in accordance with law; therefore, coalition's motion for preliminary injunction to halt impending construction project of highway was denied.

Massachusetts v. EPA, 549 U.S. 497 (2007), when it held that the EPA acted arbitrarily in refusing to initiate a rulemaking to limit greenhouse gas emissions. *Id.* at 534. The EPA did cite several relevant factors in deciding not to initiate a rulemaking, including the piecemeal approach to global warming of regulating new car emissions, the international difficulties that could be created by a domestic regulation, the possibility of a jurisdictional conflict with the Department of Transportation over any regulation requiring increased fuel efficiency, and uncertainties regarding the relationship between greenhouse gases and global warming. *See* Pierce, *supra* 51, at 78 (citing 68 Fed. Reg. 52,922, 52,928–32 (Sept. 8, 2003)). The Court found that the EPA's refusal was impermissible because it **did not consider the question of whether greenhouse gases contribute to climate change**. *See Massachusetts*, 549 U.S. at 533–34. Despite Congress's silence regarding the relevant factors and the fact that all of the factors that EPA did consider were logically relevant to its determination, the Court decided which issues were sufficiently informative to demand inclusion under hard look review. **THIS CASE MAY LIST THE RELEVANT FACTORS TO BE TAKEN INTO ACCOUNT IN AN ENDANGERMENT FINDING. The relevant factors to which the Court referred are:**

- at 512: Fifteen months after the petition's submission, EPA requested public comment on "all the issues raised in [the] petition," adding a "particular" request for comments on "any scientific, technical, legal, economic or other aspect of these issues that may be relevant to EPA's consideration of this petition." *66 Fed. Reg. 7486, 7487 (2001)*
- " may "reasonably be anticipated to endanger public health or welfare," *42 U.S.C. § 7521(a)(1)*,
- at 525: Because of the enormity of the potential consequences associated with manmade climate change, the fact that the effectiveness of a remedy might be delayed during the (relatively short) time it takes for a new motor-vehicle fleet to replace an older one is

essentially irrelevant [to standing].

- at 528: Because EPA believes that Congress did not intend it to regulate substances that contribute to climate change, the agency maintains that carbon dioxide is not an "air pollutant" within the meaning of the provision.
- The statutory text forecloses EPA's reading. The Clean Air Act's sweeping definition of "air pollutant" includes "any air pollution agent or combination of such agents, including any physical, chemical . . . substance or matter which is emitted [*529] into or otherwise enters the ambient air . . . ." § 7602(g) (emphasis added).
- at 529: Rather than relying on statutory text, EPA invokes postenactment congressional actions and deliberations it views as tantamount to a congressional command to refrain from regulating greenhouse gas emissions. Even if such postenactment legislative history could shed light on the meaning of an otherwise-unambiguous statute, EPA never identifies any action remotely suggesting that Congress meant to curtail its power to treat greenhouse gases as air pollutants. That subsequent Congresses have eschewed enacting binding **[*530]** emissions limitations to combat global warming tells us nothing about what Congress meant when it amended *§ 202(a)(1)* in 1970 and 1977.27 And unlike EPA, we have no difficulty reconciling Congress' various efforts to promote interagency collaboration and research to better understand **[**1461]** climate change28 with the Agency's pre-existing mandate to regulate "any air pollutant" that may endanger the public welfare. See *42 U.S.C. § 7601(a)(1)*. Collaboration and research do not conflict with any thoughtful regulatory effort; they complement it.29
- at 531: EPA finally argues that it cannot regulate carbon dioxide emissions from motor vehicles because doing so would require it to tighten mileage standards, a job (according to **[*532]** EPA) that Congress has assigned to DOT. See 68 Fed. Reg. 52929. But that DOT sets mileage standards in no way licenses EPA to shirk its environmental responsibilities. EPA has been charged with protecting the public's "health" and "welfare," *42 U.S.C. § 7521(a)(1)*, a statutory obligation wholly independent of DOT's mandate to promote energy efficiency. See Energy Policy and Conservation Act, § 2(5), 89 Stat. 874, *42 U.S.C. § 6201(5)*. The two obligations may overlap, but there is no reason to think the two agencies cannot both administer their obligations and yet avoid inconsistency.
- If the scientific uncertainty is so profound that it precludes EPA from making a reasoned judgment as to whether greenhouse gases contribute to global warming, EPA must say so. That EPA would prefer not to regulate greenhouse gases because of some residual uncertainty--which, contrary to Justice Scalia's apparent belief, *post, at 553-555, 167 L. Ed. 2d, at 290-291*, is in fact all that it said, see 68 Fed. Reg. 52929 ("We do not believe .

. . that it would be either effective or appropriate for EPA *to establish [greenhouse gas] standards for motor vehicles* at this time" (emphasis added))--is irrelevant. The statutory question is whether sufficient information exists to make an endangerment finding.

- at 534-35: We need not and do not reach the question whether on remand EPA must make an endangerment finding, or whether policy concerns can inform **[*535]** EPA's actions in the event that it makes such a finding. Cf. *Chevron U.S.A. Inc. v. NRDC, 467 U.S. 837, at 843-844, 104 S. Ct. 2778, 81 L. Ed. 2d 694 (1984)*. We hold only that EPA must ground its reasons for action or inaction in the statute.
- *Dissent* at 552: The Court dismisses this analysis as "rest[ing] on reasoning divorced from the statutory text." *Ante, at 532, 167 L. Ed. 2d, at 277*. "While the statute does condition the exercise of EPA's authority on its formation of a 'judgment,' . . . that judgment must relate to whether an air pollutant 'cause[s], or contribute[s] to, air pollution which may reasonably be anticipated to endanger public health or welfare.'" *Ibid.* True but irrelevant. When the Administrator *makes* a judgment whether to regulate greenhouse gases, that judgment must relate to whether they are air pollutants that "cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare." *42 U.S.C. § 7521(a)(1)*. But the statute says *nothing at all* about the reasons for which the Administrator may *defer* making a judgment--the permissible reasons for deciding not to grapple with the issue at the present time. Thus, the various "policy" rationales, *ante, at 532-533, 167 L. Ed. 2d, at 277*, that the Court criticizes are not "divorced from the statutory text," *ante, at 532, 167 L. Ed. 2d, at 277*, except in the sense that the statutory text is silent, as texts are often silent about permissible reasons for the exercise of agency discretion. The reasons EPA gave are surely considerations executive agencies *regularly* take into account (and *ought* to take into account) when deciding whether to consider entering a new field: the impact such entry would have on other Executive Branch programs and on foreign policy. There is no basis in law for the Court's imposed limitation.

B. To what this standard applies in the findings process

VI. THE RATIONAL BASIS FOR THE DECISION

The courts require that there be a rational basis for the decision. First, there must be some basis given for the decision. Second, the basis for the decision must be rationally connected to the decision and thus be sufficiently persuasive.

A. The Standard of Review **[S1]**

Lack of any basis:

State Farm, 463 U.S. at 50 (the Agency failed because it "submitted no reasons at all" for not considering air bags).

International Union v Mine Safety & Health Admin. (1987, App DC) 265 US App DC 141, 830 F2d 289, 1987 CCH OSHD P 28064. In reviewing decision of Assistant Secretary of Labor for Mine Safety and Health granting petition for modification of mandatory safety standard at mine court must determine whether granting was arbitrary, capricious, and abuse of discretion or otherwise not in accordance with law and where Assistant Secretary did not identify evidence relied upon in granting petition, nor explain why he rejected other evidence, decision will be vacated and remanded.

Offered an explanation for its decision that runs counter to the evidence before the agency

Earth Island Inst. v Evans (2004, ND Cal) *26 BNA Intl Trade Rep 1993, 34 ELR 20069,* affd (2005, CA9 Cal) *136 Fed Appx 34* and affd (2007, CA9 Cal) *484 F3d 1123, 64 Envt Rep Cas 1538, 29 BNA Intl Trade Rep 1163, 37 ELR 20093,* amd on other grounds (2007, CA9 Cal) *494 F3d 757, 38 ALR Fed 2d 663* and reprinted as amd on other grounds (2007, CA9 Cal) *494 F3d 757, 38 ALR Fed 2d 663.* Decision was arbitrary, capricious, abuse of discretion, or otherwise not in accordance with law, pursuant to *5 USCS § 706(2)(A)*, as conservation organizations amply met their burden of demonstrating that (1) Secretary's offered explanation for its decision ran counter to evidence before agency and (2) agency relied on facts that Congress did not intend it to consider.

Sisto v Civil Aeronautics Board (1949, App DC) 86 US App DC 31, 179 F2d 47. *But see*, Admission of irrelevant or incompetent evidence before administrative agency does not constitute reversible error if there is substantial evidence in record to sustain agency's determination.

Used an explanation that is so implausible that it could not be ascribed to a difference in view or the product of agency expertise." Or just inadequate data.

State Farm, 463 U.S. 29, at 43 (whether an agency's policy choice "runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise.") and at 52, 56 (the Agency did not create the necessary "rational

connection between the facts found and the choice made.")

International Union v Mine Safety & Health Admin. (1987, App DC) 265 US App DC 141, 830 F2d 289, 1987 CCH OSHD P 28064. In reviewing decision of Assistant Secretary of Labor for Mine Safety and Health granting petition for modification of mandatory safety standard at mine court must determine whether granting was arbitrary, capricious, and abuse of discretion or otherwise not in accordance with law and where Assistant Secretary did not identify evidence relied upon in granting petition, nor explain why he rejected other evidence, decision will be vacated and remanded.

High Sierra Hikers Ass'n v Weingardt (2007, ND Cal) 521 F Supp 2d 1065, motion to strike gr, motion to strike gr, in part, motion to strike den, in part (2007, ND Cal) *2007 US Dist LEXIS 84746,* injunction gr (2008, ND Cal) *561 F Supp 2d 1107.* Hikers association was entitled to summary judgment in its action challenging Forest Service's Final Environmental Impact Statement and 2005 Record of Decision which allowed special use permits for commercial pack stock operations in Ansel Adams and John Muir Wilderness areas; Forest Service's reliance on flawed survey to calculate need under *16 USCS § 1133(d)(5)* was arbitrary and capricious under *5 USCS § 706*.

Evidence too narrow to support the decision

Lloyd Noland Hospital & Clinic v Heckler (1985, CA11 Ala) 762 F2d 1561. Regulation is arbitrary and capricious where it is based upon scientific study's conclusions which are more limited than regulation and which cannot be validly extended to support regulation.

B. To what this standard applies in the findings process

VII. ABUSE OF DISCRETION

Even if court concludes that agency's findings are supported by substantial evidence, it may nonetheless find that procedures used to reach final determination reflect arbitrary and capricious action. *O'Connor v Heckler (1985, SD NY) 613 F Supp 1043.*

Tripoli Rocketry Ass'n v BATFE (2006, App DC) 369 US App DC 327, 437 F3d 75.

Decision of Bureau of Alcohol, Tobacco, Firearms & Explosives (ATFE) to designate ammonium perchlorate composite propellant (APCP), fuel used in hobby rockets, as "explosive" under *18 USCS § 841(d)* could not be sustained because ATFE's explanation for its determination that APCP deflagrates lacked any coherence, and court owed no deference to ATFE's purported expertise because court could not discern it; thus, case was remanded to ATFE for reconsideration.

United States v United States (1976, DC Dist Col) 417 F Supp 851, affd *(1977) 430 US 961, 52 L Ed 2d 352, 97 S Ct 1638.* While court's administrative review function under this section is limited, judicial deference to expertise is not boundless and expertise is not sufficient in itself to sustain a decision.

VIII. ADDITIONAL CASE CITATIONS

Dubois v. United States Dep't of Agric., 102 F.3d 1273, 1284-1285 (1st Cir. N.H. 1996)

Under the APA, "the reviewing court shall . . . hold unlawful and set aside agency action, findings, and conclusions found to be arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." 5 U.S.C. § 706(2)(A). Errors of law are reviewed by the court de novo. 5 U.S.C. § 706 (1994) ("the reviewing court shall decide all relevant questions of law"); Howard v. FAA, 17 F.3d 1213, 1215 (9th Cir. 1994).

On the other hand, the task of a court reviewing agency action under the APA's "arbitrary and capricious" standard, 5 U.S.C. § 706(2), is "to determine whether the [agency] has considered the relevant factors and articulated a rational connection between the facts [29] found and the choice made." Baltimore Gas, 462 U.S. at 105 [1285] (emphasis added) (citations omitted); see also Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co., 463 U.S. 29, 43, 77 L. Ed. 2d 443, 103 S. Ct. 2856 (1983); Bowman Transp., Inc. v. Arkansas-Best Freight Sys., Inc., 419 U.S. 281, 285-86, 42 L. Ed. 2d 447, 95 S. Ct. 438 (1974); Citizens to Preserve Overton Park, Inc. v. Volpe, 401 U.S. 402, 415-17, 28 L. Ed. 2d 136, 91 S. Ct. 814 (1971). If the agency decision was based on a consideration of the relevant factors and there has not been "a clear error of judgment," then the agency decision was not arbitrary or capricious. Overton Park, 401 U.S. at 416; Marsh v. Oregon Natural Resources Council, 490 U.S. 360, 378, 104 L. Ed. 2d 377, 109 S. Ct. 1851 (1989).

In State Farm, the Supreme Court offered several examples of circumstances in which an agency action "normally" would be considered arbitrary and capricious: situations where "the agency has relied on factors which Congress has not intended it to consider, entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise." [30] State Farm, 463 U.S. at 43. These are merely "examples," Puerto Rico Sun Oil Co. v. U.S. EPA, 8 F.3d 73, 77 (1st Cir. 1993); others could be recited as well. Whether reviewing an EIS or a rulemaking proceeding, the "reviewing court should not attempt itself to make up for such deficiencies; we may not supply a reasoned basis for the agency's action that the agency itself has not given." State Farm, 463 U.S. at 43 (citing SEC v. Chenery Corp., 332 U.S. 194, 196, 91 L. Ed. 1995, 67 S. Ct. 1575 (1947)).

"While this is a highly deferential standard of review, it is not a rubber stamp." Citizens Awareness Network, Inc. v. U.S. Nuclear Regulatory Comm'n, 59 F.3d 284, 290 (1st Cir. 1995). Although "the ultimate standard of review is a narrow one," the court must undertake a "thorough, probing, in-depth review" and a "searching and careful" inquiry into the record. Overton Park, 401 U.S. at 415-16. In order for an agency decision to pass muster under the APA's "arbitrary and capricious" test, the reviewing court must determine that the decision "makes sense." Puerto Rico Sun Oil, 8 F.3d at 77. Only by "carefully reviewing the record and satisfying [itself] that the agency has made a reasoned [31] decision" can the court "ensure that agency decisions are founded on a reasoned evaluation of the relevant factors." Marsh, 490 U.S. at 378 (internal quotation omitted).

To: Schnare, David[schnare.david@epa.gov]; benton.don@epa.gov[benton.don@epa.gov]
From: Sam Kazman
Sent: Fri 2/17/2017 7:35:19 PM
Subject: Petition for Rulemaking on the Issue of Greenhouse Gases (Endangerment)
CEI Petition for Rulemaking on Endangerment 2017.pdf

Gentlemen:

Enclosed for EPA's consideration is a petition for rulemaking on the subject of greenhouse gases and public health and welfare. The petition is submitted on behalf of CEI, the Science and Environmental Policy Project, and four individuals.

Thank you for attention to this matter.

Sam Kazman

General Counsel

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United States Environmental Protection Agency

Petition of the

Competitive Enterprise Institute and the Science and Environmental Policy Project

for Rulemaking on the Subject of Greenhouse Gases

and Their Impact on Public Health and Welfare,

in Connection with EPA's 2009 Endangerment Finding, 74 FR 66,496 (Dec. 15, 2009)

Competitive Enterprise Institute
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(202) 331-1010

Sam Kazman, General Counsel
Hans Bader, Senior Counsel

February 17, 2017

PETITION FOR RULEMAKING ON THE ISSUE OF GREENHOUSE GASES AND PUBLIC HEALTH AND WELFARE

Petitioners Competitive Enterprise Institute, the Science and Environmental Policy Project, and four individual members of the latter's Board of Directors hereby petition EPA to initiate a rulemaking proceeding on the subject of greenhouse gases and their impact on public health and welfare.

EPA addressed this matter in 2009 in its "Endangerment Finding." EPA, Final Rule, Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 FR 66,496 (Dec. 15, 2009). However, as explained below, since that finding was issued, evidence has continued to mount that directly contradicts it. For these reasons, we request that EPA commence a new proceeding on this matter.

Procedural Background

We bring this petition pursuant to 5 U.S.C. § 553(e), which grants any "interested person the right to petition for the issuance, amendment, or repeal of a rule." A rulemaking proceeding is appropriate when new developments demonstrate that an existing rule or finding rests on erroneous factual premises, and a rulemaking petition is a proper vehicle for asking an agency "to reexamine" the "continuing vitality" of a rule.[1] EPA's own website expressly notes the applicability of section 553(e) to the environmental statutes that it administers. EPA, Petitions for Rulemaking, https://www.epa.gov/aboutepa/petitions-rulemaking.[2]

Identity and Interest of the Petitioners

The Competitive Enterprise Institute (CEI) is a non-profit, 501(c)(3) public policy organization that focuses on issues of overregulation, especially its implications for affordable energy. CEI was founded in 1984 and is headquartered in Washington, D.C.

The Science and Environmental Policy Project (SEPP) is a non-profit 501(c)(3) organization, incorporated in 1993 in the State of Virginia for the purpose of promoting sound and credible science as the basis for regulatory decisions.

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[1] *Geller v. FCC*, 610 F.2d 973, 978–80 (D.C. Cir. 1979) (overturning agency's denial of petition for new rulemaking). An agency's "refusal to initiate a rulemaking naturally sets off a special alert when a petition has sought modification of a rule on the basis of a radical change in its factual premise." *American Horse Protection Ass'n v. Lyng*, 812 F.2d 1, 5 (D.C. Cir. 1987) (overturning agency's denial of petition for rulemaking in light of agency's failure to offer a satisfactory explanation). Alternatively, EPA may choose to treat our filing as a petition for reconsideration of its Endangerment Finding. The procedural basis for doing so is discussed in Concerned Household Electricity Consumers Council et al., *Petition for Reconsideration of "Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act"* (filed Jan. 20, 2017), at 1-5.

[2] *See, e.g.*, *Commonwealth of Va. v. EPA*, 108 F.3d 1397, 1402 n.3 (D.C. Cir. 1997) (successful challenge to ozone pollution rule by Virginia) ("any interested person has 'the right to petition' EPA 'for the issuance, amendment, or repeal' of any rule. 5 U.S.C. § 553(e)"), *decision modified on reh'g*, 116 F.3d 499 (D.C. Cir. 1997).

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The individual petitioners, who are members of SEPP's Board of Directors, are the following: Donna Bethell (DC), Kenneth A. Haapala (VA), Thomas Sheahen (MD), and S. Fred Singer (VA). They are citizens of the United States who reside in the jurisdictions indicated for each of them. They and/or the households to which they belong pay utility bills that are affected by EPA regulations that are based, directly or indirectly, on the Endangerment Finding – such as the Clean Power Plan, 80 FR at 64,662 (codified at 40 C.F.R. § 60.5700 *et seq.*), which threatens to increase the cost of electricity.[3] Thus, they are not only interested parties, but have standing to judicially challenge the Endangerment Finding given the new facts cited in this petition.[4]

The Lines of Evidence for EPA's Endangerment Finding

EPA's 2009 Endangerment Finding described its scientific basis in the following terms:

> "The attribution of observed climate change to anthropogenic activities is based on multiple lines of evidence. The first line of evidence arises from the basic physical understanding of the effects of changing concentrations of GHGs, natural factors, and other human impacts on the climate system. The second line of evidence arises from indirect, historical estimates of past climate changes that suggest that the changes in global surface temperature over the last several decades are unusual. The third line of evidence arises from the use of computer-based climate models to simulate the likely patterns of response of the climate system to different forcing mechanisms (both natural and anthropogenic)."

74 FR 66,518 (footnote omitted).

But as discussed below, in the seven years since the Endangerment Finding was issued, new evidence and research has cast serious doubt on the validity of its three lines of evidence.

I. There Has Been No Statistically Significant Atmospheric Warming Despite a Continued Increase in Atmospheric Carbon Dioxide Levels; This Seriously Undercuts the Endangerment Finding's First Line of Evidence Regarding an Adequate Understanding of Climate

Prior to 2016, the atmospheric temperatures showed the warmest year on record to be 1998. The atmospheric carbon dioxide concentration for December of that year was 367.13 part per million (ppm).[5]

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[3] *See, e.g.*, Concerned Household Electricity Consumers Council, *Petition for Reconsideration, supra* n.1, at 5–8 (describing in detail how the Endangerment Finding leads to increased electricity costs).

[4] *See CEI v. NHTSA*, 901 F.2d 107, 111–13 (D.C. Cir. 1990) (regulations that allegedly resulted in "high prices" for "large cars" could be challenged by group whose members sought "opportunity to buy" them); *Energy Action Educ. Found. v. Andrus*, 654 F.2d 735, 756 n.** (D.C. Cir. 1980) (consumers had standing to challenge activities claimed to "inflat[e] prices, limit[] supplies, and restrict[] choice on the market"), *rev'd on other grounds*, 454 U.S. 151 (1981); *Community Nutrition Inst. v. Block*, 698 F.2d 1239, 1248 (D.C. Cir. 1983), *rev'd on other grounds*, 467 U.S. 340 (1984) (consumers could challenge exactions imposed on milk handlers, which allegedly would be passed on to consumers).

[5] ftp://aftp.cmdl.noaa.gov/products/trends/co2/co2_mm_mlo.txt

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The past year, 2016, was reportedly warmer than 1998 by 0.02 deg. C.[6] The atmospheric carbon dioxide concentration in December 2016 was 404.48 ppm.[7]

Despite this 10 percent increase in atmospheric CO2 concentrations, however, the temperature difference between 1998 and 2016 was not statistically significant. As Dr. Roy Spencer of the University of Alabama in Huntsville has pointed out, "2016 would have had to be 0.10 C warmer than 1998 to be significantly different at the 95% confidence level."[8] In fact, the temperature difference between the two years was only one fifth of that amount.

In its Endangerment Finding, EPA acknowledged that "there have not been strong trends over the last seven to ten years in global surface temperature or lower troposphere temperatures measured by satellites." 74 FR 66,522. EPA claimed, however, that "this pause in warming should not be interpreted as a sign that the Earth is cooling or that the science supporting continued warming is in error. Year-to-year variability in natural weather and climate patterns make it impossible to draw any conclusions about whether the climate system is warming or cooling from such a limited analysis." *Id.*

Here, however, the absence of any strong warming trend has continued for 18 years. That is twice as large as the 2001–09 time period touted in the Finding as containing "eight of the 10 warmest years on record." *Id.* Moreover, the fact that the starting and end years for this 18-year period are the two reportedly warmest years on record makes the lack of warming all the more significant. In short, the absence of a strong warming trend in the face of increasing atmospheric CO2 concentrations cannot be dismissed, yet again, as being based on an overly "limited analysis." It draws into serious question EPA's contention that we have an adequate "physical understanding of the effects of changing concentrations of GHGs ... on the climate system." 74 FR 66,518.

II. Contrary to the Endangerment Finding's Second Line of Evidence, Changes in Global Temperatures in Recent Decades Are Far From Unusual

The Endangerment Finding states that "indirect, historical estimates of past climate changes … suggest that the changes in global surface temperature over the last several decades are unusual." 74 FR 66,518. But a more recent, comprehensive review of the scientific literature comes to exactly the opposite conclusion:

- "Over recent geological time, Earth's temperature has fluctuated naturally between about +4°C and -6°C with respect to twentieth century temperature. A warming of 2°C above today, should it occur, falls within the bounds of natural variability;"

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[6] *Global Temperature Report: December, 2016*, Earth System Science Center, Univ. of AL at Huntsville, http://www.nsstc.uah.edu/climate/2016/december/dec2016_GTR.pdf

[7] See n.5.

[8] Roy Spencer, Ph.D., *Global Satellites: 2016 not Statistically Warmer than 1998*, DRROYSPENCER.COM, (Jan. 3, 2017), http://www.drroyspencer.com/2017/01/global-satellites-2016-not-statistically-warmer-than-1998/.

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- "At the current level of ~400 ppm we still live in a CO2-starved world. Atmospheric levels 15 times greater existed during the Cambrian Period (about 550 million years ago) without known adverse effects."

- The overall warming since about 1860 corresponds to a recovery from the Little Ice Age modulated by natural multidecadal cycles driven by ocean-atmosphere oscillations, or by solar variations at the de Vries (~208 year) and Gleissberg (~80 year) and shorter periodicities."

- "The causes of historic global warming remain uncertain, but significant correlations exist between climate patterning and multidecadal variation and solar activity over the past few hundred years."[9]

Similarly, a comprehensive new study found that, over 13 different time periods, "once just the ENSO [El Nino Southern Oscillation] impacts on temperature data are accounted for, there is no "record setting" warming to be concerned about."[10]

For these reasons, the Finding's second line of evidence should be reconsidered.

III. The Growing Accumulation and Refinement of Balloon and Satellite Data Demonstrates that the Atmosphere Is Far Less Sensitive to CO2 Forcing than Predicted by the Climate Models; As a Result, EPA's Third Line of Evidence Is No Longer Valid

EPA's Endangerment Finding expressly noted the importance of global atmospheric temperature as a "reasonable indicator of human-induced climate change." 74 FR at 66,522 (capitalization omitted). However, EPA largely ignored the two most precise methods for measuring atmospheric temperature, satellites and weather balloons. The Finding contained no discussion at all of balloon temperature data, and there was only one brief discussion of satellite temperature data. *Id.* Computer-based climate models, on the other hand, received far more attention. EPA characterized these models as "well tested," and they were singled out by EPA as constituting the Finding's "third line of evidence."

But as demonstrated by the congressional testimony of John R. Christy, Director of the Earth System Science Center at the University of Alabama, the continued accumulation of both satellite and balloon data has thrown increasing doubt over two of EPA's three lines of evidence. Contrary to the Finding's claim that we have a "basic physical understanding of … the climate system," Christy concludes that "the theory of how climate changes occur, and the associated impact of extra greenhouse gases, is not understood well enough to even reproduce the past climate." Prepared Testimony of John R. Christy to the U.S. House Committee on Science,

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[9] Idso, Carter, and Singer, *Climate Change Reconsidered II: Physical Science* (2013), https://www.heartland.org/media-library/pdfs/CCR-II/CCR-II-Full.pdf; *Summary for Policymakers*: http://climatechangereconsidered.org/wp-content/uploads/2016/08/09-25-2013_-CCR-II-Summary-for-Policymakers.pdf, p.4.

[10] Wallace, Christy, and D'Aleo, *On the Existence of a "Tropical Hotspot" & the Validity of EPA's CO2 Endangerment Finding* (Aug. 2016), at Abstract p. 4, https://thsresearch.files.wordpress.com/2016/10/ef-cpp-sc-2016-data-ths-paper-ex-sum-101416.pdf.

Space and Technology (Feb. 2, 2016), p.2, https://science.house.gov/sites/republicans.science.house.gov/files/documents/HHRG-114-SY-WState-JChristy-20160202.pdf, attached hereto.

As Dr. Christy explains, both surface temperature stations and water temperature suffer from a number of problems. Stations are affected by "the growth of infrastructure" around them and by the "variety of changes" that they "undergo through time." Christy at 6. Water temperature readings "do not track well with those of the air temperature just above the water … even if both are measured on the same buoy over 20 years." *Id.*

Satellite and balloon data do not suffer from these problems. Moreover, the fact that balloon and satellite data correlate extremely well with one another despite their being collected through distinctly different methods makes their results far more reliable. "To be sure, satellite and balloon temperatures require their own adjustments and cannot be considered 'perfect', but do offer an independence from one another to allow direct comparison studies." *Id.* at 7.

Based on this data, Dr. Christy's essential conclusion is that the computer models "clearly overcook the atmosphere," *Id.* 2. They project a far higher rate of warming than actually observed—2.5 times faster generally, and 3 times faster for the tropical atmosphere. *Id.* at 4–5. The models were "demonstrably deficient." *Id.* at 2. They "failed at the simple test of telling us 'what' has already happened, and thus would not be in a position to give us a confident answer to 'what' may happen in the future and 'why.'" *Id.* at 12. And Dr. Christy emphasized the fact that the 37-year period that he had examined is "the period with the highest concentration of greenhouse gases and thus the period in which the response should be of largest magnitude." *Id.*

In short, EPA's claim in its Endangerment Finding that the climate models are "well-tested" no longer bears scrutiny, and its third line of evidence clearly needs to be reconsidered.

IV. Given the Mounting Evidence that EPA's Greenhouse Gas Regulations Will Have No Discernible Climate Impact, the Rationale for Its Endangerment Finding Requires Reexamination

In its Finding, EPA gave the following analogy for endangerment:

> "The question of whether there is endangerment is like the question of whether there is an illness. Once one knows there is an illness, then the next question is what to do, if anything, in response to that illness."

74 FR 66,515.

But as Dr. Christy noted in his testimony, even a total *elimination* of U.S. emissions would have a near zero impact on global climate. As he put it, if the U.S. were simply to vanish, after 50 years there would be no discernible global temperature difference, given the satellite and balloon data findings regarding atmospheric sensitivity: "the impact … would be only 0.05 to 0.08 degrees C – an amount less than that which the global temperature fluctuates from month to month." Christy at 14. Given this impossibility of treating the "illness" supposedly identified by EPA's Finding, the basis for making the Finding in the first place needs reconsideration.

This point is buttressed by testimony last year from then-EPA Administrator Gina McCarthy, when she stated that the alleged environmental benefits of EPA's massive Clean Power Plan were not purpose. At a March 22, 2016, congressional hearing, one U.S. Representative asked her: "I don't understand – if it doesn't have an impact on climate change around the world, why are we subjecting our hard working taxpayers and men and women in the coal fields to something that has no benefit?"[11]

Gina McCarthy's answer: "We see it as having had enormous benefit in showing [the] sort of domestic leadership as well as garnering support around the country for the agreement we reached in Paris."

CONCLUSION

As shown above, there is significant new data and research that seriously undercuts each of the Endangerment Finding's lines of evidence. For these reasons, EPA should conduct a new rulemaking on this issue.

Respectfully submitted on behalf of CEI, SEPP, Donna Bethell, Kenneth A. Haapala, Thomas Sheahen, and S. Fred Singer.

Dated: February 17, 2017

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[11] *Fiscal Year 2017 EPA Budget*: *Hearing Before the H. Comm. on Energy and Commerce, Subcomm. on Energy and Power*, 114th Cong. at 73–74 (Mar. 22, 2016) (testimony of EPA Administrator Gina McCarthy), *available at* http://docs.house.gov/meetings/IF/IF03/20160322/104715/HHRG-114-IF03-Transcript-20160322.pdf.

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ATTACHMENT

U.S. House Committee on Science, Space & Technology

2 Feb 2016

Testimony of John R. Christy

University of Alabama in Huntsville.

I am John R. Christy, Distinguished Professor of Atmospheric Science, Alabama's State Climatologist and Director of the Earth System Science Center at The University of Alabama in Huntsville. I have served as Lead Author, Contributing Author and Reviewer of United Nations IPCC assessments, have been awarded NASA's Medal for Exceptional Scientific Achievement, and in 2002 was elected a Fellow of the American Meteorological Society.

It is a privilege for me to offer my analysis of the current situation regarding (1) the temperature datasets used to study climate, (2) our basic understanding of climate change and (3) the effect that regulations, such as the Paris agreement, might have on climate. I have also attached an extract from my Senate Testimony last December in which I address (1) the popular notion that extreme climate events are increasing due to human-induced climate change (they are not), and (2) the unfortunate direction research in this area has taken.

My research area might be best described as building datasets from scratch to advance our understanding of what the climate is doing and why – an activity I began as a teenager over 50 years ago. I have used traditional surface observations as well as measurements from balloons and satellites to document the climate story. Many of our UAH datasets are used to test hypotheses of climate variability and change.

(1.1) Upper air temperature data from satellites and balloons

I shall begin with a discussion that was precipitated by an increasingly active campaign of negative assertions made against the observations, i.e. the data, of upper air temperatures. Figure 1 in particular has drawn considerable attention from those who view the climate system as undergoing a rapid, human-caused transformation into a climate to which people would have great difficulty adapting. This simple chart tells the story that the average model projection, on which their fears (or hopes?) are based, does poorly for the fundamental temperature metric that is allegedly the most responsive to extra greenhouse gases – the bulk atmospheric temperature of the layer from the surface to 50,000 ft. [The layer shown is known as the mid-troposphere or MT and is used because it overlaps with the region of the tropical atmosphere that has the largest anticipated signature of the greenhouse response by bulk mass – between 20,000 and 50,000 feet.] The chart indicates that the theory of how climate changes occur, and the

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associated impact of extra greenhous e gases, is not understood well enough to even reproduce the past climate [much more in section (2)] . Indeed, the models clearly over - cook the atmosphere . The issue for congress here is that such demonstrably deficient model projections are being used to make policy.

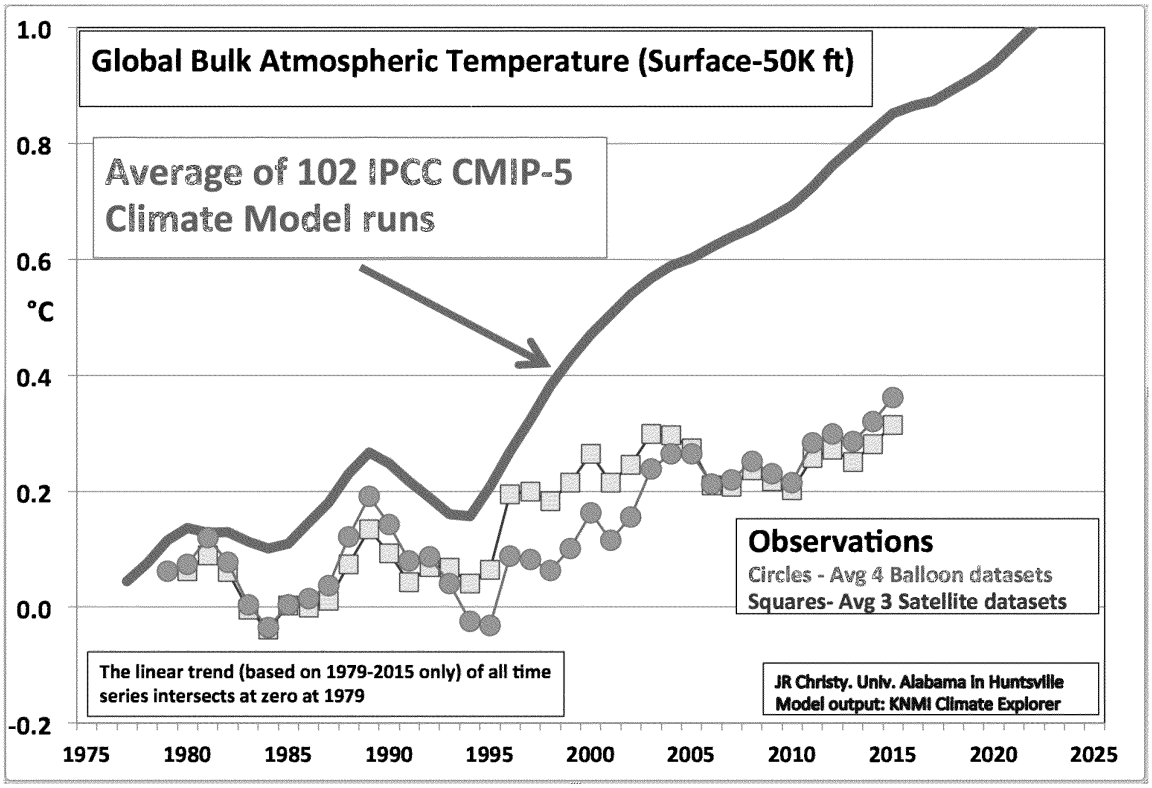

Fig. : Five-year averaged values of annual mean (1979-2015) global bulk (termed "mid-tropospheric" or "MT") temperature as depicted by the average of 102 IPCC CMIP 5 climate models (red), the average of 3 satellite datasets (green - UAH, RSS, NOAA) and 4 balloon datasets (blue, NOAA, UKMet, RICH, RAOBCORE).

Because this result challenges the current theory of greenhouse warming in relat ively straightforward fashion, there have been several well -funded attacks on those of us who build and use such datasets and on the datasets themselves . As a climate scientist I've found myself, along with fellow like-minded colleagues, tossed into a world more closely associated with character assassination and misdirection, found in Washington politics for example, rather than objective, dispassionate discourse commonly assumed for the scientific endeavor . Investigations of us by congress and the media are spurred by the idea that anyone who disagrees with the climate establishment 's view of dangerous climate change must be on the payroll of scurrilous organizations or otherwise mentally

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deficient. Also thrust into this milieu is promotional material, i.e., propaganda, attempting to discredit these data (and researchers) with claims that amount to nothing.

Several of these allegations against the data appeared a few weeks ago in the form of a well-made video. I shall address the main assertions with the following material, which in similar form has appeared in the peer-reviewed literature through the years.

The video of interest was promoted by a climate change pressure group (Yale Climate Connections, http://www.yaleclimateconnections.org/2 6/ /over-reliance-on-satellite-data-alone-criticized/) in which well-known scientists make claims that are mostly meaningless or completely wrong relative to the evidence in Fig. 1. I wish to make four points regarding the video and demonstrate the misdirection for which such agendized videos, along with a happily mimicking media, are so famous.

First, the claim is made the satellites do not measure temperature. In reality, the sensors on satellites measure temperature by emitted radiation - the same method that a physician uses to measure your body temperature to high precision using an ear probe. Atmospheric oxygen emits microwaves, the intensity of which is directly proportional to the temperature of the oxygen , and thus the atmosphere . That the satellites measure temperature is evident by the following chart which compares our UAH satellite data with temperatures calculated from balloon thermistors. As an aside, most surface temperature measurements are *indirect*, using electronic resistance.

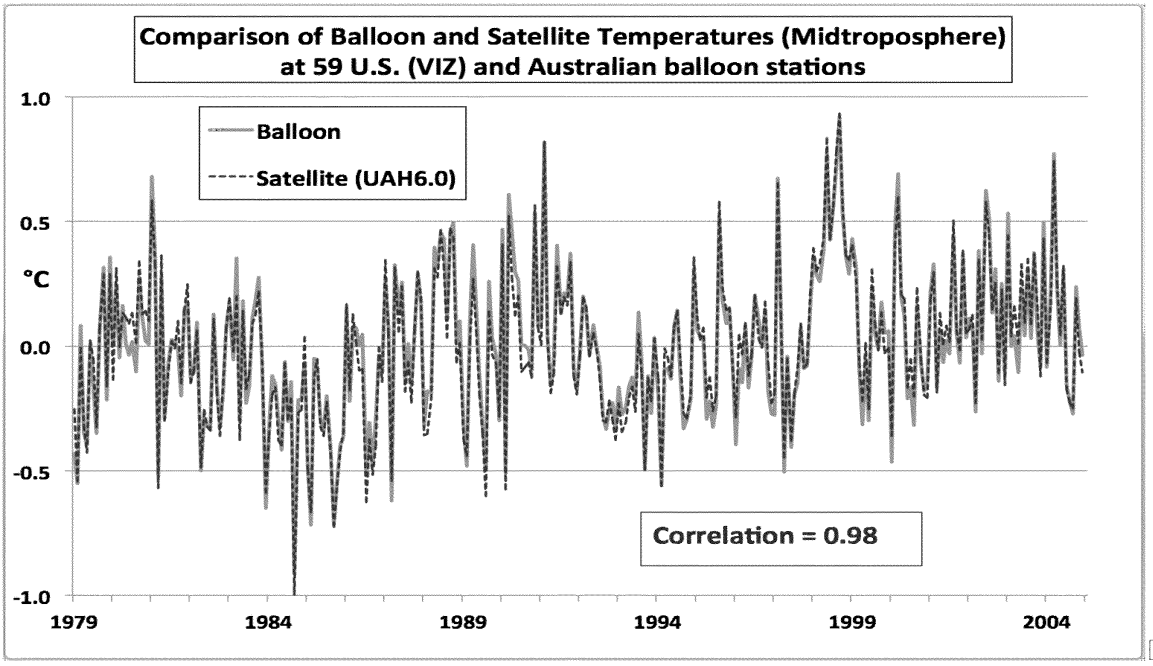

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Fig. 2: Average temperature variations measured at 59 radiosonde stations in the U.S. (VIZ manufacturer) and Australia.

Secondly, the scientists claim that the vertical drop (orbital decay) of the satellites due to atmospheric friction causes spurious cooling through time. This vertical fall has an immeasurable impact on the layer (MT) used here and so is a meaningless claim. In much earlier versions of another layer product (LT or Lower Troposphere), this was a problem, but was easily corrected almost 2 years ago. Thus, bringing up issues that affected a different variable that, in any case, was fixed many years ago is a clear misdirection that, in my view, demonstrates the weakness of their position.

Thirdly, the scientists speak of the spurious temperature changes that occur as the satellites drift in the east-west direction, the so-called diurnal drift problem (which was first detected and accounted for by us). They speak of a sign error in the correction procedure that changed the trend. Again, this error was not a factor in the MT layer in Fig. , but for the different LT layer. And, again, this issue was dealt with for LT years ago.

Finally, though not specifically mentioned in this video, some of these scientists claim Fig. above is somehow manipulated to hide their belief in the prowess and validity of the climate models. To this, on the contrary, I say that we have displayed the data in its most meaningful way. The issue here is the rate of warming of the bulk atmosphere, i.e., the trend. This metric tells us how rapidly heat is accumulating in the atmosphere – the fundamental metric of global warming. To depict this visually, I have adjusted all of the datasets so that they have a common origin. Think of this analogy: I have run over 5 races in the past 25 years, and in each one all of the runners start at the same place at the same time for the simple purpose of determining who is fastest and by how much at the finish line. Obviously, the overall relative speed of the runners is most clearly determined by their placement as they cross the finish line – but they must all start together.

In the same way I constructed the chart so that the trend line of all of the temperature time series starts at the same point in magnitude and time (zero value at 979) so the viewer may see how wide the spread is at the finish line (2 5). One way to look at this is seen in Fig. 3 where I provide what is seen in Fig. except this is only the trend line without the variations that occur from year due to volcanoes and such. This is analogous to plotting the overall average speed of a runner along the course even though they likely ran slower on an uphill, and faster on a downhill.

This image indicates the models, on average, warm this global layer about 2.5 times faster than the observations indicate. This is a significant difference that has not been

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explained and indicates the theory of greenhouse impact on atmospheric temperature is not sufficiently known to even reproduce what has already happen ed. We are not talking about or 5 years here, but 37 years - well over a third of a century. That two very independent types of measuring systems (balloons and satellites) constructed by a variety of institutions (government, university, private) all showing the much slower rate of warming gives high confidence in its result. Thus, t he evidence here strongly suggests the theory, as embodied in models, goes much to o far in forcing the atmosphere to retain heat when in reality the atmosphere has a mean s to relinquish that heat and thus warms at a much slower rate.

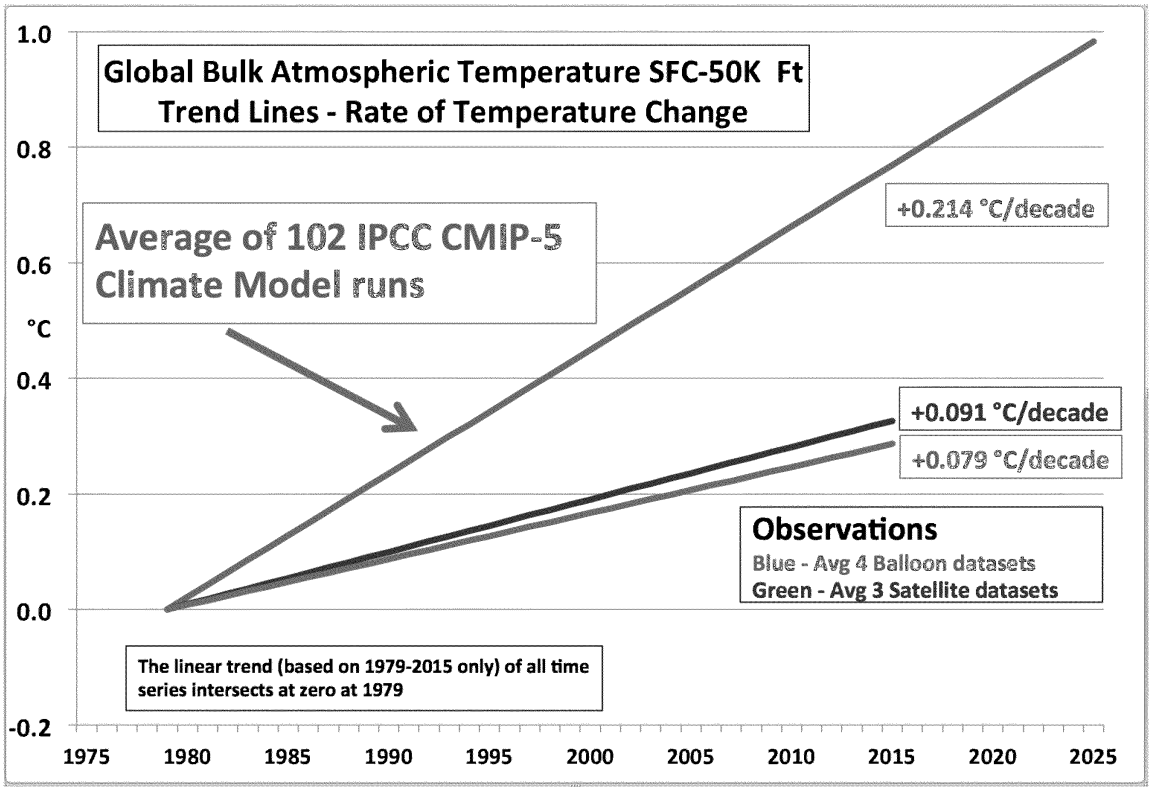

Fig. 3: The linear trend line over the period 979 -2 5. The color s represent the same source data as in fig.

I've shown here that for the global bulk atmosphere, the models overwarm the atmosphere by a factor of about 2.5. As a further note, i f one focuses on the tropics, the models show an even stronger gree nhouse warming in this layer. However, a similar calculation with observations as shown in Fig. 3 indicates the models over -warm the tropical atmosphere by a factor of approximately 3, (Models + .265, Satellites + . 95, Balloons + . 73 °C/decade) again indicating the current theory is at odds with the facts. (again, see section 2.)

It is a bold strategy in my view to actively promote the output of theoretical climate models while attacking the multiple lines of evidence from observations. Note that none of the observational datasets are perfect and continued scrutiny is healthy, but when multiple, independent groups generate the datasets and then when the results for two completely independent systems (balloons and satellites) agree closely with each other and disagree with the model output, one is left scratching one's head at the decision to launch an offensive against the data. This doesn't make scientific sense to me.

(2) Surface temperature issues

There are several issues regarding surface temperature datasets that are too involved to discuss in this material. I shall focus on a few points with which I am familiar and on which I have published.

(2.a) Surface temperature as a metric for detecting the influence of the increasing concentrations of greenhouse gases

One of my many climate interests is the way surface temperatures are measured and how surface temperatures, especially over land, are affected by their surroundings. In several papers (Christy et al. 2006 *J. Climate*, Christy et al. 2009 *J. Climate*, Christy 2003 *J. Appl. Meteor. Clim.*, Christy et al. 2006 *J. Appl. Meteor. Clim.*) I closely examined individual stations in different regions and have come to the conclusion that the magnitude of the relatively small signal we seek in human-induced climate change is easily convoluted by the growth of infrastructure around the thermometer stations and the variety of changes these stations undergo through time, as well as the variability of the natural ups and downs of climate. It is difficult to adjust for these contaminating factors to extract a pure dataset for greenhouse detection because often the non-climatic influence comes along very gradually just as is expected of the response to the enhanced greenhouse effect.

In examining ocean temperatures (Christy et al. 2001, *Geophys. Res. Lett.*) I discovered that the trends of the water temperature (m depth) do not track well with those of the air temperature just above the water (3m), even if both are measured on the same buoy over 20 years. This is important for the discussion below where NOAA used marine air temperatures to adjust water temperature measurements from ships.

There are many other factors that render surface temperature datasets to be of low effectiveness for the detection of enhanced greenhouse warming, (a) lack of systematic geographical coverage in time, (b) unsystematic measuring methods and instrumentation

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in time and space, (c) the point measurement represents at best a tiny, local area and (d) is easily impacted by slight changes in the surroundings, which can occur for example when a station moves. There have been huge efforts to try and adjust the raw surface data to give a time series that would represent that of a pristine environment, and I have led or been a part in some of these (e.g. for Central California in Christy et al. 2006 and East Africa in Christy et al. 2009 and Christy 2013).

Thus, having experience in building surface, satellite and balloon temperature datasets, and taking into account the signal we are looking for to detect the enhanced greenhouse effect, the evidence suggests to me that utilizing the bulk atmospheric measurements provides the best opportunity to answer questions about the climate's response to this human-induced change in atmospheric composition. The deep atmosphere is much more coherent in space and time in terms of its variations. It is not affected by human development at the surface. It is measured systematically. To be sure, satellite and balloon temperatures require their own adjustments and cannot be considered "perfect", but do offer an independence from one another to allow direct comparison studies. Regarding the detection of the enhanced greenhouse effect, the troposphere, as indicated by models, happens to be the atmospheric region that will respond the most, i.e. warm the fastest, and thus, in my view, is a metric that provides a better way to detect human influence on the climate.

(2.b) The new NOAA surface temperature dataset

A series of papers appeared last year (including Huang et al. 2005 *J. Climate*, Karl et al. 2005 *Science*) describing a new surface temperature dataset constructed by NOAA which indicated a bit more warming in the past to 25 years than the previous versions. The key change dealt with seawater temperatures in the dataset now known as ERSSTv4. This change introduced an additional warming into the record from about 1998 onward. The main reason for this new warming, as the authors note, was the adjustment applied to buoy data, adding about +0.12°C to the buoy readings. In 1998, only about 10 percent of the data reports were from buoys, but by 2000 about 90 percent were buoy data. Thus, because the influence of the buoy data grew significantly through time, the simple addition of a bias to all the buoys from the beginning created a warmer trend as they became the dominate source of information.

Some background is necessary. Unlike satellite and balloon datasets which measure a systematic quantity (essentially atmospheric air temperature), surface temperature datasets are a mixture of air (over land) and water (over ocean) temperatures measured over a considerable range of instruments, exposures and methods. Over land, weather stations measure the temperature of the air in varying types of instrument shelters and by

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varying techniques at a level about 5 ft above the ground. Over the ocean, however, the temperature utilized is that of the water itself, not the air above, so traditional global surface datasets do not measure a homogenous physical parameter over land versus ocean. Further, the depth of the water temperature measurement is quite varied from 2 ft to 5 ft or so, by methods that range from buckets drawn up on deck into which a thermometer is inserted to engine-intake temperatures much deeper in the water and to buoys, drifting or moored to the bottom. So the fact temperature varies by depth is an issue to tackle before the possibility of constructing a systematic dataset may be attempted. Then too, the measurements are not spatially or temporally consistent with large regions, such as Africa and the southern oceans, unmeasured.

Keep in mind that even though the trend of this NOAA dataset became more positive in the past 10 to 20 years, it is still below climate model projections over the longer term. For longer periods, such as the period since 1979 when satellites began measuring bulk atmospheric temperatures, the new global dataset is similar to that of the Hadley Centre (1979-2015: NOAA +0.155 °C/decade, Hadley Centre UKMet, +0.165 °C/decade). However, there are questions that remain concerning the new NOAA sea water dataset, especially how it indicates more warming in the last 20 years than others. Figure 4 displays the ocean trends for the region 20 S to 60 N (i.e. tropical and northern hemisphere oceans - there was too little data south of 20 S for generating near-surface air temperatures there). There are 4 datasets represented, NOAA (NOAA, red), Hadley Centre (HadCRUT4, orange), a preliminary near-surface air temperature over the oceans by my graduate student Rob Junod (yellow) and the UAH deep layer air temperature from satellites (blue). Both NOAA and HadCRUT4 are temperatures of the sea water near the surface, so should be the same.

NOAA used a curious reference variable to calibrate the water temperatures measured from ship intakes – the Night Marine Air Temperature (NMAT). This is curious because there are considerable adjustments required for the NMATs themselves, i.e. corrections for height of ship deck, etc. In any case, from this, the buoy data were then adjusted to match the ship data. It appears, then, that the foundational adjustment process depends on NMATs to adjust the ship data to then adjust the buoy data. The final product from NOAA mixes all of these together, and because the geographic representation of the different systems changed dramatically (as noted, from approximately 10% buoys and 90% ships in 1981 to 90% buoys and 10% ships today – Huang et al. 2015), an adjustment applied to the buoys will automatically influence the trend.

I'm aware that the Committee sought information about this curious process and asked NOAA to generate datasets based only on consistent measuring systems, i.e. ships alone, buoys alone and NMATs alone, to see if one system might have impacted the trends

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improperly due to distribution changes. NOAA was unable to accommodate this request. At the same time I asked my graduate student, Rob Junod, to do the work for NMAT. What is presented here is preliminary, but follows much of the previous work on NMATs (developed at the National Oceanographic Centre and the Hadley Centre in the UK) with that added advantage of being updated to 2014. The best geographical data coverage was found to be 20°S to 60°N, so this area was also applied to the other datasets for an apples to apples comparison. The results are shown in Fig. 4 in which all trends end in 2014 but cover periods in two-year increments from 20 years to 1[illegible] years.

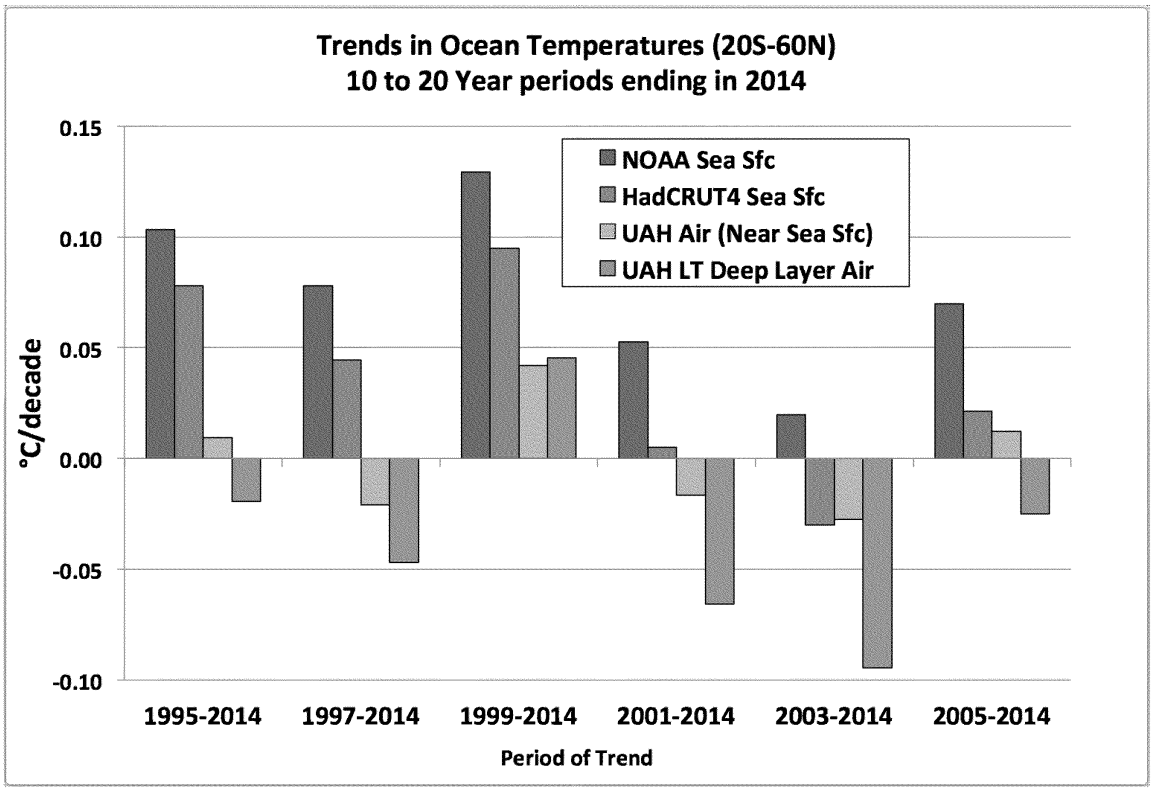

Figure 4. Decadal trends (°C/decade) of four temperature datasets over the oceans from 20°S to 60°N for varying periods ending in 2014. Red and orange are surface seawater temperature datasets from NOAA and the Hadley Centre (HadCRUT4). Yellow is a near-surface air temperature dataset (Night Marine Air Temperature) built by UAH (preliminary). Blue is the temperature trend of the deep atmosphere (surface to 35,000 ft or Lower Troposphere) from microwave emissions captured by satellites (also UAHv6.0b5.)

A number of observations are evident in Fig. 4. (1) In terms of the temperature trend, the air temperatures are less than those of the water (as indicated in my 2000 study mentioned above.) (2) NOAA warms the fastest in all periods. (3) In the past 10-40

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years, the trends of the HadCRUT4 agree better with the near-surface air temperature dataset (being near zero and supporting the notion of a hiatus) than with the trends from its physically-identical quantity from NOAA. (4) The magnitude of the NMAT trends lies between the trends of the deep atmospheric and sea water.

This figure generates a number of data quality questions too. () If NMATs were used to calibrate the ship temperatures and then the ships were used to calibrate the buoy temperatures, why does the NOAA dataset differ so much from its basic reference point – NMATs? (2) What do the time series look like and what are the sub-period trends for seawater under the condition that only ships and/or only buoys are used to build the dataset for the past 2-25 years? (3) What does the time series of NOAA's NMAT (i.e. their reference) dataset show?

The real science questions here are those which have significant importance to the understanding of how extra greenhouse gases might affect the climate as shown in the following section.

(2) How well do we understand climate change?

A critical scientific goal in our era is to determine whether emissions from human activities impact the climate and if so by how much. This is made especially difficult because we know the climate system already is subject to significant changes without the influence of humans. Because there is no measuring device that explicitly determines the *cause* of the climate changes we can measure, such as temperature, our science must take a different approach to seek understanding as to what causes the changes, i.e. how much is natural and how much is human induced. The basic approach today utilizes climate models. (The projections of these models are being utilized for carbon policies as well.)

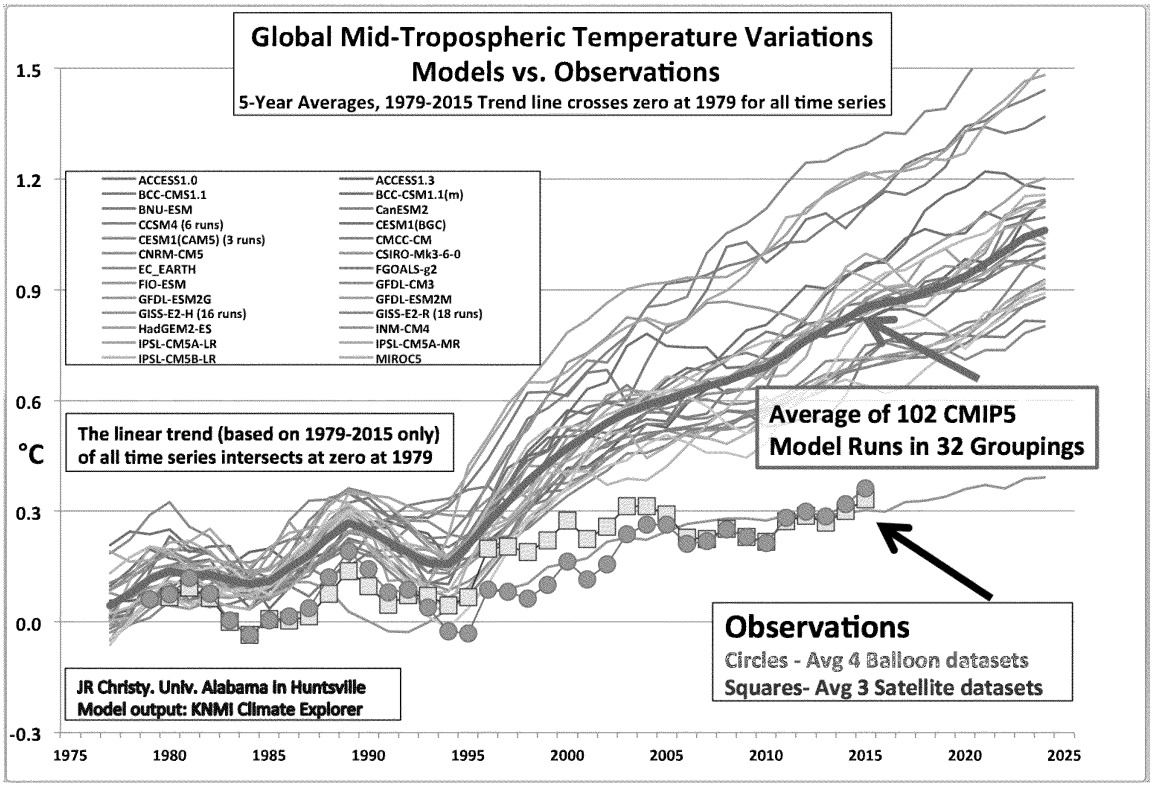
It is important to understand that output from these models, (i.e. projections of the future climate and the specific link that increasing CO2 might have on the climate) are properly defined as scientific hypotheses or claims – model output cannot be considered as providing proof of the links between climate variations and greenhouse gases. These models are complex computer programs which attempt to describe through mathematical equations as many factors that affect the climate as is possible and thus estimate how the climate might change in the future. The model, it is hoped, will provide accurate responses of the climate variables, like temperature, when extra greenhouse gases are included in the model. However, the equations for nearly all of the important climate processes are not exact, representing the best approximations modelers can devise and that computers can handle at this point.

J.R. Christy 2 Feb 2 6
House Committee on
Science, Space and Technology

A fundamental aspect of the scientific method is that if we say we understand a system (such as the climate system) then we should be able to predict its behavior. If we are unable to make accurate predictions, then at least some of the factors in the system are not well defined or perhaps even missing. [Note, however, that merely replicating the behavior of the system (i.e. reproducing "what" the climate does) does not guarantee that the fundamental physics are well-known. In other words, it is possible to obtain the right answer for the wrong reasons, i.e. getting the "what" of climate right but missing the "why".]

Do we understand how greenhouse gases affect the climate, i.e. the link between emissions and climate effects? As noted above, a very basic metric for climate studies is the temperature of the bulk atmospheric layer known as the troposphere, roughly from the surface to 5 , ft altitude. This is the layer that, according to models, should warm significantly as CO_2 increases – even faster than the surface. Unlike the surface temperature, this bulk temperature informs us about the crux of the global warming question – how much heat is accumulating in the global atmosphere? And, this CO_2-caused warming should be easily detectible by now, according to models. This provides a good test of how well we understand the climate system because since 979 we have had two independent means of monitoring this layer – satellites from above and balloons with thermometers released from the surface.

I was able to access 2 CMIP-5 rcp4.5 (representative concentration pathways) climate model simulations of the atmospheric temperatures for the tropospheric layer and generate bulk temperatures from the models for an apples-to-apples comparison with the observations from satellites and balloons. These models were developed in institutions throughout the world and used in the IPCC AR5 Scientific Assessment (2 3).



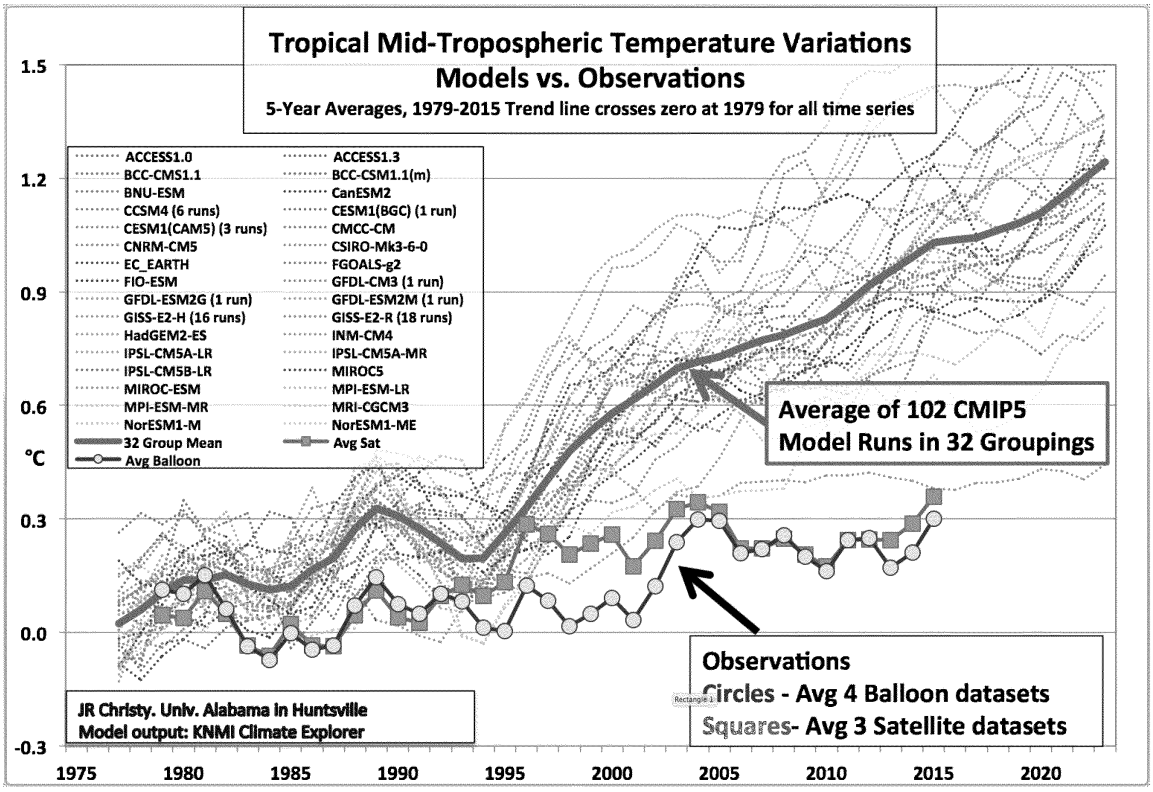
Above: Global average mid-tropospheric temperature variations (5-year averages) for 32 models (lines) representing 2 individual simulations. Circles (balloons) and squares (satellites) depict the observations. The Russian model (INM-CM4) was the only model close to the observations.

The information in this figure provides clear evidence that the models have a strong tendency to over-warm the atmosphere relative to actual observations. On average the models warm the global atmosphere at a rate 2.5 times that of the real world. This is not a short-term, specially-selected episode, but represents the past 37 years, over a third of a century. This is also the period with the highest concentration of greenhouse gases and thus the period in which the response should be of largest magnitude.

Following the scientific method of testing claims against data, we would conclude that the models do not accurately represent at least some of the important processes that impact the climate because they were unable to "predict" what has already occurred. In other words, these models failed at the simple test of telling us "what" has already happened, and thus would not be in a position to give us a confident answer to "what" may happen in the future and "why." As such, they would be of highly questionable

value in determining policy that should depend on a very confident un derstanding of how the climate system works.

There is a related climate metric that also utilizes atmospheric temperature which in models has an even larger response than that of the global average shown above. This metric, then, provides a stronger test for understanding how well models perform regarding greenhouse gases specifically. In the models, the tropical atmosphere warms significantly in response to the added greenhouse gases – more so than that of the global average atmospheric temperature.



Above: Tropical average mid -tropospheric temperature variations (5 -year averages) for 32 models (lines) representing 2 individual simulations. Circles (balloons) and squares (satellites) depict the observations.

In the tropical comparison here, the disparity between models and observations is even greater, with models on average warming this atmospheric region by a factor of three times greater than in reality. Such a result re -enforces the implication above that the models have much improvement to undergo before we may have confidence they will provide information about what the climate may do in the future or even why the climate

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varies as it does. For the issue at hand, estimates of how the global temperature might be affected by emission reductions from regulations would be exaggerated and not reliable.

(3) Climate Impact of Regulations (i.e. Paris) Will Not Be Attributable or Detectable

No one knows the climate impact of the proposed carbon emission reductions agreed to in Paris. The main reason for this is that there is considerable latitude for countries to do as little or as much as they desire. Examining the history of global carbon emissions, it is clear that countries, especially developing countries, will continue to seek to expand energy use through carbon combustion because of their affordability in providing considerable positive benefits to their citizens.

In any case, impact on global temperature for current and proposed reductions in greenhouse gases will be tiny at best. To demonstrate this, let us assume, for example, that the total emissions from the United States were reduced to zero, as of last May 13th, 2015 (the date of a hearing at which I testified). In other words as of that day and going forward, there would be no industry, no cars, no utilities, no people – i.e. the United States would cease to exist as of that day. Regulations, of course, will only reduce emissions a small amount, but to make the point of how minuscule the regulatory impact will be, we shall simply go way beyond reality and cause the United States to vanish. With this we shall attempt to answer the question of climate change impact due to emissions reductions.

Using the U.N. IPCC impact tool known as Model for the Assessment of Greenhouse-gas Induced Climate Change or MAGICC, graduate student Rob Junod and I reduced the projected growth in total global emissions by U.S. emission contribution starting on this date and continuing on. We also used the value of the equilibrium climate sensitivity as determined from empirical techniques of 1.8 °C. After 15 years, the impact as determined by these model calculations would be only 0.15 to 0.18 °C – an amount less than that which the global temperature fluctuates from month to month. [These calculations used emission scenarios A1B-AIM and A1F-MI with U.S. emissions comprising 14 percent to 17 percent of the 2015 global emissions. There is evidence that the climate sensitivity is less than 1.8 °C, which would further lower these projections.]

As noted, the impact on global emission and global climate of the recent agreements in Paris regarding global emissions is not exactly quantifiable. Knowing how each country will behave regarding their emissions is essentially impossible to predict besides the added issue of not knowing how energy systems themselves will evolve over time.

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Because halting the emissions of our entire country would have such a tiny calculated impact on global climate, it is obvious that fractional reductions in emissions through regulation would produce imperceptible results. In other words, there would be no evidence in the future to demonstrate that a particular climate impact was induced by the proposed and enacted regulations. Thus, the regulations will have no meaningful or useful consequence on the physical climate system – even if one believes climate models are useful tools for prediction.

Summary

Climate change is a wide-ranging topic with many difficulties. Our basic knowledge about what the climate is doing (i.e. measurements) is plagued by uncertainties. In my testimony today I have given evidence that the bulk atmospheric temperature is measured well-enough to demonstrate that our understanding of how greenhouse gases affect the climate is significantly inadequate to explain the climate since 1979. In particular, the actual change of the fundamental metric of the greenhouse warming signature – the bulk atmospheric temperature where models indicate the most direct evidence for greenhouse warming should lie - is significantly misrepresented by the models. Though no dataset is perfect, the way in which surface datasets have been constructed leaves many unanswered questions, especially for the recent NOAA update which shows more warming than the others. Finally, regulations already enforced or being proposed, such as those from the Paris Agreement, will have virtually no impact on whatever the climate is going to do.

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Appendix A

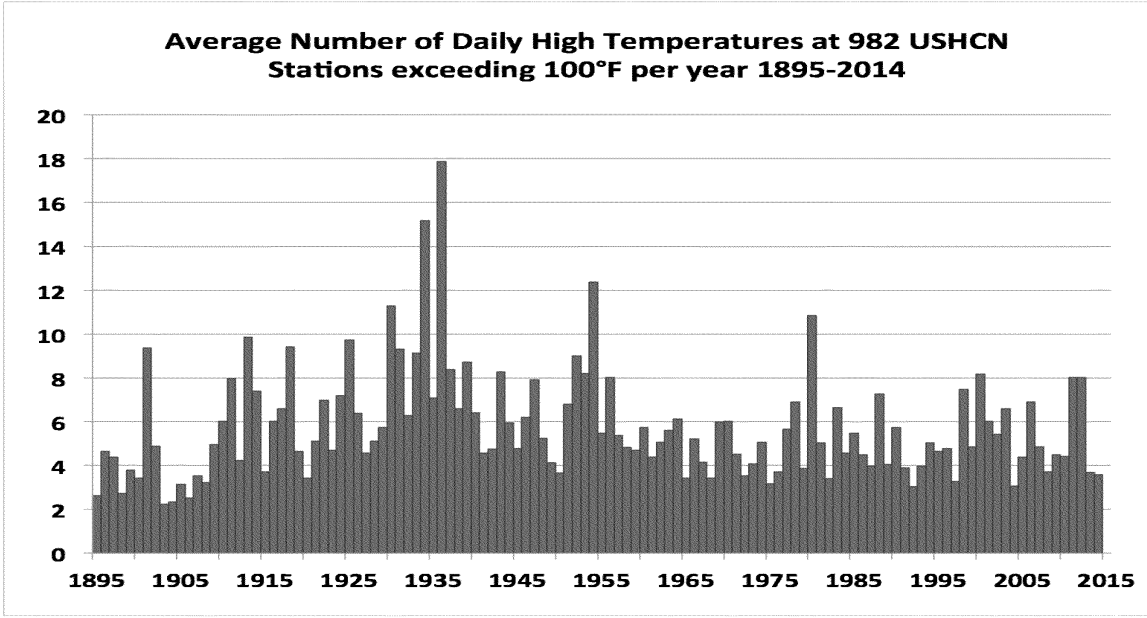
This appendix is an extract from my written testimony presented at the following Hearing:

U.S. Senate Committee on
Commerce, Science, & Transportation
Subcommittee on Space, Science and Competitiveness
8 Dec 2015
Testimony of John R. Christy
University of Alabama in Huntsville.

Alleged impacts of human-induced climate changes regarding extreme events

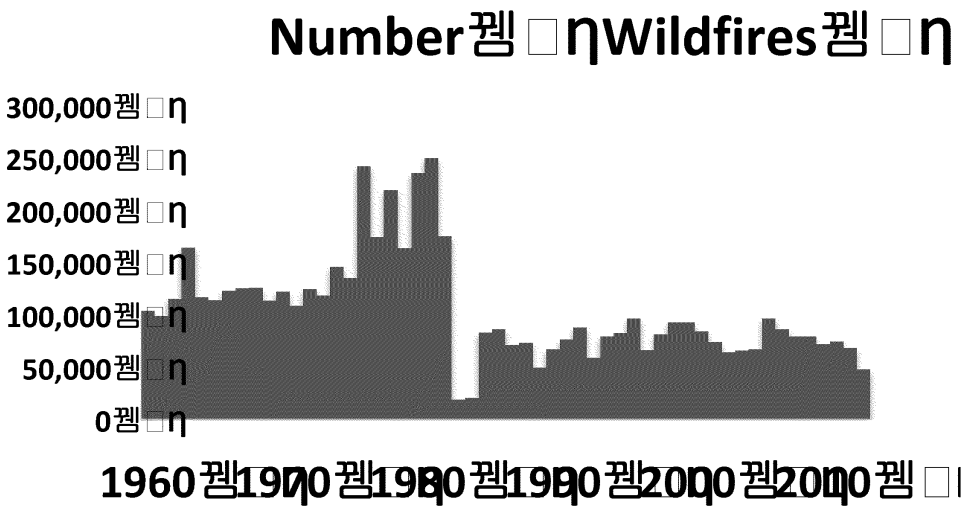
Much of the alarm related to increasing greenhouse gas concentrations shifted in the past decade from global temperature changes to changes in extreme events, i.e. those events which typically have a negative impact on the economy. These events may be heat waves, floods, hurricanes, etc.

In terms of heat waves, below is the number of °F days observed in the U.S. from a controlled set of weather stations. It is not only clear that hot days have not increased, but it is interesting that in the most recent years there has been a relative dearth of them.

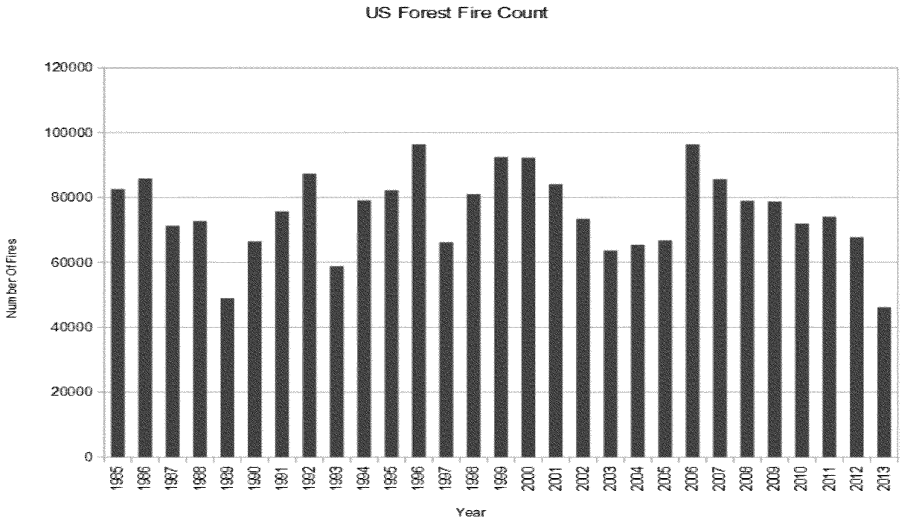


Above: Average number of days per-station in each year reaching or exceeding °F in 982 stations of the USHCN database (NOAA/NCEI, prepared by JRChristy).

Forest and wild fires are documented for the US. The evidence below indicates there has not been any change in frequency of wildfires. Acreage (not shown) shows little change as well.



Above: Number of U.S. wildfires. As the management of these events changes, and thus the number also changes, but the number of events since 1985 has remained constant. (National Interagency Fire Center https://www.nifc.gov/fireInfo/nfn.htm)



Above: Number of U.S. forest fires per year since 1965.

The two figures above demonstrate that fire events have not increased in frequency in the United States during the past several decades.

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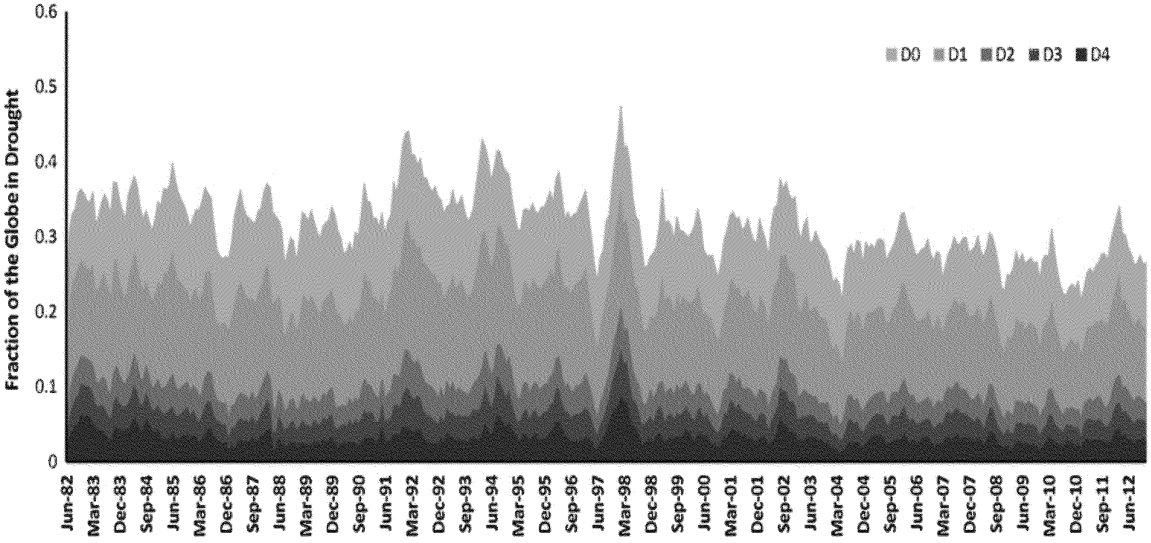
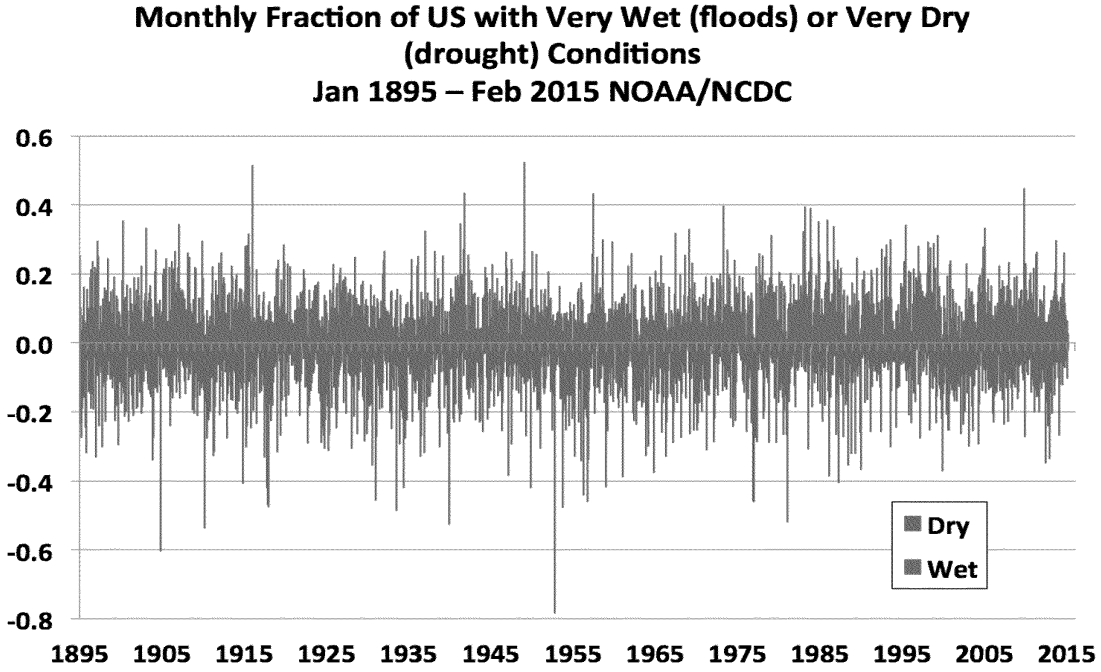
The claims that droughts and floods are increasing may be examined by the observational record as well.

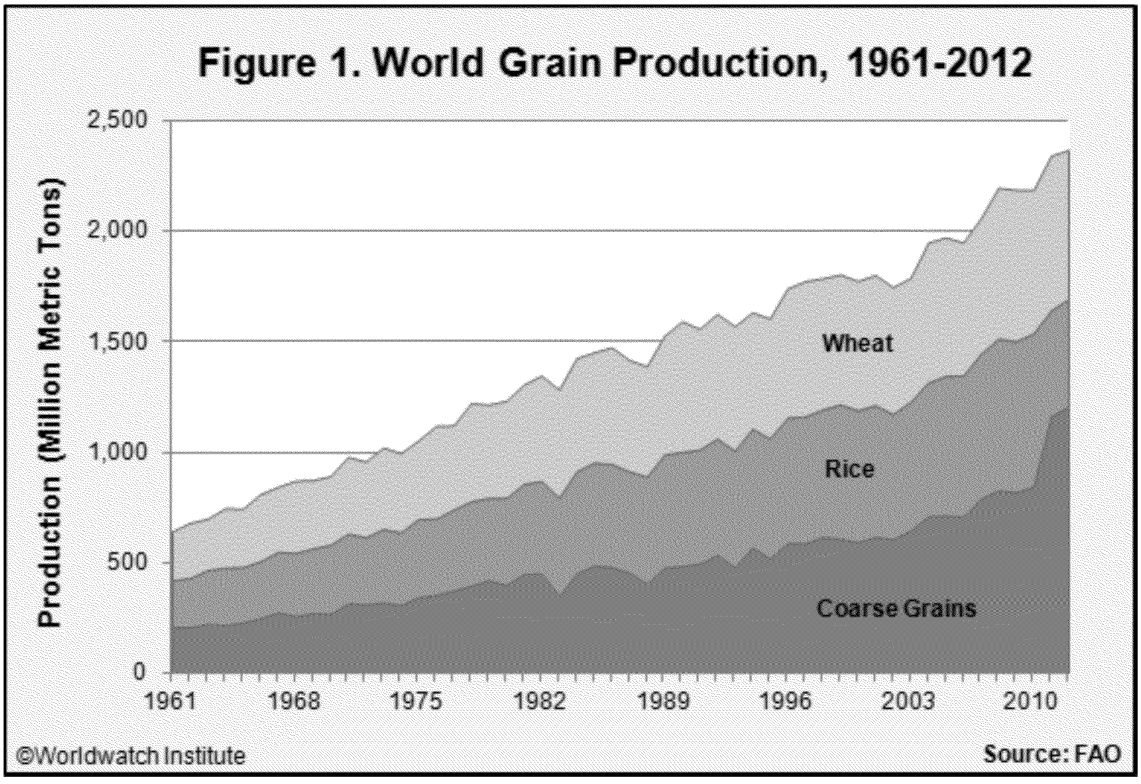


Above: Global areal extent of five levels of drought for 1982-2012 where dryness is indicated in percentile rankings with D1 < 30, D2 < 20, D3 < 10, D3 < 5 and D4 < 2 percentile of average moisture availability. (Hao et al. 2014)



Above: Areal fraction of conterminous U.S. under very wet (blue) or very dry (red) conditions. NOAA/NCEI.

The two figures above demonstrate that moisture conditions have not shown a tendency to have decreased (more drought) or increased (more large-scale wetness). Such information is rarely consulted when it is more convenient simply to make unsubstantiated claims that moisture extremes, i.e. droughts and floods (which have always occurred), are somehow becoming even more extreme. Over shorter periods and in certain locations, there is evidence that the heaviest precipitation events are tending to be greater. This is not a universal phenomenon and it has not been established that such changes may be due to changes in greenhouse gas concentrations as demonstrated earlier because the model projections are unable to reproduce the simplest of metrics.



Above: World grain production 1961-2012. U.N. Food and Agriculture Organization.

It is a simple matter to find documentation of the ever-rising production of grains. One wonders about the Federal Council on Environmental Quality's allegation that there has been "harm to agriculture" from human-induced climate change because when viewing the total growth in production, which appears to be accelerating, one would assume no "harm" has been done during a period of rising greenhouse gases.

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With the evidence in these examples above, it is obviously difficult to establish the claims about worsening conditions due to human-caused climate change, or more generally that any change could be directly linked to increasing CO2. This point also relates to the issue of climate model capability noted earlier. It is clear that climate models fall short on some very basic issues of climate variability, being unable to reproduce "what" has happened regarding global temperature, and therefore not knowing "why" any of it happened. It is therefore premature to claim that one knows the causes for changes in various exotic measures of weather, such as rainfall intensity over short periods, which are not even explicitly generated in climate model output.

The Disappointing Scientific Process

I have written much for previous congressional hearings and other venues about the failure of the scientific community to objectively approach the study of climate and climate change. (See Appendix) Climate science is a murky science with large uncertainties on many critical components such as cloud distributions and surface heat exchanges. As mentioned above, there is no objective instrumentation that can tell us "why" changes occur. That being the case, we are left with hypotheses (claims) to put forward and then to test. The information given above, in my view, is clear evidence that the current theoretical understanding of "why" the climate changes, as embodied in models (and on which current policy is based), fails such tests. Indeed, the theoretical (model) view as expressed in the IPCC AR5 in every case overestimated the bulk tropical atmospheric temperature response of extra greenhouse gases (see above and IPCC Supplementary Material Figure .SM.) indicating the theoretical understanding of the climate response is too sensitive to greenhouse gases.

One problem with our science relates to the funding process for climate studies, the vast majority of which is provided through federal agencies. Funding decisions are decided by people, and people have biases. Our science has also seen the move toward "consensus" science where "agreement" between people and groups is elevated above determined, objective investigation. The sad progression of events here has even led to congressional investigations designed to silence (with some success) those whose voices, including my own, have challenged the politically-correct views on climate (i.e. congressional investigation by Rep. Grijalva, 22 Feb 2015, http://www.scribd.com/doc/256829/Letter-to-UAH-re-John-Christy.)

Today, funding decisions are made by review panels. In this process, many proposals for funding are submitted to the agencies, but the agencies only have a fraction of the funds available to support the proposals, so only a few proposals can be funded and these are selected by panels. In the area of climate, it is clear the agencies are convinced of the

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consensus view of dangerous climate change as indicated by their various statements and press releases on the issue. Therefore, when a contrarian proposal is submitted that seeks to discover other possible explanations besides greenhouse gases for the small changes we now see, or one that seeks to rigorously and objectively investigate climate model output, there is virtually no chance for funding. This occurs because the panel determines by majority vote whom to fund, and with tight competition, any bias by just a couple of panel members against a contrarian proposal is sufficient for rejection. Of course, the agencies will claim all is done in complete objectivity, but that would be precisely the expected response of someone already within the "consensus" and whose agency has stated its position on climate change. This brings me to "consensus science."

The term "consensus science" will often be appealed to regarding arguments about climate change to bolster an assertion. This is a form of "argument from authority." Consensus, however, is a political notion, not a scientific notion. As I testified to the Inter-Academy Council in June 2 , wrote in *Nature* that same year (Christy 2), and documented in my written testimony for several congressional hearings (e.g., House Space, Science and Technology, 3 Mar 2) the IPCC and other similar Assessments do not represent for me a consensus of much more than the consensus of those selected to agree with a particular consensus.

The content of these climate reports is actually under the control of a relatively small number of individuals - I often refer to them as the "climate establishment" – who through the years, in my opinion, came to act as *gatekeepers* of scientific opinion and information, rather than *brokers*. The voices of those of us who object to various statements and emphases in these assessments are by-in-large dismissed rather than accommodated. This establishment includes the same individuals who become the "experts" called on to promote IPCC claims in government reports such as the endangerment finding by the Environmental Protection Agency.

As outlined in my previous testimonies, these "experts" become the authors and evaluators of their own research relative to research which challenges their work. This becomes an obvious conflict of interest. But with the luxury of having the "last word" as "expert" authors of the reports, alternative views vanish. This is not a process that provides the best information to the peoples' representatives. The U.S. Congress must have the full range of views on issues such as climate change which are (a) characterized by considerable ambiguity (see model results) (b) used to promote regulatory actions which will be economically detrimental to the American people and, most ironically, (c) will have no impact on whatever the climate will do.

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I've often stated that climate science is a "murky" science. We do not have laboratory methods of testing our hypotheses as many other sciences do. As a result what passes for science includes, opinion, arguments-from-authority, dramatic press releases, and fuzzy notions of consensus generated by preselected groups. This is not science.

We know from Climategate emails and many other sources that the IPCC has had problems with those who take different positions on climate change than what the IPCC promotes. There is another way to deal with this however. Since the IPCC activity (and climate research in general) *is* funded by U.S. taxpayers, then I propose that five to ten percent of the funds be allocated to a group of well-credentialed scientists to produce an assessment that expresses legitimate, alternative hypotheses that have been (in their view) marginalized, misrepresented or ignored in previous IPCC reports (and thus the EPA Endangerment Finding and National Climate Assessments).

Such activities are often called "Red Team" reports and are widely used in government and industry. Decisions regarding funding for "Red Teams" should not be placed in the hands of the current "establishment" but in panels populated by credentialed scientists who have experience in examining these issues. Some efforts along this line have arisen from the private sector (i.e. *The Non-governmental International Panel on Climate Change* at http://nipccreport.org/ and Michaels (2 2) *ADDENDUM: Global Climate Change Impacts in the United States*). I believe policymakers, with the public's purse, should actively support the assembling all of the information that is vital to addressing this murky and wicked science, since the public will ultimately pay the cost of any legislation alleged to deal with climate.

Topics to be addressed in this "Red Team" assessment, for example, would include (a) evidence for a low climate sensitivity to increasing greenhouse gases, (b) the role and importance of natural, unforced variability, (c) a rigorous and independent evaluation of climate model output, (d) a thorough discussion of uncertainty, (e) a focus on metrics that most directly relate to the rate of accumulation of heat in the climate system, (f) analysis of the many consequences, including benefits, that result from CO_2 increases, and (g) the importance that affordable and accessible energy has to human health and welfare.

What this proposal seeks is to provide to the Congress and other policymakers a parallel, scientifically-based assessment regarding the state of climate science which addresses issues which here-to-for have been un- or under-represented by previous tax-payer funded, government-directed climate reports. In other words, our policymakers need to see the entire range of findings regarding climate change.

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Summary of Extract

The messages of the two points outlined in the extract above are: (1) the claims about increases in frequency and intensity of extreme events are generally not supported by actual observations and, (2) official information about climate science is largely controlled by agencies through (a) funding choices for research and (b) by the carefully-selected (i.e. biased) authorship of reports such as the EPA Endangerment Finding and the National Climate Assessment.

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To: Schnare, David[schnare.david@epa.gov]
From: DWSschnare
Sent: Thur 2/16/2017 7:22:58 PM
Subject: IG response to the agency response
11-p-0702_ig_comment_on_response.pdf

https://www.epa.gov/sites/production/files/2015-10/documents/11-p-0702_ig_comment_on_response.pdf

Sent from my iPad

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

FEB 7 2012

THE INSPECTOR GENERAL

MEMORANDUM

SUBJECT: Close-Out of OIG Report No. 11-P-0702, *Procedural Review of Greenhouse Gases Endangerment Finding Data Quality Processes*, September 26, 2011

TO: Paul T. Anastas
Assistant Administrator for Research and Development

Michael L. Goo
Associate Administrator for Policy

Gina McCarthy
Assistant Administrator for Air and Radiation

Thank you for your January 11, 2012, response to the subject report. We appreciate the U.S. Environmental Protection Agency's (EPA's) constructive approach to resolving the issues raised in our report.

In accordance with EPA Manual 2750, your response included a proposed corrective action plan addressing each of the open recommendations. The proposed corrective actions and proposed timelines for completion meet the intent of our recommendations. Thus, with this memorandum, we are closing these recommendations in our tracking system. The Agency is responsible for tracking and certifying completion of these actions in its Management Audit Tracking System. Please notify my staff if there is a significant change in the agreed-to corrective action plan.

The attached Office of Inspector General action plan analysis provides detailed information on each of the corrective actions for recommendations 1, 2.a., 2.b., and 3, and the timelines for completion. If you or your staff have any questions regarding this memorandum or the attachment, please contact Elizabeth Grossman, Acting Assistant Inspector General for Program Evaluation, at (202) 566-0838; Rick Beusse at (919) 541-5747; or Jim Hatfield at (919) 541-1030.

Arthur A. Elkins, Jr.

Attachment

ED_001612_00028365-00001

cc: Bob Perciasepe, Deputy Administrator
Scott Fulton, General Counsel
Malcolm Jackson, Assistant Administrator for Environmental Information and Chief Information Officer
Brenda Mallory, Deputy General Counsel, Office of General Counsel
Shannon Kenny, Deputy Associate Administrator, Office of Policy
Lek Kadeli, Deputy Assistant Administrator for Management, Office of Research and Development (ORD)
Janet McCabe, Principal Deputy Assistant Administrator, Office of Air and Radiation (OAR)
Kevin Teichman, Deputy Assistant Administrator for Science, ORD
Bicky Corman, Deputy Associate Administrator, Office of Policy
Mike Flynn, Acting Deputy Assistant Administrator, OAR
Norman Adkins, Audit Follow-Up Coordinator, ORD
David LaRoche, Audit Follow-Up Coordinator, OAR
J. Anthony Ogden, Counsel to the Inspector General, Office of Inspector General (OIG)
Elizabeth Grossman, Acting Assistant Inspector General for Program Evaluation, OIG
Rick Beusse, Director, Air and Research Program, Office of Program Evaluation, OIG
Jim Hatfield, Project Manager, Office of Program Evaluation, OIG

OIG Action Plan Analysis, OIG Report No. 11-P-0702, Procedural Review of Greenhouse Gases Endangerment Finding Data Quality Processes, September 26, 2011

OIG recommendation	Agency action(s) taken, ongoing, or planned	OIG analysis	Status
1. Direct the Environmental Protection Agency (EPA) Science Policy Council to revise the flowchart on page 2 of EPA's *Peer Review Handbook* to ensure that the flowchart accurately depicts Office of Management and Budget (OMB) requirements for external peer review of highly influential scientific assessments.	*EPA Response:* Office of the Science Advisor (OSA) staff will develop a modification, as appropriate, to the flow chart on page 2 of EPA's *Peer Review Handbook* to clarify as needed the OMB requirements for external peer review of highly influential scientific assessments. The modified flow chart will be reviewed by the Agency's Peer Review Advisory Group. EPA's Science Advisor will then submit the modified flow chart to EPA's Science and Technology Policy Council (formerly the Science Policy Council) for concurrence and incorporation into EPA's *Peer Review Handbook.* *Planned Completion Date:* 6/30/2012 *Lead Responsibility:* EPA Science Advisor	We accept the Agency's planned actions and the timeline for completion of the corrective actions.	Recommendation closed.
2.a. Direct the EPA Science Policy Council to instruct program offices that, when using influential scientific information or highly influential scientific assessments supporting an action, to include language in the preamble of proposed and final rules that specifically states that the action was supported by influential scientific information or a highly influential scientific assessment, and certifies that EPA conducted a peer review of the supporting information in accordance with OMB's *Final Information Quality Bulletin for Peer Review.*	*EPA Response:* EPA's Science Advisor and the Associate Administrator for Policy will issue a joint memorandum to the Agency's Assistant and Regional Administrators reiterating the use of language from the Agency's Peer Handbook (Attachment A, page C-3) for the preambles of proposed and final rules (actions) that specifically states: (a) whether the action was supported by influential scientific information or a highly influential scientific assessment; and (b) whether or not a peer review of supporting information was conducted in accordance with EPA's *Peer Review Handbook.* *Planned Completion Date:* 6/30/2012 *Lead Responsibility:* EPA Science Advisor and Associate Administrator for Policy	We accept the Agency's planned actions and the timeline for completion of the corrective actions.	Recommendation closed.

OIG Action Plan Analysis, OIG Report No. 11-P-0702, Procedural Review of Greenhouse Gases Endangerment Finding Data Quality Processes, September 26, 2011

2.b. Direct the EPA Science Policy Council to instruct program offices that, when using influential scientific information or highly influential scientific assessments supporting an action, to include a compliance statement in its action memoranda stating that the Agency followed its peer review policy.	*EPA Response:* EPA's Science Advisor and the Associate Administrator for Policy will issue a joint memorandum to the Agency's Assistant and Regional Administrators reiterating that, when using influential scientific information or a highly influential scientific assessment supporting an action, to include a compliance statement in their action memoranda stating that the Agency followed its peer review policy (as required by the Agency's Peer Handbook, Attachment B, page C-6). *Planned Completion Date:* 6/30/2012 *Lead Responsibility:* EPA Science Advisor and Associate Administrator for Policy	We accept the Agency's planned actions and the timeline for completion of the corrective actions.	Recommendation closed.
3. Revise EPA's guidance document, *A Summary of General Assessment Factors for Evaluating the Quality of Scientific and Technical Information,* to establish minimum review and documentation requirements for assessing and accepting data from other organizations.	*EPA Response (part 1):* A workgroup under the auspices of the Science and Technology Policy Council will evaluate existing EPA review and documentation requirements for assessing and accepting data from third party organizations. The workgroup will develop modifications to be made to EPA's guidance document, *A Summary of General Assessment Factors for Evaluating the Quality of Scientific and Technical Information*, to include minimum review and documentation requirements for assessing and accepting data from third party organizations. *Planned Completion Date:* 4/27/2012 *EPA Response (part 2):* The workgroup will submit the modifications to the Science and Technology Policy Council for concurrence and approval. *Planned Completion Date:* 6/30/2012 *EPA Response (part 3):* An update EPA's guidance document, *A Summary of General Assessment Factors for Evaluating the Quality of Scientific and Technical Information*, is finalized and published, to include as appropriate minimum review and documentation requirements for assessing and accepting data from third party organizations. *Planned Completion Date:* 12/31/2012 *Lead Responsibility:* Deputy Director, Office of the Science Advisor	We accept the Agency's planned actions and the timeline for completion of the corrective actions.	Recommendation closed.

To: Schnare, David[schnare.david@epa.gov]
From: DWSschnare
Sent: Thur 2/16/2017 7:22:20 PM
Subject: Agency response
11-p-0702_agency_response.pdf

https://www.epa.gov/sites/production/files/2015-10/documents/11-p-0702_agency_response.pdf

Sent from my iPad

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 11 2012

MEMORANDUM

SUBJECT: U.S. Environmental Protection Agency (EPA) Response to Final OIG Report Dated September 26, 2011, "*Procedural Review of Greenhouse Gases Endangerment Finding Data Quality Processes*", Report No. 11-P-0702

FROM: Paul Anastas, PhD
Assistant Administrator for Research and Development

Michael L. Goo
Associate Administrator for Policy

Gina McCarthy
Assistant Administrator for Air and Radiation

TO: Arthur A. Elkins, Jr.
Inspector General

EPA appreciates the opportunity to respond to the Office of the Inspector General (OIG) final report "*Procedural Review of Greenhouse Gases Endangerment Finding Data Quality Processes*" (Project No. OPE-FY10-0017), dated September 26, 2011.

We note that your report focuses on the process used to develop the Technical Support Document (TSD). It does not attempt to evaluate the quality of the underlying science supporting the Endangerment Finding and does not make any recommendations regarding the Endangerment Finding itself. We appreciate the recognition that the Agency "*met statutory requirements for rulemaking and generally followed requirements and guidance related to ensuring the quality of the supporting technical information.*"

Your report raised concern over certain specific aspects of the peer review conducted for the TSD review based on your opinion regarding how to classify the document for purposes of peer review. As noted in your report, both the Office and Management and Budget (OMB) and EPA agree that the Endangerment TSD itself did not have the impacts or characteristics required to meet the OMB Peer

Review Bulletin's definition of a highly influential scientific assessment (HISA). We appreciate your clarification that your findings are solely based on your opinion regarding how to classify the document.

We have previously submitted detailed discussion of the issues addressed by your report. Despite our disagreement with many of your findings, we have considered your recommendations on their own merit and we have included an attached response for your consideration. If you or your staff have any questions, please contact Norman Adkins at (919) 541-0872.

cc: Bob Perciasepe, Deputy Administrator, OA
Scott Fulton, General Counsel, OGC
Malcolm Jackson, Chief Information Officer, OEI
Brenda Mallory, Deputy General Counsel, OGC
Shannon Kenny, Deputy Associate Administrator, OP
Lek Kadeli, Deputy Assistant Administrator for Management, ORD
Janet McCabe, Principal Deputy Assistant Administrator, OAR
Kevin Teichman, Deputy Assistant Administrator for Science, ORD
Bicky Corman, Deputy Associate Administrator, OP
Mike Flynn, Acting Deputy Assistant Administrator, OAR
Wade Najjum, Assistant Inspector General for Program Evaluation, OIG
Rick Beusse, Director of Program Evaluation, Air & Research Issues, OIG

Attachment I

EPA Response to Recommendations and Projected Completion Dates

Rec No.	OIG Recommendation	Lead Responsibility	EPA Response	Planned Completion Date
1	Direct the EPA Science Policy Council to revise the flowchart on page 2 of EPA's Peer Review Handbook to ensure that the flowchart accurately depicts OMB requirements for external peer review of highly influential scientific assessments.	EPA Science Advisor	OSA Staff will develop a modification, as appropriate, to the flow chart on Page 2 of EPA's Peer Review Handbook to clarify as needed the OMB requirements for external peer review of highly influential scientific assessments. The modified flow chart will be reviewed by the Agency's Peer Review Advisory Group. EPA's Science Advisor will then submit the modified flow chart to EPA's Science and Technology Policy Council (formerly the Science Policy Council) for concurrence and incorporation into EPA's Peer Review Handbook.	6/30/2012
2a	Direct the EPA Science Policy Council to instruct program offices that, when using influential scientific information or highly influential scientific assessments supporting an action, to include language in the preamble of proposed and final rules that specifically states that the action was supported by influential scientific information or a highly influential scientific assessment, and certifies that EPA conducted a peer review of the supporting information in accordance with OMB's Final Information Quality Bulletin for Peer Review.	EPA Science Advisor and Associate Administrator for Policy	EPA's Science Advisor and the Associate Administrator for Policy will issue a joint memorandum to the Agency's Assistant and Regional Administrators reiterating the use of language from the Agency's Peer Handbook (Attachment A, Page C-3) for the preambles of proposed and final rules (actions) that specifically states: (a) whether the action was supported by influential scientific information or a highly influential scientific assessment; and (b) whether or not a peer review of supporting information was conducted in accordance with EPA's Peer Review Handbook.	6/30/2012
2b	Direct the EPA Science Policy Council to instruct program offices that, when using influential scientific information or highly influential scientific assessments supporting an action, to include a compliance statement in its action memoranda stating that the Agency followed its peer review policy.	EPA Science Advisor and Associate Administrator for Policy	EPA's Science Advisor and the Associate Administrator for Policy will issue a joint memorandum to the Agency's Assistant and Regional Administrators reiterating that, when using influential scientific information or a highly influential scientific assessment supporting an action, to include a compliance statement in their action memoranda stating that the Agency followed its peer review policy (as required by the Agency's Peer Handbook Attachment B Page C-6).	6/30/2012
3	Revise EPA's guidance document, *A Summary of General Assessment Factors for Evaluating the Quality of Scientific and Technical Information*, to establish minimum review and documentation requirements for assessing and accepting data from other organizations.	Deputy Director, Office of the Science Advisor	A workgroup under the auspices of the Science and Technology Policy Council will evaluate existing EPA review and documentation requirements for assessing and accepting data from third party organizations. The workgroup will develop modifications to be made to EPA's guidance document, *A Summary of General Assessment Factors for Evaluating the Quality of Scientific and Technical Information*, to include minimum review and documentation requirements for assessing and accepting data from third party organizations.	4/27/2012
			The workgroup will submit the modifications to the Science and Technology Policy Council for concurrence and approval.	6/30/2012
			An update EPA's guidance document, *A Summary of General Assessment Factors for Evaluating the Quality of Scientific and Technical Information*, is finalized and published, to include as appropriate minimum review and documentation requirements for assessing and accepting data from third party organizations.	12/31/2012

To: Schnare, David[schnare.david@epa.gov]
From: DWSschnare
Sent: Thur 2/16/2017 7:20:44 PM
Subject: OIG letter
ig_statement_greenhouse_gases_endangerment_report.pdf

https://www.epa.gov/sites/production/files/2015-09/documents/ig_statement_greenhouse_gases_endangerment_report.pdf

Sent from my iPad

Press Statement

U.S. Environmental Protection Agency
Office of Inspector General
Washington, D.C.

For Immediate Release
September 28, 2011
Contact: John Manibusan
Phone: (202) 566-2391

WASHINGTON, D.C. – Statement of Inspector General Arthur A. Elkins, Jr., on the Office of Inspector General (OIG) report *Procedural Review of EPA's Greenhouse Gases Endangerment Finding Data Quality Processes*:

"The OIG evaluated EPA's compliance with established policy and procedures in the development of the endangerment finding, including processes for ensuring information quality. We concluded that the technical support document that accompanied EPA's endangerment finding is a highly influential scientific assessment and thus required a more rigorous EPA peer review than occurred. EPA did not certify whether it complied with OMB's or its own peer review policies in either the proposed or final endangerment findings as required. While it may be debatable what impact, if any, this had on EPA's finding, it is clear that EPA did not follow all required steps for a highly influential scientific assessment. We also noted that documentation of events and analyses could be improved.

We made no determination regarding the impact that EPA's information quality control systems may have had on the scientific information used to support the finding. We did not test the validity of the scientific or technical information used to support the endangerment finding, nor did we evaluate the merit of EPA's conclusions or analyses.

We make recommendations that we think will strengthen EPA's control over data quality processes. EPA disagreed with our conclusions and did not agree to take any corrective actions in response to this report. All the report's recommendations are unresolved."

###

Please visit the OIG's website at http://www.epa.gov/oig for more information.

To: Schnare, David[schnare.david@epa.gov]
From: DWSschnare
Sent: Thur 2/16/2017 7:14:46 PM
Subject: EPA: the Endangerment Finding was not a “highly influential scientific assessment” « Climate Audit

https://climateaudit.org/2011/10/04/epa-the-endangerment-finding-was-not-a-highly-influential-scientific-assessment/

Sent from my iPad

To: Schnare, David[schnare.david@epa.gov]
From: DWSschnare
Sent: Sat 1/28/2017 2:02:01 AM
Subject: Fwd: My new blog post recommending petitions to EPA to revoke the GHG Endangerment Finding FYI

Sent from my iPad

Begin forwarded message:

From: Alan Carlin <Personal Email/Ex. 6
Date: January 27, 2017 at 5:30:47 PM EST
To: Myron Ebell <Myron.Ebell@cei.org>, David Schnare <Personal Email/Ex. 6 Marc Morano <morano@climatedepot.com>, Kenneth Haapala <Ken@haapala.com>
Subject: My new blog post recommending petitions to EPA to revoke the GHG Endangerment Finding FYI

http://www.carlineconomics.com/archives/3368

Alan Carlin

To: Schnare, David[schnare.david@epa.gov]; benton.don@epa.gov[benton.don@epa.gov]
From: Sam Kazman
Sent: Thur 2/23/2017 11:15:56 PM
Subject: RE: Petition for Rulemaking on the Issue of Greenhouse Gases (Endangerment)
CEI Petition for Rulemaking on Endangerment 2017, corrected.pdf

Gentlemen:

In connection with the petition that we filed with you last Friday, we've made one minor correction to footnote 10 and to the text accompanying it on p.4. We apologize for any inconvenience.

Our thanks once again for your consideration of our filing.

Sam Kazman

General Counsel

Competitive Enterprise Institute

1310 L St. NW, 7th Floor

Washington DC 20005

www.cei.org

Personal Phone/Ex. 6

From: Sam Kazman
Sent: Friday, February 17, 2017 2:35 PM

To: 'schnare.david@epa.gov' <schnare.david@epa.gov>; 'benton.don@epa.gov' <benton.don@epa.gov>
Subject: Petition for Rulemaking on the Issue of Greenhouse Gases (Endangerment)

Gentlemen:

Enclosed for EPA's consideration is a petition for rulemaking on the subject of greenhouse gases and public health and welfare. The petition is submitted on behalf of CEI, the Science and Environmental Policy Project, and four individuals.

Thank you for attention to this matter.

Sam Kazman

General Counsel

Competitive Enterprise Institute

1310 L St. NW, 7th Floor

Washington DC 20005

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Personal Phone/Ex. 6

United States Environmental Protection Agency

Petition of the

Competitive Enterprise Institute and the Science and Environmental Policy Project

for Rulemaking on the Subject of Greenhouse Gases

and Their Impact on Public Health and Welfare,

in Connection with EPA's 2009 Endangerment Finding, 74 FR 66,496 (Dec. 15, 2009)

Competitive Enterprise Institute
1310 L Street, NW, 7th Floor
Washington, D.C. 20005
(202) 331-1010

Sam Kazman, General Counsel
Hans Bader, Senior Counsel

February 17, 2017
(corrected February 23)

PETITION FOR RULEMAKING ON THE ISSUE OF GREENHOUSE GASES AND PUBLIC HEALTH AND WELFARE

Petitioners Competitive Enterprise Institute, the Science and Environmental Policy Project, and four individual members of the latter's Board of Directors hereby petition EPA to initiate a rulemaking proceeding on the subject of greenhouse gases and their impact on public health and welfare.

EPA addressed this matter in 2009 in its "Endangerment Finding." EPA, Final Rule, Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 FR 66,496 (Dec. 15, 2009). However, as explained below, since that finding was issued, evidence has continued to mount that directly contradicts it. For these reasons, we request that EPA commence a new proceeding on this matter.

Procedural Background

We bring this petition pursuant to 5 U.S.C. § 553(e), which grants any "interested person the right to petition for the issuance, amendment, or repeal of a rule." A rulemaking proceeding is appropriate when new developments demonstrate that an existing rule or finding rests on erroneous factual premises, and a rulemaking petition is a proper vehicle for asking an agency "to reexamine" the "continuing vitality" of a rule.[1] EPA's own website expressly notes the applicability of section 553(e) to the environmental statutes that it administers. EPA, Petitions for Rulemaking, https://www.epa.gov/aboutepa/petitions-rulemaking.[2]

Identity and Interest of the Petitioners

The Competitive Enterprise Institute (CEI) is a non-profit, 501(c)(3) public policy organization that focuses on issues of overregulation, especially its implications for affordable energy. CEI was founded in 1984 and is headquartered in Washington, D.C.

The Science and Environmental Policy Project (SEPP) is a non-profit 501(c)(3) organization, incorporated in 1993 in the State of Virginia for the purpose of promoting sound and credible science as the basis for regulatory decisions.

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[1] *Geller v. FCC*, 610 F.2d 973, 978–80 (D.C. Cir. 1979) (overturning agency's denial of petition for new rulemaking). An agency's "refusal to initiate a rulemaking naturally sets off a special alert when a petition has sought modification of a rule on the basis of a radical change in its factual premise." *American Horse Protection Ass'n v. Lyng*, 812 F.2d 1, 5 (D.C. Cir. 1987) (overturning agency's denial of petition for rulemaking in light of agency's failure to offer a satisfactory explanation). Alternatively, EPA may choose to treat our filing as a petition for reconsideration of its Endangerment Finding. The procedural basis for doing so is discussed in Concerned Household Electricity Consumers Council et al., *Petition for Reconsideration of "Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act"* (filed Jan. 20, 2017), at 1-5.

[2] *See, e.g.*, *Commonwealth of Va. v. EPA*, 108 F.3d 1397, 1402 n.3 (D.C. Cir. 1997) (successful challenge to ozone pollution rule by Virginia) ("any interested person has 'the right to petition' EPA 'for the issuance, amendment, or repeal' of any rule. 5 U.S.C. § 553(e)"), *decision modified on reh'g*, 116 F.3d 499 (D.C. Cir. 1997).

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The individual petitioners, who are members of SEPP's Board of Directors, are the following: Donna Bethell (DC), Kenneth A. Haapala (VA), Thomas Sheahen (MD), and S. Fred Singer (VA). They are citizens of the United States who reside in the jurisdictions indicated for each of them. They and/or the households to which they belong pay utility bills that are affected by EPA regulations that are based, directly or indirectly, on the Endangerment Finding – such as the Clean Power Plan, 80 FR at 64,662 (codified at 40 C.F.R. § 60.5700 *et seq.*), which threatens to increase the cost of electricity.[3] Thus, they are not only interested parties, but have standing to judicially challenge the Endangerment Finding given the new facts cited in this petition.[4]

The Lines of Evidence for EPA's Endangerment Finding

EPA's 2009 Endangerment Finding described its scientific basis in the following terms:

> "The attribution of observed climate change to anthropogenic activities is based on multiple lines of evidence. The first line of evidence arises from the basic physical understanding of the effects of changing concentrations of GHGs, natural factors, and other human impacts on the climate system. The second line of evidence arises from indirect, historical estimates of past climate changes that suggest that the changes in global surface temperature over the last several decades are unusual. The third line of evidence arises from the use of computer-based climate models to simulate the likely patterns of response of the climate system to different forcing mechanisms (both natural and anthropogenic)."

74 FR 66,518 (footnote omitted).

But as discussed below, in the seven years since the Endangerment Finding was issued, new evidence and research has cast serious doubt on the validity of its three lines of evidence.

I. There Has Been No Statistically Significant Atmospheric Warming Despite a Continued Increase in Atmospheric Carbon Dioxide Levels; This Seriously Undercuts the Endangerment Finding's First Line of Evidence Regarding an Adequate Understanding of Climate

Prior to 2016, the atmospheric temperatures showed the warmest year on record to be 1998. The atmospheric carbon dioxide concentration for December of that year was 367.13 part per million (ppm).[5]

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[3] *See, e.g.*, Concerned Household Electricity Consumers Council, *Petition for Reconsideration, supra* n.1, at 5–8 (describing in detail how the Endangerment Finding leads to increased electricity costs).

[4] *See CEI v. NHTSA*, 901 F.2d 107, 111–13 (D.C. Cir. 1990) (regulations that allegedly resulted in "high prices" for "large cars" could be challenged by group whose members sought "opportunity to buy" them); *Energy Action Educ. Found. v. Andrus*, 654 F.2d 735, 756 n.** (D.C. Cir. 1980) (consumers had standing to challenge activities claimed to "inflat[e] prices, limit[] supplies, and restrict[] choice on the market"), *rev'd on other grounds*, 454 U.S. 151 (1981); *Community Nutrition Inst. v. Block*, 698 F.2d 1239, 1248 (D.C. Cir. 1983), *rev'd on other grounds*, 467 U.S. 340 (1984) (consumers could challenge exactions imposed on milk handlers, which allegedly would be passed on to consumers).

[5] ftp://aftp.cmdl.noaa.gov/products/trends/co2/co2_mm_mlo.txt

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The past year, 2016, was reportedly warmer than 1998 by 0.02 deg. C.[6] The atmospheric carbon dioxide concentration in December 2016 was 404.48 ppm.[7]

Despite this 10 percent increase in atmospheric CO2 concentrations, however, the temperature difference between 1998 and 2016 was not statistically significant. As Dr. Roy Spencer of the University of Alabama in Huntsville has pointed out, "2016 would have had to be 0.10 C warmer than 1998 to be significantly different at the 95% confidence level."[8] In fact, the temperature difference between the two years was only one fifth of that amount.

In its Endangerment Finding, EPA acknowledged that "there have not been strong trends over the last seven to ten years in global surface temperature or lower troposphere temperatures measured by satellites." 74 FR 66,522. EPA claimed, however, that "this pause in warming should not be interpreted as a sign that the Earth is cooling or that the science supporting continued warming is in error. Year-to-year variability in natural weather and climate patterns make it impossible to draw any conclusions about whether the climate system is warming or cooling from such a limited analysis." *Id.*

Here, however, the absence of any strong warming trend has continued for 18 years. That is twice as large as the 2001–09 time period touted in the Finding as containing "eight of the 10 warmest years on record." *Id.* Moreover, the fact that the starting and end years for this 18-year period are the two reportedly warmest years on record makes the lack of warming all the more significant. In short, the absence of a strong warming trend in the face of increasing atmospheric CO2 concentrations cannot be dismissed, yet again, as being based on an overly "limited analysis." It draws into serious question EPA's contention that we have an adequate "physical understanding of the effects of changing concentrations of GHGs ... on the climate system." 74 FR 66,518.

II. Contrary to the Endangerment Finding's Second Line of Evidence, Changes in Global Temperatures in Recent Decades Are Far From Unusual

The Endangerment Finding states that "indirect, historical estimates of past climate changes … suggest that the changes in global surface temperature over the last several decades are unusual." 74 FR 66,518. But a more recent, comprehensive review of the scientific literature comes to exactly the opposite conclusion:

- "Over recent geological time, Earth's temperature has fluctuated naturally between about +4°C and -6°C with respect to twentieth century temperature. A warming of 2°C above today, should it occur, falls within the bounds of natural variability;"

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[6] *Global Temperature Report: December, 2016*, Earth System Science Center, Univ. of AL at Huntsville, http://www.nsstc.uah.edu/climate/2016/december/dec2016_GTR.pdf

[7] See n.5.

[8] Roy Spencer, Ph.D., *Global Satellites: 2016 not Statistically Warmer than 1998*, DRROYSPENCER.COM, (Jan. 3, 2017), http://www.drroyspencer.com/2017/01/global-satellites-2016-not-statistically-warmer-than-1998/.

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- "At the current level of ~400 ppm we still live in a CO2-starved world. Atmospheric levels 15 times greater existed during the Cambrian Period (about 550 million years ago) without known adverse effects."

- The overall warming since about 1860 corresponds to a recovery from the Little Ice Age modulated by natural multidecadal cycles driven by ocean-atmosphere oscillations, or by solar variations at the de Vries (~208 year) and Gleissberg (~80 year) and shorter periodicities."

- "The causes of historic global warming remain uncertain, but significant correlations exist between climate patterning and multidecadal variation and solar activity over the past few hundred years."[9]

Similarly, a comprehensive new study of 13 complete temperature data sets (nine in the tropics, one in the U.S. and three global) found that "once just the ENSO [El Nino Southern Oscillation] impacts on temperature data are accounted for, there is no 'record setting' warming to be concerned about."[10]

For these reasons, the Finding's second line of evidence should be reconsidered.

III. The Growing Accumulation and Refinement of Balloon and Satellite Data Demonstrates that the Atmosphere Is Far Less Sensitive to CO2 Forcing than Predicted by the Climate Models; As a Result, EPA's Third Line of Evidence Is No Longer Valid

EPA's Endangerment Finding expressly noted the importance of global atmospheric temperature as a "reasonable indicator of human-induced climate change." 74 FR at 66,522 (capitalization omitted). However, EPA largely ignored the two most precise methods for measuring atmospheric temperature, satellites and weather balloons. The Finding contained no discussion at all of balloon temperature data, and there was only one brief discussion of satellite temperature data. *Id.* Computer-based climate models, on the other hand, received far more attention. EPA characterized these models as "well tested," and they were singled out by EPA as constituting the Finding's "third line of evidence."

But as demonstrated by the congressional testimony of John R. Christy, Director of the Earth System Science Center at the University of Alabama, the continued accumulation of both satellite and balloon data has thrown increasing doubt over two of EPA's three lines of evidence. Contrary to the Finding's claim that we have a "basic physical understanding of … the climate system," Christy concludes that "the theory of how climate changes occur, and the associated impact of extra greenhouse gases, is not understood well enough to even reproduce the past

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[9] Idso, Carter, and Singer, *Climate Change Reconsidered II: Physical Science* (2013), https://www.heartland.org/media-library/pdfs/CCR-II/CCR-II-Full.pdf; *Summary for Policymakers*: http://climatechangereconsidered.org/wp-content/uploads/2016/08/09-25-2013_-CCR-II-Summary-for-Policymakers.pdf, p.4.

[10] Wallace, Christy, and D'Aleo, *On the Existence of a "Tropical Hotspot" & the Validity of EPA's CO2 Endangerment Finding* (Aug. 2016), at pp. 4 and 13, Table II-1, https://thsresearch.files.wordpress.com/2016/10/ef-cpp-sc-2016-data-ths-paper-ex-sum-101416.pdf.

climate." Prepared Testimony of John R. Christy to the U.S. House Committee on Science, Space and Technology (Feb. 2, 2016), p.2, https://science.house.gov/sites/republicans.science.house.gov/files/documents/HHRG-114-SY-WState-JChristy-20160202.pdf, attached hereto.

As Dr. Christy explains, both surface temperature stations and water temperature suffer from a number of problems. Stations are affected by "the growth of infrastructure" around them and by the "variety of changes" that they "undergo through time." Christy at 6. Water temperature readings "do not track well with those of the air temperature just above the water … even if both are measured on the same buoy over 20 years." *Id.*

Satellite and balloon data do not suffer from these problems. Moreover, the fact that balloon and satellite data correlate extremely well with one another despite their being collected through distinctly different methods makes their results far more reliable. "To be sure, satellite and balloon temperatures require their own adjustments and cannot be considered 'perfect', but do offer an independence from one another to allow direct comparison studies." *Id.* at 7.

Based on this data, Dr. Christy's essential conclusion is that the computer models "clearly overcook the atmosphere," *Id.* 2. They project a far higher rate of warming than actually observed—2.5 times faster generally, and 3 times faster for the tropical atmosphere. *Id.* at 4–5. The models were "demonstrably deficient." *Id.* at 2. They "failed at the simple test of telling us 'what' has already happened, and thus would not be in a position to give us a confident answer to 'what' may happen in the future and 'why.'" *Id.* at 12. And Dr. Christy emphasized the fact that the 37-year period that he had examined is "the period with the highest concentration of greenhouse gases and thus the period in which the response should be of largest magnitude." *Id.*

In short, EPA's claim in its Endangerment Finding that the climate models are "well-tested" no longer bears scrutiny, and its third line of evidence clearly needs to be reconsidered.

IV. Given the Mounting Evidence that EPA's Greenhouse Gas Regulations Will Have No Discernible Climate Impact, the Rationale for Its Endangerment Finding Requires Reexamination

In its Finding, EPA gave the following analogy for endangerment:

> "The question of whether there is endangerment is like the question of whether there is an illness. Once one knows there is an illness, then the next question is what to do, if anything, in response to that illness."

74 FR 66,515.

But as Dr. Christy noted in his testimony, even a total *elimination* of U.S. emissions would have a near zero impact on global climate. As he put it, if the U.S. were simply to vanish, after 50 years there would be no discernible global temperature difference, given the satellite and balloon data findings regarding atmospheric sensitivity: "the impact … would be only 0.05 to 0.08 degrees C – an amount less than that which the global temperature fluctuates from month to

month." Christy at 14. Given this impossibility of treating the "illness" supposedly identified by EPA's Finding, the basis for making the Finding in the first place needs reconsideration.

This point is buttressed by testimony last year from then-EPA Administrator Gina McCarthy, when she stated that the alleged environmental benefits of EPA's massive Clean Power Plan were not purpose. At a March 22, 2016, congressional hearing, one U.S. Representative asked her: "I don't understand – if it doesn't have an impact on climate change around the world, why are we subjecting our hard working taxpayers and men and women in the coal fields to something that has no benefit?"[11]

Gina McCarthy's answer: "We see it as having had enormous benefit in showing [the] sort of domestic leadership as well as garnering support around the country for the agreement we reached in Paris."

CONCLUSION

As shown above, there is significant new data and research that seriously undercuts each of the Endangerment Finding's lines of evidence. For these reasons, EPA should conduct a new rulemaking on this issue.

Respectfully submitted on behalf of CEI, SEPP, Donna Bethell, Kenneth A. Haapala, Thomas Sheahen, and S. Fred Singer.

Dated: February 17, 2017
(corrected Feb. 23)

/s/ Sam Kazman
Sam Kazman
Hans Bader
Competitive Enterprise Institute
1310 L St., NW, 7th Floor
Washington, D.C. 20005

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Attorneys for Petitioners

[11] *Fiscal Year 2017 EPA Budget*: *Hearing Before the H. Comm. on Energy and Commerce, Subcomm. on Energy and Power*, 114th Cong. at 73–74 (Mar. 22, 2016) (testimony of EPA Administrator Gina McCarthy), *available at* http://docs.house.gov/meetings/IF/IF03/20160322/104715/HHRG-114-IF03-Transcript-20160322.pdf.

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ATTACHMENT

U.S. House Committee on Science, Space & Technology

2 Feb 2016

Testimony of John R. Christy

University of Alabama in Huntsville.

I am John R. Christy, Distinguished Professor of Atmospheric Science, Alabama's State Climatologist and Director of the Earth System Science Center at The University of Alabama in Huntsville. I have served as Lead Author, Contributing Author and Reviewer of United Nations IPCC assessments, have been awarded NASA's Medal for Exceptional Scientific Achievement, and in 2002 was elected a Fellow of the American Meteorological Society.

It is a privilege for me to offer my analysis of the current situation regarding (1) the temperature datasets used to study climate, (2) our basic understanding of climate change and (3) the effect that regulations, such as the Paris agreement, might have on climate. I have also attached an extract from my Senate Testimony last December in which I address (1) the popular notion that extreme climate events are increasing due to human-induced climate change (they are not), and (2) the unfortunate direction research in this area has taken.

My research area might be best described as building datasets from scratch to advance our understanding of what the climate is doing and why – an activity I began as a teenager over 50 years ago. I have used traditional surface observations as well as measurements from balloons and satellites to document the climate story. Many of our UAH datasets are used to test hypotheses of climate variability and change.

(1.1) Upper air temperature data from satellites and balloons

I shall begin with a discussion that was precipitated by an increasingly active campaign of negative assertions made against the observations, i.e. the data, of upper air temperatures. Figure 1 in particular has drawn considerable attention from those who view the climate system as undergoing a rapid, human-caused transformation into a climate to which people would have great difficulty adapting. This simple chart tells the story that the average model projection, on which their fears (or hopes?) are based, does poorly for the fundamental temperature metric that is allegedly the most responsive to extra greenhouse gases – the bulk atmospheric temperature of the layer from the surface to 50,000 ft. [The layer shown is known as the mid-troposphere or MT and is used because it overlaps with the region of the tropical atmosphere that has the largest anticipated signature of the greenhouse response by bulk mass – between 20,000 and 50,000 feet.] The chart indicates that the theory of how climate changes occur, and the

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associated impact of extra greenhous e gases, is not understood well enough to even reproduce the past climate [much more in section (2)] . Indeed, the models clearly over - cook the atmosphere . The issue for congress here is that such demonstrably deficient model projections are being used to make policy.

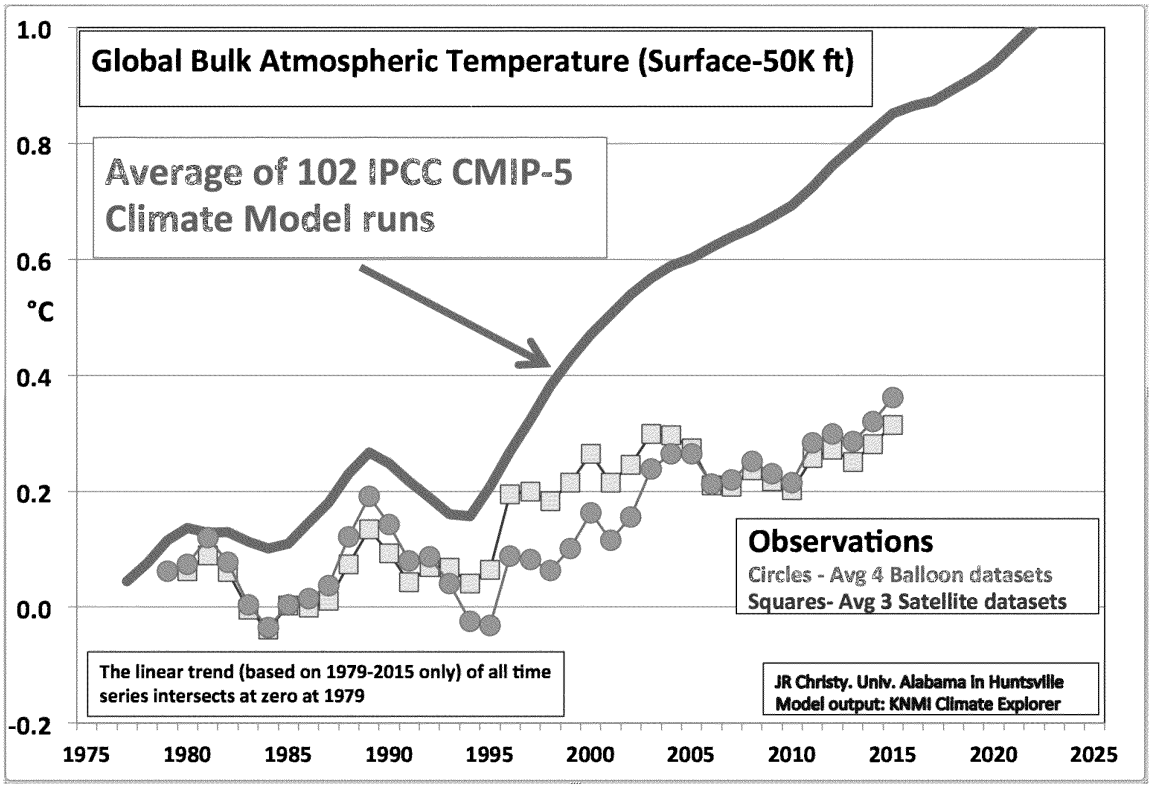

Fig. : Five-year averaged values of annual mean (1979-2015) global bulk (termed "mid-tropospheric" or "MT") temperature as depicted by the average of 102 IPCC CMIP 5 climate models (red), the average of 3 satellite datasets (green - UAH, RSS, NOAA) and 4 balloon datasets (blue, NOAA, UKMet, RICH, RAOBCORE).

Because this result challenges the current theory of greenhouse warming in relat ively straightforward fashion, there have been several well -funded attacks on those of us who build and use such datasets and on the datasets themselves . As a climate scientist I've found myself, along with fellow like-minded colleagues, tossed into a world more closely associated with character assassination and misdirection, found in Washington politics for example, rather than objective, dispassionate discourse commonly assumed for the scientific endeavor . Investigations of us by congress and the media are spurred by the idea that anyone who disagrees with the climate establishment 's view of dangerous climate change must be on the payroll of scurrilous organizations or otherwise mentally

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deficient. Also thrust into this milieu is promotional material, i.e., propaganda, attempting to discredit these data (and researchers) with claims that amount to nothing.

Several of these allegations against the data appeared a few weeks ago in the form of a well-made video. I shall address the main assertions with the following material, which in similar form has appeared in the peer-reviewed literature through the years.

The video of interest was promoted by a climate change pressure group (Yale Climate Connections, http://www.yaleclimateconnections.org/2 6/ /over-reliance-on-satellite-data-alone-criticized/) in which well-known scientists make claims that are mostly meaningless or completely wrong relative to the evidence in Fig. 1. I wish to make four points regarding the video and demonstrate the misdirection for which such agendized videos, along with a happily mimicking media, are so famous.

First, the claim is made the satellites do not measure temperature. In reality, the sensors on satellites measure temperature by emitted radiation - the same method that a physician uses to measure your body temperature to high precision using an ear probe. Atmospheric oxygen emits microwaves, the intensity of which is directly proportional to the temperature of the oxygen , and thus the atmosphere . That the satellites measure temperature is evident by the following chart which compares our UAH satellite data with temperatures calculated from balloon thermistors. As an aside, most surface temperature measurements are *indirect*, using electronic resistance.

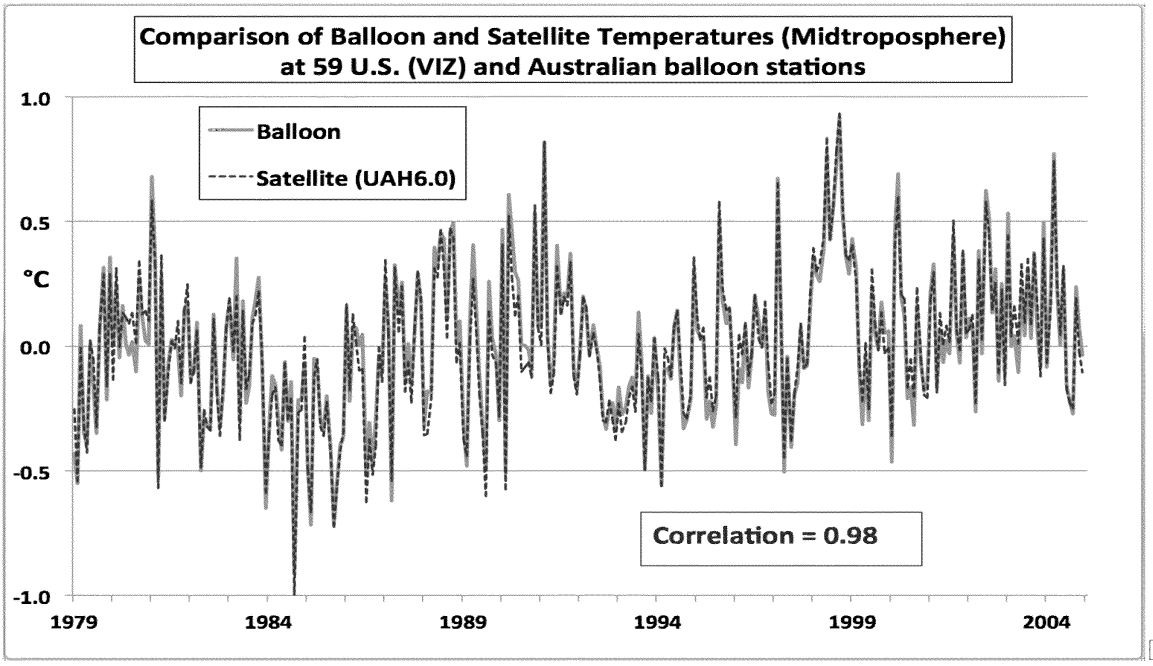

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Fig. 2: Average temperature variations measured at 59 radiosonde stations in the U.S. (VIZ manufacturer) and Australia.

Secondly, the scientists claim that the vertical drop (orbital decay) of the satellites due to atmospheric friction causes spurious cooling through time. This vertical fall has an immeasurable impact on the layer (MT) used here and so is a meaningless claim. In much earlier versions of another layer product (LT or Lower Troposphere), this was a problem, but was easily corrected almost 2 years ago. Thus, bringing up issues that affected a different variable that, in any case, was fixed many years ago is a clear misdirection that, in my view, demonstrates the weakness of their position.

Thirdly, the scientists speak of the spurious temperature changes that occur as the satellites drift in the east-west direction, the so-called diurnal drift problem (which was first detected and accounted for by us). They speak of a sign error in the correction procedure that changed the trend. Again, this error was not a factor in the MT layer in Fig. , but for the different LT layer. And, again, this issue was dealt with for LT years ago.

Finally, though not specifically mentioned in this video, some of these scientists claim Fig. above is somehow manipulated to hide their belief in the prowess and validity of the climate models. To this, on the contrary, I say that we have displayed the data in its most meaningful way. The issue here is the rate of warming of the bulk atmosphere, i.e., the trend. This metric tells us how rapidly heat is accumulating in the atmosphere – the fundamental metric of global warming. To depict this visually, I have adjusted all of the datasets so that they have a common origin. Think of this analogy: I have run over 5 races in the past 25 years, and in each one all of the runners start at the same place at the same time for the simple purpose of determining who is fastest and by how much at the finish line. Obviously, the overall relative speed of the runners is most clearly determined by their placement as they cross the finish line – but they must all start together.

In the same way I constructed the chart so that the trend line of all of the temperature time series starts at the same point in magnitude and time (zero value at 979) so the viewer may see how wide the spread is at the finish line (2 5). One way to look at this is seen in Fig. 3 where I provide what is seen in Fig. except this is only the trend line without the variations that occur from year due to volcanoes and such. This is analogous to plotting the overall average speed of a runner along the course even though they likely ran slower on an uphill, and faster on a downhill.

This image indicates the models, on average, warm this global layer about 2.5 times faster than the observations indicate. This is a significant difference that has not been

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explained and indicates the theory of greenhouse impact on atmospheric temperature is not sufficiently known to even reproduce what has already happen ed. We are not talking about or 5 years here, but 37 years - well over a third of a century. That two very independent types of measuring systems (balloons and satellites) constructed by a variety of institutions (government, university, private) all showing the much slower rate of warming gives high confidence in its result. Thus, t he evidence here strongly suggests the theory, as embodied in models, goes much to o far in forcing the atmosphere to retain heat when in reality the atmosphere has a mean s to relinquish that heat and thus warms at a much slower rate.

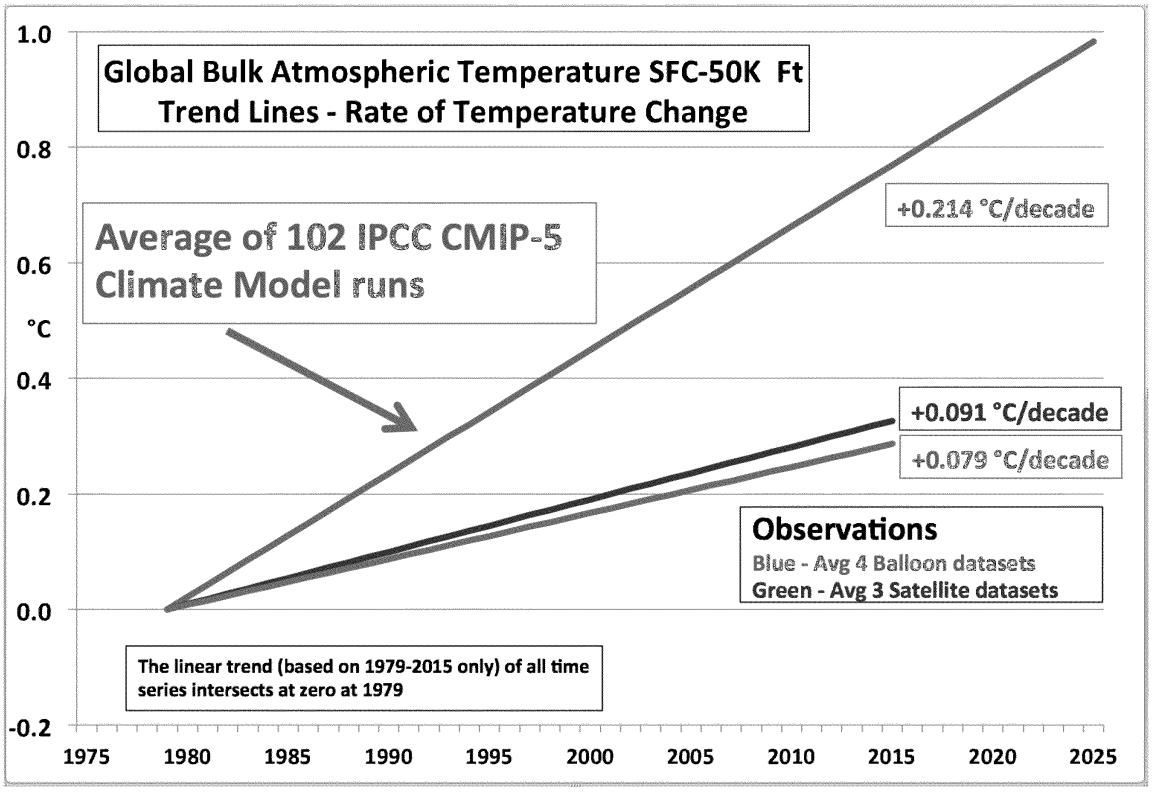

Fig. 3: The linear trend line over the period 1979 -2 5. The color s represent the same source data as in fig.

I've shown here that for the global bulk atmosphere, the models overwarm the atmosphere by a factor of about 2.5. As a further note, i f one focuses on the tropics, the models show an even stronger gree nhouse warming in this layer. However, a similar calculation with observations as shown in Fig. 3 indicates the models over -warm the tropical atmosphere by a factor of approximately 3, (Models + .265, Satellites + . 95, Balloons + . 73 °C/decade) again indicating the current theory is at odds with the facts. (again, see section 2.)

It is a bold strategy in my view to actively promote the output of theoretical climate models while attacking the multiple lines of evidence from observations. Note that none of the observational datasets are perfect and continued scrutiny is healthy, but when multiple, independent groups generate the datasets and then when the results for two completely independent systems (balloons and satellites) agree closely with each other and disagree with the model output, one is left scratching one's head at the decision to launch an offensive against the data. This doesn't make scientific sense to me.

(2) Surface temperature issues

There are several issues regarding surface temperature datasets that are too involved to discuss in this material. I shall focus on a few points with which I am familiar and on which I have published.

(2.a) Surface temperature as a metric for detecting the influence of the increasing concentrations of greenhouse gases

One of my many climate interests is the way surface temperatures are measured and how surface temperatures, especially over land, are affected by their surroundings. In several papers (Christy et al. 2006 *J. Climate*, Christy et al. 2009 *J. Climate*, Christy 2003 *J. Appl. Meteor. Clim.*, Christy et al. 2006 *J. Appl. Meteor. Clim.*) I closely examined individual stations in different regions and have come to the conclusion that the magnitude of the relatively small signal we seek in human-induced climate change is easily convoluted by the growth of infrastructure around the thermometer stations and the variety of changes these stations undergo through time, as well as the variability of the natural ups and downs of climate. It is difficult to adjust for these contaminating factors to extract a pure dataset for greenhouse detection because often the non-climatic influence comes along very gradually just as is expected of the response to the enhanced greenhouse effect.

In examining ocean temperatures (Christy et al. 2001, *Geophys. Res. Lett.*) I discovered that the trends of the water temperature (1m depth) do not track well with those of the air temperature just above the water (3m), even if both are measured on the same buoy over 20 years. This is important for the discussion below where NOAA used marine air temperatures to adjust water temperature measurements from ships.

There are many other factors that render surface temperature datasets to be of low effectiveness for the detection of enhanced greenhouse warming, (a) lack of systematic geographical coverage in time, (b) unsystematic measuring methods and instrumentation

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in time and space, (c) the point measurement represents at best a tiny, local area and (d) is easily impacted by slight changes in the surroundings, which can occur for example when a station moves. There have been huge efforts to try and adjust the raw surface data to give a time series that would represent that of a pristine environment, and I have led or been a part in some of these (e.g. for Central California in Christy et al. 2006 and East Africa in Christy et al. 2009 and Christy 2013).

Thus, having experience in building surface, satellite and balloon temperature datasets, and taking into account the signal we are looking for to detect the enhanced greenhouse effect, the evidence suggests to me that utilizing the bulk atmospheric measurements provides the best opportunity to answer questions about the climate's response to this human-induced change in atmospheric composition. The deep atmosphere is much more coherent in space and time in terms of its variations. It is not affected by human development at the surface. It is measured systematically. To be sure, satellite and balloon temperatures require their own adjustments and cannot be considered "perfect", but do offer an independence from one another to allow direct comparison studies. Regarding the detection of the enhanced greenhouse effect, the troposphere, as indicated by models, happens to be the atmospheric region that will respond the most, i.e. warm the fastest, and thus, in my view, is a metric that provides a better way to detect human influence on the climate.

(2.b) The new NOAA surface temperature dataset

A series of papers appeared last year (including Huang et al. 2005 *J. Climate*, Karl et al. 2005 *Science*) describing a new surface temperature dataset constructed by NOAA which indicated a bit more warming in the past to 25 years than the previous versions. The key change dealt with seawater temperatures in the dataset now known as ERSSTv4. This change introduced an additional warming into the record from about 1990 onward. The main reason for this new warming, as the authors note, was the adjustment applied to buoy data, adding about +0.12°C to the buoy readings. In 1980, only about 10 percent of the data reports were from buoys, but by 2000 about 90 percent were buoy data. Thus, because the influence of the buoy data grew significantly through time, the simple addition of a bias to all the buoys from the beginning created a warmer trend as they became the dominate source of information.

Some background is necessary. Unlike satellite and balloon datasets which measure a systematic quantity (essentially atmospheric air temperature), surface temperature datasets are a mixture of air (over land) and water (over ocean) temperatures measured over a considerable range of instruments, exposures and methods. Over land, weather stations measure the temperature of the air in varying types of instrument shelters and by

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varying techniques at a level about 5 ft above the ground. Over the ocean, however, the temperature utilized is that of the water itself, not the air above, so traditional global surface datasets do not measure a homogenous physical parameter over land versus ocean. Further, the depth of the water temperature measurement is quite varied from 2 ft to 5 ft or so, by methods that range from buckets drawn up on deck into which a thermometer is inserted to engine-intake temperatures much deeper in the water and to buoys, drifting or moored to the bottom. So the fact temperature varies by depth is an issue to tackle before the possibility of constructing a systematic dataset may be attempted. Then too, the measurements are not spatially or temporally consistent with large regions, such as Africa and the southern oceans, unmeasured.

Keep in mind that even though the trend of this NOAA dataset became more positive in the past 10 to 20 years, it is still below climate model projections over the longer term. For longer periods, such as the period since 1979 when satellites began measuring bulk atmospheric temperatures, the new global dataset is similar to that of the Hadley Centre (1979-2015: NOAA +0.155 °C/decade, Hadley Centre UKMet, +0.165 °C/decade). However, there are questions that remain concerning the new NOAA sea water dataset, especially how it indicates more warming in the last 20 years than others. Figure 4 displays the ocean trends for the region 20 S to 60 N (i.e. tropical and northern hemisphere oceans - there was too little data south of 20 S for generating near-surface air temperatures there). There are 4 datasets represented, NOAA (NOAA, red), Hadley Centre (HadCRUT4, orange), a preliminary near-surface air temperature over the oceans by my graduate student Rob Junod (yellow) and the UAH deep layer air temperature from satellites (blue). Both NOAA and HadCRUT4 are temperatures of the sea water near the surface, so should be the same.

NOAA used a curious reference variable to calibrate the water temperatures measured from ship intakes – the Night Marine Air Temperature (NMAT). This is curious because there are considerable adjustments required for the NMATs themselves, i.e. corrections for height of ship deck, etc. In any case, from this, the buoy data were then adjusted to match the ship data. It appears, then, that the foundational adjustment process depends on NMATs to adjust the ship data to then adjust the buoy data. The final product from NOAA mixes all of these together, and because the geographic representation of the different systems changed dramatically (as noted, from approximately 10% buoys and 90% ships in 1980 to 90% buoys and 10% ships today – Huang et al. 2015), an adjustment applied to the buoys will automatically influence the trend.

I'm aware that the Committee sought information about this curious process and asked NOAA to generate datasets based only on consistent measuring systems, i.e. ships alone, buoys alone and NMATs alone, to see if one system might have impacted the trends

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improperly due to distribution changes. NOAA was unable to accommodate this request. At the same time I asked my graduate student, Rob Junod, to do the work for NMAT. What is presented here is preliminary, but follows much of the previous work on NMATs (developed at the National Oceanographic Centre and the Hadley Centre in the UK) with that added advantage of being updated to 2014. The best geographical data coverage was found to be 20°S to 60°N, so this area was also applied to the other datasets for an apples to apples comparison. The results are shown in Fig. 4 in which all trends end in 2014 but cover periods in two-year increments from 20 years to 10 years.

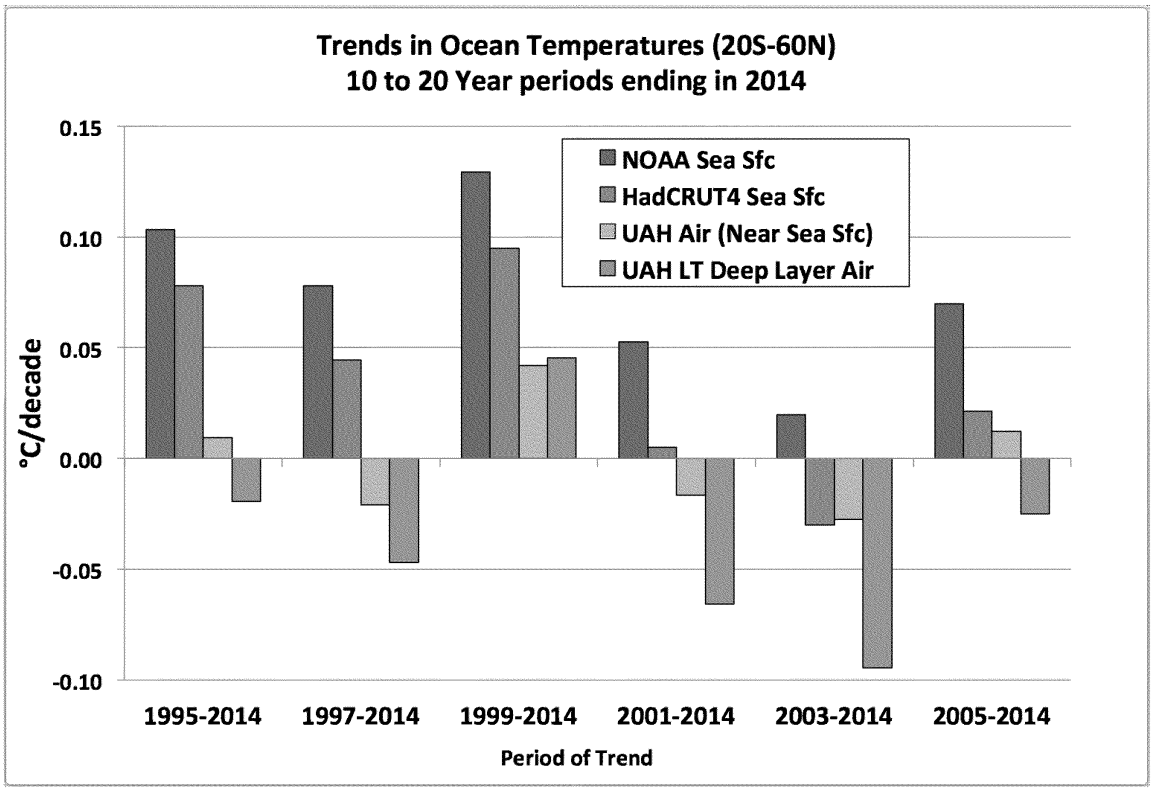

Figure 4. Decadal trends (°C/decade) of four temperature datasets over the oceans from 20°S to 60°N for varying periods ending in 2014. Red and orange are surface seawater temperature datasets from NOAA and the Hadley Centre (HadCRUT4). Yellow is a near-surface air temperature dataset (Night Marine Air Temperature) built by UAH (preliminary). Blue is the temperature trend of the deep atmosphere (surface to 35,000 ft or Lower Troposphere) from microwave emissions captured by satellites (also UAHv6.0b5.)

A number of observations are evident in Fig. 4. (1) In terms of the temperature trend, the air temperatures are less than those of the water (as indicated in my 2000 study mentioned above.) (2) NOAA warms the fastest in all periods. (3) In the past 10-40

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years, the trends of the HadCRUT4 agree better with the near-surface air temperature dataset (being near zero and supporting the notion of a hiatus) than with the trends from its physically-identical quantity from NOAA. (4) The magnitude of the NMAT trends lies between the trends of the deep atmospheric and sea water.

This figure generates a number of data quality questions too. () If NMATs were used to calibrate the ship temperatures and then the ships were used to calibrate the buoy temperatures, why does the NOAA dataset differ so much from its basic reference point – NMATs? (2) What do the time series look like and what are the sub-period trends for seawater under the condition that only ships and/or only buoys are used to build the dataset for the past 2-25 years? (3) What does the time series of NOAA's NMAT (i.e. their reference) dataset show?

The real science questions here are those which have significant importance to the understanding of how extra greenhouse gases might affect the climate as shown in the following section.

(2) How well do we understand climate change?

A critical scientific goal in our era is to determine whether emissions from human activities impact the climate and if so by how much. This is made especially difficult because we know the climate system already is subject to significant changes without the influence of humans. Because there is no measuring device that explicitly determines the *cause* of the climate changes we can measure, such as temperature, our science must take a different approach to seek understanding as to what causes the changes, i.e. how much is natural and how much is human induced. The basic approach today utilizes climate models. (The projections of these models are being utilized for carbon policies as well.)

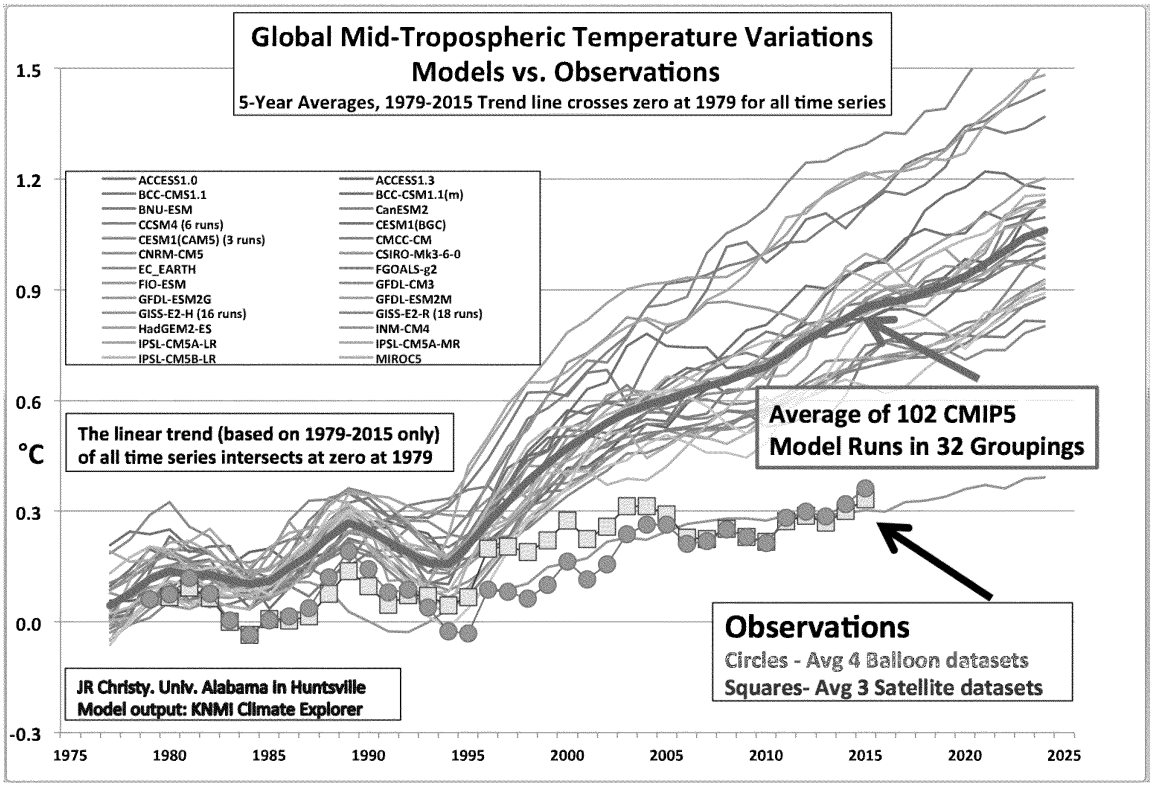
It is important to understand that output from these models, (i.e. projections of the future climate and the specific link that increasing CO2 might have on the climate) are properly defined as scientific hypotheses or claims – model output cannot be considered as providing proof of the links between climate variations and greenhouse gases. These models are complex computer programs which attempt to describe through mathematical equations as many factors that affect the climate as is possible and thus estimate how the climate might change in the future. The model, it is hoped, will provide accurate responses of the climate variables, like temperature, when extra greenhouse gases are included in the model. However, the equations for nearly all of the important climate processes are not exact, representing the best approximations modelers can devise and that computers can handle at this point.

J.R. Christy 2 Feb 2 6
House Committee on
Science, Space and Technology

A fundamental aspect of the scientific method is that if we say we understand a system (such as the climate system) then we should be able to predict its behavior. If we are unable to make accurate predictions, then at least some of the factors in the system are not well defined or perhaps even missing. [Note, however, that merely replicating the behavior of the system (i.e. reproducing "what" the climate does) does not guarantee that the fundamental physics are well-known. In other words, it is possible to obtain the right answer for the wrong reasons, i.e. getting the "what" of climate right but missing the "why".]

Do we understand how greenhouse gases affect the climate, i.e. the link between emissions and climate effects? As noted above, a very basic metric for climate studies is the temperature of the bulk atmospheric layer known as the troposphere, roughly from the surface to 5 , ft altitude. This is the layer that, according to models, should warm significantly as CO2 increases – even faster than the surface. Unlike the surface temperature, this bulk temperature informs us about the crux of the global warming question – how much heat is accumulating in the global atmosphere? And, this CO2-caused warming should be easily detectible by now, according to models. This provides a good test of how well we understand the climate system because since 979 we have had two independent means of monitoring this layer – satellites from above and balloons with thermometers released from the surface.

I was able to access 2 CMIP-5 rcp4.5 (representative concentration pathways) climate model simulations of the atmospheric temperatures for the tropospheric layer and generate bulk temperatures from the models for an apples-to-apples comparison with the observations from satellites and balloons. These models were developed in institutions throughout the world and used in the IPCC AR5 Scientific Assessment (2 3).



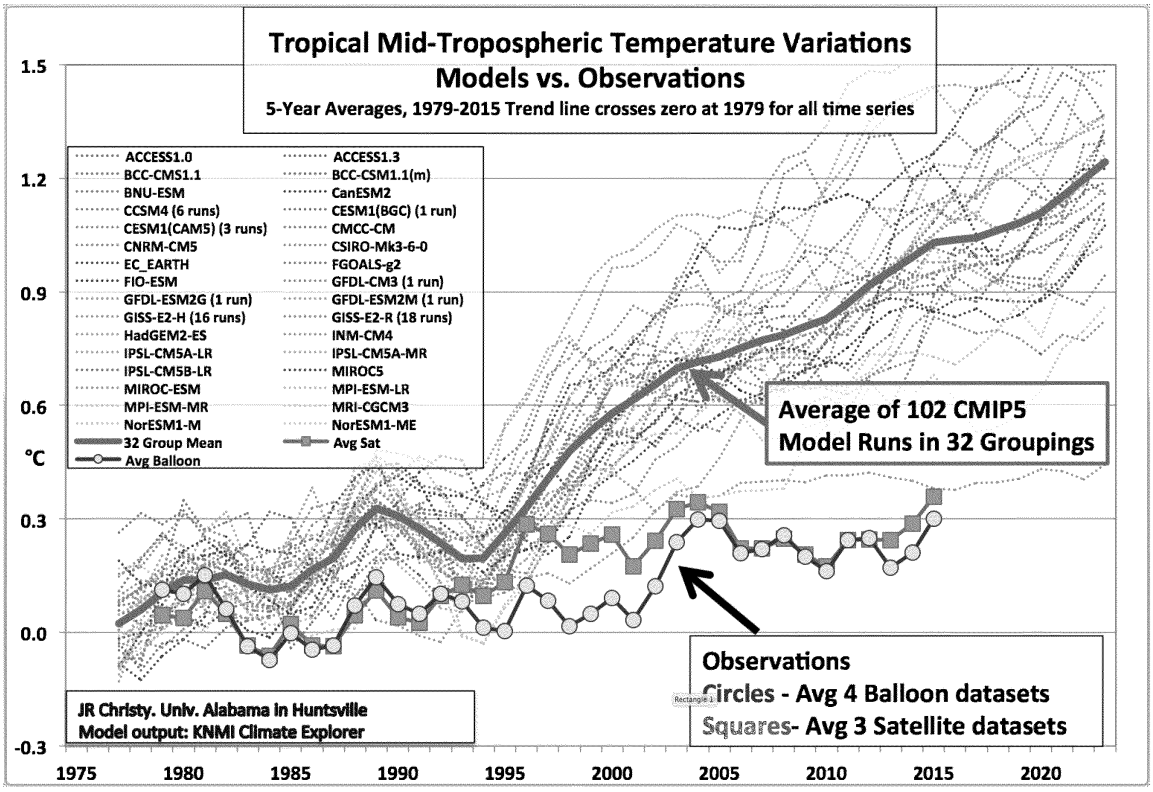
Above: Global average mid-tropospheric temperature variations (5-year averages) for 32 models (lines) representing 2 individual simulations. Circles (balloons) and squares (satellites) depict the observations. The Russian model (INM-CM4) was the only model close to the observations.

The information in this figure provides clear evidence that the models have a strong tendency to over-warm the atmosphere relative to actual observations. On average the models warm the global atmosphere at a rate 2.5 times that of the real world. This is not a short-term, specially-selected episode, but represents the past 37 years, over a third of a century. This is also the period with the highest concentration of greenhouse gases and thus the period in which the response should be of largest magnitude.

Following the scientific method of testing claims against data, we would conclude that the models do not accurately represent at least some of the important processes that impact the climate because they were unable to "predict" what has already occurred. In other words, these models failed at the simple test of telling us "what" has already happened, and thus would not be in a position to give us a confident answer to "what" may happen in the future and "why." As such, they would be of highly questionable

value in determining policy that should depend on a very confident un derstanding of how the climate system works.

There is a related climate metric that also utilizes atmospheric temperature which in models has an even larger response than that of the global average shown above. This metric, then, provides a stronger test for understanding how well models perform regarding greenhouse gases specifically. In the models, the tropical atmosphere warms significantly in response to the added greenhouse gases – more so than that of the global average atmospheric temperature.



Above: Tropical average mid -tropospheric temperature variations (5 -year averages) for 32 models (lines) representing 2 individual simulations. Circles (balloons) and squares (satellites) depict the observations.

In the tropical comparison here, the disparity between models and observations is even greater, with models on average warming this atmospheric region by a factor of three times greater than in reality. Such a result re -enforces the implication above that the models have much improvement to undergo before we may have confidence they will provide information about what the climate may do in the future or even why the climate

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varies as it does. For the issue at hand, estimates of how the global temperature might be affected by emission reductions from regulations would be exaggerated and not reliable.

(3) Climate Impact of Regulations (i.e. Paris) Will Not Be Attributable or Detectable

No one knows the climate impact of the proposed carbon emission reductions agreed to in Paris. The main reason for this is that there is considerable latitude for countries to do as little or as much as they desire. Examining the history of global carbon emissions, it is clear that countries, especially developing countries, will continue to seek to expand energy use through carbon combustion because of their affordability in providing considerable positive benefits to their citizens.

In any case, impact on global temperature for current and proposed reductions in greenhouse gases will be tiny at best. To demonstrate this, let us assume, for example, that the total emissions from the United States were reduced to zero, as of last May 13th, 2015 (the date of a hearing at which I testified). In other words as of that day and going forward, there would be no industry, no cars, no utilities, no people – i.e. the United States would cease to exist as of that day. Regulations, of course, will only reduce emissions a small amount, but to make the point of how minuscule the regulatory impact will be, we shall simply go way beyond reality and cause the United States to vanish. With this we shall attempt to answer the question of climate change impact due to emissions reductions.

Using the U.N. IPCC impact tool known as Model for the Assessment of Greenhouse-gas Induced Climate Change or MAGICC, graduate student Rob Junod and I reduced the projected growth in total global emissions by U.S. emission contribution starting on this date and continuing on. We also used the value of the equilibrium climate sensitivity as determined from empirical techniques of 1.8 °C. After 15 years, the impact as determined by these model calculations would be only 0.15 to 0.18 °C – an amount less than that which the global temperature fluctuates from month to month. [These calculations used emission scenarios A1B-AIM and AIF-MI with U.S. emissions comprising 14 percent to 17 percent of the 2015 global emissions. There is evidence that the climate sensitivity is less than 1.8 °C, which would further lower these projections.]

As noted, the impact on global emission and global climate of the recent agreements in Paris regarding global emissions is not exactly quantifiable. Knowing how each country will behave regarding their emissions is essentially impossible to predict besides the added issue of not knowing how energy systems themselves will evolve over time.

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Because halting the emissions of our entire country would have such a tiny calculated impact on global climate, it is obvious that fractional reductions in emissions through regulation would produce imperceptible results. In other words, there would be no evidence in the future to demonstrate that a particular climate impact was induced by the proposed and enacted regulations. Thus, the regulations will have no meaningful or useful consequence on the physical climate system – even if one believes climate models are useful tools for prediction.

Summary

Climate change is a wide-ranging topic with many difficulties. Our basic knowledge about what the climate is doing (i.e. measurements) is plagued by uncertainties. In my testimony today I have given evidence that the bulk atmospheric temperature is measured well-enough to demonstrate that our understanding of how greenhouse gases affect the climate is significantly inadequate to explain the climate since 1979. In particular, the actual change of the fundamental metric of the greenhouse warming signature – the bulk atmospheric temperature where models indicate the most direct evidence for greenhouse warming should lie - is significantly misrepresented by the models. Though no dataset is perfect, the way in which surface datasets have been constructed leaves many unanswered questions, especially for the recent NOAA update which shows more warming than the others. Finally, regulations already enforced or being proposed, such as those from the Paris Agreement, will have virtually no impact on whatever the climate is going to do.

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Appendix A

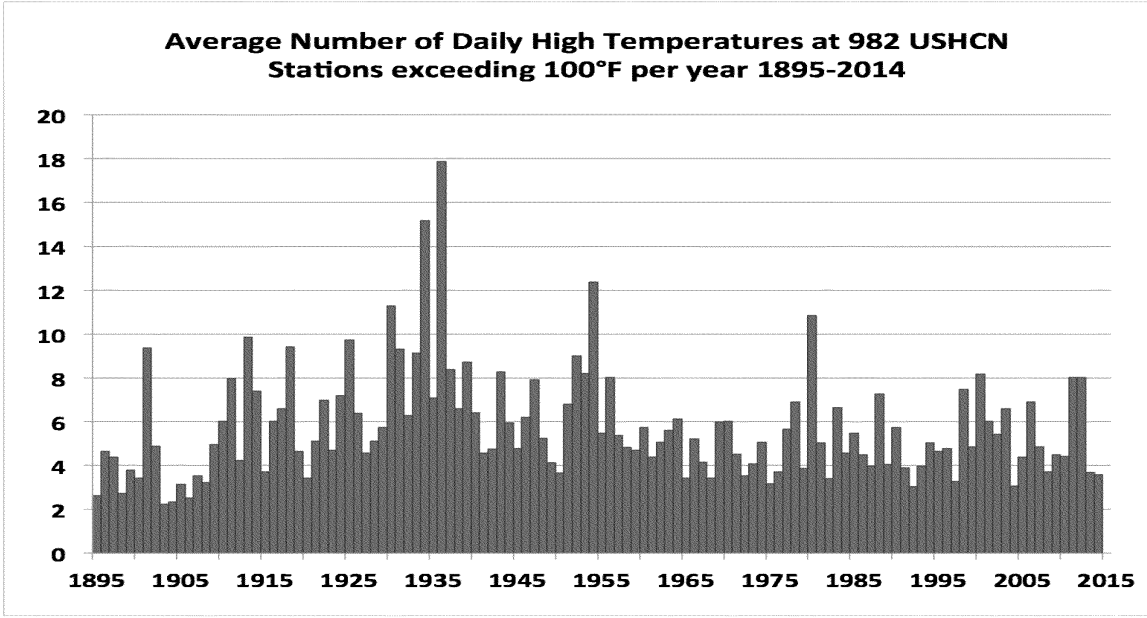
This appendix is an extract from my written testimony presented at the following Hearing:

U.S. Senate Committee on
Commerce, Science, & Transportation
Subcommittee on Space, Science and Competitiveness
8 Dec 2015
Testimony of John R. Christy
University of Alabama in Huntsville.

Alleged impacts of human-induced climate changes regarding extreme events

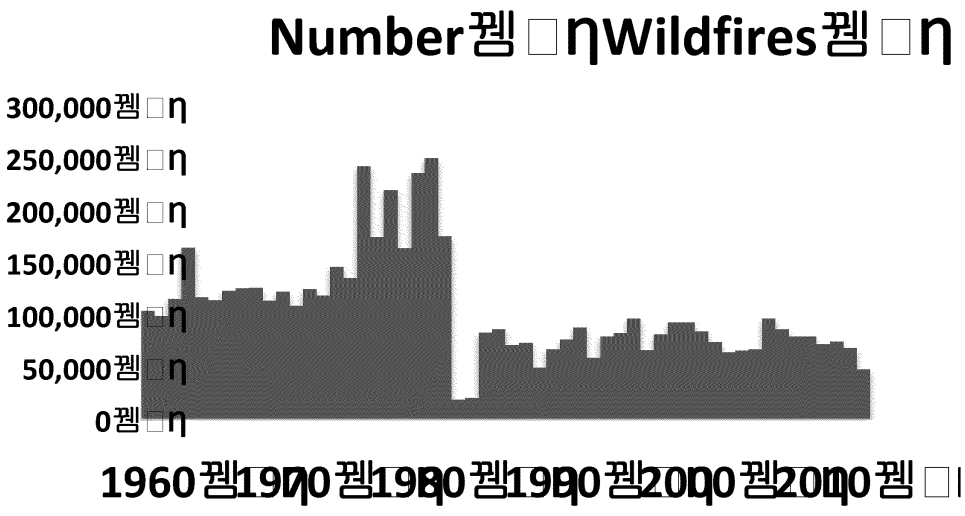
Much of the alarm related to increasing greenhouse gas concentrations shifted in the past decade from global temperature changes to changes in extreme events, i.e. those events which typically have a negative impact on the economy. These events may be heat waves, floods, hurricanes, etc.

In terms of heat waves, below is the number of °F days observed in the U.S. from a controlled set of weather stations. It is not only clear that hot days have not increased, but it is interesting that in the most recent years there has been a relative dearth of them.

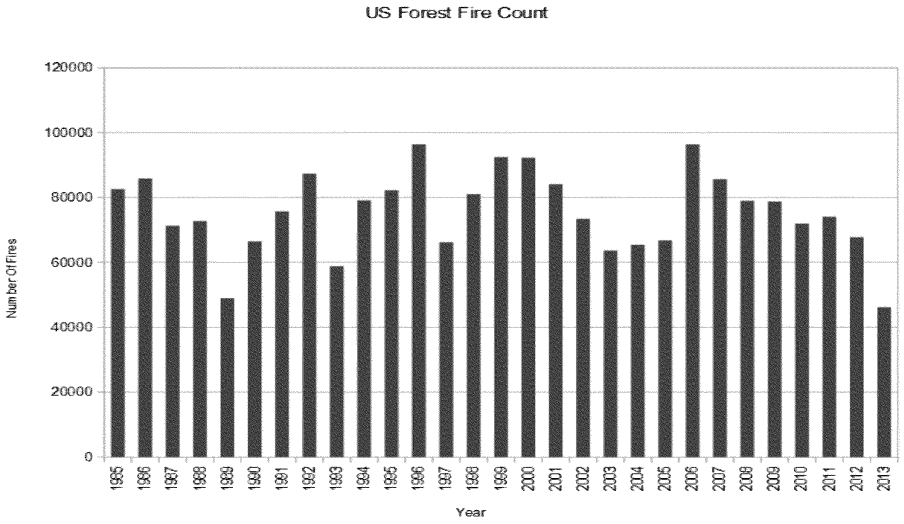


Above: Average number of days per-station in each year reaching or exceeding °F in 982 stations of the USHCN database (NOAA/NCEI, prepared by JRChristy).

Forest and wild fires are documented for the US. The evidence below indicates there has not been any change in frequency of wildfires. Acreage (not shown) shows little change as well.



Above: Number of U.S. wildfires. As the management of these events changes, and thus the number also changes, but the number of events since 1985 has remained constant. (National Interagency Fire Center https://www.nifc.gov/fireInfo/nfn.htm)



Above: Number of U.S. forest fires per year since 1965.

The two figures above demonstrate that fire events have not increased in frequency in the United States during the past several decades.

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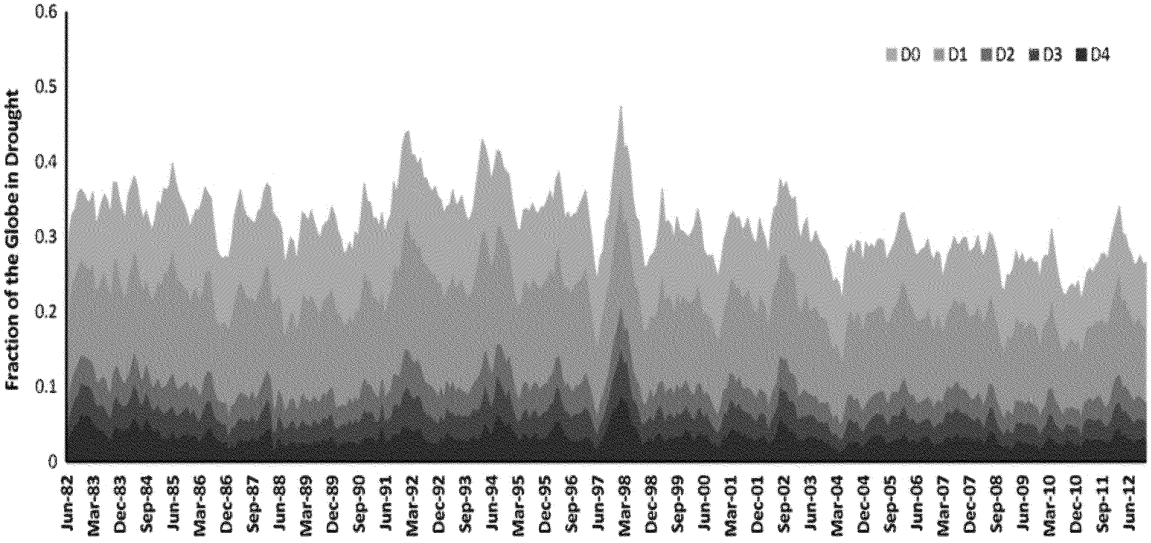
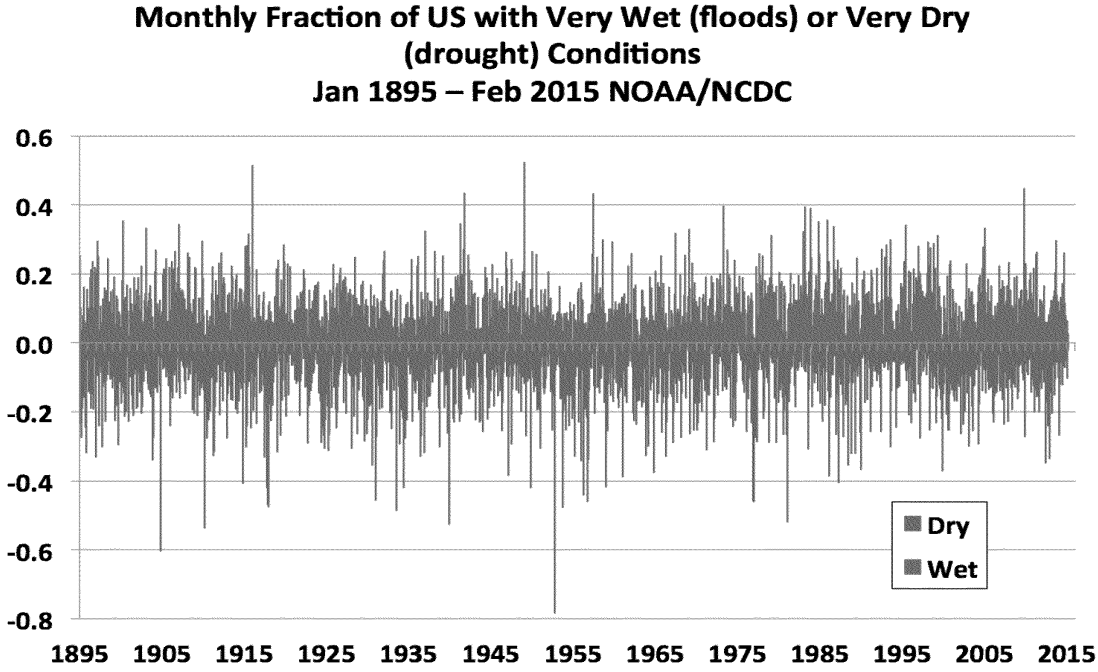
The claims that droughts and floods are increasing may be examined by the observational record as well.

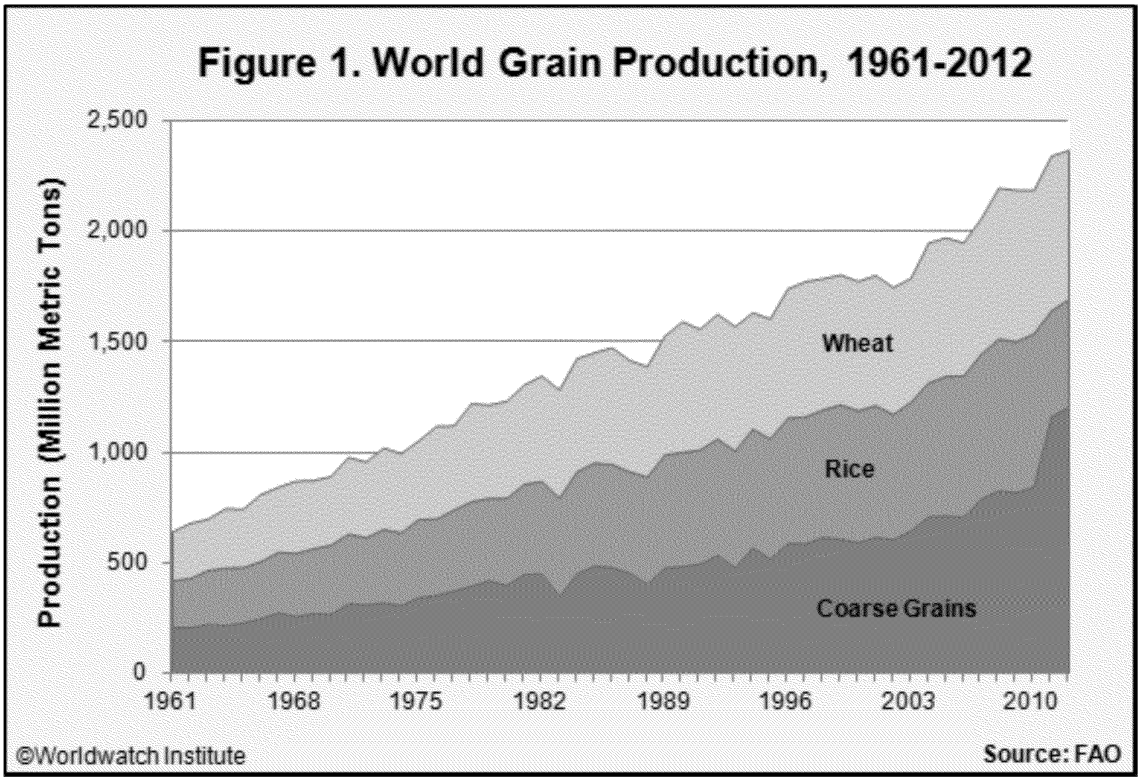


Above: Global areal extent of five levels of drought for 1982-2012 where dryness is indicated in percentile rankings with D0 < 30, D1 < 20, D2 < 10, D3 < 5 and D4 < 2 percentile of average moisture availability. (Hao et al. 2014)



Above: Areal fraction of conterminous U.S. under very wet (blue) or very dry (red) conditions. NOAA/NCEI.

The two figures above demonstrate that moisture conditions have not shown a tendency to have decreased (more drought) or increased (more large-scale wetness). Such information is rarely consulted when it is more convenient simply to make unsubstantiated claims that moisture extremes, i.e. droughts and floods (which have always occurred), are somehow becoming even more extreme. Over shorter periods and in certain locations, there is evidence that the heaviest precipitation eve nts are tending to be greater. This is not a universal phenomenon and it has not been established that such changes may be due to changes in greenhouse gas concentrations as demonstrated earlier because the model projections are unable to reproduce the simplest of metrics.



Above: World grain production 96 -2 2. U.N. Food and Agriculture Organization.

It is a simple matter to find documentation of the ever -rising production of grains. One wonders about the Federal Council on Environmental Quality's allegation that there has been "harm to agriculture" from human -induced climate change because when viewing the total growth in production, which appears to be accelerating, one would assume no "harm" has been done during a period of rising greenhouse gases.

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With the evidence in these examples above, it is obviously difficult to establish the claims about worsening conditions due to human-caused climate change, or more generally that any change could be directly linked to increasing CO2. This point also relates to the issue of climate model capability noted earlier. It is clear that climate models fall short on some very basic issues of climate variability, being unable to reproduce "what" has happened regarding global temperature, and therefore not knowing "why" any of it happened. It is therefore premature to claim that one knows the causes for changes in various exotic measures of weather, such as rainfall intensity over short periods, which are not even explicitly generated in climate model output.

The Disappointing Scientific Process

I have written much for previous congressional hearings and other venues about the failure of the scientific community to objectively approach the study of climate and climate change. (See Appendix) Climate science is a murky science with large uncertainties on many critical components such as cloud distributions and surface heat exchanges. As mentioned above, there is no objective instrumentation that can tell us "why" changes occur. That being the case, we are left with hypotheses (claims) to put forward and then to test. The information given above, in my view, is clear evidence that the current theoretical understanding of "why" the climate changes, as embodied in models (and on which current policy is based), fails such tests. Indeed, the theoretical (model) view as expressed in the IPCC AR5 in every case overestimated the bulk tropical atmospheric temperature response of extra greenhouse gases (see above and IPCC Supplementary Material Figure .SM.) indicating the theoretical understanding of the climate response is too sensitive to greenhouse gases.

One problem with our science relates to the funding process for climate studies, the vast majority of which is provided through federal agencies. Funding decisions are decided by people, and people have biases. Our science has also seen the move toward "consensus" science where "agreement" between people and groups is elevated above determined, objective investigation. The sad progression of events here has even led to congressional investigations designed to silence (with some success) those whose voices, including my own, have challenged the politically-correct views on climate (i.e. congressional investigation by Rep. Grijalva, 22 Feb 2015, http://www.scribd.com/doc/256829/Letter-to-UAH-re-John-Christy.)

Today, funding decisions are made by review panels. In this process, many proposals for funding are submitted to the agencies, but the agencies only have a fraction of the funds available to support the proposals, so only a few proposals can be funded and these are selected by panels. In the area of climate, it is clear the agencies are convinced of the

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consensus view of dangerous climate change as indicated by their various statements and press releases on the issue. Therefore, when a contrarian proposal is submitted that seeks to discover other possible explanations besides greenhouse gases for the small changes we now see, or one that seeks to rigorously and objectively investigate climate model output, there is virtually no chance for funding. This occurs because the panel determines by majority vote whom to fund, and with tight competition, any bias by just a couple of panel members against a contrarian proposal is sufficient for rejection. Of course, the agencies will claim all is done in complete objectivity, but that would be precisely the expected response of someone already within the "consensus" and whose agency has stated its position on climate change. This brings me to "consensus science."

The term "consensus science" will often be appealed to regarding arguments about climate change to bolster an assertion. This is a form of "argument from authority." Consensus, however, is a political notion, not a scientific notion. As I testified to the Inter-Academy Council in June 2 , wrote in *Nature* that same year (Christy 2), and documented in my written testimony for several congressional hearings (e.g., House Space, Science and Technology, 3 Mar 2) the IPCC and other similar Assessments do not represent for me a consensus of much more than the consensus of those selected to agree with a particular consensus.

The content of these climate reports is actually under the control of a relatively small number of individuals - I often refer to them as the "climate establishment" – who through the years, in my opinion, came to act as *gatekeepers* of scientific opinion and information, rather than *brokers*. The voices of those of us who object to various statements and emphases in these assessments are by-in-large dismissed rather than accommodated. This establishment includes the same individuals who become the "experts" called on to promote IPCC claims in government reports such as the endangerment finding by the Environmental Protection Agency.

As outlined in my previous testimonies, these "experts" become the authors and evaluators of their own research relative to research which challenges their work. This becomes an obvious conflict of interest. But with the luxury of having the "last word" as "expert" authors of the reports, alternative views vanish. This is not a process that provides the best information to the peoples' representatives. The U.S. Congress must have the full range of views on issues such as climate change which are (a) characterized by considerable ambiguity (see model results) (b) used to promote regulatory actions which will be economically detrimental to the American people and, most ironically, (c) will have no impact on whatever the climate will do.

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I've often stated that climate science is a "murky" science. We do not have laboratory methods of testing our hypotheses as many other sciences do. As a result what passes for science includes, opinion, arguments-from-authority, dramatic press releases, and fuzzy notions of consensus generated by preselected groups. This is not science.

We know from Climategate emails and many other sources that the IPCC has had problems with those who take different positions on climate change than what the IPCC promotes. There is another way to deal with this however. Since the IPCC activity (and climate research in general) *is* funded by U.S. taxpayers, then I propose that five to ten percent of the funds be allocated to a group of well-credentialed scientists to produce an assessment that expresses legitimate, alternative hypotheses that have been (in their view) marginalized, misrepresented or ignored in previous IPCC reports (and thus the EPA Endangerment Finding and National Climate Assessments).

Such activities are often called "Red Team" reports and are widely used in government and industry. Decisions regarding funding for "Red Teams" should not be placed in the hands of the current "establishment" but in panels populated by credentialed scientists who have experience in examining these issues. Some efforts along this line have arisen from the private sector (i.e. *The Non-governmental International Panel on Climate Change* at http://nipccreport.org/ and Michaels (2 2) *ADDENDUM: Global Climate Change Impacts in the United States*). I believe policymakers, with the public's purse, should actively support the assembling all of the information that is vital to addressing this murky and wicked science, since the public will ultimately pay the cost of any legislation alleged to deal with climate.

Topics to be addressed in this "Red Team" assessment, for example, would include (a) evidence for a low climate sensitivity to increasing greenhouse gases, (b) the role and importance of natural, unforced variability, (c) a rigorous and independent evaluation of climate model output, (d) a thorough discussion of uncertainty, (e) a focus on metrics that most directly relate to the rate of accumulation of heat in the climate system, (f) analysis of the many consequences, including benefits, that result from CO_2 increases, and (g) the importance that affordable and accessible energy has to human health and welfare.

What this proposal seeks is to provide to the Congress and other policymakers a parallel, scientifically-based assessment regarding the state of climate science which addresses issues which here-to-for have been un- or under-represented by previous tax-payer funded, government-directed climate reports. In other words, our policymakers need to see the entire range of findings regarding climate change.

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Summary of Extract

The messages of the two points outlined in the extract above are: (1) the claims about increases in frequency and intensity of extreme events are generally not supported by actual observations and, (2) official information about climate science is largely controlled by agencies through (a) funding choices for research and (b) by the carefully-selected (i.e. biased) authorship of reports such as the EPA Endangerment Finding and the National Climate Assessment.

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To: Schnare, David[schnare.david@epa.gov]
From: Zack Colman
Sent: Thur 2/23/2017 2:18:35 AM
Subject: Re: Endangerment finding

Understood. Thought I might as well try!

On Wed, Feb 22, 2017 at 6:49 PM, Schnare, David <schnare.david@epa.gov> wrote:

Not something I can do.

From: Zack Colman [mailto:colmanz@csmonitor.com]
Sent: Wednesday, February 22, 2017 5:19 PM
To: Schnare, David <schnare.david@epa.gov>
Subject: Endangerment finding

Hi David,

Zack Colman here, deputy energy & enviro editor with CSMonitor. Hope this email finds you well. Wanted to know if you had time to chat about the endangerment finding. Had a couple questions about procedure.

Spoke to Sen. Inhofe who mentioned the idea of opening up the science and including different findings. Not sure how that would impact the endangerment finding — whether that would mean a less aggressive GHG policy was needed, or whether it is just the beginning of an avenue to submit new literature that would then need to go through the regulatory process.

Anyway, that's not the only question I have with respect to the endangerment finding. Maybe it's not one that you can help on, but perhaps there's others. Can email me here, though a phone call might be most efficient — can get me at Personal Phone/Ex. 6

Thanks,

-Zack

--

Zack Colman

Deputy Energy/Enviro Editor

Christian Science Monitor

Knight Science Journalism fellow at MIT, '15-16

Personal Phone/Ex. 6

Twitter: Personal Matters/Ex. 6

--
Zack Colman

Deputy Energy/Enviro Editor
Christian Science Monitor
Knight Science Journalism fellow at MIT, '15-16
Personal Phone/Ex. 6
Twitter: Personal Matters/Ex. 6

To: Srinivasan, Gautam[Srinivasan.Gautam@epa.gov]
Cc: Schnare, David[schnare.david@epa.gov]; Schmidt, Lorie[Schmidt.Lorie@epa.gov]; Minoli, Kevin[Minoli.Kevin@epa.gov]
From: Schwab, Justin
Sent: Thur 2/23/2017 1:59:12 AM
Subject: Re: Follow up on endangerment

Thanks!

Sent from my iPhone

> On Feb 22, 2017, at 8:58 PM, Srinivasan, Gautam <Srinivasan.Gautam@epa.gov> wrote:
>
> David and Justin- The links below and the attachments to this email provide the information you requested at our meeting last week. If you need anything further, please let Lorie or me know.
>
> (1) Proposed and final GHG endangerment findings:
>
>
> * 2009 vehicle endangerment finding
> * Proposal: 74 FR 18886 (available at https://www.gpo.gov/fdsys/pkg/FR-2009-04-24/pdf/E9-9339.pdf#page=2)
> * Final: 74 FR 66496 (available at https://www.gpo.gov/fdsys/pkg/FR-2009-12-15/pdf/E9-29537.pdf#page=3)
> * Notice of denial of petitions for reconsideration: 75 FR 49556 (available at https://www.gpo.gov/fdsys/pkg/FR-2010-08-13/pdf/2010-19153.pdf#page=2). EPA also prepared a three volume response to these petitions, which is attached for your information.
>
>
> * 2016 aircraft endangerment finding
> * Proposal: 80 FR 37758 (available at https://www.gpo.gov/fdsys/pkg/FR-2015-07-01/pdf/2015-15192.pdf#page=2)
> * Final: 81 FR 54422 (available at https://www.gpo.gov/fdsys/pkg/FR-2016-08-15/pdf/2016-18399.pdf#page=2)
>
>
> * 2015 111(b) rule for GHG emissions from power plants
> * Proposal: 79 FR 1430 (new sources) (available at https://www.gpo.gov/fdsys/pkg/FR-2014-01-08/pdf/2013-28668.pdf#page=2) ; 79 FR 34960 (modified and reconstructed sources) (available at https://www.gpo.gov/fdsys/pkg/FR-2014-06-18/pdf/2014-13725.pdf#page=2)
> * Final: 80 FR 64510 (available at https://www.gpo.gov/fdsys/pkg/FR-2015-10-23/pdf/2015-22837.pdf#page=1)
>
>
> * 2016 oil and gas sector emission standards for new, reconstructed, and modified sources
> * Proposal: 80 FR 56593 (available at https://www.gpo.gov/fdsys/pkg/FR-2015-09-18/pdf/2015-21023.pdf#page=1)
> * Final: 81 FR 35824 (available at https://www.gpo.gov/fdsys/pkg/FR-2016-06-03/pdf/2016-11971.pdf#page=2)
>
> (2) The D.C. Circuit decision in Coalition for Responsible Regulation v. EPA, 684 F.3d 102 (D.C. Circuit 2012) is attached, which affirmed both EPA's 2009 endangerment finding and its denial of the petitions for reconsideration of that finding. Also attached the Supreme Court decision in Massachusetts v. EPA, 549 U.S. 497 (2007), as that decision also discusses the findings under section 202(a).
>
> (3) Our brief before the D.C. Circuit in Coalition for Responsible Regulation discusses the legislative

history on 202(a)(1). The brief is attached; see pages 30-34. Also attached is a reprint of an excerpt of the legislative history that is discussed in the brief and in the 2009 and 2016 endangerment findings for motor vehicles and aircraft (H.R. Rep. No 95-294, pp. 43-51, reprinted in A Legislative History of the Clean Air Act Amendments of 1977: A Continuation of the Clean Air Act Amendments of 1970 Together with a Section-by-Section Index, Vol. 4 (1978), pp. 2510 – 2518.)
>
> Again, please let us know what else you need. We look forward to continuing the conversation.
>
> ++++++++++++
> 202-564-5647 (o)
> Personal Phone/Ex. 6
>
> From: Schnare, David
> Sent: Friday, February 17, 2017 3:41 PM
> To: Schmidt, Lorie <Schmidt.Lorie@epa.gov>
> Cc: Schwab, Justin <schwab.justin@epa.gov>; Minoli, Kevin <Minoli.Kevin@epa.gov>; Srinivasan, Gautam <Srinivasan.Gautam@epa.gov>
> Subject: Re: Follow up on endangerment
>
> Thank you. Very timely.
>
> dschnare
>
> Sent from my iPhone
>
> On Feb 17, 2017, at 3:39 PM, Schmidt, Lorie <Schmidt.Lorie@epa.gov<mailto:Schmidt.Lorie@epa.gov>> wrote:
> David and Justin,
>
> I have asked a staff attorney to pull together our GHG endangerment findings, the DC Circuit case addressing our 2009 GHG endangerment finding, and legislative history information related to endangerment.
>
> Our goal is to email these to you on Tuesday or Wednesday. If that timing is problematic, please let me know.
>
> Have a good week-end,
>
> Lorie
>
> Lorie Schmidt
> Associate General Counsel, Air and Radiation
> Office of General Counsel
> US Environmental Protection Agency
> (202)564-1681
>
> <Coal. Resp. Reg. 684 F.3d 102 DC Cir.doc>
> <Mass v EPA.RTF>
> <EPA final endangerment brief in CRR.PDF>
> <HR Rep No 95-294 pp 43-51.pdf>
> <Reconsid response Vol 1.pdf>
> <Reconsid response Vol 2.pdf>
> <Reconsid response Vol 3.pdf>

To: Schnare, David[schnare.david@epa.gov]
From: Zack Colman
Sent: Wed 2/22/2017 10:18:52 PM
Subject: Endangerment finding

Hi David,
Zack Colman here, deputy energy & enviro editor with CSMonitor. Hope this email finds you well. Wanted to know if you had time to chat about the endangerment finding. Had a couple questions about procedure.

Spoke to Sen. Inhofe who mentioned the idea of opening up the science and including different findings. Not sure how that would impact the endangerment finding — whether that would mean a less aggressive GHG policy was needed, or whether it is just the beginning of an avenue to submit new literature that would then need to go through the regulatory process.

Anyway, that's not the only question I have with respect to the endangerment finding. Maybe it's not one that you can help on, but perhaps there's others. Can email me here, though a phone call might be most efficient — can get me at 248.563.9744.

Thanks,

-Zack

--
Zack Colman

Deputy Energy/Enviro Editor
Christian Science Monitor
Knight Science Journalism fellow at MIT, '15-16
248.563.9744
Twitter: @zcolman

To: Schnare, David[schnare.david@epa.gov]
Cc: Francis J. Menton Jr.[fmenton@manhattancontrarian.com]
From: Harry MacDougald
Sent: Sat 1/21/2017 4:56:16 PM
Subject: Petition
1.20.17 HWM lt McCabe.pdf
Petition for Reconsideration of Endangerment Finding FINAL.pdf

Please see the attached.

Harry W. MacDougald
Caldwell Propst & DeLoach, LLP
Two Ravinia Drive
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Atlanta, Georgia 30346
404-843-1956

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HARRY W. MACDOUGALD

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TELEPHONE 404-843-1956
FACSIMILE 404-843-2737

January 20, 2017

VIA FEDERAL EXPRESS

Ms. Catherine McCabe
Acting Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue NW
Washington, DC 20460

Dear Acting Administrator McCabe:

Enclosed please find a Petition for Reconsideration of Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(A) of The Clean Air Act, submitted on behalf of the Concerned Household Electricity Consumers Council ("CHECC"), and Joseph D'Aleo, Russell Slanover, Scott Univer, James P. Wallace and Robin D. Weaver.

Please direct any replies to the counsel of record indicated on the cover of the Petition.

Sincerely,

CALDWELL, PROPST, & DELOACH, LLP

Harry W. MacDougald

Enclosure
cc: Frances Menton (w/ enclosure)

BEFORE THE UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

In re:	)	
	)	EPA Docket No.
Endangerment and Cause or Contribute	)	
Findings for Greenhouse Gases Under	)	EPA-HQ-OAR-2009-01
Section 202(a) of the Clean Air Act	)	
	)	

PETITION FOR RECONSIDERATION OF
"ENDANGERMENT AND CAUSE OR CONTRIBUTE FINDINGS FOR GREENHOUSE GASES UNDER SECTION 202(a) OF THE CLEAN AIR ACT"

Filed by

Concerned Household Electricity Consumers Council, consistingof Joseph D'Aleo, Clement Dwyer, Jr.,Russell C. Slanover, Scott Univer, James P. Wallace III , Robin D. Weaver, and Douglas S. Springer

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Attorneys for Concerned Household Electricity Consumers Council and its members

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I. INTRODUCTION

Pursuant to Section 307(d) of the Clean Air Act, 42 U.S.C. § 7607(d), the Concerned Household Electricity Consumers Council ("CHECC"), consisting of Joseph D'Aleo, Clement Dwyer, Jr., Russell C. Slanover, Scott Univer, James P. Wallace III, Robin D. Weaver and Douglas S. Springer, hereby petition the U.S. Environmental Protection Agency ("EPA" or "the Agency") to convene a proceeding for reconsideration of the "Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act" published by the Agency on December 15, 2009 (74 F.R. 66496, Dec. 15, 2009) (original EPA Docket No. Docket EPA-HQ-OAR-2009-171) ("the Endangerment Finding").

As is more fully shown below, the Endangerment Finding was based on attribution of observed climate change to anthropogenic activities through what EPA termed its three "lines of evidence." 74 C.F.R. at 66518. Scientific research since the adoption of the Endangerment Finding has invalidated each of EPA's three lines of evidence. This Petition principally relies on the peer-reviewed Research Report of Wallace, *et al.*, that was first published on September 21, 2016. *See* https://thsresearch.files.wordpress.com/2016/09/ef-cpp-sc-2016-data-ths-paper-ex-sum-090516v2.pdf ("Research Report"). That Research Report is based on evidence that includes data as to atmospheric temperatures subsequent to the 2009 Endangerment Finding. The invalidation of the Endangerment Finding is conclusive, and thoroughly undermines all basis for any and all EPA regulation that is based on the Endangerment Finding, and the Social Cost of Carbon estimates that are based on this Finding.

The regulations that are based on the Endangerment Finding have resulted in much ongoing activity in the economy that looks to shut down existing sources of electricity and replace them with other much more expensive sources. Much of this activity is ongoing and, if not halted promptly, will impose massive new burdens on consumers of electricity. Therefore, Petitioners ask that EPA promptly convene hearings on this subject and issue a new "Non-Endangerment Finding" no later than June 20, 2017.

II. LEGAL STANDARD

Section 307(d)(7)(B) of the Clean Air Act, 42 U.S.C. § 7607(d)(7)(B), states in relevant part:

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> If the person raising an objection can demonstrate to the Administrator that it was impracticable to raise such an objection within such time or if the grounds for such objection arose after the period for public comment (but within the time specified for judicial review) and if such objection is of central relevance to the outcome of the rule, the Administrator shall convene a proceeding for reconsideration of the rule and provide the same procedural rights as would have been afforded had the information been available at the time the rule was proposed.

Thus, EPA is required to convene a proceeding for reconsideration upon a showing of two conditions precedent: (1) the information arose after the period for public comment on the Endangerment Finding and (2) the objection is of "central relevance to the outcome of the rule."

The procedural and substantive requirements for a petition for reconsideration are easily met here. The matters in this Petition could not have been raised during the comment period on the Endangerment Finding because the Research Report on which this Petition principally relies was first publishd on September 21, 2016, close to seven years *after* the Endangerment Finding. The Research Report in turn relies on substantial scientific evidence and data that did not exist at the time of the Endangerment Finding, namely data as to atmospheric temperatures that include extensive data for time periods subsequent to the Endangerment Finding. It was therefore not only impracticable but impossible to have raised these grounds within the original comment period or the period for judicial review of the Endangerment Finding.

The Petition is also timely under the rule of *Oljato Chapter of the Navajo Tribe v. Train* , 515 F.2d 654 (D.C. Cir. 1975).[1] *Oljato Tribe* sets forth a straightforward three-step process for EPA to follow in handling petitions for reconsideration under the Clean Air Act:

> (1) The person seeking revision of a standard of performance, or any other standard reviewable under Section 307, should petition EPA to revise the standard in question. The petition should be submitted together with supporting materials, or references to supporting materials. (2) EPA should respond to the petition and, if it denies the petition, set

[1] The Clean Air Act's legislative history makes clear that "the committee bill confirms the court's decision in *Oljato Chapter of the Navajo Tribe v. Train*, 515 F.2d 654 (D.C. Cir. 1975)." *See* H.R. Rep. 95-294, at 323 (May 12, 1977).

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> forth its reasons. (3) If the petition is denied, the petitioner may seek review of the denial in this court pursuant to Section 307.

Id. at 666.

This Petition satisfies the requirements enumerated in *Oljato Tribe*. It satisfies the first step because it seeks the withdrawal of the Endangerment Finding on specified legal grounds, namely that the attribution of warming to human emissions on which the Endangerment Finding is based has been conclusively invalidated. EPA thus has a duty to respond under the second step, with any denial of the Petition subject to review in the D.C. Circuit under the third step.

Oljato Tribe, in establishing the right to seek reconsideration, does no more than recognize the reality, first emphasized in the legislative history to the 1970 Clean Air Act Amendments, that regulations may need to be revised in light of new information:

> Section 307 originated in the Senate version of the Clean Air Act. The Senate committee described its purpose in allowing for subsequent review based on new information as follows:
>
> > The committee recognizes that it would not be in the public interest to measure for all time the adequacy of a promulgation of any standard or regulation by the information available at the time of such promulgation. In the area of protection of public health and environmental quality, it is clear that new information will be developed and that such information may dictate a revision or modification of any promulgated standard or regulation established under the act. The judicial review section, therefore, provides that any person may challenge any promulgated implementation plan after the date of promulgation whenever it is alleged that significant new information has become available.
>
> S.Rep.No.91-1196, 91st Cong., 2d Sess., 41-42 (1970.

Oljato Tribe, 515 F.2d at 660. Thus, when critical new information becomes available, as here, after a "regulation" has been "promulgated," argument should be directed to EPA in the first instance on reconsideration, to build an appropriate administrative record for later D.C. Circuit review. *See id*. 665-66.

In *Oljato Tribe*, the holding of which was expressly confirmed in the legislative history of the 1977 Clean Air Act amendments, the relevant

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reconsideration petition was remanded to EPA for consideration on its merits even though it was filed long outside the review period. Where, as here, the grounds for reconsideration arise after the close of the review period, the petition must still be considered.

The D.C. Circuit explained in *Oljato Tribe* that "the public's right to petition the Administrator for revision of a standard of performance and the Administrator's duty to respond substantively to such requests *exist completely independently of Section 307 and this court's appellate jurisdiction*." 515 F.2d at 667 (emphasis added). Thus, in *PPG Indus., Inc. v. Costle*, 659 F.2d 1239, 1250 (D.C. Cir. 1981), the D.C. Circuit held that amendment or repeal of a Clean Air Act regulation could be sought under APA Section 553(e) or Section 307(d)(7)(B), even well outside the 60-day review window:

> Alternatively, a petition may be filed directly with EPA to interpret or amend the standard, to withdraw the Guidelines, or to specify midnight to midnight reporting procedures. *See* 42 U.S.C. § 7607(d)(7)(B); 5 U.S.C. § 553(e). Either route would provide a reviewing court with a contemporaneous record of the agency's consideration of this issue, rather than with the "post hoc rationalizations of counsel." *See Oljato Chapter of the Navajo Tribe et al. v. Train*, 515 F.2d 654, 665-68 (D.C. Cir. 1975).

PPG Indus., Inc. v. Costle, 659 F.2d at 1250. This procedure has been repeatedly recognized and approved. "The court subsequently endorsed the same procedure [as in *Ojlato Tribe*], also under section 307, in *Group Against Smog & Pollution, Inc. v. EPA*, 665 F.2d 1284, 1290 (D.C. Cir. 1981); and *Natural Resources Defense Council, Inc. v. Thomas*, 845 F.2d 1088 (D.C.Cir.1988)." *Ciba-Geigy Corp. v. EPA*, 46 F.3d 1208, 1210 (D.C. Cir. 1995) (agreeing with the reasoning of those cases). The Agency itself granted a three-month stay of an emissions standard promulgated nearly four years earlier. S*ee* 63 Fed. Reg. 24,749 (May 5, 1998).

In sum, it is well-settled that EPA has a duty to consider and grant this Petition for Reconsideration, under both Section 307 and as a petition for rulemaking under 5 U.S.C. 553(e), because the grounds presented arose after the close of the period for public comment and judicial review.[2]

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[2] To be clear, this Petition seeks relief alternatively under Clean Air Act Section 307(d)(7)(B) and 5 U.S.C. § 553(e).

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Where, as here, the issues on reconsideration are substantial, a summary denial of the Petition would constitute an abuse of EPA's discretion. *Id.* at 666, n. 19. Likewise, a decision that EPA lacks authority to entertain the petition at all would misread the Agency's statutory mandate. *See Prill v. NLRB*, 755 F.2d 941, 947-48 (D.C. Cir. 1985), and its progeny. EPA may and must exercise the statutory discretion it has been delegated to consider this Petition on its merits.

The matters raised in this Petition are clearly of "central relevance" to the outcome of the Endangerment Finding. Indeed, the Research Report thoroughly and conclusively invalidates the entire basis for the Endangerment Finding, as that basis is stated and defined in the Endangerment Finding itself. *See Coalition for Responsible Regulation v. EPA*, 684 F. 3d 102, 125, 126 (D.C. Cir. 2012) (defining test of "central relevance"), *reversed on other grounds sub. nom. Utility Air Regulatory Group v. EPA*, 134 S.Ct. 2427 (2014).

III. STANDING OF THE PETITIONERS

The Petitioners herein are the Concerned Household Electricity Consumers Council ("CHECC"), and its members, namely Joseph D'Aleo, Clement Dwyer, Jr., Russell C. Slanover, Scott Univer, James P. Wallace III, Robin D. Weaver, and Douglas S. Springer.

Each of CHECC's members is a citizen of the United States and a member of a household that pays a monthly electricity bill to a utility that in turn is regulated by EPA. EPA's regulations based on the Endangerment Finding – notably but not exclusively including the so-called Clean Power Plan, 40 C.F.R. at 64662, *et seq*. – seek to replace current electricity generation sources primarily based on fossil fuels like coal and natural gas with so-called "renewables," principally wind turbines and solar panels. Replacement of fossil fuel sources with such renewables, that provide power only intermittently, threatens to increase the cost of electricity paid by the Petitioners (and by all Americans) by a factor of five or likely far more. Thus, should EPA's Endangerment Finding not be reconsidered and revoked, each of the Petitioners faces electricity bills that will inevitably increase over the coming years by many thousands of dollars per year. On a nationwide basis, the unnecessary incremental cost to consumers of replacing fossil fuel-based electricity generation with intermittent renewables is likely to be in the range of hundreds of billions of dollars per year, if not more.

A critical problem with intermittent renewables like wind and solar power lies in the excess costs that must be incurred to turn power from these sources into a fully-functioning electricity system that provides reliable power 24 hours a day, 7

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days a week, and 365 days a year. Unfortunately, the wind is often calm or blows lightly; and the sun goes completely dark fully half the time ("night"), and also shines at far less than full strength on winter days, cloudy days, cloudy winter days, and at dawn and dusk. At many of these times, consumer power demands are high.

When the intermittent sources provide less than 10% of the electricity in a system, the problems of intermittency typically make only a small cost difference. On a calm night, the lack of power from wind and solar sources can be covered over by a cushion of 10 – 15% or so of excess fossil fuel-based electric power generation capacity. But as the percent of electricity generation from intermittent renewables increases to 15% and beyond, the necessary additional costs multiply. That proposition is demonstrated by the experience of states and countries that have attempted to increase the percent of their electricity generated by intermittent renewables.

For example, California is a "leader" in the United States in generating power from wind and solar sources. According to the California Energy Commission, in 2015 California got 6% of its electricity supply from solar and 8.2% from wind, for a total of 14.2% from those two intermittent sources. *See* http://www.energy.ca.gov/almanac/electricity_data/total_system_power.html According to the U.S. Energy Information Agency, California's average electricity rate that year was 15.62 cents per kWh, versus a U.S. average of 10.31 cents per kWh. *See* https://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a In Europe, Germany began its so-called *Energiewende* ("energy transformation") in 2010, and by 2015 had gotten the portion of its electricity generated from wind and solar all the way up to just over 30%. *See* http://www.eia.gov/todayinenergy/detail.php?id=26372 The result: the average German household's electricity rate in 2015 had risen to 28.7 euro cents per kWh, about *triple* the average U.S. rate. *See* https://www.cleanenergywire.org/factsheets/what-german-households-pay-power

Analyses of the soaring price of electricity in Germany place the blame squarely on excess costs that have been necessarily incurred to try to get to a stable, functioning, 24/7/365 system with so much input from intermittent renewables. First, massive wind and solar capacity must be installed to tryto deal with days of light wind and heavy clouds And for calm nights when the wind and solar sources produce nothing, nearly the entire fleet of fossil fuel plants must be maintained and ready to go, even though those sources may be idle much of the time. And then, some means must be found to deal with the surges of available

electricity when the wind and sun suddenly blow and shine together at full strength at the same time. As noted by Benny Peiser at the Global Warming Policy Foundation on April 4, 2015 (http://www.thegwpf.com/benny-peiser-eus-green-energy-debacle-shows-the-futility-of-unilateral-climate-policies/):

> Every 10 new units worth of wind power installation has to be backed up with some eight units worth of fossil fuel generation. This is because fossil fuel plants have to power up suddenly to meet the deficiencies of intermittent renewables. In short, renewables do not provide an escape route from fossil fuel use without which they are unsustainable. . . . To avoid blackouts, the government has to subsidize uneconomic gas and coal power plants. . . . Germany's renewable energy levy, which subsidizes green energy production, rose from 14 billion euros to 20 billion euros in just one year as a result of the fierce expansion of wind and solar power projects. Since the introduction of the levy in 2000, the electricity bill of the typical German consumer has doubled.

And those extra costs are just to get to a system that gets about 30% of power from the intermittent renewables. To get higher than that, some means must be found to store the power from the wind and sun for release at times of calm and dark. To make this work, major cities like New York would require the equivalent of tens of millions of Teslas' worth of batteries, at a cost of tens or hundreds of billions of dollars.

An idea of how much extra costs must be incurred to get to a system that approaches 50% or more of electricity generation from intermittent renewables, we can look to a demonstration project that was put together in South Korea for a small community of just 97 households and 178 people. A report on the Gapa Island Project appeared on the Hankyoreh news site in July 2016 at http://english.hani.co.kr/arti/english_edition/e_national/752623.html. With average electricity usage of 142 kw, and maximum usage of 230 kw, the islanders installed wind and solar capacity of 674 kw– about *three times* maximum usage, to deal with light wind and low sun They also bought battery capacity for about eight hours of average usage. The cost of the wind and solar capacity plus batteries was approximately $12.5 million, or about $125,000 per household. And with all that investment the islanders were still only able to get about 42% of their electricity from the sun and wind when averaged over a full month. They still needed the full fossil fuel backup capacity.

By applying a reasonable cost of capital to a system like that of Gapa Island, and considering additional elements of a system, like additional storage, that would

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be necessary to push generation from renewables to higher levels, one can calculate that a system like the Gapa Island demonstration project for the full United States would lead to electricity costs of*at least five times* their current level, and more likely, far higher. Even then, the U.S. would be hard-pressed to achieve 50% of electricity from intermittent renewables. The Petitioners obviously have a strong personal interest in heading off such disastrous cost increases. Granting the relief sought by this Petition would prevent those cost increases from occurring.

IV. THE "LINES OF EVIDENCE" ON WHICH EPA BASED THE ENDANGERMENT FINDING HAVE ALL BEEN INVALIDATED.

EPA's Endangerment Finding appears at 74 C.F.R., page 66,495,*et seq*. At page 66,518 EPA sets forth the three "lines of evidence" upon which it says it has attributed "observed climate change" to "anthropogenic activities," thus providing the basis for the Finding that human GHG emissions endanger human health and welfare:

> The attribution of observed climate change to anthropogenic activities is based on multiple lines of evidence. The first line of evidence arises from our basic physical understanding of the effects of changing concentrations of greenhouse gases, natural factors, and other human impacts on the climate system. The second line of evidence arises from indirect, historical estimates of past climate changes that the changes in global surface temperature over the last several decades are unusual. The third line of evidence arises from the use of computer-based climate models to simulate the likely patterns of response of the climate system to different forcing mechanisms (both natural and anthropogenic).

More information about the nature of each of the three "lines of evidence" can be gleaned from EPA's further elaboration in the Endangerment Finding itself and the associated Technical Support Document.

By the first "line of evidence," ("our basic physical understanding of the effects of changing concentrations of greenhouse gases, natural factors, and other human impacts on the climate system"), EPA is referring to its "greenhouse gas fingerprint" or "tropical hot spot" ("Hot Spot") theory, which is that in the tropics, the upper troposphere is warming faster than the lower troposphere and the lower is warming faster than the surface, all due to rising atmospheric greenhouse gas concentrations blocking heat transfer into outer space. By this mechanism,

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increasing greenhouse gas concentration is assumed to increase surface temperatures.

The second "line of evidence" ("indirect, historical estimates of past climate changes that suggest that the changes in global surface temperature over the last several decades are unusual") refers to EPA's claim that global average surface temperatures have been rising in a dangerous fashion over the last fifty years.

The third "line of evidence" ("use of computer-based climate models to simulate the likely patterns of response of the climate system to different forcing mechanisms (both natural and anthropogenic)")consists of EPA's reliance on climate models (not actually "evidence") that assume that greenhouse gases are a key determinant of climate change. EPA uses climate models for two purposes: to "attribute" warming to human GHG emissions, and to set regulatory policy for such emissions based on their modeled impact on global temperatures.

The Research Report of Wallace, et al. (September 21, 2016) undertook to assess each of EPA's three "lines of evidence" and to either validate or invalidate each of them based on the best available historical temperature data. In accordance with the scientific method, the Research Report used the best available temperature data from multiple sources, all of them completely independent from each other, for the validation/invalidation exercise. The data used in the Research Report are available at the following url: https://thsresearch.files.wordpress.com/2017/01/ef-cpp-sc-2016-data-ths-data-master-original.xlsx. Equally available from the text of the Report itself are all the methods, equations and formulas that were used to produce its results. In other words, the Report is fully replicable by any scientist who wishes to check or question its methods or results.

The principal conclusions of the Research Report are as follows:

- "These analysis results would appear to leave very, very little doubt but that EPA's claim of a Tropical Hot Spot (THS), caused by rising atmospheric CO2 levels, simply does not exist in the real world."

- Once EPA's THS assumption is invalidated, it is obvious why the climate models they claim can be relied upon, are also invalid.

- "[T]his analysis failed to find that the steadily rising Atmospheric CO2 Concentrations have had a statistically significant impact on any of the 13 critically important temperature time series data analyzed."

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- "[T]hese results clearly demonstrate - 13 times in fact - that once just the ENSO [El Nino/La Nina] impacts on temperature data are accounted for, there is no "record setting" warming to be concerned about. In fact, there is no ENSO-Adjusted Warming at all."

Research Report, p. 4.

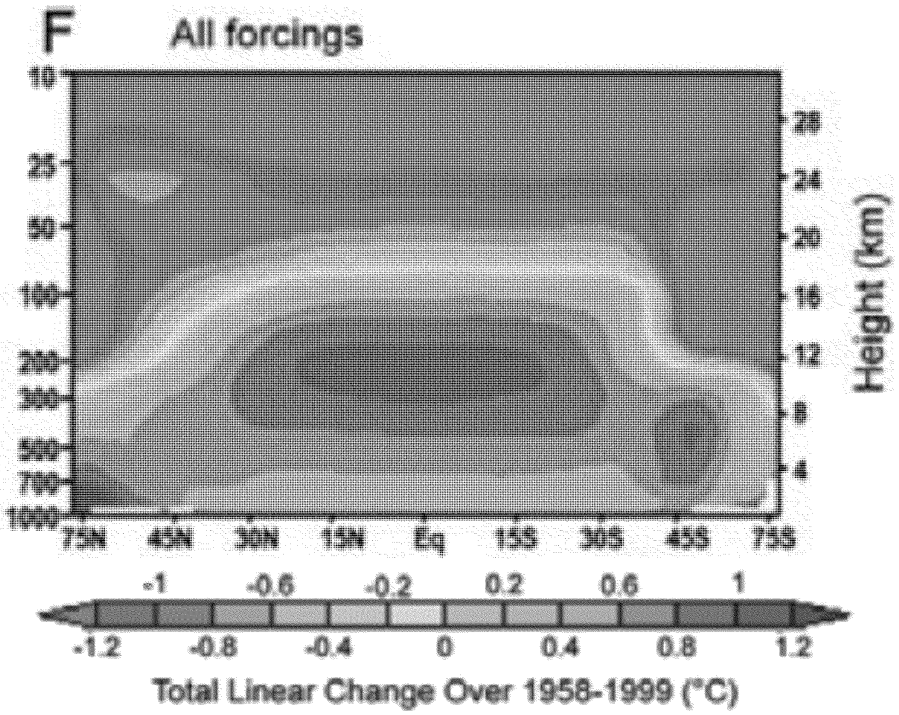
This means that the climate sensitivity parameter's estimate is not statistically significant. Therefore, the Social Cost of Carbon esimates now in widespread use to justify regulation of CO2 emissions are fundamentally flawed. The actual Social Cost of Carbon is negative rather than positive, meaning that CO2 is in fact a benefical gas.

Invalidation of the the Hot Spot requires reconsideration of the Endangerment Finding because the Hot Spot is a critical and necessary component of the "physical understanding" of climate that EPA claims as the foundational line of evidence supporting the Endangerment Finding. For example, the "physical understanding" of the atmospheric greenhouse mechanism set forth in U.S. Climate Change Science Program, Synthesis and Assessment Product 1.1, Temperature Trends in the Lower Atmosphere - Understanding and Reconciling Differences, ("SAP 1.1"), Chapter 1,§ 1.1, The Thermal Structure of the Atmosphere, p. 17-19, https://www.gfdl.noaa.gov/bibliography/related_files/vr0603.pdf : explicitly relies upon the Hot Spot:

> The presence of such greenhouse gases (e.g., carbon dioxide, methane, nitrous oxide, halocarbons) increases the radiative heating of the surface and troposphere. As specific humidity is strongly related to temperature, it is expected to rise with surface warming (IPCC, 1990), The increased moisture content of the atmosphere amplifies the initial radiative heating due to the greenhouse gas increases (Manabe and Wetherald, 1967; Ramanathan, 1981). The re-establishment of a new thermal equilibrium in the climate system involves the communication of the added heat input to the troposphere and surface, leading to surface warming (Goody and Yung, 1989; IPCC, 1990; Lindzen and Emanuel, 2002). From the preceding discussions, the lapse rate can be expected to decrease with the resultant increase in humidity, and also to depend on the resultant changes in atmospheric circulation. **In general, the lapse rate can be expected to decrease with warming such that temperature changes aloft exceed those at the surface.** As a consequence, the characteristic

infrared emission level of the planet is shifted to a higher altitude in the atmosphere.

(Emphasis added). The CCSP SAP 1.1 report depicted the Hot Spot graphically in figure 1.3, p. 25, as follows:



Similarly, the IPCC's Fourth Assessment Report (AR4) also states unequivocally that the Hot Spot is an integral feature of the "physical understanding" of the climate's hypothesized greenhouse warming mechanism. This is demonstrated by AR4 WG1, The Physical Science Basis, Chapter 9, Figure 9.1. Panel (c) shows the modeled effect of GHGs, and clearly depicts the hot spot:

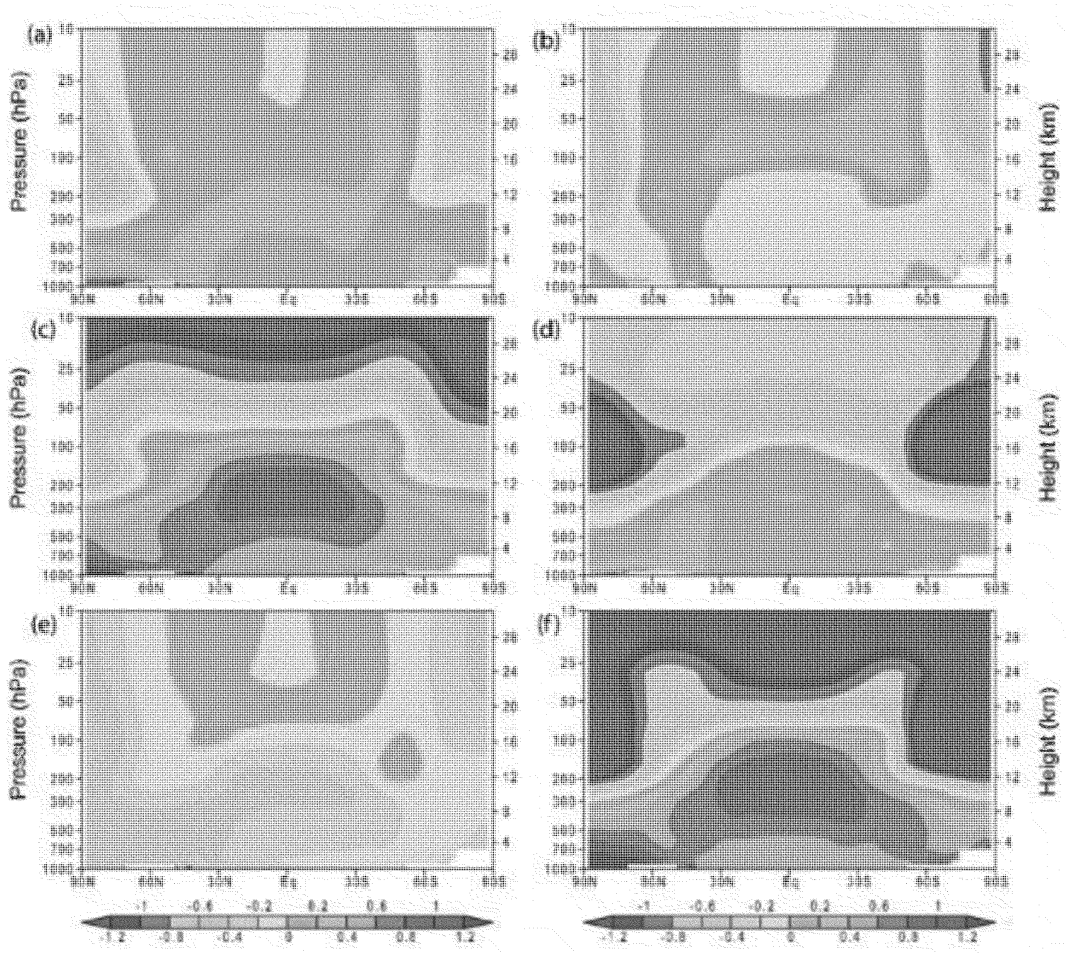


Figure 9.1. Zonal mean atmospheric temperature change from 1890 to 1999 (°C per century) as simulated by the PCM model from (a) solar forcing, (b) volcanoes, (c) well-mixed greenhouse gases, (d) tropospheric and stratospheric ozone changes, (e) direct sulphate aerosol forcing and (f) the sum of all forcings. Plot is from 1,000 hPa to 10 hPa (shown on left scale) and from 0 km to 30 km (shown on right). See Appendix 9.C for additional information. Based on Santer et al. (2003a).

The text accompanying this figure explains that "The major features shown in Figure 9.1 are robust to using different climate models." IPCC AR4 WG1 § 9.2.2. (http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch9s9-2-2.html). "Greenhouse gas forcing is expected to produce warming in the troposphere, … ." *Id.*

In adopting the Endangerment Finding, EPA explicitly, repeatedly and irrevocably placed primary reliance on the US CCSP reports and the IPCC AR4. *See* TSD Box 1.1, p 4. These assessments are cited thousands of times in the full set of documentation for the Endangerment Finding.

The CCSP report cited above said if the Hot Spot were missing it would be a "*potentially serious inconsistency*." SAP 1.1, p. 11. (Emphasis added). Yet the

CCSP ultimately sided with those claiming at the time that the mismatch between observations and prediction was not fatal. *Id.*

EPA also acknowledged in the Technical Support Document for the Endangerment Finding that if the Hot Spot were missing it would be "an important inconsistency." TSD p. 50. EPA's team, including Tom Karl,agreed with the CCSP (led by the same Tom Karl) and concluded there was no dispositive conflict between prediction and observation. *Id.*

The Research Report, using substantial scientific evidence and additional data available only after 2009, not only shows a "an important inconsistency," it invalidates the Hot Spot entirely. This is fatal to the EPA's claimed physical understanding of climate, and is likewise fatal to the climate models constituting EPA's third line of evidence. These models, relying on an invalidated physical theory, all predict the Hot Spot. Proper analysis of more than 50 years of balloon and 37 years of satellite temperature data generated by five independent entities conclusively shows that the Hot Spot does not exist. This demonstrates that the models are invalid and unreliable, and cannot properly be used for attribution analysis or forecasting warming due to anthropogenic CO2 emissions.

In sum, all three of the lines of evidence relied upon by EPA to attribute warming to human GHG emissions are invalid. The Endangerment Finding itself is therefore invalid and should be reconsidered. Moreover, this reconsideration is particulary urgent at this point in time in that the widely used Social Cost of Carbon has now been demonstrated tobe fundamentally flawed. To put it mildly, the current Endangerment Finding and Social Cost of Carbon are leading the nation in the wrong direction from an energy polcy standpoint. Decarbonization makes absolutely no scientific or economic sense.

V. CONCLUSION

No scientists have yet devised an empirically validated theory proving that higher atmospheric CO2 levels will lead to higher global average surface temperatures. Moreover, if the causal link between higher atmospheric CO2 concentrations and higher temperatures is broken by invalidating each of EPA's three lines of evidence, then EPA's assertions that higher CO2 concentrations also cause sea-level increases and more frequent and severe storms, floods, and droughts and other deleterious effects on human health and welfare are also disproved. Such causality assertions require a validated theory that higher atmospheric CO2 concentrations cause increases in temperatures. Lacking such a validated theory, EPA's conclusionscannot stand. In science, credible empirical

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data always trump proposed theories, even if those theories are claimed to (or actually do) represent the current consensus, or, in this case, a finding made by EPA.

The invalidated Endangerment Finding, combined with a fundamentally flawed and dangerous Social Cost of Carbon estimate, are now driving numerous potentially crippling regulations, including the Clean Power Plan and the newly proposed automotive fuel economy standards. EPA should therefore promptly convene a proceeding to reconsider the Endangerment Finding.

Respectfully submitted this 20th day of January, 2017.

Attorneys for Petitioners,

Francis Menton

Francis Menton by Hull with express permission

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ED_001612_00029647-00016

To: Schnare, David[schnare.david@epa.gov]
From: Jackson, Ryan (Inhofe)
Sent: Thur 2/9/2017 6:02:49 PM
Subject: FW: EPA Executive Orders
Final - Climate Change.docx
Final - Cost-Benefit and Domestic Benefits EO.docx
Final - Critical Infrastructure Protection EO.docx
Final - LNG Export PM.docx
Final - Offshore PM.docx
Final - Onshore Energy PM.docx
Final - Ozone.docx
Final - Regional Haze NAAQS EO.docx
Final - RFS PM.docx
Final - Scientific Rigor EO.docx
Final - WOTUS EO.docx

David, what kind of media prep is the press office (and I guess I mean Doug and John) preparing for to explain these?

---------- Forwarded message ----------
From: **David Schnare** Personal Email/Ex. 6
Date: Thu, Feb 2, 2017 at 4:10 PM
Subject: EPA Executive Orders
To: ryan_jackson@inhofe.senate.gov, Personal Email/Ex. 6 - Patrick Wyrick

Patrick and Ryan:

Attached are the Executive Orders as approved by Andrew Bremberg, now the President's Domestic Policy Advisor. We have prepared directives for the Mr. Pruitt's signature to implement each element of these EO's, directives he can sign on day 1 if he wants to.

I will send the action plan under separate cover as the length of this material clogs the internet pipes and may not otherwise make it through to you.

d.

--

David W. Schnare, Esq. Ph.D.

To: Schnare, David[schnare.david@epa.gov]
Cc: Flynn, Mike[Flynn.Mike@epa.gov]; Minoli, Kevin[Minoli.Kevin@epa.gov]; Jackson, Ryan (Inhofe)[Ryan_Jackson@inhofe.senate.gov]; Jackson, Ryan[jackson.ryan@epa.gov]; Kenny, Shannon[Kenny.Shannon@epa.gov]
From: Reeder, John
Sent: Tue 2/21/2017 9:38:50 PM
Subject: Re: Request to Reopen Clean Power Plan

We've got to send these to OEX and the lead is typically the program office. Can add cc's for counsel, policy office and others as we wish.

Sent from my iPhone

On Feb 21, 2017, at 4:36 PM, Schnare, David <schnare.david@epa.gov> wrote:

And here's another one. Again, let me know it is logged in and who has the lead.

dschnare

From: Marlo Lewis [mailto:Marlo.Lewis@cei.org]
Sent: Tuesday, February 21, 2017 2:52 PM
To: Schnare, David <schnare.david@epa.gov>
Cc: Sam Kazman <Sam.Kazman@cei.org>; Myron Ebell <Myron.Ebell@cei.org>
Subject: Request to Reopen Clean Power Plan

We respectfully request that the U.S. Environmental Protection Agency (EPA) either open a new rulemaking on, or reconsider, the agency's Clean Power Plan (CPP). We make this request under 5 U.S.C. 553(3).[1] For the reasons set forth below, we submit that the CPP is an egregious case of regulatory overreach which EPA should either repeal or drastically reform.

The CPP imposes first-ever carbon dioxide (CO2) performance standards on "existing" (already built) fossil-fuel power plants. Unlike all previous existing source performance standards (ESPS) promulgated by the EPA under §111(d) of the Clean Air Act (CAA), the CPP standards are (a) more stringent than the corresponding standards for new sources and (b) unachievable by any individual existing source.[2]

The EPA's authority under CAA §111(d) is limited to establishing ESPS that are "achievable" at the source through cost-effective improvements in technology and operating

practices. However, such "inside the fence line" actions would only reduce power-sector CO2 emissions by a few percent,[3] not enough to accelerate coal power plant retirements or deployment of new renewable capacity. So the EPA promulgated unachievable standards that effectively require power plant owners to reduce output, cease production, or invest in new renewable generation.

ESPS are supposed to reflect the "best system of emission reduction" (BSER) that has been "adequately demonstrated," taking cost into account. In more than 40 years BSER has always meant a pollution-control technology or operating practice that can be applied at the source;[4] nonetheless, the EPA defined "system" to include market-restructuring policies such as cap-and-trade, renewable electricity standards, and low-carbon dispatch.

In effect, the CPP treats power plants as components of a single source—the U.S. electric power sector. However, CAA §111(a) clearly defines a "source" as an individual physical object—a "building, structure, facility, or installation." The EPA has no authority to control owners' investments and transactions in the wider electricity marketplace "beyond the fence line." An ESPS that reduces emissions by reducing output is a non-performance mandate, not a bona fide CAA performance standard.[5]

The CPP is also unlawful because its statewide emission-reduction targets, which are based on the ESPS, require states to modify their electricity laws and regulations. There is nary a word in the CAA about regulating electricity markets. Congress prohibited even the Federal Energy Regulatory Commission (FERC) from interfering with "state authority in such traditional areas as the authority over . . . administration of integrated resource planning and . . . utility generation and resource portfolios."[6]

In short, the CPP is an attempt to inflate a three-sentence, seldom-used provision[7] of the CAA into far-reaching legislative authority to decarbonize the U.S. electric supply system—a policy Congress has not approved in almost three decades of debate on climate policy. For the foregoing reasons, it should reexamine this action and the regulations that resulted from it.

Sincerely,

Marlo Lewis, Ph.D.

Senior Fellow

Competitive Enterprise Institute

202-331-2267

Marlo.Lewis@cei.org

[1] *See, e.g.*, *Commonwealth of Va. v. EPA*, 108 F.3d 1397, 1402 n.3 (D.C. Cir. 1997) (successful challenge to a Clean Air Act rule) ("any interested person has 'the right to petition' EPA 'for the issuance, amendment, or repeal' of any rule. 5 U.S.C. § 553(e)"), *decision modified on reh'g*, 116 F.3d 499 (D.C. Cir. 1997); *Geller v. FCC*, 610 F.2d 973, 978–80 (D.C. Cir. 1979) (overturning agency's denial of petition for rulemaking seeking reconsideration of agency rules); *American Horse Protection Ass'n v. Lyng*, 812 F.2d 1, 5 (D.C. Cir. 1987) (overturning denial of rulemaking petition).

[2] The CPP establishes ESPS of 1,305 lbs. CO2/MWh for existing coal power plants and 771 lbs. CO2/MWh for existing natural gas combined cycle (NGCC) power plants (80 FR 64707). The corresponding NSPS are 1,400 lbs. CO2/MWh new coal power plants and 1,000 lbs. CO2/MWh NGCC power plants (80 FR 64658, 64513).

[3] 80 FR 64,787.

[4] Peter S. Glaser and Carroll W. McGuffey, III, Regulating Greenhouse Gases Under the Clean Air Act: Is the Bubble About to Burst? Journal of Energy & Environmental Law, Winter 2016, p. 8, https://gwujeel.files.wordpress.com/2016/02/glaser_jeel_vol6_issue3.pdf.

[5] Linda Tsang and Alexandra M. Wyatt, Clean Power Plan: Legal Background and Pending Litigation in West Virginia v. EPA, Congressional Research Service, January 10, 2017, https://fas.org/sgp/crs/misc/R44480.pdf.

[6] New York v. FERC, 535 U.S. 1, 24 (2002), quoted by Glaser and McGuffey, p. 11.

[7] Section 111(d) has been used a total of five times to regulate three pollutants, and only once (in 1996) since the Clean Air Act Amendments of 1990. Glaser and McGuffey, p. 7, fn. 91.

To: Schnare, David[schnare.david@epa.gov]
Cc: Sam Kazman[Sam.Kazman@cei.org]; Myron Ebell[Myron.Ebell@cei.org]
From: Marlo Lewis
Sent: Tue 2/21/2017 7:52:14 PM
Subject: Request to Reopen Clean Power Plan

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The CPP is also unlawful because its statewide emission-reduction targets, which are based on the ESPS, require states to modify their electricity laws and regulations. There is nary a word in the CAA about regulating electricity markets. Congress prohibited even the Federal Energy Regulatory Commission (FERC) from interfering with "state authority in such traditional areas as the authority over . . . administration of integrated resource planning and . . . utility generation and resource portfolios."[6]

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Sincerely,

Marlo Lewis, Ph.D.

Senior Fellow

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[1] *See, e.g.*, *Commonwealth of Va. v. EPA*, 108 F.3d 1397, 1402 n.3 (D.C. Cir. 1997) (successful challenge to a Clean Air Act rule) ("any interested person has 'the right to petition' EPA 'for the issuance, amendment, or repeal' of any rule. 5 U.S.C. § 553(e)"), *decision modified on reh'g*, 116 F.3d 499 (D.C. Cir. 1997); *Geller v. FCC*, 610 F.2d 973, 978–80 (D.C. Cir. 1979) (overturning agency's denial of petition for rulemaking seeking reconsideration of agency rules); *American Horse Protection Ass'n v. Lyng*, 812 F.2d 1, 5 (D.C. Cir. 1987) (overturning denial of rulemaking petition).

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[3] 80 FR 64,787.

[4] Peter S. Glaser and Carroll W. McGuffey, III, Regulating Greenhouse Gases Under the Clean Air Act: Is the Bubble About to Burst? Journal of Energy & Environmental Law, Winter 2016, p. 8, https://gwujeel.files.wordpress.com/2016/02/glaser_jeel_vol6_issue3.pdf.

[5] Linda Tsang and Alexandra M. Wyatt, Clean Power Plan: Legal Background and Pending Litigation in West Virginia v. EPA, Congressional Research Service, January 10, 2017, https://fas.org/sgp/crs/misc/R44480.pdf.

[6] New York v. FERC, 535 U.S. 1, 24 (2002), quoted by Glaser and McGuffey, p. 11.

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To: Schnare, David[schnare.david@epa.gov]
From: David Schnare
Sent: Tue 1/24/2017 8:43:08 AM
Subject: Fwd: GHG Organizing Principles
Endangerment Finding Organizing Principles.docx
ATT00001.htm

Sent from my iPad

Begin forwarded message:

From: David Schnare <david.w.schnare@ptt.gov>
Date: January 19, 2017 at 4:15:36 PM EST
To: schnare@torcastlelaw.net
Subject: GHG Organizing Principles

RECONSIDERATION OF THE GREENHOUSE GASES ENDANGERMENT FINDING

Organizing Principles

Under the Clean Air Act, EPA has a duty to determine whether or not emissions of air pollutants cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare, or whether the science is too uncertain to make a reasoned decision.[1] It has been more than six years since EPA considered this question regarding greenhouse gases and the Agency has been petitioned to review and reconsider this question. The EPA Administrator has granted this petition, stating that in so doing, the Agency will employ certain organizing principles during its examination of the issue. The sections below identify these principles, define them, discuss the context within which they apply, the degree to which they are antagonistic or reinforcing to each other, and how can be applied to various elements of an endangerment finding for greenhouse gases.

Assimilative Capacity

Definition

Context for use

Limitations to application of the principle

Relationship to other principles

Elements of a finding to which the principle is reasonably applied

The Precautionary Principle

Definition

Context for use

Limitations to application of the principle

[1] *Cite to Mass v. EPA and quote the decision on this issue.*

ED_001612_00030589-00001

Relationship to other principles

Elements of a finding to which the principle is reasonably applied

The Proactionary Principle

Definition

Context for use

Limitations to application of the principle

Relationship to other principles

Elements of a finding to which the principle is reasonably applied

Opportunity Cost

Definition

Context for use

Limitations to application of the principle

Relationship to other principles

Elements of a finding to which the principle is reasonably applied

Relative Risk to human health and mankind

ED_001612_00030589-00002

Definition

Context for use

Limitations to application of the principle

Relationship to other principles

Elements of a finding to which the principle is reasonably applied

Guidelines for ensuring and maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies

Definition

Context for use

Limitations to application of the principle

Relationship to other principles

Elements of a finding to which the principle is reasonably applied

The Agency's policies on peer review

Definition

Context for use

ED_001612_00030589-00003

Limitations to application of the principle

Relationship to other principles

Elements of a finding to which the principle is reasonably applied

Citizen science

Definition

Context for use

Limitations to application of the principle

Relationship to other principles

Elements of a finding to which the principle is reasonably applied

ED_001612_00030589-00004

To: Reeder, John[Reeder.John@epa.gov]
Cc: Flynn, Mike[Flynn.Mike@epa.gov]; Minoli, Kevin[Minoli.Kevin@epa.gov]; Jackson, Ryan (Inhofe)[Ryan_Jackson@inhofe.senate.gov]; Jackson, Ryan[jackson.ryan@epa.gov]; Kenny, Shannon[Kenny.Shannon@epa.gov]
From: Schnare, David
Sent: Tue 2/21/2017 9:40:29 PM
Subject: RE: Request to Reopen Clean Power Plan

Please send them to OEX and ask the relevant program office to provide us a timeline on which they can prepare a response to the petition.

dschnare

From: Reeder, John
Sent: Tuesday, February 21, 2017 4:39 PM
To: Schnare, David <schnare.david@epa.gov>
Cc: Flynn, Mike <Flynn.Mike@epa.gov>; Minoli, Kevin <Minoli.Kevin@epa.gov>; Jackson, Ryan (Inhofe) <Ryan_Jackson@inhofe.senate.gov>; Jackson, Ryan <jackson.ryan@epa.gov>; Kenny, Shannon <Kenny.Shannon@epa.gov>
Subject: Re: Request to Reopen Clean Power Plan

We've got to send these to OEX and the lead is typically the program office. Can add cc's for counsel, policy office and others as we wish.

Sent from my iPhone

On Feb 21, 2017, at 4:36 PM, Schnare, David <schnare.david@epa.gov> wrote:

And here's another one. Again, let me know it is logged in and who has the lead.

dschnare

From: Marlo Lewis [mailto:Marlo.Lewis@cei.org]
Sent: Tuesday, February 21, 2017 2:52 PM
To: Schnare, David <schnare.david@epa.gov>
Cc: Sam Kazman <Sam.Kazman@cei.org>; Myron Ebell <Myron.Ebell@cei.org>
Subject: Request to Reopen Clean Power Plan

We respectfully request that the U.S. Environmental Protection Agency (EPA) either open a new rulemaking on, or reconsider, the agency's Clean Power Plan (CPP). We make this request under 5 U.S.C. 553(3).[1] For the reasons set forth below, we submit that the CPP is an egregious case of regulatory overreach which EPA should either repeal or drastically reform.

The CPP imposes first-ever carbon dioxide (CO2) performance standards on "existing" (already built) fossil-fuel power plants. Unlike all previous existing source performance standards (ESPS) promulgated by the EPA under §111(d) of the Clean Air Act (CAA), the CPP standards are (a) more stringent than the corresponding standards for new sources and (b) unachievable by any individual existing source.[2]

The EPA's authority under CAA §111(d) is limited to establishing ESPS that are "achievable" at the source through cost-effective improvements in technology and operating practices. However, such "inside the fence line" actions would only reduce power-sector CO2 emissions by a few percent,[3] not enough to accelerate coal power plant retirements or deployment of new renewable capacity. So the EPA promulgated unachievable standards that effectively require power plant owners to reduce output, cease production, or invest in new renewable generation.

ESPS are supposed to reflect the "best system of emission reduction" (BSER) that has been "adequately demonstrated," taking cost into account. In more than 40 years BSER has always meant a pollution-control technology or operating practice that can be applied at the source;[4] nonetheless, the EPA defined "system" to include market-restructuring policies such as cap-and-trade, renewable electricity standards, and low-carbon dispatch.

In effect, the CPP treats power plants as components of a single source—the U.S. electric power sector. However, CAA §111(a) clearly defines a "source" as an individual physical object—a "building, structure, facility, or installation." The EPA has no authority to control owners' investments and transactions in the wider electricity marketplace "beyond the fence line." An ESPS that reduces emissions by reducing output is a non-performance mandate, not a bona fide CAA performance standard.[5]

The CPP is also unlawful because its statewide emission-reduction targets, which are based on the ESPS, require states to modify their electricity laws and regulations. There is nary a word in the CAA about regulating electricity markets. Congress prohibited even the Federal Energy Regulatory Commission (FERC) from interfering with "state authority in such traditional areas as the authority over . . . administration of integrated resource planning and . . . utility generation and resource portfolios."[6]

In short, the CPP is an attempt to inflate a three-sentence, seldom-used provision[7] of the CAA into far-reaching legislative authority to decarbonize the U.S. electric supply system—a policy Congress has not approved in almost three decades of debate on climate policy. For the foregoing reasons, it should reexamine this action and the regulations that resulted from it.

Sincerely,

Marlo Lewis, Ph.D.

Senior Fellow

Competitive Enterprise Institute

202-331-2267

Marlo.Lewis@cei.org

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[1] *See, e.g.*, *Commonwealth of Va. v. EPA*, 108 F.3d 1397, 1402 n.3 (D.C. Cir. 1997) (successful challenge to a Clean Air Act rule) ("any interested person has 'the right to petition' EPA 'for the issuance, amendment, or repeal' of any rule. 5 U.S.C. § 553(e)"), *decision modified on reh'g*, 116 F.3d 499 (D.C. Cir. 1997); *Geller v. FCC*, 610 F.2d 973, 978–80 (D.C. Cir. 1979) (overturning agency's denial of petition for rulemaking seeking reconsideration of agency rules); *American Horse Protection Ass'n v. Lyng*, 812 F.2d 1, 5 (D.C. Cir. 1987) (overturning denial of rulemaking petition).

[2] The CPP establishes ESPS of 1,305 lbs. CO2/MWh for existing coal power plants and 771 lbs. CO2/MWh for existing natural gas combined cycle (NGCC) power plants (80 FR 64707). The corresponding NSPS are 1,400 lbs. CO2/MWh new coal power plants and 1,000 lbs. CO2/MWh NGCC power plants (80 FR 64658, 64513).

[3] 80 FR 64,787.

[4] Peter S. Glaser and Carroll W. McGuffey, III, Regulating Greenhouse Gases Under the Clean Air Act: Is the Bubble About to Burst? Journal of Energy & Environmental Law, Winter 2016, p. 8, https://gwujeel.files.wordpress.com/2016/02/glaser_jeel_vol6_issue3.pdf.

[5] Linda Tsang and Alexandra M. Wyatt, Clean Power Plan: Legal Background and Pending Litigation in West Virginia v. EPA, Congressional Research Service, January 10, 2017, https://fas.org/sgp/crs/misc/R44480.pdf.

[6] New York v. FERC, 535 U.S. 1, 24 (2002), quoted by Glaser and McGuffey, p. 11.

[7] Section 111(d) has been used a total of five times to regulate three pollutants, and only once (in 1996) since the Clean Air Act Amendments of 1990. Glaser and McGuffey, p. 7, fn. 91.

To: colmanz@csmonitor.com[colmanz@csmonitor.com]
From: Schnare, David
Sent: Wed 2/22/2017 11:49:05 PM
Subject: RE: Endangerment finding

Not something I can do.

From: Zack Colman [mailto:colmanz@csmonitor.com]
Sent: Wednesday, February 22, 2017 5:19 PM
To: Schnare, David <schnare.david@epa.gov>
Subject: Endangerment finding

Hi David,

Zack Colman here, deputy energy & enviro editor with CSMonitor. Hope this email finds you well. Wanted to know if you had time to chat about the endangerment finding. Had a couple questions about procedure.

Spoke to Sen. Inhofe who mentioned the idea of opening up the science and including different findings. Not sure how that would impact the endangerment finding — whether that would mean a less aggressive GHG policy was needed, or whether it is just the beginning of an avenue to submit new literature that would then need to go through the regulatory process.

Anyway, that's not the only question I have with respect to the endangerment finding. Maybe it's not one that you can help on, but perhaps there's others. Can email me here, though a phone call might be most efficient — can get me at 248.563.9744.

Thanks,

-Zack

--

Zack Colman

Deputy Energy/Enviro Editor

Christian Science Monitor

Knight Science Journalism fellow at MIT, '15-16

248.563.9744

Twitter: @zcolman

To: Schnare, David[schnare.david@epa.gov]
From: Schnare, David
Sent: Wed 2/1/2017 11:54:31 AM
Subject: Fwd: Petition
1.20.17 HWM lt McCabe.pdf
ATT00001.htm
Petition for Reconsideration of Endangerment Finding FINAL.pdf
ATT00002.htm

Sent from my iPhone

Begin forwarded message:

From: "Schnare, David" <schnare.david@epa.gov>
Date: January 21, 2017 at 7:27:09 PM EST
To: "schnare@torcastlelaw.net" <schnare@torcastlelaw.net>
Subject: Fwd: Petition

Sent from my iPhone

Begin forwarded message:

From: "Harry MacDougald" <hmacdougald@cpdlawyers.com>
To: "Schnare, David" <schnare.david@epa.gov>
Cc: "Francis J. Menton Jr." <fmenton@manhattancontrarian.com>
Subject: Petition

Please see the attached.

Harry W. MacDougald
Caldwell Propst & DeLoach, LLP
Two Ravinia Drive
Suite 1600
Atlanta, Georgia 30346
404-843-1956

To: Minoli, Kevin[Minoli.Kevin@epa.gov]
From: Schnare, David
Sent: Mon 2/6/2017 6:18:19 PM
Subject: Endangerment

Kevin

Deliberative Process Privilege/Ex. 5

meeting with your staff to discuss this, or in the alternative, point me at written materials that constitute our standing policy on this.
dschnare

Sent from my iPhone

To: Ericksen, Doug[ericksen.doug@epa.gov]
From: Schnare, David
Sent: Fri 1/27/2017 8:46:48 PM
Subject: FW: Reporter Inquiry - Clean Power Plan Petition for Review Appeal
~WRD000.jpg

From: Ericksen, Doug
Sent: Friday, January 27, 2017 3:38 PM
To: Benton, Donald <benton.donald@epa.gov>; Munoz, Charles <munoz.charles@epa.gov>; Schnare, David <schnare.david@epa.gov>; Schwab, Justin <schwab.justin@epa.gov>
Subject: FW: Reporter Inquiry - Clean Power Plan Petition for Review Appeal

From: Michael Phillis [mailto:michael.phillis@law360.com]
Sent: Friday, January 27, 2017 3:35 PM
To: ericksen.doug@epamail.epa.gov
Subject: Reporter Inquiry - Clean Power Plan Petition for Review Appeal

Hello,

I'm a reporter with Law360. This week, a number of states asked the D.C. Circuit to consider overturning EPA's denials of their petition to review the Clean Power Plan.

I'm writing to ask for your thoughts on the actions the states are taking? Do you support it and will the EPA defend its rule before the D.C. Circuit?

Thank you in advance for your time.

Sincerely,

Michael Phillis

Reporter, Law360

michael.phillis@law360.com

646.350.1399

Legal News & Data

111 W. 19th Street, 5th Floor

New York, NY 10011

To: Minoli, Kevin[Minoli.Kevin@epa.gov]
From: Schnare, David
Sent: Thur 2/16/2017 11:39:35 PM
Subject: Endangerment

Can we find time tomorrow to have the discussion we had to put off?

Sent from my iPhone

To: David Schnare Personal Email/Ex. 6
From: Schnare, David
Sent: Sun 1/22/2017 12:27:09 AM
Subject: Fwd: Petition
1.20.17 HWM lt McCabe.pdf
ATT00001.htm
Petition for Reconsideration of Endangerment Finding FINAL.pdf
ATT00002.htm

Sent from my iPhone

Begin forwarded message:

From: "Harry MacDougald" <hmacdougald@cpdlawyers.com>
To: "Schnare, David" <schnare.david@epa.gov>
Cc: "Francis J. Menton Jr." <fmenton@manhattancontrarian.com>
Subject: Petition

Please see the attached.

Harry W. MacDougald
Caldwell Propst & DeLoach, LLP
Two Ravinia Drive
Suite 1600
Atlanta, Georgia 30346
404-843-1956

BEFORE THE UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

In re:	)	
	)	EPA Docket No.
Endangerment and Cause or Contribute	)	
Findings for Greenhouse Gases Under	)	EPA-HQ-OAR-2009-01
Section 202(a) of the Clean Air Act	)	
	)	

PETITION FOR RECONSIDERATION OF
"ENDANGERMENT AND CAUSE OR CONTRIBUTE FINDINGS FOR GREENHOUSE GASES UNDER SECTION 202(a) OF THE CLEAN AIR ACT"

Filed by

Concerned Household Electricity Consumers Council, consisting of Joseph D'Aleo, Clement Dwyer, Jr., Russell C. Slanover, Scott Univer, James P. Wallace III, Robin D. Weaver, and Douglas S. Springer

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Attorneys for Concerned Household Electricity Consumers Council and its members

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I. INTRODUCTION

Pursuant to Section 307(d) of the Clean Air Act, 42 U.S.C. § 7607(d), the Concerned Household Electricity Consumers Council ("CHECC"), consisting of Joseph D'Aleo, Clement Dwyer, Jr., Russell C. Slanover, Scott Univer, James P. Wallace III, Robin D. Weaver and Douglas S. Springer, hereby petition the U.S. Environmental Protection Agency ("EPA" or "the Agency") to convene a proceeding for reconsideration of the "Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act" published by the Agency on December 15, 2009 (74 F.R. 66496, Dec. 15, 2009) (original EPA Docket No. Docket EPA-HQ-OAR-2009-171) ("the Endangerment Finding").

As is more fully shown below, the Endangerment Finding was based on attribution of observed climate change to anthropogenic activities through what EPA termed its three "lines of evidence." 74 C.F.R. at 66518. Scientific research since the adoption of the Endangerment Finding has invalidated each of EPA's three lines of evidence. This Petition principally relies on the peer-reviewed Research Report of Wallace, *et al.*, that was first published on September 21, 2016. *See* https://thsresearch.files.wordpress.com/2016/09/ef-cpp-sc-2016-data-ths-paper-ex-sum-090516v2.pdf ("Research Report"). That Research Report is based on evidence that includes data as to atmospheric temperatures subsequent to the 2009 Endangerment Finding. The invalidation of the Endangerment Finding is conclusive, and thoroughly undermines all basis for any and all EPA regulation that is based on the Endangerment Finding, and the Social Cost of Carbon estimates that are based on this Finding.

The regulations that are based on the Endangerment Finding have resulted in much ongoing activity in the economy that looks to shut down existing sources of electricity and replace them with other much more expensive sources. Much of this activity is ongoing and, if not halted promptly, will impose massive new burdens on consumers of electricity. Therefore, Petitioners ask that EPA promptly convene hearings on this subject and issue a new "Non-Endangerment Finding" no later than June 20, 2017.

II. LEGAL STANDARD

Section 307(d)(7)(B) of the Clean Air Act, 42 U.S.C. § 7607(d)(7)(B), states in relevant part:

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> If the person raising an objection can demonstrate to the Administrator that it was impracticable to raise such an objection within such time or if the grounds for such objection arose after the period for public comment (but within the time specified for judicial review) and if such objection is of central relevance to the outcome of the rule, the Administrator shall convene a proceeding for reconsideration of the rule and provide the same procedural rights as would have been afforded had the information been available at the time the rule was proposed.

Thus, EPA is required to convene a proceeding for reconsideration upon a showing of two conditions precedent: (1) the information arose after the period for public comment on the Endangerment Finding and (2) the objection is of "central relevance to the outcome of the rule."

The procedural and substantive requirements for a petition for reconsideration are easily met here. The matters in this Petition could not have been raised during the comment period on the Endangerment Finding because the Research Report on which this Petition principally relies was first published on September 21, 2016, close to seven years *after* the Endangerment Finding. The Research Report in turn relies on substantial scientific evidence and data that did not exist at the time of the Endangerment Finding, namely data as to atmospheric temperatures that include extensive data for time periods subsequent to the Endangerment Finding. It was therefore not only impracticable but impossible to have raised these grounds within the original comment period or the period for judicial review of the Endangerment Finding.

The Petition is also timely under the rule of *Oljato Chapter of the Navajo Tribe v. Train*, 515 F.2d 654 (D.C. Cir. 1975).[1] *Oljato Tribe* sets forth a straightforward three-step process for EPA to follow in handling petitions for reconsideration under the Clean Air Act:

> (1) The person seeking revision of a standard of performance, or any other standard reviewable under Section 307, should petition EPA to revise the standard in question. The petition should be submitted together with supporting materials, or references to supporting materials. (2) EPA should respond to the petition and, if it denies the petition, set

[1] The Clean Air Act's legislative history makes clear that "the committee bill confirms the court's decision in *Oljato Chapter of the Navajo Tribe v. Train*, 515 F.2d 654 (D.C. Cir. 1975)." *See* H.R. Rep. 95-294, at 323 (May 12, 1977).

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> forth its reasons. (3) If the petition is denied, the petitioner may seek review of the denial in this court pursuant to Section 307.

Id. at 666.

This Petition satisfies the requirements enumerated in *Oljato Tribe*. It satisfies the first step because it seeks the withdrawal of the Endangerment Finding on specified legal grounds, namely that the attribution of warming to human emissions on which the Endangerment Finding is based has been conclusively invalidated. EPA thus has a duty to respond under the second step, with any denial of the Petition subject to review in the D.C. Circuit under the third step.

Oljato Tribe, in establishing the right to seek reconsideration, does no more than recognize the reality, first emphasized in the legislative history to the 1970 Clean Air Act Amendments, that regulations may need to be revised in light of new information:

> Section 307 originated in the Senate version of the Clean Air Act. The Senate committee described its purpose in allowing for subsequent review based on new information as follows:
>
> > The committee recognizes that it would not be in the public interest to measure for all time the adequacy of a promulgation of any standard or regulation by the information available at the time of such promulgation. In the area of protection of public health and environmental quality, it is clear that new information will be developed and that such information may dictate a revision or modification of any promulgated standard or regulation established under the act. The judicial review section, therefore, provides that any person may challenge any promulgated implementation plan after the date of promulgation whenever it is alleged that significant new information has become available.
>
> S.Rep.No.91-1196, 91st Cong., 2d Sess., 41-42 (1970.

Oljato Tribe, 515 F.2d at 660. Thus, when critical new information becomes available, as here, after a "regulation" has been "promulgated," argument should be directed to EPA in the first instance on reconsideration, to build an appropriate administrative record for later D.C. Circuit review. *See id.* 665-66.

In *Oljato Tribe*, the holding of which was expressly confirmed in the legislative history of the 1977 Clean Air Act amendments, the relevant

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reconsideration petition was remanded to EPA for consideration on its merits even though it was filed long outside the review period. Where, as here, the grounds for reconsideration arise after the close of the review period, the petition must still be considered.

The D.C. Circuit explained in *Oljato Tribe* that "the public's right to petition the Administrator for revision of a standard of performance and the Administrator's duty to respond substantively to such requests *exist completely independently of Section 307 and this court's appellate jurisdiction*." 515 F.2d at 667 (emphasis added). Thus, in *PPG Indus., Inc. v. Costle*, 659 F.2d 1239, 1250 (D.C. Cir. 1981), the D.C. Circuit held that amendment or repeal of a Clean Air Act regulation could be sought under APA Section 553(e) or Section 307(d)(7)(B), even well outside the 60-day review window:

> Alternatively, a petition may be filed directly with EPA to interpret or amend the standard, to withdraw the Guidelines, or to specify midnight to midnight reporting procedures. *See* 42 U.S.C. § 7607(d)(7)(B); 5 U.S.C. § 553(e). Either route would provide a reviewing court with a contemporaneous record of the agency's consideration of this issue, rather than with the "post hoc rationalizations of counsel." *See Oljato Chapter of the Navajo Tribe et al. v. Train*, 515 F.2d 654, 665-68 (D.C. Cir. 1975).

PPG Indus., Inc. v. Costle, 659 F.2d at 1250. This procedure has been repeatedly recognized and approved. "The court subsequently endorsed the same procedure [as in *Ojlato Tribe*], also under section 307, in *Group Against Smog & Pollution, Inc. v. EPA*, 665 F.2d 1284, 1290 (D.C. Cir. 1981); and *Natural Resources Defense Council, Inc. v. Thomas*, 845 F.2d 1088 (D.C.Cir.1988)." *Ciba-Geigy Corp. v. EPA*, 46 F.3d 1208, 1210 (D.C. Cir. 1995) (agreeing with the reasoning of those cases). The Agency itself granted a three-month stay of an emissions standard promulgated nearly four years earlier. S*ee* 63 Fed. Reg. 24,749 (May 5, 1998).

In sum, it is well-settled that EPA has a duty to consider and grant this Petition for Reconsideration, under both Section 307 and as a petition for rulemaking under 5 U.S.C. 553(e), because the grounds presented arose after the close of the period for public comment and judicial review.[2]

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[2] To be clear, this Petition seeks relief alternatively under Clean Air Act Section 307(d)(7)(B) and 5 U.S.C. § 553(e).

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Where, as here, the issues on reconsideration are substantial, a summary denial of the Petition would constitute an abuse of EPA's discretion. *Id.* at 666, n. 19. Likewise, a decision that EPA lacks authority to entertain the petition at all would misread the Agency's statutory mandate. *See Prill v. NLRB*, 755 F.2d 941, 947-48 (D.C. Cir. 1985), and its progeny. EPA may and must exercise the statutory discretion it has been delegated to consider this Petition on its merits.

The matters raised in this Petition are clearly of "central relevance" to the outcome of the Endangerment Finding. Indeed, the Research Report thoroughly and conclusively invalidates the entire basis for the Endangerment Finding, as that basis is stated and defined in the Endangerment Finding itself. *See Coalition for Responsible Regulation v. EPA*, 684 F. 3d 102, 125, 126 (D.C. Cir. 2012) (defining test of "central relevance"), *reversed on other grounds sub. nom. Utility Air Regulatory Group v. EPA*, 134 S.Ct. 2427 (2014).

III. STANDING OF THE PETITIONERS

The Petitioners herein are the Concerned Household Electricity Consumers Council ("CHECC"), and its members, namely Joseph D'Aleo, Clement Dwyer, Jr., Russell C. Slanover, Scott Univer, James P. Wallace III, Robin D. Weaver, and Douglas S. Springer.

Each of CHECC's members is a citizen of the United States and a member of a household that pays a monthly electricity bill to a utility that in turn is regulated by EPA. EPA's regulations based on the Endangerment Finding – notably but not exclusively including the so-called Clean Power Plan, 40 C.F.R. at 64662, *et seq.* – seek to replace current electricity generation sources primarily based on fossil fuels like coal and natural gas with so-called "renewables," principally wind turbines and solar panels. Replacement of fossil fuel sources with such renewables, that provide power only intermittently, threatens to increase the cost of electricity paid by the Petitioners (and by all Americans) by a factor of five or likely far more. Thus, should EPA's Endangerment Finding not be reconsidered and revoked, each of the Petitioners faces electricity bills that will inevitably increase over the coming years by many thousands of dollars per year. On a nationwide basis, the unnecessary incremental cost to consumers of replacing fossil fuel-based electricity generation with intermittent renewables is likely to be in the range of hundreds of billions of dollars per year, if not more.

A critical problem with intermittent renewables like wind and solar power lies in the excess costs that must be incurred to turn power from these sources into a fully-functioning electricity system that provides reliable power 24 hours a day, 7

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days a week, and 365 days a year. Unfortunately, the wind is often calm or blows lightly; and the sun goes completely dark fully half the time ("night"), and also shines at far less than full strength on winter days, cloudy days, cloudy winter days, and at dawn and dusk. At many of these times, consumer power demands are high.

When the intermittent sources provide less than 10% of the electricity in a system, the problems of intermittency typically make only a small cost difference. On a calm night, the lack of power from wind and solar sources can be covered over by a cushion of 10 – 15% or so of excess fossil fuel-based electric power generation capacity. But as the percent of electricity generation from intermittent renewables increases to 15% and beyond, the necessary additional costs multiply. That proposition is demonstrated by the experience of states and countries that have attempted to increase the percent of their electricity generated by intermittent renewables.

For example, California is a "leader" in the United States in generating power from wind and solar sources. According to the California Energy Commission, in 2015 California got 6% of its electricity supply from solar and 8.2% from wind, for a total of 14.2% from those two intermittent sources. *See* http://www.energy.ca.gov/almanac/electricity_data/total_system_power.html According to the U.S. Energy Information Agency, California's average electricity rate that year was 15.62 cents per kWh, versus a U.S. average of 10.31 cents per kWh. *See* https://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a In Europe, Germany began its so-called *Energiewende* ("energy transformation") in 2010, and by 2015 had gotten the portion of its electricity generated from wind and solar all the way up to just over 30%. *See* http://www.eia.gov/todayinenergy/detail.php?id=26372 The result: the average German household's electricity rate in 2015 had risen to 28.7 euro cents per kWh, about *triple* the average U.S. rate. *See* https://www.cleanenergywire.org/factsheets/what-german-households-pay-power

Analyses of the soaring price of electricity in Germany place the blame squarely on excess costs that have been necessarily incurred to try to get to a stable, functioning, 24/7/365 system with so much input from intermittent renewables. First, massive wind and solar capacity must be installed to try to deal with days of light wind and heavy clouds. And for calm nights when the wind and solar sources produce nothing, nearly the entire fleet of fossil fuel plants must be maintained and ready to go, even though those sources may be idle much of the time. And then, some means must be found to deal with the surges of available

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electricity when the wind and sun suddenly blow and shine together at full strength at the same time. As noted by Benny Peiser at the Global Warming Policy Foundation on April 4, 2015 (http://www.thegwpf.com/benny-peiser-eus-green-energy-debacle-shows-the-futility-of-unilateral-climate-policies/):

> Every 10 new units worth of wind power installation has to be backed up with some eight units worth of fossil fuel generation. This is because fossil fuel plants have to power up suddenly to meet the deficiencies of intermittent renewables. In short, renewables do not provide an escape route from fossil fuel use without which they are unsustainable. . . . To avoid blackouts, the government has to subsidize uneconomic gas and coal power plants. . . . Germany's renewable energy levy, which subsidizes green energy production, rose from 14 billion euros to 20 billion euros in just one year as a result of the fierce expansion of wind and solar power projects. Since the introduction of the levy in 2000, the electricity bill of the typical German consumer has doubled.

And those extra costs are just to get to a system that gets about 30% of power from the intermittent renewables. To get higher than that, some means must be found to store the power from the wind and sun for release at times of calm and dark. To make this work, major cities like New York would require the equivalent of tens of millions of Teslas' worth of batteries, at a cost of tens or hundreds of billions of dollars.

An idea of how much extra costs must be incurred to get to a system that approaches 50% or more of electricity generation from intermittent renewables, we can look to a demonstration project that was put together in South Korea for a small community of just 97 households and 178 people. A report on the Gapa Island Project appeared on the Hankyoreh news site in July 2016 at http://english.hani.co.kr/arti/english_edition/e_national/752623.html. With average electricity usage of 142 kw, and maximum usage of 230 kw, the islanders installed wind and solar capacity of 674 kw – about *three times* maximum usage, to deal with light wind and low sun. They also bought battery capacity for about eight hours of average usage. The cost of the wind and solar capacity plus batteries was approximately $12.5 million, or about $125,000 per household. And with all that investment the islanders were still only able to get about 42% of their electricity from the sun and wind when averaged over a full month. They still needed the full fossil fuel backup capacity.

By applying a reasonable cost of capital to a system like that of Gapa Island, and considering additional elements of a system, like additional storage, that would

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be necessary to push generation from renewables to higher levels, one can calculate that a system like the Gapa Island demonstration project for the full United States would lead to electricity costs of *at least five times* their current level, and more likely, far higher. Even then, the U.S. would be hard-pressed to achieve 50% of electricity from intermittent renewables. The Petitioners obviously have a strong personal interest in heading off such disastrous cost increases. Granting the relief sought by this Petition would prevent those cost increases from occurring.

IV. THE "LINES OF EVIDENCE" ON WHICH EPA BASED THE ENDANGERMENT FINDING HAVE ALL BEEN INVALIDATED.

EPA's Endangerment Finding appears at 74 C.F.R., page 66,495, *et seq*. At page 66,518 EPA sets forth the three "lines of evidence" upon which it says it has attributed "observed climate change" to "anthropogenic activities," thus providing the basis for the Finding that human GHG emissions endanger human health and welfare:

> The attribution of observed climate change to anthropogenic activities is based on multiple lines of evidence. The first line of evidence arises from our basic physical understanding of the effects of changing concentrations of greenhouse gases, natural factors, and other human impacts on the climate system. The second line of evidence arises from indirect, historical estimates of past climate changes that the changes in global surface temperature over the last several decades are unusual. The third line of evidence arises from the use of computer-based climate models to simulate the likely patterns of response of the climate system to different forcing mechanisms (both natural and anthropogenic).

More information about the nature of each of the three "lines of evidence" can be gleaned from EPA's further elaboration in the Endangerment Finding itself and the associated Technical Support Document.

By the first "line of evidence," ("our basic physical understanding of the effects of changing concentrations of greenhouse gases, natural factors, and other human impacts on the climate system"), EPA is referring to its "greenhouse gas fingerprint" or "tropical hot spot" ("Hot Spot") theory, which is that in the tropics, the upper troposphere is warming faster than the lower troposphere and the lower is warming faster than the surface, all due to rising atmospheric greenhouse gas concentrations blocking heat transfer into outer space. By this mechanism,

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increasing greenhouse gas concentration is assumed to increase surface temperatures.

The second "line of evidence" ("indirect, historical estimates of past climate changes that suggest that the changes in global surface temperature over the last several decades are unusual") refers to EPA's claim that global average surface temperatures have been rising in a dangerous fashion over the last fifty years.

The third "line of evidence" ("use of computer-based climate models to simulate the likely patterns of response of the climate system to different forcing mechanisms (both natural and anthropogenic)") consists of EPA's reliance on climate models (not actually "evidence") that assume that greenhouse gases are a key determinant of climate change. EPA uses climate models for two purposes: to "attribute" warming to human GHG emissions, and to set regulatory policy for such emissions based on their modeled impact on global temperatures.

The Research Report of Wallace, et al. (September 21, 2016) undertook to assess each of EPA's three "lines of evidence" and to either validate or invalidate each of them based on the best available historical temperature data. In accordance with the scientific method, the Research Report used the best available temperature data from multiple sources, all of them completely independent from each other, for the validation/invalidation exercise. The data used in the Research Report are available at the following url: https://thsresearch.files.wordpress.com/2017/01/ef-cpp-sc-2016-data-ths-data-master-original.xlsx. Equally available from the text of the Report itself are all the methods, equations and formulas that were used to produce its results. In other words, the Report is fully replicable by any scientist who wishes to check or question its methods or results.

The principal conclusions of the Research Report are as follows:

- "These analysis results would appear to leave very, very little doubt but that EPA's claim of a Tropical Hot Spot (THS), caused by rising atmospheric CO2 levels, simply does not exist in the real world."
- Once EPA's THS assumption is invalidated, it is obvious why the climate models they claim can be relied upon, are also invalid.
- "[T]his analysis failed to find that the steadily rising Atmospheric CO2 Concentrations have had a statistically significant impact on any of the 13 critically important temperature time series data analyzed."

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- "[T]hese results clearly demonstrate - 13 times in fact - that once just the ENSO [El Nino/La Nina] impacts on temperature data are accounted for, there is no "record setting" warming to be concerned about. In fact, there is no ENSO-Adjusted Warming at all."

Research Report, p. 4.

This means that the climate sensitivity parameter's estimate is not statistically significant. Therefore, the Social Cost of Carbon esimates now in widespread use to justify regulation of CO2 emissions are fundamentally flawed. The actual Social Cost of Carbon is negative rather than positive, meaning that CO2 is in fact a benefical gas.

Invalidation of the the Hot Spot requires reconsideration of the Endangerment Finding because the Hot Spot is a critical and necessary component of the "physical understanding" of climate that EPA claims as the foundational line of evidence supporting the Endangerment Finding. For example, the "physical understanding" of the atmospheric greenhouse mechanism set forth in U.S. Climate Change Science Program, Synthesis and Assessment Product 1.1, Temperature Trends in the Lower Atmosphere - Understanding and Reconciling Differences, ("SAP 1.1"), Chapter 1, § 1.1, The Thermal Structure of the Atmosphere, p. 17-19, https://www.gfdl.noaa.gov/bibliography/related_files/vr0603.pdf ; explicitly relies upon the Hot Spot:

> The presence of such greenhouse gases (e.g., carbon dioxide, methane, nitrous oxide, halocarbons) increases the radiative heating of the surface and troposphere. As specific humidity is strongly related to temperature, it is expected to rise with surface warming (IPCC, 1990), The increased moisture content of the atmosphere amplifies the initial radiative heating due to the greenhouse gas increases (Manabe and Wetherald, 1967; Ramanathan, 1981). The re-establishment of a new thermal equilibrium in the climate system involves the communication of the added heat input to the troposphere and surface, leading to surface warming (Goody and Yung, 1989; IPCC, 1990; Lindzen and Emanuel, 2002). From the preceding discussions, the lapse rate can be expected to decrease with the resultant increase in humidity, and also to depend on the resultant changes in atmospheric circulation. **In general, the lapse rate can be expected to decrease with warming such that temperature changes aloft exceed those at the surface.** As a consequence, the characteristic

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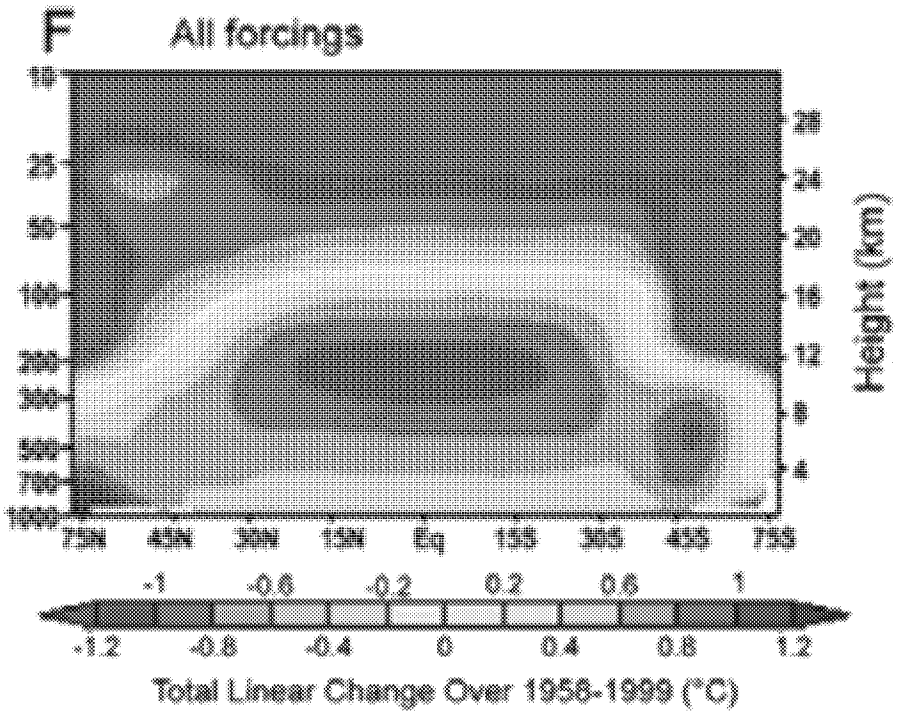
infrared emission level of the planet is shifted to a higher altitude in the atmosphere.

(Emphasis added). The CCSP SAP 1.1 report depicted the Hot Spot graphically in figure 1.3, p. 25, as follows:



Similarly, the IPCC's Fourth Assessment Report (AR4) also states unequivocally that the Hot Spot is an integral feature of the "physical understanding" of the climate's hypothesized greenhouse warming mechanism. This is demonstrated by AR4 WG1, The Physical Science Basis, Chapter 9, Figure 9.1. Panel (c) shows the modeled effect of GHGs, and clearly depicts the hot spot:

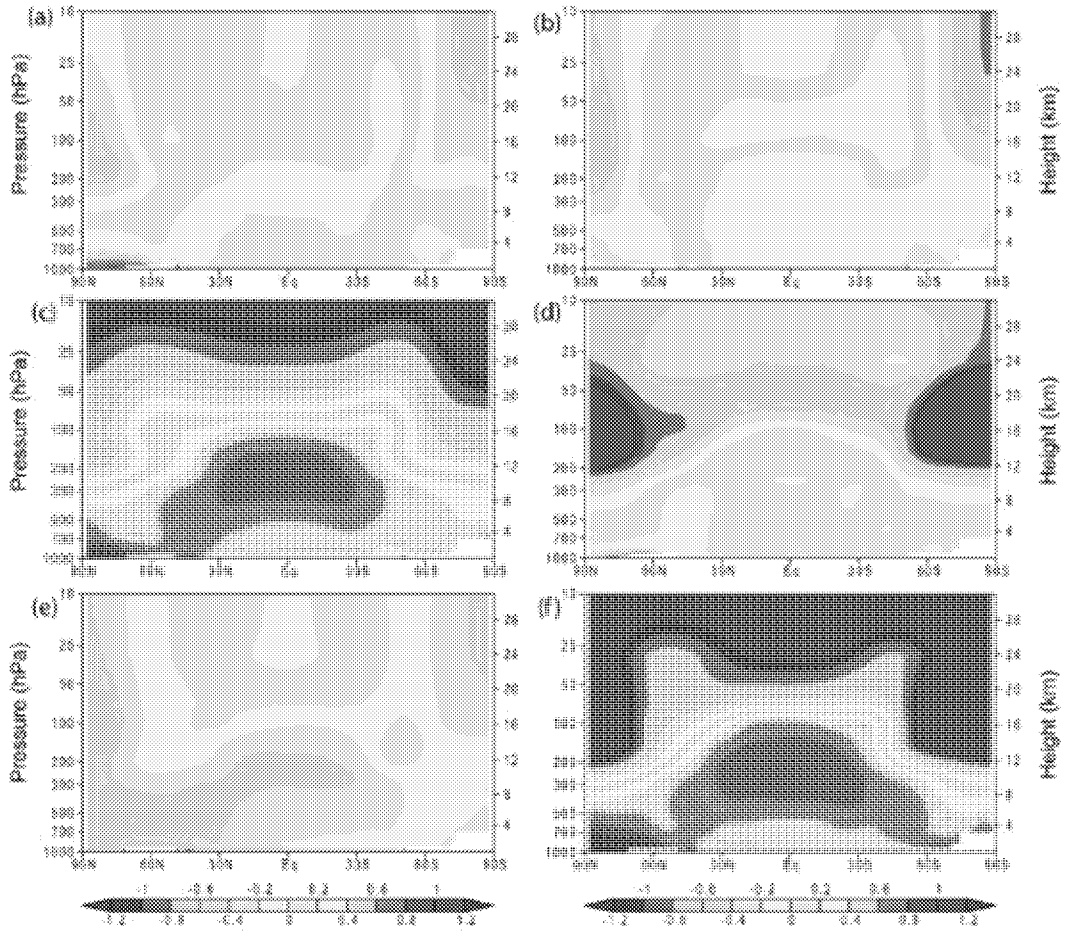


Figure 9.1. Zonal mean atmospheric temperature change from 1890 to 1999 (°C per century) as simulated by the PCM model from (a) solar forcing, (b) volcanoes, (c) well-mixed greenhouse gases, (d) tropospheric and stratospheric ozone changes, (e) direct sulphate aerosol forcing and (f) the sum of all forcings. Plot is from 1,000 hPa to 10 hPa (shown on left scale) and from 0 km to 30 km (shown on right). See Appendix 9.C for additional information. Based on Santer et al. (2003a).

The text accompanying this figure explains that "The major features shown in Figure 9.1 are robust to using different climate models." IPCC AR4 WG1 § 9.2.2. (http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch9s9-2-2.html). "Greenhouse gas forcing is expected to produce warming in the troposphere, … ." *Id.*

In adopting the Endangerment Finding, EPA explicitly, repeatedly and irrevocably placed primary reliance on the US CCSP reports and the IPCC AR4. *See* TSD Box 1.1, p 4. These assessments are cited thousands of times in the full set of documentation for the Endangerment Finding.

The CCSP report cited above said if the Hot Spot were missing it would be a "*potentially serious inconsistency*." SAP 1.1, p. 11. (Emphasis added). Yet the

CCSP ultimately sided with those claiming at the time that the mismatch between observations and prediction was not fatal. *Id.*

EPA also acknowledged in the Technical Support Document for the Endangerment Finding that if the Hot Spot were missing it would be "an important inconsistency." TSD p. 50. EPA's team, including Tom Karl, agreed with the CCSP (led by the same Tom Karl) and concluded there was no dispositive conflict between prediction and observation. *Id.*

The Research Report, using substantial scientific evidence and additional data available only after 2009, not only shows a "an important inconsistency," it invalidates the Hot Spot entirely. This is fatal to the EPA's claimed physical understanding of climate, and is likewise fatal to the climate models constituting EPA's third line of evidence. These models, relying on an invalidated physical theory, all predict the Hot Spot. Proper analysis of more than 50 years of balloon and 37 years of satellite temperature data generated by five independent entities conclusively shows that the Hot Spot does not exist. This demonstrates that the models are invalid and unreliable, and cannot properly be used for attribution analysis or forecasting warming due to anthropogenic CO2 emissions.

In sum, all three of the lines of evidence relied upon by EPA to attribute warming to human GHG emissions are invalid. The Endangerment Finding itself is therefore invalid and should be reconsidered. Moreover, this reconsideration is particulary urgent at this point in time in that the widely used Social Cost of Carbon has now been demonstrated to be fundamentally flawed. To put it mildly, the current Endangerment Finding and Social Cost of Carbon are leading the nation in the wrong direction from an energy polcy standpoint. Decarbonization makes absolutely no scientific or economic sense.

V. CONCLUSION

No scientists have yet devised an empirically validated theory proving that higher atmospheric CO2 levels will lead to higher global average surface temperatures. Moreover, if the causal link between higher atmospheric CO2 concentrations and higher temperatures is broken by invalidating each of EPA's three lines of evidence, then EPA's assertions that higher CO2 concentrations also cause sea-level increases and more frequent and severe storms, floods, and droughts and other deleterious effects on human health and welfare are also disproved. Such causality assertions require a validated theory that higher atmospheric CO2 concentrations cause increases in temperatures. Lacking such a validated theory, EPA's conclusions cannot stand. In science, credible empirical

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data always trump proposed theories, even if those theories are claimed to (or actually do) represent the current consensus, or, in this case, a finding made by EPA.

The invalidated Endangerment Finding, combined with a fundamentally flawed and dangerous Social Cost of Carbon estimate, are now driving numerous potentially crippling regulations, including the Clean Power Plan and the newly proposed automotive fuel economy standards. EPA should therefore promptly convene a proceeding to reconsider the Endangerment Finding.

Respectfully submitted this 20th day of January, 2017.

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ED_001612_00031960-00016

To: Sugiyama, George[sugiyama.george@epa.gov]
From: Rees, Sarah
Sent: Mon 4/3/2017 6:45:17 PM
Subject: RE: endangerment finding for aircraft emissions of lead

Nope – it was never finalized….somehow doesn't seem fair…..

From: Sugiyama, George
Sent: Monday, April 03, 2017 2:44 PM
To: Rees, Sarah <rees.sarah@epa.gov>
Subject: RE: endangerment finding for aircraft emissions of lead

Do we get credit for the withdrawal

From: Rees, Sarah
Sent: Monday, April 3, 2017 2:42 PM
To: Sugiyama, George <sugiyama.george@epa.gov>
Subject: RE: endangerment finding for aircraft emissions of lead

Yep – this is one that we flagged and Ryan/Samantha decided it should be withdrawn.

From: Sugiyama, George
Sent: Monday, April 03, 2017 2:08 PM
To: Rees, Sarah <rees.sarah@epa.gov>
Subject: endangerment finding for aircraft emissions of lead

Deliberative Process Privilege/Ex. 5

Deliberative Process Privilege/Ex. 5

George

Deliberative Process Privilege/Ex. 5

\

George

To: Sugiyama, George[sugiyama.george@epa.gov]
From: George Sugiyama
Sent: Tue 3/28/2017 3:57:55 PM
Subject: endangerment_tsd
endangerment_tsd.pdf
ATT00001.txt

Technical Support Document for

Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act

December 7, 2009

Climate Change Division, Office of Atmospheric Programs
U.S. Environmental Protection Agency
Washington, DC

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Executive Summary

This document provides technical support for the endangerment and cause or contribute analyses concerning greenhouse gas (GHG) emissions under section 202(a) of the Clean Air Act. This document itself does not convey any judgment or conclusion regarding the question of whether GHGs may be reasonably anticipated to endanger public health or welfare, as this decision is ultimately left to the judgment of the Administrator. The conclusions here and the information throughout this document are primarily drawn from the assessment reports of the Intergovernmental Panel on Climate Change (IPCC), the U.S. Climate Change Science Program (CCSP), the U.S. Global Change Research Program (USGCRP), and the National Research Council (NRC).

Observed Trends in Greenhouse Gas Emissions and Concentrations

Greenhouse gases, once emitted, can remain in the atmosphere for decades to centuries, meaning that 1) their concentrations become well-mixed throughout the global atmosphere regardless of emission origin, and 2) their effects on climate are long lasting. The primary long-lived GHGs directly emitted by human activities include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Greenhouse gases have a warming effect by trapping heat in the atmosphere that would otherwise escape to space.

In 2007, U.S. GHG emissions were 7,150 teragrams[1] of CO_2 equivalent[2] ($TgCO_2eq$). The dominant gas emitted is CO_2, mostly from fossil fuel combustion. Methane is the second largest component of U.S. emissions, followed by N_2O and the fluorinated gases (HFCs, PFCs, and SF_6). Electricity generation is the largest emitting sector (34% of total U.S. GHG emissions), followed by transportation (28%) and industry (19%).

Transportation sources under Section 202 of the Clean Air Act (passenger cars, light duty trucks, other trucks and buses, motorcycles, and cooling) emitted 1,649 $TgCO_2eq$ in 2007, representing 23% of total U.S. GHG emissions.

U.S. transportation sources under Section 202 made up 4.3% of total global GHG emissions in 2005, which, in addition to the United States as a whole, ranked only behind total GHG emissions from China, Russia, and India but ahead of Japan, Brazil, Germany, and the rest of the world's countries. In 2005, total U.S. GHG emissions were responsible for 18% of global emissions, ranking only behind China, which was responsible for 19% of global GHG emissions.

U.S. emissions of sulfur oxides (SOx), nitrogen oxides (NO_x), direct particulates, and ozone precursors have decreased in recent decades, due to regulatory actions and improvements in technology. Sulfur dioxide (SO_2) emissions in 2007 were 5.9 Tg of sulfur, primary fine particulate matter ($PM_{2.5}$) emissions in 2005 were 5.0 Tg, NO_x emissions in 2005 were 18.5 Tg, volatile organic compound (VOC) emissions in 2005 were 16.8 Tg, and ammonia emissions in 2005 were 3.7 Tg.

The global atmospheric CO_2 concentration has increased about 38% from pre-industrial levels to 2009, and almost all of the increase is due to anthropogenic emissions. The global atmospheric

[1] One teragram (Tg) = 1 million metric tons. 1 metric ton = 1,000 kilograms = 1.102 short tons = 2,205 pounds.
[2] Long-lived GHGs are compared and summed together on a CO_2-equivalent basis by multiplying each gas by its global warming potential (GWP), as estimated by IPCC. In accordance with United Nations Framework Convention on Climate Change (UNFCCC) reporting procedures, the U.S. quantifies GHG emissions using the 100-year timeframe values for GWPs established in the IPCC Second Assessment Report.

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concentration of CH_4 has increased by 149% since pre-industrial levels (through 2007); and the N_2O concentration has increased by 23% (through 2007). The observed concentration increase in these gases can also be attributed primarily to anthropogenic emissions. The industrial fluorinated gases, HFCs, PFCs, and SF_6, have relatively low atmospheric concentrations but the total radiative forcing due to these gases is increasing rapidly; these gases are almost entirely anthropogenic in origin.

Historic data show that current atmospheric concentrations of the two most important directly emitted, long-lived GHGs (CO_2 and CH_4) are well above the natural range of atmospheric concentrations compared to at least the last 650,000 years. Atmospheric GHG concentrations have been increasing because anthropogenic emissions have been outpacing the rate at which GHGs are removed from the atmosphere by natural processes over timescales of decades to centuries.

Observed Effects Associated With Global Elevated Concentrations of GHGs

Current ambient air concentrations of CO_2 and other GHGs remain well below published exposure thresholds for any direct adverse health effects, such as respiratory or toxic effects.

The global average net effect of the increase in atmospheric GHG concentrations, plus other human activities (e.g., land-use change and aerosol emissions), on the global energy balance since 1750 has been one of warming. This total net heating effect, referred to as forcing, is estimated to be +1.6 (+0.6 to +2.4) watts per square meter (W/m^2), with much of the range surrounding this estimate due to uncertainties about the cooling and warming effects of aerosols. However, as aerosol forcing has more regional variability than the well-mixed, long-lived GHGs, the global average might not capture some regional effects. The combined radiative forcing due to the cumulative (i.e., 1750 to 2005) increase in atmospheric concentrations of CO_2, CH_4, and N_2O is estimated to be +2.30 (+2.07 to +2.53) W/m^2. The rate of increase in positive radiative forcing due to these three GHGs during the industrial era is very likely to have been unprecedented in more than 10,000 years.

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. Global mean surface temperatures have risen by 1.3 ± 0.32°F (0.74°C ± 0.18°C) over the last 100 years. Eight of the 10 warmest years on record have occurred since 2001. Global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period during the preceding four centuries.

Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations. Climate model simulations suggest natural forcing alone (i.e., changes in solar irradiance) cannot explain the observed warming.

U.S. temperatures also warmed during the 20th and into the 21st century; temperatures are now approximately 1.3°F (0.7°C) warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years. Both the IPCC and the CCSP reports attributed recent North American warming to elevated GHG concentrations. In the CCSP (2008g) report, the authors find that for North America, "more than half of this warming [for the period 1951-2006] is likely the result of human-caused greenhouse gas forcing of climate change."

Observations show that changes are occurring in the amount, intensity, frequency and type of precipitation. Over the contiguous United States, total annual precipitation increased by 6.1% from 1901 to 2008. It is likely that there have been increases in the number of heavy precipitation events within

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many land regions, even in those where there has been a reduction in total precipitation amount, consistent with a warming climate.

There is strong evidence that global sea level gradually rose in the 20th century and is currently rising at an increased rate. It is not clear whether the increasing rate of sea level rise is a reflection of short-term variability or an increase in the longer-term trend. Nearly all of the Atlantic Ocean shows sea level rise during the last 50 years with the rate of rise reaching a maximum (over 2 millimeters [mm] per year) in a band along the U.S. east coast running east-northeast.

Satellite data since 1979 show that annual average Arctic sea ice extent has shrunk by 4.1% per decade. The size and speed of recent Arctic summer sea ice loss is highly anomalous relative to the previous few thousands of years.

Widespread changes in extreme temperatures have been observed in the last 50 years across all world regions, including the United States. Cold days, cold nights, and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent.

Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases. However, directly attributing specific regional changes in climate to emissions of GHGs from human activities is difficult, especially for precipitation.

Ocean CO_2 uptake has lowered the average ocean pH (increased acidity) level by approximately 0.1 since 1750. Consequences for marine ecosystems can include reduced calcification by shell-forming organisms, and in the longer term, the dissolution of carbonate sediments.

Observations show that climate change is currently affecting U.S. physical and biological systems in significant ways. The consistency of these observed changes in physical and biological systems and the observed significant warming likely cannot be explained entirely due to natural variability or other confounding non-climate factors.

Projections of Future Climate Change With Continued Increases in Elevated GHG Concentrations

Most future scenarios that assume no explicit GHG mitigation actions (beyond those already enacted) project increasing global GHG emissions over the century, with climbing GHG concentrations. Carbon dioxide is expected to remain the dominant anthropogenic GHG over the course of the 21st century. The radiative forcing associated with the non-CO_2 GHGs is still significant and increasing over time.

Future warming over the course of the 21st century, even under scenarios of low-emission growth, is very likely to be greater than observed warming over the past century. According to climate model simulations summarized by the IPCC, through about 2030, the global warming rate is affected little by the choice of different future emissions scenarios. By the end of the 21st century, projected average global warming (compared to average temperature around 1990) varies significantly depending on the emission scenario and climate sensitivity assumptions, ranging from 3.2 to 7.2□F (1.8 to 4.0□C), with an uncertainty range of 2.0 to 11.5□F (1.1 to 6.4□C).

All of the United States is very likely to warm during this century, and most areas of the United States are expected to warm by more than the global average. The largest warming is projected to occur in winter over northern parts of Alaska. In western, central and eastern regions of North America,

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the projected warming has less seasonal variation and is not as large, especially near the coast, consistent with less warming over the oceans.

It is very likely that heat waves will become more intense, more frequent, and longer lasting in a future warm climate, whereas cold episodes are projected to decrease significantly.

Increases in the amount of precipitation are very likely in higher latitudes, while decreases are likely in most subtropical latitudes and the southwestern United States, continuing observed patterns. The mid-continental area is expected to experience drying during summer, indicating a greater risk of drought.

Intensity of precipitation events is projected to increase in the United States and other regions of the world. More intense precipitation is expected to increase the risk of flooding and result in greater runoff and erosion that has the potential for adverse water quality effects.

It is likely that hurricanes will become more intense, with stronger peak winds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures. Frequency changes in hurricanes are currently too uncertain for confident projections.

By the end of the century, global average sea level is projected by IPCC to rise between 7.1 and 23 inches (18 and 59 centimeter [cm]), relative to around 1990, in the absence of increased dynamic ice sheet loss. Recent rapid changes at the edges of the Greenland and West Antarctic ice sheets show acceleration of flow and thinning. While an understanding of these ice sheet processes is incomplete, their inclusion in models would likely lead to increased sea level projections for the end of the 21st century.

Sea ice extent is projected to shrink in the Arctic under all IPCC emissions scenarios.

Projected Risks and Impacts Associated With Future Climate Change

Risk to society, ecosystems, and many natural Earth processes increase with increases in both the rate and magnitude of climate change. Climate warming may increase the possibility of large, abrupt regional or global climatic events (e.g., disintegration of the Greenland Ice Sheet or collapse of the West Antarctic Ice Sheet). The partial deglaciation of Greenland (and possibly West Antarctica) could be triggered by a sustained temperature increase of 2 to 7°F (1 to 4ºC) above 1990 levels. Such warming would cause a 13 to 20 feet (4 to 6 meter) rise in sea level, which would occur over a time period of centuries to millennia.

CCSP reports that climate change has the potential to accentuate the disparities already evident in the American health care system, as many of the expected health effects are likely to fall disproportionately on the poor, the elderly, the disabled, and the uninsured. IPCC states with very high confidence that climate change impacts on human health in U.S. cities will be compounded by population growth and an aging population.

Severe heat waves are projected to intensify in magnitude and duration over the portions of the United States where these events already occur, with potential increases in mortality and morbidity, especially among the elderly, young, and frail.

Some reduction in the risk of death related to extreme cold is expected. It is not clear whether reduced mortality from cold will be greater or less than increased heat-related mortality in the United States due to climate change.

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Increases in regional ozone pollution relative to ozone levels without climate change are expected due to higher temperatures and weaker circulation in the United States and other world cities relative to air quality levels without climate change. Climate change is expected to increase regional ozone pollution, with associated risks in respiratory illnesses and premature death. In addition to human health effects, tropospheric ozone has significant adverse effects on crop yields, pasture and forest growth, and species composition. The directional effect of climate change on ambient particulate matter levels remains uncertain.

Within settlements experiencing climate change, certain parts of the population may be especially vulnerable; these include the poor, the elderly, those already in poor health, the disabled, those living alone, and/or indigenous populations dependent on one or a few resources. Thus, the potential impacts of climate change raise environmental justice issues.

CCSP concludes that, with increased CO_2 and temperature, the life cycle of grain and oilseed crops will likely progress more rapidly. But, as temperature rises, these crops will increasingly begin to experience failure, especially if climate variability increases and precipitation lessens or becomes more variable. Furthermore, the marketable yield of many horticultural crops (e.g., tomatoes, onions, fruits) is very likely to be more sensitive to climate change than grain and oilseed crops.

Higher temperatures will very likely reduce livestock production during the summer season in some areas, but these losses will very likely be partially offset by warmer temperatures during the winter season.

Cold-water fisheries will likely be negatively affected; warm-water fisheries will generally benefit; and the results for cool-water fisheries will be mixed, with gains in the northern and losses in the southern portions of ranges.

Climate change has very likely increased the size and number of forest fires, insect outbreaks, and tree mortality in the interior West, the Southwest, and Alaska, and will continue to do so. Over North America, forest growth and productivity have been observed to increase since the middle of the 20th century, in part due to observed climate change. Rising CO_2 will very likely increase photosynthesis for forests, but the increased photosynthesis will likely only increase wood production in young forests on fertile soils. The combined effects of expected increased temperature, CO_2, nitrogen deposition, ozone, and forest disturbance on soil processes and soil carbon storage remain unclear.

Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution. Sea level is rising along much of the U.S. coast, and the rate of change will very likely increase in the future, exacerbating the impacts of progressive inundation, storm-surge flooding, and shoreline erosion. Storm impacts are likely to be more severe, especially along the Gulf and Atlantic coasts. Salt marshes, other coastal habitats, and dependent species are threatened by sea level rise, fixed structures blocking landward migration, and changes in vegetation. Population growth and rising value of infrastructure in coastal areas increases vulnerability to climate variability and future climate change.

Climate change will likely further constrain already overallocated water resources in some regions of the United States, increasing competition among agricultural, municipal, industrial, and ecological uses. Although water management practices in the United States are generally advanced, particularly in the West, the reliance on past conditions as the basis for current and future planning may no longer be appropriate, as climate change increasingly creates conditions well outside of historical observations. Rising temperatures will diminish snowpack and increase evaporation, affecting seasonal

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availability of water. In the Great Lakes and major river systems, lower water levels are likely to exacerbate challenges relating to water quality, navigation, recreation, hydropower generation, water transfers, and binational relationships. Decreased water supply and lower water levels are likely to exacerbate challenges relating to aquatic navigation in the United States.

Higher water temperatures, increased precipitation intensity, and longer periods of low flows will exacerbate many forms of water pollution, potentially making attainment of water quality goals more difficult. As waters become warmer, the aquatic life they now support will be replaced by other species better adapted to warmer water. In the long term, warmer water and changing flow may result in deterioration of aquatic ecosystems.

Ocean acidification is projected to continue, resulting in the reduced biological production of marine calcifiers, including corals.

Climate change is likely to affect U.S. energy use and energy production and physical and institutional infrastructures. It will also likely interact with and possibly exacerbate ongoing environmental change and environmental pressures in settlements, particularly in Alaska where indigenous communities are facing major environmental and cultural impacts. The U.S. energy sector, which relies heavily on water for hydropower and cooling capacity, may be adversely impacted by changes to water supply and quality in reservoirs and other water bodies. Water infrastructure, including drinking water and wastewater treatment plants, and sewer and stormwater management systems, will be at greater risk of flooding, sea level rise and storm surge, low flows, and other factors that could impair performance.

Disturbances such as wildfires and insect outbreaks are increasing in the United States and are likely to intensify in a warmer future with warmer winters, drier soils, and longer growing seasons. Although recent climate trends have increased vegetation growth, continuing increases in disturbances are likely to limit carbon storage, facilitate invasive species, and disrupt ecosystem services.

Over the 21st century, changes in climate will cause species to shift north and to higher elevations and fundamentally rearrange U.S. ecosystems. Differential capacities for range shifts and constraints from development, habitat fragmentation, invasive species, and broken ecological connections will alter ecosystem structure, function, and services.

Climate change impacts will vary in nature and magnitude across different regions of the United States.

- Sustained high summer temperatures, heat waves, and declining air quality are projected in the **Northeast**[3]**, Southeast**[4]**, Southwest**[5]**,** and **Midwest**[6]. Projected climate change would continue to cause loss of sea ice, glacier retreat, permafrost thawing, and coastal erosion in **Alaska**.
- Reduced snowpack, earlier spring snowmelt, and increased likelihood of seasonal summer droughts are projected in the **Northeast, Northwest**[7]**,** and **Alaska**. More severe, sustained droughts and water scarcity are projected in the **Southeast, Great Plains**[8]**,** and **Southwest**.

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[3] Northeast includes West Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine.
[4] Southeast includes Kentucky, Virginia, Arkansas, Tennessee, North Carolina, South Carolina, southeast Texas, Louisiana, Mississippi, Alabama, Georgia, and Florida.
[5] Southwest includes California, Nevada, Utah, western Colorado, Arizona, New Mexico (except the extreme eastern section), and southwest Texas.
[6] The Midwest includes Minnesota, Wisconsin, Michigan, Iowa, Illinois, Indiana, Ohio, and Missouri.
[7] The Northwest includes Washington, Idaho, western Montana, and Oregon.

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- The **Southeast, Midwest,** and **Northwest** in particular are expected to be impacted by an increased frequency of heavy downpours and greater flood risk.
- Ecosystems of the **Southeast, Midwest, Great Plains, Southwest, Northwest,** and **Alaska** are expected to experience altered distribution of native species (including local extinctions), more frequent and intense wildfires, and an increase in insect pest outbreaks and invasive species.
- Sea level rise is expected to increase storm surge height and strength, flooding, erosion, and wetland loss along the coasts, particularly in the **Northeast, Southeast,** and **islands**.
- Warmer water temperatures and ocean acidification are expected to degrade important aquatic resources of **islands** and coasts such as coral reefs and fisheries.
- A longer growing season, low levels of warming, and fertilization effects of carbon dioxide may benefit certain crop species and forests, particularly in the **Northeast and Alaska**. Projected summer rainfall increases in the Pacific **islands** may augment limited freshwater supplies. Cold-related mortality is projected to decrease, especially in the **Southeast**. In the **Midwest** in particular, heating oil demand and snow-related traffic accidents are expected to decrease.

Climate change impacts in certain regions of the world may exacerbate problems that raise humanitarian, trade, and national security issues for the United States. The IPCC identifies the most vulnerable world regions as the Arctic, because of the effects of high rates of projected warming on natural systems; Africa, especially the sub-Saharan region, because of current low adaptive capacity as well as climate change; small islands, due to high exposure of population and infrastructure to risk of sea level rise and increased storm surge; and Asian mega-deltas, such as the Ganges-Brahmaputra and the Zhujiang, due to large populations and high exposure to sea level rise, storm surge and river flooding. Climate change has been described as a potential threat multiplier with regard to national security issues.

[8] The Great Plains includes central and eastern Montana, North Dakota, South Dakota, Wyoming, Nebraska, eastern Colorado, Nebraska, Kansas, extreme eastern New Mexico, central Texas, and Oklahoma

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Part I

Introduction

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Section 1

Introduction and Background

The purpose of this Technical Support Document (TSD) is to provide scientific and technical information for an endangerment and cause or contribute analysis regarding greenhouse gas (GHG) emissions from new motor vehicles and engines under Section 202(a) of the Clean Air Act. Section 202 (a)(1) of the Clean Air Act states that:

> the Administrator shall by regulation prescribe (and from time to time revise)…standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles …, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.

Thus before EPA may issue standards addressing emissions of an air pollutant from new motor vehicles or new motor vehicle engines under Section 202(a), the Administrator must make a so-called "endangerment finding." That finding is a two-step test. First, the Administrator must decide if, in her judgment, air pollution may reasonably be anticipated to endanger public health or welfare. Second, the Administrator must decide whether, in her judgment, emissions of any air pollutant from new motor vehicles or engines cause or contribute to this air pollution. If the Administrator answers both questions in the affirmative, EPA shall issue standards under Section 202(a).

This document itself does not convey any judgment or conclusion regarding the two steps of the endangerment finding, as these decisions are ultimately left to the judgment of the Administrator. Readers should refer to the Final Endangerment and Cause or Contribute Findings for Greenhouse Gases (signed December 7, 2009) for a discussion of how the Administrator considered the information contained in this TSD in her determinations regarding the endangerment and cause or contribute findings.

This TSD has been revised and updated since the version of this document released April 17, 2009, to accompany the Administrator's proposed endangerment and cause or contribute findings (74 FR 18886, EPA-HQ-OAR-2009-0171). The proposed findings and TSD were subject to a 60-day public comment period as well as two public hearings. An earlier version of the TSD was released July 11, 2008, to accompany the Advance Notice of Proposed Rulemaking on the Regulation of Greenhouse Gases under the Clean Air Act (73 FR 44353, EPA-HQ-OAR-2008-0318), which was subject to a 120-day public comment period. The draft released in April 2009 has been revised to reflect the most up-to-date GHG emissions and climate data, a new major scientific assessment by the U.S. Global Change Research Program (USGCRP), and EPA's responses to significant public comments pertaining to the draft TSD.[9] The remainder of this introductory chapter explains the scope and approach of this document and the underlying references and data sources on which it relies.

1(a) Scope and Approach of This Document

The primary GHGs that are directly emitted by human activities in general are those reported in EPA's annual *Inventory of U.S. Greenhouse Gas Emissions and Sinks* and include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6). The primary effect of these gases is their influence on the climate system by trapping

[9] Detailed responses to all significant public comments received on the Administrator's Proposed Endangerment and Cause or Contribute Findings released on April 17, 2009, can be found in the separate Response to Comments document.

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heat in the atmosphere that would otherwise escape to space. This heating effect (referred to as radiative forcing) is very likely to be the cause of most of the observed global warming over the last 50 years. Global warming and climate change can, in turn, affect health, society, and the environment. There also are some cases where these gases have other non-climate effects. For example, elevated concentrations of CO_2 can lead to ocean acidification and stimulate terrestrial plant growth, and CH_4 emissions can contribute to background levels of tropospheric ozone, a criteria pollutant. These effects can in turn be influenced by climate change in certain cases. Carbon dioxide and other GHGs can also have direct health effects but at concentrations far in excess of current or projected future ambient concentrations. There are other known anthropogenic forcing agents that influence climate, such as changes in land use, which can in turn change surface reflectivity, as well as emissions of aerosols, which can have both heating and cooling influences on the climate. These other forcing agents are discussed as well to place the anthropogenic GHG influence in context.

This document reviews a wide range of observed and projected vulnerabilities, risks, and impacts due to the elevated levels of GHGs in the atmosphere and associated climate change. Any known or expected benefits of elevated atmospheric concentrations of GHGs or of climate change are documented as well (recognizing that climate impacts can have both positive and negative consequences). The extent to which observed climate change can be attributed to anthropogenic GHG emissions is assessed. The term "climate change" in this document generally refers to climate change induced by human activities, including activities that emit GHGs. Future projections of climate change, based primarily on future scenarios of anthropogenic GHG emissions, are shown for the global and national scale.

The vulnerability, risk, and impact assessment in this document primarily focuses on the United States. However, given the global nature of climate change, there is a brief review of potential impacts in other regions of the world. Greenhouse gases, once emitted, become well mixed in the atmosphere, meaning U.S. emissions can affect not only the U.S. population and environment but other regions of the world as well; likewise, emissions in other countries can affect the United States. Furthermore, impacts in other regions of the world may have consequences that in turn raise humanitarian, trade, and national security concerns for the United States.

The timeframe over which vulnerabilities, risks, and impacts are considered is consistent with the timeframe over which GHGs, once emitted, have an effect on climate, which is decades to centuries for the primary GHGs of concern. Therefore, in addition to reviewing recent observations, this document generally considers the next several decades, until approximately 2100, and for certain impacts, beyond 2100.

Adaptation to climate change is a key focus area of the climate change research community. This document, however, does not assess the climate change impacts in light of potential adaptation measures. This is because adaptation is essentially a response to any known and/or perceived risks due to climate change. Likewise, mitigation measures to reduce GHGs, which could also reduce long-term risks, are not explicitly addressed. The purpose of this document is to review the effects of climate change and not to assess any potential policy or societal response to climate change. There are cases in this document, however, where some degree of adaptation is accounted for; these cases occur where the literature on which this document relies already incorporates information about adaptation that has already occurred or uses assumptions about adaptation when projecting the future effects of climate change. Such cases are noted in the document.[10]

[10] A brief overview of adaptation is provided in Appendix A.

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1(b) Data and Scientific Findings Considered by EPA

This document relies most heavily on existing, and in most cases very recent, synthesis reports of climate change science and potential impacts, which have undergone their own peer-review processes, including review by the U.S. government. Box 1.1 describes this process[11]. The information in this document has been developed and prepared in a manner that is consistent with EPA's *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility and Integrity of Information Disseminated by the Environmental Protection Agency* (U.S. EPA 2002). In addition to its reliance on existing and recent synthesis reports, which have each gone through extensive peer-review procedures, this document also underwent a technical review by 12 federal climate change experts, internal EPA review, interagency review, and a public comment period.

Box 1.1: Peer Review, Publication, and Approval Processes for IPCC, CCSP/USGCRP, and NRC Reports

Intergovernmental Panel on Climate Change
The World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988. It bases its assessment mainly on peer reviewed and published scientific/technical literature. IPCC has established rules and procedures for producing its assessment reports. Report outlines are agreed to by government representatives in consultation with the IPCC bureau. Lead authors are nominated by governments and are selected by the respective IPCC Working Groups on the basis of their scientific credentials and with due consideration for broad geographic representation. For Working Group I (The Physical Science Basis) there were 152 coordinating lead authors, and for Working Group II (Impacts, Adaptation and Vulnerability) there were 48 coordinating lead authors. Drafts prepared by the authors are subject to two rounds of review; the first round is technical (or "expert" in the IPCC lexicon), and the second round includes government review. For the IPCC Working Group I report, more than 30,000 written comments were submitted by over 650 individual experts, governments, and international organizations. For Working Group II there were 910 expert reviewers. Under the IPCC procedures, review editors for each chapter are responsible for ensuring that all substantive government and expert review comments receive appropriate consideration. For transparency, IPCC documents how every comment is addressed. Each Summary for Policymakers is approved line-by-line, and the underlying chapters then accepted, by government delegations in formal plenary sessions. Further information about IPCC's (2009) principles and procedures can be found at: http://www.ipcc.ch/organization/organization_procedures.htm.

U.S. Climate Change Science Program and U.S. Global Change Research Program
Under the Bush Administration, the U.S. Climate Change Science Program (CCSP) integrated federal research on climate and global change, as sponsored by thirteen federal agencies and overseen by the Office of Science and Technology Policy, the Council on Environmental Quality, the National Economic Council and the Office of Management and Budget. As of January 16, 2009, the CCSP had completed 21 synthesis and assessment products (SAPs) that address the highest priorities for U.S. climate change research, observation, and decision support needs. Different agencies were designated the lead for different SAPs; EPA was the designated lead for three of the six SAPs addressing impacts and adaptation. For each SAP, there was first a prospectus that provided an outline, the proposed authors, and the process for completing the SAP; this went through two stages of expert, interagency, and public review. Authors produced a first draft that went through expert review; a second draft was posted for public review. The designated lead agency ensured that the third draft complied with the Information Quality Act. Finally, each SAP was submitted for approval by the National Science and Technology Council (NSTC), a cabinet-level council that coordinates science and technology research across the federal government. Further information about the clearance and review procedures for the CCSP SAPs can be found at: http://www.climatescience.gov/Library/sap/sap-guidelines-clarification-aug2007.htm.

In June 2009, the U.S. Global Change Research Program (which had been incorporated under the CCSP during the

[11] Volume 1 of EPA's Response to Comments document on the on the Administrator's Endangerment and Cause or Contribute Findings, provides more detailed information on these review processes.

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Bush Administration, but, as of January 2009, was re-established as the comprehensive and integrating body for global change research, subsuming CCSP and its products) completed an assessment, *Global Climate Change Impacts in the United States* that incorporated all 21 SAPs from the CCSP, as well as the IPCC Fourth Assessment Report. As stated in that report, "This report meets all Federal requirements associated with the Information Quality Act, including those pertaining to public comment and transparency."

National Research Council of the U.S. National Academy of Sciences
The National Research Council (NRC) is part of the National Academies, which also comprise the National Academy of Sciences, National Academy of Engineering and Institute of Medicine. They are private, nonprofit institutions that provide science, technology, and health policy advice under a congressional charter. The NRC has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. Federal agencies are the primary financial sponsors of the Academies' work. The Academies provide independent advice; the external sponsors have no control over the conduct of a study once the statement of task and budget are finalized. The NRC (2001a) study, *Climate Change Science: An Analysis of Some Key Questions*, originated from a White House request. The NRC (2001b) study, *Global Air Quality: An Imperative for Long-Term Observational Strategies*, was supported by EPA and NASA. The NRC 2004 study, *Air Quality Management in the United States*, was supported by EPA. The NRC 2005 study, *Radiative Forcing of Climate Change: Expanding the Concept and Addressing Uncertainties*, was in response to a CCSP request and was supported by NOAA. The NRC (2006b) study, *Surface Temperature Reconstructions for the Last 2,000 Years*, was requested by the Science Committee of the U.S. House of Representatives. Each NRC report is authored by its own committee of experts, reviewed by outside experts, and approved by the Governing Board of the NRC.

Table 1.1 lists the core reference documents for this TSD. These include the *2007 Fourth Assessment Report* of the Intergovernmental Panel on Climate Change (IPCC), the *Synthesis and Assessment Products of the U.S. Climate Change Science Program* (CCSP) published between 2006 and 2009, the 2009 USGCRP scientific assessment, National Research Council (NRC) reports under the U.S. National Academy of Sciences (NAS), the National Oceanic and Atmospheric Administration's (NOAA's) 2009 *State of the Climate in 2008* report, the 2009 EPA annual *U.S. Inventory of Greenhouse Gas Emissions and Sinks*, and the 2009 EPA assessment of the impacts of global change on regional U.S. air quality.

This version of the TSD, as well as previous versions of the TSD dating back to 2007, have taken the approach of relying primarily on these assessment reports because they 1) are very recent and represent the current state of knowledge on GHG emissions, climate change science, vulnerabilities, and potential impacts; 2) have assessed numerous individual, peer-reviewed studies in order to draw general conclusions about the state of science; 3) have been reviewed and formally accepted, commissioned, or in some cases authored by U.S. government agencies and individual government scientists; and 4) they reflect and convey the consensus conclusions of expert authors. Box 1.1 describes the peer review and publication approval processes of IPCC, CCSP/USGCRP and NRC reports. Peer review and transparency are central to each of these research organizations' report development process. Given the comprehensiveness of these assessments and their review processes, these assessment reports provide EPA with assurances that this material has been well vetted by both the climate change research community and by the U.S. government. Furthermore, use of these assessments complies with EPA's information quality guidelines, as this document relies on information that is objective, technically sound and vetted, and of high integrity.[12]

[12] The Response to Comments document, which also accompanies the Administrator's final Endangerment and Cause or Contribute Findings, contains additional information about EPA's responses to comments received about EPA's use of assessment reports such as those from IPCC and USGCRP, as well as issues concerning the Data Quality Act.

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Table 1.1 Core references relied upon most heavily in this document.	
Science Body/Author	**Short Title and Year of Publication**
NOAA	State of the Climate in 2008 (2009)
USGCRP	Global Climate Change Impacts in the United States (2009)
IPCC	Working Group I: The Physical Science Basis (2007)
IPCC	Working Group II: Impacts, Adaptation and Vulnerability (2007)
IPCC	Working Group III: Mitigation of Climate Change (2007)
CCSP	SAP 1.1: Temperature Trends in the Lower Atmosphere (2006)
CCSP	SAP 1.2: Past Climate Variability and Change in the Arctic and at High Latitudes (2009)
CCSP	SAP 1.3: Re-analyses of Historical Climate Data (2008)
CCSP	SAP 2.1: Scenarios of GHG Emissions and Atmospheric Concentrations (2007)
CCSP	SAP 2.3: Aerosol Properties and their Impacts on Climate
CCSP	SAP 2.4: Trends in Ozone-Depleting Substances (2008)
CCSP	SAP 3.1: Climate Change Models (2008)
CCSP	SAP 3.2: Climate Projections (2008)
CCSP	SAP 3.3: Weather and Climate Extremes in a Changing Climate (2008)
CCSP	SAP 3.4: Abrupt Climate Change (2008)
CCSP	SAP 4.1: Coastal Sensitivity to Sea Level Rise (2009)
CCSP	SAP 4.2: Thresholds of Change in Ecosystems (2009)
CCSP	SAP 4.3: Agriculture, Land Resources, Water Resources, and Biodiversity (2008)
CCSP	SAP 4.5: Effects on Energy Production and Use (2007)
CCSP	SAP 4.6: Analyses of the Effects of Global Change on Human Health (2008)
CCSP	SAP 4.7: Impacts of Climate Change and Variability on Transportation Systems (2008)
NRC	Climate Change Science: Analysis of Some Key Questions (2001)
NRC	Radiative Forcing of Climate Change (2005)
NRC	Surface Temperature Reconstructions for the Last 2,000 Years (2006)
NRC	Potential Impacts of Climate Change on U.S. Transportation (2008)
EPA	Impacts of Global Change on Regional U.S. Air Quality (2009)
EPA	Inventory of U.S. Greenhouse Gas Emissions and Sinks (2009)
ACIA	Arctic Climate Impact Assessment (2004)

Uncertainties and confidence levels associated with the scientific conclusions and findings in this document are reported, to the extent that such information was provided in the original scientific reports upon which this document is based. Box 1.2 describes the lexicon used by IPCC to communicate uncertainty and confidence levels associated with the most important IPCC findings. The CCSP and USGCRP generally adopted the same lexicon with their respective definitions. Therefore, this document employs the same lexicon when referencing IPCC, CCSP and USGCRP statements.

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Box 1.2: Communication of Uncertainty in the IPCC *Fourth Assessment Report* and CCSP/USGCRP

Because some aspects of climate change are better understood, established, and/or resolved than others and involve projections, it is helpful to precisely convey the degree of certainty of statements and findings. Uncertainty can arise from a variety of sources: (1) a misspecification of the cause(s), such as the omissions of a causal factor resulting in spurious correlations; (2) mischaracterization of effect(s), such as a model that predicts cooling rather than warming; (3) absence of or imprecise measurement or calibration; (4) fundamental stochastic (chance) processes; (5) ambiguity over the temporal ordering of cause and effect; (6) time delays in cause and effect; and (7) complexity where cause and effect between certain factors are camouflaged by a context with multiple causes and effects, feedback loops, and considerable noise (CCSP, 2008b). For this reason, climate change assessments have developed procedures and terminology for communicating uncertainty. Consistent and transparent treatment of uncertainty helps minimize ambiguity and opportunities for misinterpretation of language.

IPCC *Fourth Assessment Report* Uncertainty Treatment

A set of terms to describe uncertainties in current knowledge is common to all parts of the IPCC *Fourth Assessment Report* based on the *Guidance Notes for Lead Authors of the IPCC Fourth Assessment Report on Addressing Uncertainties(*http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-uncertaintyguidancenote.pdf), produced by the IPCC in July 2005 (IPCC, 2005). Any use of these terms in association with IPCC statements in this Technical Support Document carries the same meaning as originally intended in the IPCC *Fourth Assessment Report*.

Description of confidence

Based on a comprehensive reading of the literature and their expert judgment, authors have assigned a confidence level as to the correctness of a model, an analysis, or a statement as follows:

Very high confidence	At least 9 out of 10 chance of being correct
High confidence	About 8 out of 10 chance
Medium confidence	About 5 out of 10 chance
Low confidence	About 2 out of 10 chance
Very low confidence	Less than a 1 out of 10 chance

Description of likelihood

Likelihood refers to a probabilistic assessment of some well defined outcome having occurred or occurring in the future, and may be based on quantitative analysis or an elicitation of expert views. When authors evaluate the likelihood of certain outcomes, the associated meanings are:

Virtually certain	>99% probability of occurrence
Very likely	90 to 99% probability
Likely	66 to 90% probability
About as likely as not	33 to 66% probability
Unlikely	10 to 33% probability
Very unlikely	1 to 10% probability
Exceptionally unlikely	<1% probability

CCSP/USGCRP Uncertainty Treatment

In many of its SAPs and its report "Global Climate Change Impacts in the United States" (Karl et al., 2009), the CCSP/USGCRP uses the same or similar terminology to the IPCC to describe confidence and likelihood. However, there is some variability from report to report, so readers should refer to the individual SAPs for a full accounting of the respective uncertainty language. In this document, when referencing CCSP/USGCRP reports, EPA attempted to reflect the underlying CCSP/USGCRP reports' terminology for communicating uncertainty.

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Throughout this document, when these various assessments are referred to in general or as a whole, the full reports are cited. For example, a general reference to the CCSP report *Weather and Climate Extremes in a Changing Climate* is cited as "CCSP, 2008i" (the "i" differentiates the report from other CCSP reports published that same year). When specific findings or conclusions from these larger assessment reports are referenced, citations are given for the relevant individual chapter or section. For example, a finding from CCSP, 2008i, Chapter 5 "Observed Changes in Weather and Climate" by Kunkel et al., is cited as "Kunkel et al., 2008." In some cases, this document references other reports and studies in addition to the core references of IPCC, CCSP/USGCRP, NRC, and, for GHG emissions, EPA. These references are primarily for major reports and studies produced by U.S. federal and state government agencies. This document also references data made available by other government agencies, such as NOAA and National Aeronautics and Space Administration (NASA).

EPA recently completed and published an assessment of the literature on the effect of climate change on air quality (U.S. EPA, 2009a). Therefore, because EPA evaluated the literature in the preparation of that assessment, EPA does cite some individual studies it reviewed in its summary of this topic in Section 8. Also, for Section 16a on the national security implications of climate change, this document cites a number of analyses and publications, from inside and outside the government, because IPCC and CCSP/USGCRP assessments have not traditionally addressed these issues.

EPA recognizes that scientific research is very active and constantly evolving in many areas addressed in this document (e.g., aerosol effects on climate, climate feedbacks such as water vapor, and internal and external climate forcing mechanisms) as well as for some emerging issues (e.g., ocean acidification, and climate change effects on water quality). For this very reason, major assessments are conducted periodically by the scientific community to update the general understanding of the effects of GHG emissions on the climate and on the numerous impact sectors; such a process places individual, less-comprehensive studies in the context of the broader body of peer-reviewed literature.

EPA reviewed new literature in preparation of this TSD to evaluate its consistency with recent scientific assessments. We also considered public comments received and studies incorporated by reference. In a number of cases, the TSD was updated based on such information to add context for assessment literature findings which includes supporting information and/or qualifying statements. In other cases, material that was not incorporated into the TSD is discussed within the Response to Comments document[13] as part of EPA's responses to key scientific and technical comments received by the public.

1(c) Roadmap for This Document

The remainder of this document is structured as follows:

- **Part II, Section 2** describes sources of U.S. and global GHG emissions. How anthropogenic GHG emissions have contributed to changes in global atmospheric concentrations of GHGs is described, along with other anthropogenic drivers of climate change.

[13] The Response to Comments document addresses many individual studies that were either included or referenced as part of the public comments. These individual studies may not be reflected in this TSD if the studies were not or have not yet been incorporated into the major and more comprehensive assessments on which this TSD relies. EPA considered all studies submitted to the Agency through the public comment process. Refer to sections I.C.3 and III.A in Final Endangerment and Cause or Contribute Findings for Greenhouse Gases for further discussion on the scientific information from which the findings are based.

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- **Part III, Sections 3 – 6** describe the effects of elevated GHG concentrations including any direct health and environmental effects (3); the heating or radiative forcing effects on the climate system (4); observed climate change (e.g., changes in temperature, precipitation and sea level rise) for the United States and for the globe (5); and recent conclusions about the extent to which observed climate change can be attributed to the elevated levels of GHG concentrations; these sections also summarize future projections of climate change—driven primarily by scenarios of anthropogenic GHG emissions—for the remainder of this century (6).
- **Part IV, Sections 7 – 15** review recent findings for the broad range of observed and projected vulnerabilities, risks, and impacts for human health, society, and the environment within the United States due to climate change. The specific sectors, systems and regions include:
    - Human health (7)
    - Air Quality (8)
    - Food Production and Agriculture (9)
    - Forestry (10)
    - Water Resources (11)
    - Coastal Areas (12)
    - Energy, Infrastructure and Settlements (13)
    - Ecosystems and Wildlife (14)
    - Regional Risks and Impacts for the United States (15)
- **Part V, Section 16** briefly addresses some key impacts in other world regions that may occur due to climate change, with a view towards how some of these impacts may in turn affect the United States.
    - **Impacts in Other World Regions** (16)

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Part II

Greenhouse Gas Emissions and Concentrations

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Section 2

Greenhouse Gas Emissions and Concentrations

This section first describes current U.S. and global anthropogenic GHG emissions, as well as historic and current global GHG atmospheric concentrations. Future GHG emissions scenarios are described in Part III, Section 6; however, these scenarios primarily focus on global emissions, rather than detailing individual U.S. sources.

2(a) U.S. and Global Greenhouse Gas and Selected Aerosol Emissions

To track the national trend in GHG emissions and carbon removals since 1990, EPA develops the official U.S. GHG inventory each year. In accordance with Article 4.1 of the United Nations Framework Convention on Climate Change (UNFCCC), the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* includes emissions and removals of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) resulting from anthropogenic activities in the United States.

Total emissions are presented in teragrams[14] (Tg) of CO_2 equivalent ($TgCO_2eq$), consistent with IPCC inventory guidelines. To determine the CO_2 equivalency of different GHGs, in order to sum and compare different GHGs, emissions of each gas are multiplied by its global warming potential (GWP), a factor that relates it to CO_2 in its ability to trap heat in the atmosphere over a certain timeframe. Box 2.1 provides more information about GWPs and the GWP values used throughout this report.

Box 2.1: Global Warming Potentials Used in This Document

In accordance with UNFCCC reporting procedures, the United States quantifies GHG emissions using the 100-year timeframe values for GWPs established in the IPCC Second Assessment Report (SAR) (IPCC, 1996). The GWP index is defined as the cumulative radiative forcing between the present and some chosen later time horizon (100 years) caused by a unit mass of gas emitted now. All GWPs are expressed relative to a reference gas, CO_2, which is assigned a GWP = 1. Estimation of the GWPs requires knowledge of the fate of the emitted gas and the radiative forcing due to the amount remaining in the atmosphere. To estimate the CO_2 equivalency of a non-CO_2 GHG, the appropriate GWP of that gas is multiplied by the amount of the gas emitted.

100-year GWPs	
CO_2	1
CH_4	21
N_2O	310
HFCs	140 to 6,300 (depending on type of HFC)
PFCs	6,500 to 9,200 (depending on type of PFC)
SF_6	23,900

The GWP for CH_4 includes the direct effects and those indirect effects due to the production of tropospheric ozone and stratospheric water vapor. These GWP values have been updated twice in the IPCC Third (IPCC, 2001c) and Fourth Assessment Reports (IPCC, 2007a).

The national inventory totals used in this report for the United States (and other countries) are gross emissions, which include GHG emissions from the electricity, industrial, commercial, residential, and agriculture sectors. Emissions and sequestration occurring in the land use, land-use change, and forestry

[14] 1 teragram (Tg) = 1 million metric tons. 1 metric ton = 1,000 kilograms = 1.102 short tons = 2,205 pounds.

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sector (e.g., forests, soil carbon) are not included in gross national totals but are reported under net emission totals (sources and sinks), according to international practice. In the United States, this sector is a significant net sink, while in some developing countries it is a significant net source of emissions.

Also excluded from emission totals in this report are bunker fuels (fuels used for international transport). According to UNFCCC reporting guidelines, emissions from the consumption of these fuels should be reported separately and not included in national emission totals, because there exists no agreed upon international formula for allocation between countries.

The most recent inventory was published in 2009 and includes U.S. annual data for the years 1990 to 2007.

U.S. Greenhouse Gas Emissions

In 2007, U.S. GHG emissions were 7,150.1 $TgCO_2eq$ (see Figure 2.1).[15] The dominant gas emitted is CO_2, mostly from fossil fuel combustion (85.4%) (U.S. EPA, 2009b). Weighted by GWP, CH_4 is the second largest component of emissions, followed by N_2O, and the high-GWP fluorinated gases (HFCs, PFCs, and SF_6). Electricity generation (2445.1 $TgCO_2eq$) is the largest emitting sector, followed by transportation (1995.2 $TgCO_2eq$) and industry (1386.3 $TgCO_2eq$) (U.S. EPA, 2009b) (Figure 2.2). Agriculture and the commercial and residential sectors emit 502.8 $TgCO_2eq$, 407.6 $TgCO_2eq$, and 355.3 $TgCO_2eq$, respectively (U.S. EPA, 2009b). Removals of carbon through land use, land-use change and forestry activities are not included in Figure 2.2 but are significant; net sequestration is estimated to be 1062.6 $TgCO_2eq$ in 2007, offsetting 14.9% of total emissions (U.S. EPA, 2009b).

[15] Per UNFCCC reporting requirements, the United States reports its annual emissions in gigagrams (Gg) with two significant digits (http://unfccc.int/national_reports/annex_i_ghg_inventories/reporting_requirements/items/2759.php). For ease of communicating the findings, the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* report presents total emissions in Tg with one significant digit.

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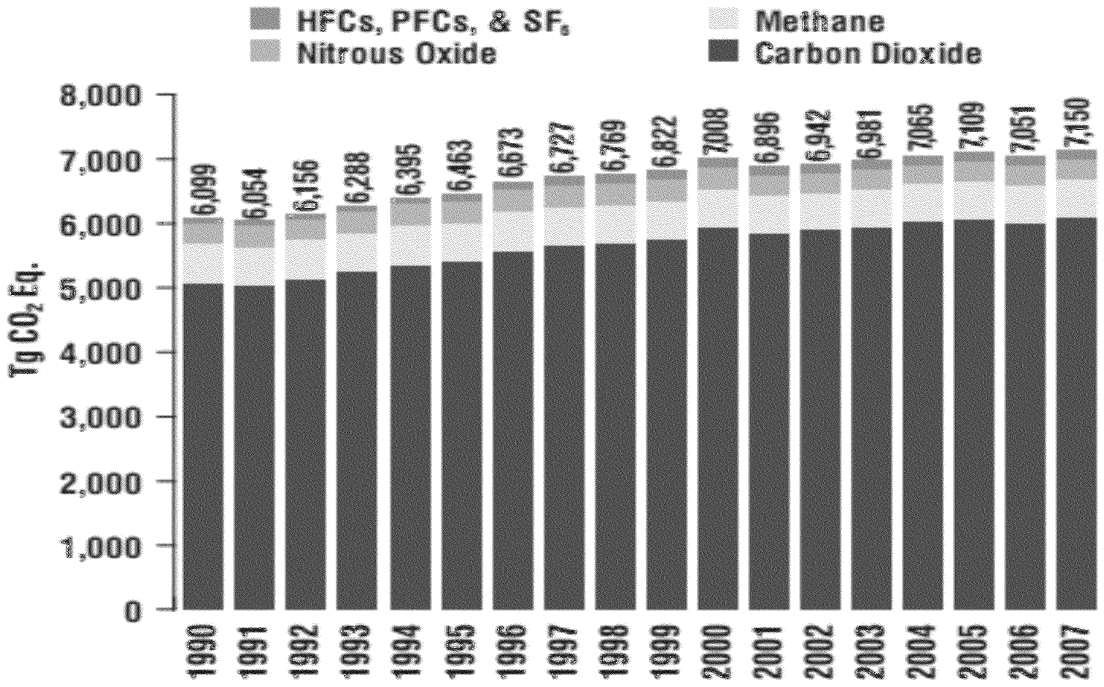
Figure 2.1: Total U.S. Greenhouse Gas Emissions: 1990-2007



Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007 (U.S. EPA, 2009b). Excludes land-use change and forestry and international bunker fuels.

U.S. emissions increased by 1051.4 $TgCO_2eq$, or 17.2.% between 1990 and 2007 (see Figure 2.1) (U.S. EPA, 2009b). Historically, changes in fossil fuel consumption have been the dominant factor affecting U.S. emission trends. The fundamental factors driving this trend include a generally growing domestic economy over the last 17 years, leading to overall growth in emissions from electricity generation (increase of 31.5%) and transportation activities (increase of 29.3%) (U.S. EPA, 2009b). Over the same time period, industrial sector emissions decreased by 7.3%, while residential, commercial, and agricultural sector emissions increased by 3.1%, 3.7%, and 17.3%, respectively (Figure 2.2) (U.S. EPA, 2009b).

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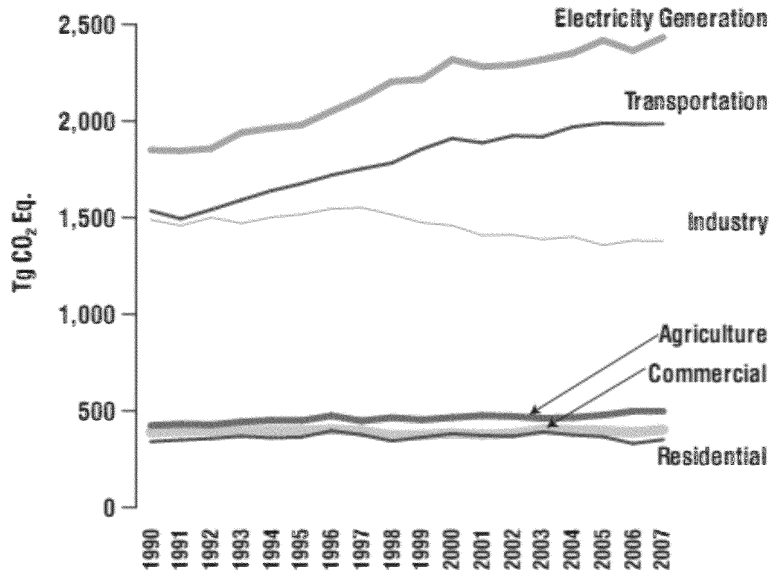
U.S. Emissions of Selected Aerosols and Ozone Precursors

Aerosols are not GHGs but rather small, short-lived particles present in the atmosphere with widely varying size, concentration, and chemical composition. They can be directly emitted or formed in secondary reactions from emitted compounds. Aerosols are removed from the atmosphere primarily through cloud processing and wet deposition in precipitation, a mechanism that establishes average tropospheric aerosol atmospheric lifetimes at a week or less (CCSP, 2009a). Tropospheric ozone is a short-lived GHG produced largely by chemical reactions of precursor species in the atmosphere.

Figure 2.2: U.S. GHG Emissions Allocated to Economic Sector



Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007 (U.S. EPA, 2009b). All GHGs. Excludes land use, land-use change and forestry, emissions from U.S. territories and international bunker fuels.

Aerosols and tropospheric ozone precursors do not have widely accepted GWP or CO_2 equivalent values but can still have significant impacts on regional and global climate. Four of the more important aerosols are sulfates, nitrates, organic carbon, and black carbon. Tropospheric ozone is not directly emitted but is a secondary product formed by atmospheric reactions from ozone precursors such as volatile organic compounds (VOCs) and nitrogen oxides (NO_x). While some aerosols are directly emitted, others are formed through secondary reactions (for example, sulfates and nitrates can be formed by oxidation of sulfur dioxide [SO_2] and NO_x respectively), and their properties can change as they mix and react in the atmosphere. In the United States, these substances have been controlled under a number of local, state, and federal regulations over the last several decades, either directly, for SO_2 by the Clean Air Act Amendments of 1990, among other legislation; or indirectly, for black and organic carbon as components of particulate matter (a criteria pollutant); for example through the 2007 Highway Diesel Rule or the National Ambient Air Quality (NAAQS) standards. The U.S. inventory does include SO_2 emissions, which were 5.9 Tg of sulfur (TgS) in 2007, a reduction from 10.5 TgS in 1990 (U.S. EPA, 2009b) and 12 TgS in 1980 (CCSP 2009a). EPA estimates that 0.44 TgS per year (yr^{-1}) of those emissions come from the transportation sector (U.S. EPA, 2009b). National inventories do not yet explicitly include black carbon or organic carbon: however, black carbon and organic carbon emissions can be derived from total fine particulate matter ($PM_{2.5}$) emissions, which were estimated to be 5.0 Tg in 2005. In that year, ammonia emissions were 3.7 Tg, and of the ozone precursors, NO_x emissions were estimated to be 18.5 Tg and VOC emissions were 16.8 Tg (U.S. EPA, 2009c). According to the EPA, U.S. emissions of SO_x, NO_x, direct particulates, and ozone precursors have decreased from 1990 to 2007 (U.S. EPA, 2008), and average concentrations of sulfates, nitrates, particulate matter, and ozone as measured at U.S. monitoring sites have all decreased between 1990 and 2007 (U.S. EPA, 2008).

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U.S. Greenhouse Gas Emissions From Source Categories Under Section 202(a) of the Clean Air Act

Source categories under Section 202(a) of the Clean Air Act include passenger vehicles, light- and heavy-duty trucks, buses, motorcycles, and the cooling systems designed for passenger comfort, as well as auxiliary systems for refrigeration.

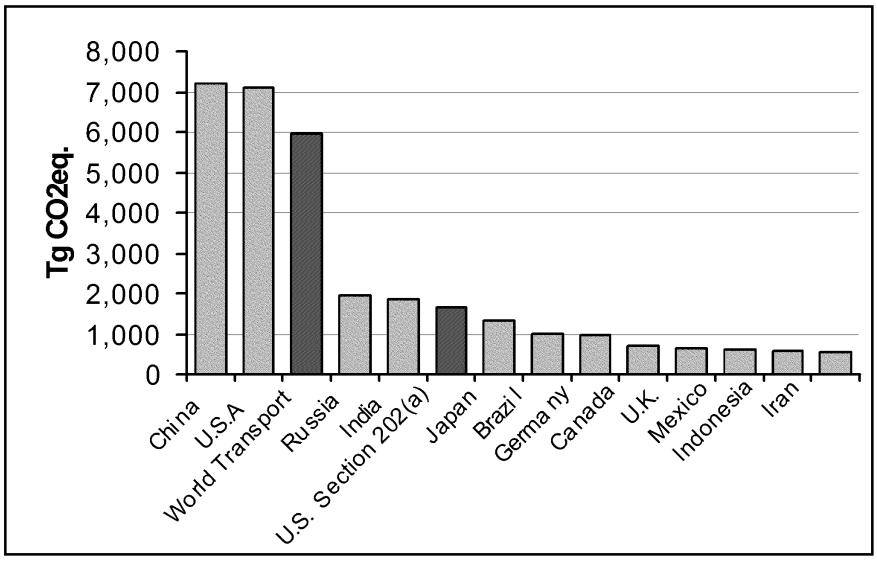
In 2007, Section 202(a) source categories collectively were the second largest GHG-emitting sector within the United States (behind the electricity generating sector), emitting 1,649 $TgCO_2eq$ and representing 23% of total U.S. GHG emissions. Between 1990 and 2007, total GHG emissions from passenger cars decreased 2.6%, while emissions from light-duty trucks increased 59 percent, largely due to the increased use of sport-utility vehicles and other light-duty trucks.

Total global emissions are estimated by summing emissions of the six GHGs, by country. The World Resources Institute compiles data from recognized national and international data sources in its Climate Analysis Indicators Tool (CAIT).[16] Globally, total GHG emissions were 38,725.9 $TgCO_2eq$ in 2005, the most recent year for which data are available for *all* countries and *all* GHGs (WRI, 2009).[17] This global total for the year 2005 represents an increase of about 26% from the 1990 global GHG emission total of 30,704.9 $TgCO_2eq$ (WRI, 2009). Excluding land use, land-use change, and forestry, U.S. emissions were 18% of the total year 2005 global emissions (see Figure 2.3) (WRI, 2009).

Global Greenhouse Gas Emissions

Globally in 2005, Section 202(a) source category GHG emissions represented 28% of global transport GHG emissions and 4.3% of total global GHG emissions (Figure 2.3). The global transport sector was 15% of all global GHG emissions in 2005. If U.S. Section 202(a) source category GHG emissions were ranked against total GHG emissions for entire countries, U.S. Section 202(a) emissions would rank behind only China, the United States as a whole, Russia, and India, and would rank ahead of Japan, Brazil, Germany, and every other country in the world (Figure 2.3).

Figure 2.3: Total GHG Emissions for 2005 by Country and for U.S. Section 202a Source Categories



Source: WRI (2009). Available at http://cait.wri.org/. Excludes land use, land-use change and forestry, and international bunker fuels. More recent emission data are available for the United States and other individual countries, but 2005 is the most recent year for which data for all countries and all gases are available. Data accessed August 5, 2009. Refer to Appendix B for U.S. section 202a data and reference.

[16] Primary data sources referenced in CAIT include the U.S. Department of Energy's Carbon Dioxide Information Analysis Center, EPA, the International Energy Agency, and the National Institute for Public Health and the Environment, an internationally recognized source of non-CO_2 data.
[17] Source: WRI Climate Analysis and Indicators Tool. Available at http://cait.wri.org/.

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Further detail on these emissions can be found in Appendix B of this document.

Global Emissions of Aerosols

Inventories of anthropogenic aerosol emissions are not regularly reported in most national climate inventories, and the uncertainties in inventory estimates tend to be larger than for GHGs, ranging from 15% for sulfur emissions to a factor of two for black carbon (Forster et al., 2007). CCSP (2009a) provided estimates for global emissions of black carbon, organic matter, and sulfur in the year 2000: 7.7 Tg yr^{-1} of black carbon, 47 Tg yr^{-1} of particulate organic matter, and 112.6 Tg yr^{-1} of sulfur emissions (including SO_2 and particulate sulfate). Historically, particle emissions were high due to lack of particulate controls and use of biofuels, but more recently technological controls have led to reductions in particulate emissions from coal burning. Therefore, over the past century, emissions of particulates did not grow as fast as CO_2 emissions, as the latter are roughly proportional to total fuel use (CCSP, 2009a).

2(b) Lifetime of Greenhouse Gases in the Atmosphere

Greenhouse gas concentrations in the atmosphere are a function of both the emissions of the GHGs and the effective lifetime of these gases. Each gas has a characteristic lifetime that is a function of the total atmospheric burden and the removal mechanism (i.e., sinks) for that gas. Each GHG has different interactions of each gas with the various available sinks, which include chemical reaction with the hydroxyl (OH) free radical or other highly reactive species, photolysis by sunlight, dissolution into the oceans, reactions on the surface, biological processes, or other mechanisms. According to the IPCC, the lifetime of the HFCs of industrial importance range from 1.4 to 270 years, the lifetime of N_2O is 114 years, and the lifetime of the PFCs and SF_6 range from 1,000 to 50,000 years (Forster et al., 2007). The lifetime of CH_4 is more complicated: the atmospheric lifetime or residence time (the burden over the sink) is 8.7 years; however, emissions of CH_4 lead to consumption of the available OH sink, thereby increasing the lifetime for the remaining CH_4 in the atmosphere. Therefore, a "perturbation lifetime" of CH_4 that accounts for this effect is used for most purposes, and the IPCC reports the perturbation lifetime to be 12 years (Denman et al., 2007).

Carbon dioxide has a very different life cycle compared to the other GHGs, which have well-defined lifetimes. Instead, unlike the other gases, CO_2 is not destroyed by chemical, photolytic, or other reaction mechanisms, but rather the carbon in CO_2 cycles between different reservoirs in the atmosphere, ocean, land vegetation, soils, and sediments. There are large exchanges between these reservoirs, which are approximately balanced such that the net source or sink is near zero. Anthropogenic CO_2 emissions released through the use of fossil fuel combustion and cement production from geologically stored carbon (e.g., coal, oil, and natural gas) that is hundreds of millions of years old, as well as anthropogenic CO_2 emissions from land-use changes such as deforestation, perturb the atmospheric concentration of CO_2 and the distribution of carbon within different reservoirs readjusts. Carbon cycle models indicate that for a pulse of CO_2 emissions, given an equilibrium background, 50% of the atmospheric increase will disappear within 30 years, 30% within a few centuries, and the last 20% may remain in the atmosphere for thousands of years (Denman et al., 2007).

Because it takes one to two years to mix the emissions of a species throughout the troposphere, gases that are chemically stable and persist in the atmosphere over time scales of decades to centuries or longer are referred to in the IPCC as "long-lived" or "well-mixed" gases.

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2(c) Historic and Current Global Greenhouse Gas Concentrations

Greenhouse gas concentrations in the atmosphere vary over very long time scales in response to natural influences such as geologic activity and temperature change associated with ice age cycles, but ice core data show nearly constant concentrations of CO_2, CH_4 and N_2O over more than 10,000 years prior to the Industrial Revolution. However, since the Industrial Revolution, anthropogenic GHG emissions have resulted in substantial increases in the concentrations of GHGs in the atmosphere (IPCC, 2007d; NRC, 2001a).

Carbon Dioxide (CO_2)

Carbon dioxide concentrations have increased substantially from pre-industrial levels (Figure 2.4). The long-term trends in the CO_2 concentrations are as follows (NOAA, 2009c; Forster et al., 2007; Karl et al., 2009):

- The CO_2 concentration has increased about 38% from a pre-industrial value of about 280 parts per million (ppm) to 385 ppm (which is about 0.039% of the atmosphere by volume) in 2008[18].
- The present atmospheric concentration of CO_2 exceeds by far the natural range over the last 800,000 years (172 to 300 ppm) as determined from ice cores (Karl et al., 2009).
- The annual CO_2 concentration growth rate[19] has been larger since 2000 (2000-2008 average: 1.9 ppm per year), than it was over the previous 20 years (1980-1999 average: 1.5 ppm per year) or since the beginning of continuous direct atmospheric measurements at Mauna Loa (1959–1999 average: 1.3 ppm per year) although there is year-to-year variability.

Almost all of the increase in the CO_2 concentration during the Industrial Era is due to anthropogenic emissions (Forster et al., 2007). Since the 1980s, about half of the anthropogenic emissions have been taken up by the terrestrial biosphere and the oceans, but observations demonstrate that these processes cannot remove all of the extra flux due to human activities. Historically, about half of the anthropogenic emissions have remained in the atmosphere. There is year-to-year variability in the fraction of fossil fuel emissions remaining in the atmosphere due to changes in land-atmosphere fluxes associated with El Niño Southern Oscillation (ENSO[20]) and events such as the eruption of Pinatubo (Forster et al., 2007). The rate of emission of CO_2 currently exceeds its rate of removal, and the slow and incomplete removal implies that small to moderate reductions in its emissions would not result in stabilization of CO_2 concentrations but rather would only reduce the rate of its growth in coming decades (Meehl et al., 2007).

[18] The 2008 value is preliminary.

[19] The estimated uncertainty in the global annual mean growth rate at marine surface sites is 0.1010 ppm/yr, in the Mauna Loa growth rate it is 0.11 ppm/yr. The 2000-2008 average rate of change at Mauna Loa is 2.0 ppm/yr.

[20] ENSO describes the full range of the Southern Oscillation (a see-saw of atmospheric mass or pressure between the Pacific and Indo-Australian areas) that includes both sea surface temperature (SST) increases as well as SST decreases when compared to a long-term average. It has sometimes been used by scientists to relate only to the broader view of El Niño or the warm events, the warming of SSTs in the central and eastern equatorial Pacific. The acronym, ENSO, is composed of El Niño-Southern Oscillation, where El Niño is the oceanic component of the phenomenon, and the Southern Oscillation is the atmospheric component.

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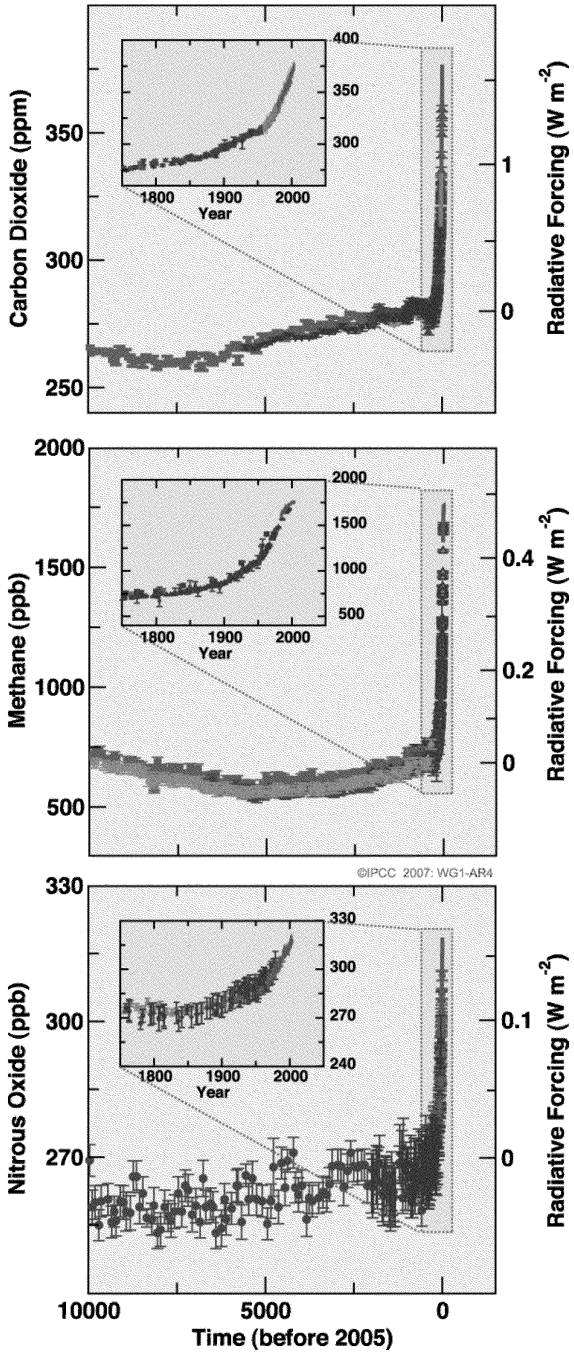
Methane (CH_4)

Methane concentrations have also risen substantially (Figure 2.4). The following trends in atmospheric methane have been observed according to the NOAA *State of the Climate* reports for 2007 and 2008 and IPCC (Horvitz, 2008; Peterson and Baringer, 2009; Forster et al., 2007):

- The global atmospheric concentration of methane has increased from a pre-industrial value of about 715 parts per billion (ppb) to 1732 ppb in the early 1990s, and was 1782 ppb in 2007—a 149% increase from pre-industrial levels.
- The atmospheric concentration of methane in 2007 exceeds by far the natural range of the last 650,000 years (320 to 790 ppb) as determined from ice cores (Jansen et al., 2007).
- Growth rates declined between the early 1990s and mid-2000s. The reasons for the decrease in the atmospheric CH_4 growth rate and the implications for future changes in its atmospheric burden are not well understood but are clearly related to the imbalances between CH_4 sources and sinks.

The methane concentration grew 7.5 ppb between 2006 and 2007, driven by increased emissions in both the Arctic and tropical regions likely caused by high temperatures and precipitation in wetland regions, particularly in the Arctic. Analysis of carbon monoxide measurements suggests little contribution from enhanced biomass burning. Methane concentrations grew again in 2008, with most of the increase driven by the tropics, the first consecutive year-to-year increases since 1998.
The observed increase in methane concentration is very likely due to anthropogenic activities, predominantly agriculture and fossil fuel use, but relative contributions from different source types are not well determined (Forster et al., 2007).

Figure 2.4: Atmospheric Concentrations of Carbon Dioxide, Methane and Nitrous Oxide over the Last 10,000 Years



Source: IPCC (2007d). Atmospheric concentrations of carbon dioxide, methane and nitrous oxide over the last 10,000 years (large panels) and since 1750 (inset panels). Measurements are shown from ice cores (symbols with different colors for different studies) and atmospheric samples (red lines). The corresponding radiative forcings (discussed in Section 2(e)) are shown on the right-hand axes of the large panels.

Nitrous Oxide (N_2O)

The N_2O concentration has increased 23% from its pre-industrial value of 262 ppb (Figure 2.4) to 322 ppb in 2007 (Peterson and Baringer, 2009). The concentration has increased linearly by about 0.8 ppb yr^{-1} over the past few decades and is due primarily to human activities, particularly agriculture and associated land-use change (Forster et al., 2007). Ice core data show that the present atmospheric concentration of N_2O exceeds levels measured in the ice core record of the past 650,000 years, with sufficient resolution to exclude a peak similar to the present for at least the past 16,000 years with very high confidence (Jansen et al., 2007).

Fluorinated Gases

The industrial fluorinated gases that serve as substitutes for chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), such as HFCs, PFCs, and SF_6, have relatively low atmospheric concentrations. Concentrations of many of these gases increased by large factors (between 1.3 and 4.3) between 1998 and 2005. These gases are almost entirely anthropogenic in origin, although CF_4, which contributes 20% of the total forcing due to anthropogenic increases in these gases, has a natural source that accounts for about one-half of its current atmospheric content (Forster et al., 2007).

Ozone-depleting substances covered by the Montreal Protocol

Chlorofluorocarbons and HCFCs are GHGs that are entirely anthropogenic in origin. Emissions of these gases have decreased due to their phase-out under the Montreal Protocol, and the atmospheric concentrations of CFC-11 and CFC-113 are now decreasing due to natural removal processes (Forster et al., 2007). Ice core and in situ data confirm that industrial sources are the cause of observed atmospheric increases in CFCs and HCFCs (Forster et al., 2007).

Ozone (O_3)

Due to its short atmospheric life time, tropospheric ozone concentrations exhibit large spatial and temporal variability. Changes in tropospheric ozone also occur due to changes in transport of ozone across the tropopause (Forster et al., 2007). Relative to the other GHGs, there is less confidence in reproducing the changes in ozone associated with large changes in emissions or climate, and in the simulation of observed long-term trends in ozone concentrations over the 20th century (Forster et al., 2007).

Aerosols (Sulfates, Nitrates, Black Carbon, and Organic Carbon Aerosols)

On a global basis, aerosol mass derives predominantly from natural sources, mainly sea salt and dust. However, anthropogenic (manmade) aerosols, arising primarily from a variety of combustion sources, can dominate concentrations in and downwind of highly populated and industrialized regions and in areas of intense agricultural burning (CCSP, 2009a). Aerosol optical density trends observed in the satellite and surface-based data records suggest that since the mid-1990s, the amount of anthropogenic aerosol has decreased over North America and Europe, but has increased over parts of east and south Asia; on average, the atmospheric concentration of low-latitude smoke particles has increased, consistent with changes in emissions (CCSP, 2009a). Ice core data from Greenland and Northern Hemisphere mid-latitudes show a *very likely* rapid post-industrial era increase in sulfate concentrations above the preindustrial background, though in recent years, SO_2 emissions have decreased globally and in many regions of the Northern Hemisphere. In general, the concentration, composition, and distribution of aerosols in the paleoclimate record are not as well known as the long-lived GHGs (Jansen et al., 2007).

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Part III

Global and U.S. Observed and Projected Effects From Elevated Greenhouse Gas Concentrations

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Section 3

Direct Effects of Elevated Greenhouse Gas Concentrations

Carbon dioxide and other GHGs can have direct effects that are independent of their radiative forcing on climate (the primary effect discussed throughout this document). Such effects are described in the following sections.

Effects on Human Health

Current and projected ambient GHG concentrations remain well below published thresholds for any direct adverse health effects, such as respiratory or toxic effects. The literature supporting this conclusion is described in Appendix C.

Effects on Plants and Carbon Dioxide Fertilization

Carbon dioxide can have a stimulatory or fertilization effect on plant growth. There is debate and uncertainty about the sensitivity of crop yields to the direct effects of elevated CO_2 levels. However, the IPCC (Easterling et al., 2007) confirmed the general conclusions from its previous *Third Assessment Report* in 2001 and concluded that elevated CO_2 levels are expected to result in small beneficial effects on crop yields. Experimental research on crop responses to elevated CO_2 through the FACE (Free Air CO_2 Enrichment)[21] experiments indicate that, at ambient CO_2 concentrations of 550 ppm (approximately double the concentration from pre-industrial times) crop yields increase under unstressed conditions by 10 to 25% for C3 crops, and by 0 to 10% for C4 crops[22] (medium confidence). Crop model simulations under elevated CO_2 are consistent with these ranges (high confidence) (Easterling et al., 2007). High temperatures and ozone exposure, however, could significantly limit the direct stimulatory CO_2 response (see also Section 8 on Air Quality and Section 9 on Food Production and Agriculture).

Studies have demonstrated increases in CO_2 effects water use and water use efficiency of plants. For example, elevated CO_2 causes partial stomatal closure, which decreases conductance, and reduces loss of water vapor from leaves to the atmosphere (Hatfield et al., 2008). Interpolating the results from several studies indicates that it is very likely that an increase in CO_2 concentration from 380 to 440 ppm will cause reductions in stomatal conductance on the order of 10% compared to today's values (Hatfield et al., 2008). Elevated CO_2 may affect forage quality for livestock, because it can increase the carbon-to-nitrogen ratio in forages, thus reducing the nutritional value of those grasses. This, in turn, can affect animal weight and performance. The decline under elevated CO_2 of C4 grasses, however, which are less nutritious than C3 grasses, may compensate for the reduced protein (Hatfield et al., 2008).

At much higher ambient CO_2 concentrations, such as those areas exposed to natural CO_2 outgassing due to volcanic activity, the main characteristic of long-term elevated CO_2 zones at the surface is the lack of vegetation (IPCC, 2005). New CO_2 releases into vegetated areas cause noticeable die-off. In those areas where significant impacts to vegetation have occurred, CO_2 makes up about 20 to 95% of the soil gas, whereas normal soil gas usually contains about 0.2 to 4% CO_2. Carbon dioxide concentrations above 5% may be dangerous for vegetation and as concentrations approach 20%, CO_2 becomes phytotoxic. Carbon

[21] http://www.bnl.gov/face/

[22] C3 and C4 refer to different carbon fixation pathways in plants during photosynthesis. C3 is the most common pathway, and C3 crops (e.g., wheat, soybeans, and rice) are more responsive to CO_2 enrichment than C4 crops such as maize.

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dioxide can cause death of plants through "root anoxia," together with low oxygen concentration (IPCC, 2005). No projections show CO_2 concentrations approaching these phytotoxic levels.

As concentrations of atmospheric CO_2 increase, more CO_2 is absorbed at the surface of oceans, estuaries, streams, and lakes. Increases in the amount of dissolved CO_2 and, for some species, bicarbonate ions (HCO_3^-) present in aquatic environments will lead to higher rates of photosynthesis in submerged aquatic vegetation, similar to the fertilization effects of CO_2 enrichment on most terrestrial plants, if other limiting factors do not offset the potential for enhanced productivity. A study cited in Nicholls et al., (2007) indicates algal growth may also respond positively to elevated dissolved inorganic carbon (DIC), though marine macroalgae do not appear to be limited by DIC levels. An increase in epiphytic or suspended algae would decrease light available to submerged aquatic vegetation and also increase the incidence of algal blooms that lower dissolved oxygen available to fish and shellfish (Nicholls et al., 2007).

Ocean Acidification

According to the IPCC (Fischlin et al., 2007) elevated CO_2 concentrations are resulting in ocean acidification, which may affect marine ecosystems (medium confidence). This issue is discussed further in Sections 4h, 6b, and 14a.

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Section 4

Radiative Forcing and Observed Climate Change

This section focuses primarily on the more significant effects associated with GHGs, which is their heat-trapping ability (referred to as radiative forcing) that results in climate change. Observed climate change is reviewed, including changes in temperature, precipitation, and sea level rise, for the globe and the United States. Observed changes in climate-sensitive physical and biological systems are also addressed, as well as observed trends in extreme events. Sections 7 to 16 provide more specific information on the sectoral implications of both the observed changes described here and the projected changes described in Section 6.

4(a) Radiative Forcing Due to Greenhouse Gases and Other Factors

This section describes radiative forcing and the factors that contribute to it. Radiative forcing is a measure of the change that a factor causes in altering the balance of incoming (solar) and outgoing (infrared and reflected shortwave) energy in the Earth-atmosphere system, and thus shows the relative importance of different factors in terms of their contribution to climate change. Positive forcing means the factor causes a warming effect, and negative forcing means the factor causes a cooling effect.

Radiative forcing values presented here for GHGs and other factors come from the IPCC *Fourth Assessment Report* of Working Group I (IPCC, 2007a). These radiative forcing values are the result of *global* changes in atmospheric concentrations of GHGs (see Section 2(c) above) and other factors, and are therefore not the result of U.S. transportation emissions in isolation. All values are for the year 2005 relative to pre-industrial times in 1750; represent global averages; and are expressed in watts per square meter[23] (W/m^2).

IPCC (2007d) concluded that the understanding of anthropogenic warming and cooling influences on climate has improved since the IPCC *Third Assessment Report*, leading to *very high confidence*[24] that the global average net effect of human activities since 1750 has been one of warming, with a radiative forcing of +1.6 (+0.6 to +2.4) W/m^2.

Greenhouse gases have a positive forcing because they absorb and reradiate in all directions outgoing, infrared radiation that would otherwise directly escape into space. The combined radiative forcing due to the cumulative (i.e., 1750 to 2005) increase in atmospheric concentrations of CO_2, CH_4, and N_2O is +2.30 W/m^2 (with an uncertainty range of +2.07 to +2.53 W/m^2) (see Figure 4.1). This positive radiative forcing, like the observed accumulation of these gases in the atmosphere, is primarily anthropogenic in origin. Furthermore, the IPCC (2007d) stated that the rate of increase in positive radiative forcing due to these three GHGs during the industrial era is "very likely to have been unprecedented in more than 10,000 years."

The positive radiative forcing due to CO_2 is the largest ($+1.66 \pm 0.17$ W/m^2) (Figure 4.1) and has increased by 20% from 1995 to 2005, the largest change for any decade in at least the last 200 years. Methane is the second largest source of positive radiative forcing ($+0.48 \pm 0.05$ W/m^2). Nitrous oxide has a positive radiative forcing of +0.16 ($\pm$0.02) W/m^2.

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[23] Watts per square meter is the standard metric unit for radiative and other energy fluxes.

[24] According to IPCC terminology, "very high confidence" conveys a 9 out of 10 chance of being correct. See Box 1.2 for a full description of IPCC's uncertainty terms.

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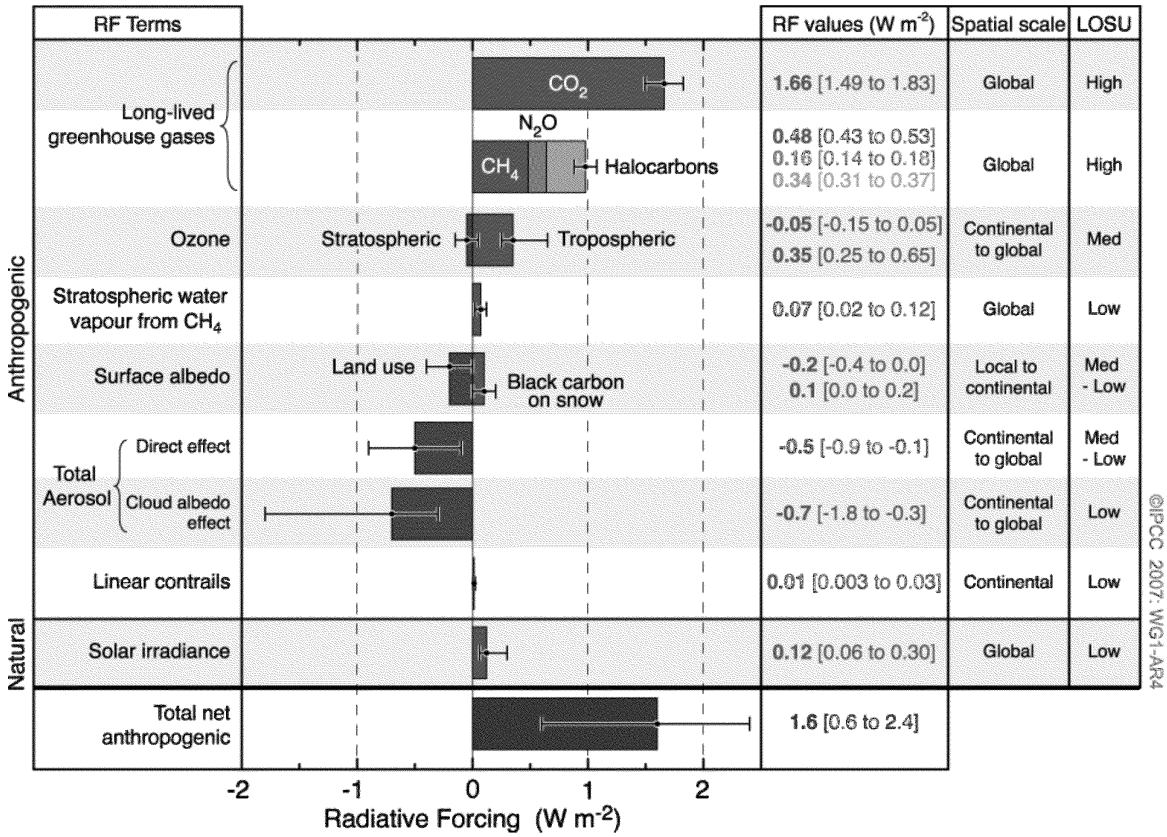
Figure 4.1: Global Average Radiative Forcing (RF) Estimates and Ranges in 2005 for Anthropogenic GHG Emissions and Other Factors



Source: IPCC (2007d). Global average radiative forcing (RF) estimates and ranges in 2005 for anthropogenic carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and other important factors, together with the typical geographical extent (spatial scale) of the forcing and the assessed level of scientific understanding (LOSU). The net anthropogenic radiative forcing and its range are also shown. These require summing asymmetric uncertainty estimates from the component terms, and cannot be obtained by simple addition. Additional forcing factors not included here are considered to have a very low LOSU. Volcanic aerosols contribute an additional natural forcing but are not included in this figure due to their episodic nature. The range for linear contrails does not include other possible effects of aviation on cloudiness.

The other three GHGs reported by the U.S. Inventory—HFCs, PFCs and SF_6—have a total radiative forcing in 2005 of +0.017 (±0.002) W/m^2, which is increasing by roughly 10% per year (Forster et al., 2007).

The ozone-depleting substances covered under the Montreal Protocol (CFCs, HCFCs, and chlorocarbons) are also strong GHGs and, as a group, contributed +0.32 (±0.03) W/m^2 to anthropogenic radiative forcing in 2005. Their radiative forcing peaked in 2003 and is now beginning to decline (Forster et al., 2007). The radiative forcing due to the destruction of stratospheric ozone by these gases is estimated to be –0.05 ± 0.10 W/m^2 with a medium level of scientific understanding (Forster et al., 2007).

In addition to the six main GHGs directly emitted by human activities and the gases covered by the Montreal Protocol, there are additional anthropogenic and natural factors that contribute to both positive and negative forcing.

With regard to climate change, ozone affects the radiative budget of the atmosphere through its interaction with both shortwave and longwave radiation (Forster et al., 2007). Tropospheric ozone changes caused by emissions of ozone-forming chemicals, or precursors (nitrogen oxides, carbon monoxide, and hydrocarbons including methane), contribute a positive forcing of +0.35 (+0.25 to +0.65) W/m^2. As described in CCSP (2008d), robust model simulations project climate change will also increase the radiative forcing from ozone by increasing stratosphere-troposphere exchange and hence ozone near the tropopause where it is most important radiatively. Unlike the GHGs mentioned previously, tropospheric ozone is not as well-mixed in the global atmosphere because its atmospheric lifetime is on the order of days to months (versus decades to centuries for the well-mixed GHGs). Tropospheric ozone is a criteria air pollutant under the U.S. Clean Air Act.

Emissions of ozone precursors and other substances also contribute to changes in levels of the reactive gas OH. OH is the major oxidizing chemical in the atmosphere, destroying significant quantities of many non-CO_2 GHGs (e.g., CH_4, HFCs, HCFCs, and ozone) thus influencing their chemical lifetimes and radiative forcing; it also plays an important role in the formation of sulfate, nitrate, and some organic aerosol species (Forster et al., 2007).

Anthropogenic emissions of aerosols contribute to both positive and negative radiative forcing. Aerosols are non-gaseous substances other than water or ice that are suspended in the atmosphere and are either solid particles or liquid droplets. Most aerosols, such as sulfates (which are mainly the result of SO_2 emissions from fossil fuel burning), exert a negative forcing or cooling effect, as they reflect and scatter incoming solar radiation. Some aerosols, such as black carbon, cause a positive forcing by absorbing incoming solar radiation. IPCC (2007d) estimated that the net effect of all anthropogenic increases in aerosols (primarily sulfate, organic carbon, black carbon, nitrate, and dust) produce a cooling effect, with a total direct radiative forcing of –0.5 (–0.9 to –0.1) W/m^2 and an additional indirect cloud albedo (i.e., enhanced reflectivity)[25] forcing of –0.7 (–1.8 to –0.3) W/m^2. Understanding of these forcings has improved since the IPCC *Third Assessment Report* (IPCC, 2001c) but nevertheless remain the dominant uncertainty in radiative forcing (IPCC, 2007d).

The direct radiative forcing of the individual aerosol species is less certain than the total direct aerosol radiative forcing. The estimates are: sulfate, -0.4 (□ 0.2) W/m^2; fossil fuel organic carbon, -0.05 (□0.05) W/m^2; fossil fuel black carbon, +0.2 (□0.15) W/m^2; biomass burning, +0.03 (□0.12) W/m^2; nitrate, -0.1 (□0.1) W/m^2; and mineral dust, -0.1 (□0.2) W/m^2. Including both fossil fuel and biomass burning sources, the total black carbon aerosol forcing is estimated to be 0.34 (0.09 to 0.59) W/m^2. In addition, black carbon can cause another positive radiative forcing effect (+0.1 (0.0 to +0.2) W/m^2) by decreasing the surface albedo of snow and ice, although scientific understanding of this forcing is low (Forster et al., 2007), with implications for Arctic and glacial melt. Also, according to the CCSP (2009a), since aerosol forcing is much more pronounced on regional scales than on the global scale because of the highly variable aerosol distributions, it would be insufficient or even misleading to place too much emphasis on the global average, with effects being dependent on both the location and timing of the emissions. Aerosols can alter the atmospheric circulation patterns and water cycles due to the manner in which aerosols can heat the atmosphere and cool the surface as well as to various cloud interactions (CCSP, 2009a). The total forcing associated with anthropogenic aerosols is less certain than that for GHGs, due to the indirect effects of aerosols, including cloud formation and albedo change.

[25] In addition to directly reflecting solar radiation, aerosols cause an additional, indirect negative forcing effect by enhancing cloud albedo (a measure of reflectivity or brightness). This effect occurs because aerosols act as particles around which cloud droplets can form; an increase in the number of aerosol particles leads to a greater number of smaller cloud droplets, which leads to enhanced cloud albedo. Aerosols also influence cloud lifetime and precipitation, but no central estimates of these indirect forcing effects are estimated by IPCC. These aerosol indirect effects remain some of the biggest uncertainties of the climate forcing/feedback processes (CCSP, 2009a).

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The radiative forcing from increases in stratospheric water vapor due to oxidation of anthropogenic increases in CH_4 is estimated to be +0.07 ± 0.05 W/m^2 (Forster et al., 2007). The level of scientific understanding is low because the contribution of CH_4 to the corresponding vertical structure of the water vapor change near the tropopause is uncertain.

Changes in surface albedo due to human-induced land cover changes exert a forcing of –0.2 (–0.4 to 0.0) W/m^2. Changes in solar irradiance since 1750 are estimated to cause a radiative forcing of +0.12 (+0.06 to +0.30) W/m^2. This estimate is less than half of the estimate given in IPCC's *Third Assessment Report* (2001), with a low level of scientific understanding (Forster et al., 2007). Uncertainties remain large because of the lack of direct observations and incomplete understanding of solar variability mechanisms over long time scales. Empirical associations have been reported between solar-modulated cosmic ray ionization of the atmosphere and global average low-level cloud cover, but evidence for a systematic indirect solar effect remains ambiguous. The lack of a proven physical mechanism and the plausibility of other causal factors make the association between galactic cosmic ray-induced changes in aerosol and cloud formation controversial (Forster et al., 2007).

Although water vapor is the most important and abundant GHG in the atmosphere, human activities produce only a very small direct increase in tropospheric water vapor (Karl et al., 2009). Irrigation and deforestation both have small, poorly understood effects on humidity, in opposite directions, and the IPCC concluded that radiative forcing from these sources of tropospheric water vapor is smaller than their non-radiative effects (such as evaporative cooling). Emissions of water vapor from combustion processes are significantly lower than emissions from land use; hence the absence of water vapor in Figure 4.1 (Forster et al., 2007). As temperatures increase, however, tropospheric water vapor concentrations also increase, representing a key positive feedback (e.g., one that enhances warming) but not a forcing of climate change (Solomon et al., 2007). Feedbacks are defined as processes in the climate system (such as a change in water vapor concentrations) that can either amplify or dampen the system's initial response to radiative forcing changes (NRC, 2005).

4(b) Global Changes in Temperature

Multiple lines of evidence lead to the robust conclusion that the climate system is warming. The IPCC (2007d) stated in its *Fourth Assessment Report*:

"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."

This finding was reaffirmed in the U.S. Global Change Research Program's June 2009 report *Global Climate Change Impacts in the United States* (Karl et al., 2009).

Air temperature is a main property of climate and the most easily measured, directly observable, and geographically consistent indicator of climate change. The extent to which observed changes in global and continental temperature and other climate factors can be attributed to anthropogenic emissions of GHGs is addressed in Section 5.

Global Surface Temperatures

Surface temperature is calculated by processing data from thousands of worldwide observation sites on land and sea. Substantial gaps in data coverage remain, especially in the tropics and the Southern Hemisphere, particularly Antarctica, although data coverage has improved with time. These gaps are

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largest in the 19th century and during the two world wars (Trenberth et al., 2007). The long-term mean temperatures are calculated by interpolating within areas with no measurements using the collected data available. Mears et al. (2006) caution: "For regions with either poor coverage or data gaps, trends in surface air temperature should be regarded with considerable caution, but do not have serious effects on the largest of scales as most of the variability is well sampled."

Biases may exist in surface temperatures due to changes in station exposure and instrumentation over land, or changes in measurement techniques by ships and buoys in the ocean. It is likely that these biases are largely random and therefore cancel out over large regions such as the globe or tropics (Wigley et al., 2006). Likewise, urban heat island effects are real but local, and have not biased the large-scale trends (Trenberth et al., 2007). However, it is conceivable that systematic changes in many station exposures of a similar kind may exist over the land during the last few decades. If such changes exist, they may lead to small amounts of spurious cooling or warming, even when the data are averaged over large land areas (Mears et al., 2006).

The following trends in global surface temperatures were observed for the period 1850 to 2005, according to the IPCC (Trenberth et al., 2007):

- Global mean surface temperatures have risen by 1.3 □ 0.3□F (0.74 ± 0.18°C) when estimated by a linear trend over the last 100 years (1906–2005) as shown by the magenta line in Figure 4.2. The warmest years in the instrumental record of global surface temperatures are 1998 and 2005, with 1998 ranking first in one estimate, but with 2005 slightly higher in the other two estimates. 2002 to 2004 are the third, fourth, and fifth warmest years in the series since 1850. Eleven of the last 12 years (1995 to 2006) – the exception being 1996 – rank among the 12 warmest years on record since 1850. Temperatures in 2006 were similar to the average of the past five years.

- The warming has not been steady, as shown in Figure 4.2. Two periods of warming stand out: an increase of 0.63□F (0.35°C) that occurred from the 1910s to the 1940s and then a warming of about 0.99□F (0.55°C) from the 1970s up to the end of 2006. In between those two periods (from the 1940s to the 1970s), temperatures leveled off or cooled slightly. The remainder of the past 150 years has included short periods of both cooling and warming. The rate of warming over the last 50 years is almost double that over the last 100 years 0.23 □ 0.05□F vs. 0.13 □ 0.04□F (0.13 ± 0.03°C vs. 0.07 ± 0.02°C) per decade.

- Land regions have warmed at a faster rate than oceans. Warming has occurred in both land and oceans and in both sea surface temperature (SST) and nighttime marine air temperature over the oceans. However, for the globe as a whole, surface air temperatures over land have risen at about double the ocean rate after 1979 (more than 0.49□F [0.27°C] per decade vs. 0.23□F [0.13°C] per decade), with the greatest warming during winter (December to February) and spring (March to May) in the Northern Hemisphere. Recent warming is strongly evident at all latitudes in SSTs over each of the oceans.

- Average Arctic temperatures increased at almost twice the global average rate in the past 100 years. Arctic temperatures have high decadal variability. A slightly longer warm period, almost as warm as the present, was also observed from the late 1920s to the early 1950s, but appears to have had a different spatial distribution than the recent warming.

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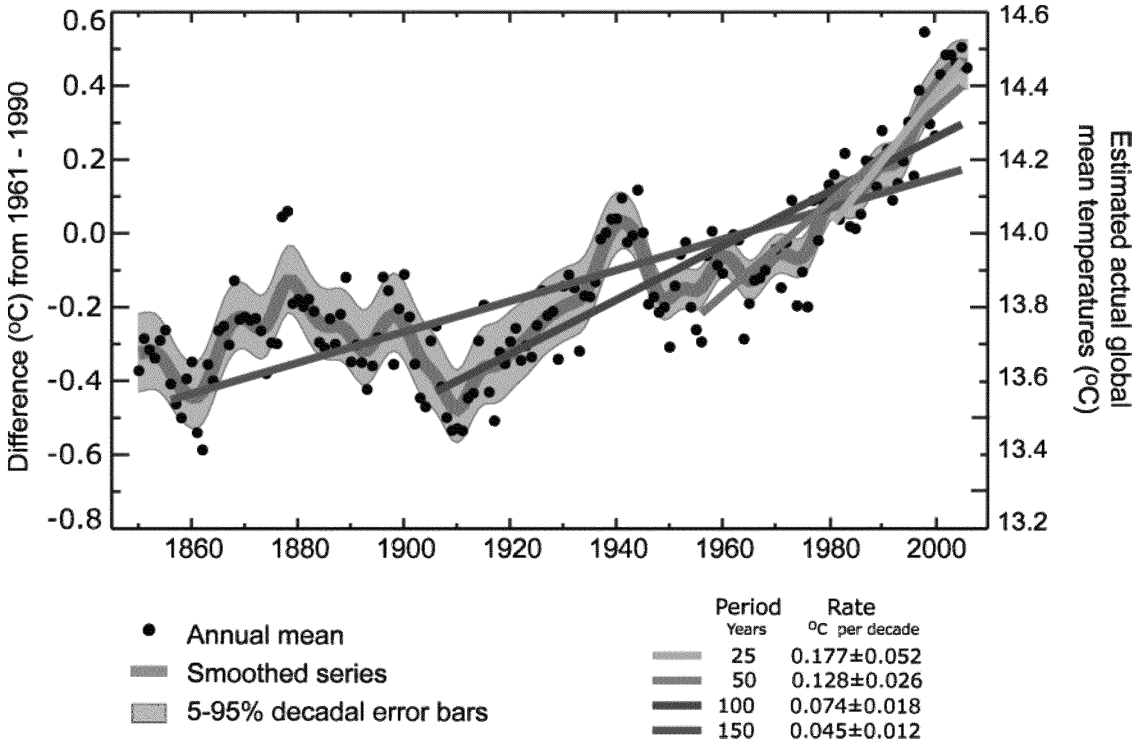
Figure 4.2: Annual Global Mean Temperatures (black dots) with Linear Fits to the Data.



Source: Solomon et al. (2007). The left-hand axis shows temperature anomalies relative to the 1961 to 1990 average, and the right-hand axis shows estimated actual temperatures, both in Celsius. Linear trends are shown for the last 25 (yellow), 50 (orange), 100 (magenta), and 150 years (red). The smooth blue curve shows decadal variations with the decadal 90% error range shown as a pale blue band about that line. The total temperature increase from the period 1850 to 1899 to the period 2001 to 2005 is 1.37°F ± 0.34°F (0.76°C ± 0.19°C).

- Between 1901 and 2005, statistically significant warming was observed over most of the world's surface with the exception of an area south of Greenland and three smaller regions over the southeastern United States and parts of Bolivia and the Congo basin. The lack of significant warming at about 20% of the locations and the enhanced warming in other places, is likely to be a result of changes in atmospheric circulation. Warming is strongest over the continental interiors of Asia and northwestern North America and over some mid-latitude ocean regions of the Southern Hemisphere as well as southeastern Brazil.

- Since 1979, warming has been strongest over western North America; northern Europe and China in winter; Europe and northern and eastern Asia in spring; Europe and North Africa in summer; and northern North America, Greenland, and eastern Asia in autumn.

Box 4.1: Updated Global Surface Temperature Trends Through 2008

The global surface temperature trend analysis in IPCC (2007a) includes data through 2005 from the United Kingdom's Hadley Centre (Hadley Centre, 2009), referred to as HadCRUT. Three additional years of data have become available since then (2006-2008) and two additional global surface temperature datasets are available for

comparison. The updated HadCRUT dataset[26] (which spans 1850-2008), NOAA's Merged Land-Ocean Surface Temperature dataset[27] (which spans 1880-2008) (NOAA, 2009a), and NASA's Global Surface Temperature dataset[28] (which spans 1880-2008), (NASA, 2009) all indicate:

- Eight of the 10 warmest years on record have occurred since 2001
- The 10 warmest years have all occurred in the past 12 years
- The 20 warmest years have all occurred since 1981

2008 was the ninth warmest year on record globally for the NOAA and NASA datasets and the 10th warmest year on record for the HadCRUT dataset. The warmest year on record was 2005 for the NOAA and NASA datasets and 1998 for the HadCRUT dataset.

Because trends may be sensitive to the choice of start date in a time series, it is instructive to analyze trends when varying these dates. The following table shows warming trends[29] starting in 1880 (when data is available across all three datasets) at 20 year intervals for all three datasets:

Period	HadCRUT	NOAA	NASA
1880-2008	0.11°F (0.061□C) /decade	0.10°F (0.056□C) /decade	0.10°F (0.056□C) /decade
1900-2008	0.13°F (0.072□C) /decade	0.13°F (0.072□C) /decade	0.12°F (0.067□C) /decade
1920-2008	0.13°F (0.072□C) /decade	0.12°F (0.067□C) /decade	0.12°F (0.067□C) /decade
1940-2008	0.15°F (0.083□C) /decade	0.15°F (0.083□C) /decade	0.14°F (0.078□C) /decade
1960-2008	0.25°F (0.14□C) /decade	0.24°F (0.13□C) /decade	0.24°F (0.13□C) /decade
1980-2008	0.29°F (0.16□C) /decade	0.30°F (0.17□C) /decade	0.29°F (0.16□C) /decade

These trends show strong agreement among the three datasets, a conclusion also drawn in CCSP (2006), Trenberth et al. (2007), and the NOAA study, "State of the Climate in 2008" (Peterson and Baringer, 2009). The warming rate in the last 10 30-year periods (averaging about 0.30°F [0.17□C] per decade) is the greatest in the observed record, followed closely by the warming rate (averaging about 0.25°F [0.14□C] per decade) observed during a number of 30-year periods spanning the 1910s to the 1940s.

Though most of the warmest years on record have occurred in the last decade in all available datasets, according to an analysis of the HadCRUT dataset in the "State of the Climate in 2008" report (Peterson and Baringer, 2009), the rate of warming has, for a short time, slowed. The temperature trend calculated for January 1999 to December 2008 was about +0.13 ± 0.13°F (+0.07 ± 0.07°C) per decade, which is less than the 0.32°F (0.18°C) per decade trend recorded between 1979 and 2005 (or 0.30°F [0.17□C] per decade for 1980 to 2008 as stated above). However, NOAA (NOAA, 2009a) and NASA (NASA, 2009) trends do not show the same marked slowdown for the 1999-2008 period. The NOAA trend was ~0.21°F (0.12□C) per decade while the NASA trend was ~0.34°F (0.19□C) per decade. The variability among datasets is a reflection of fewer data points and some differences in dataset methodologies. Analysis of trends for the years 2000, 2001, and 2002 through 2008 indicate a rather flat trend, with slight warming or cooling depending on choice of dataset and start date. It is important to recognize that year-to-year fluctuations in natural weather and climate patterns can produce a period that does not follow the long-term trend (Karl et al., 2009). Thus, each year will not necessarily be warmer than every year before it, though the long-term warming trend continues (Karl et al., 2009). For a discussion of how recent temperature trends relate to future climate projections, refer to Section 6b.

[26] Downloadable from: http://cdiac.ornl.gov/ftp/trends/temp/jonescru/global.dat
[27] Downloadable from: ftp://ftp.ncdc.noaa.gov/pub/data/anomalies/annual.land_ocean.90S.90N.df_1901-2000mean.dat
[28] Downloadable from: http://data.giss.nasa.gov/gistemp/tabledata/GLB.Ts+dSST.txt
[29] The trends in this table do not provide uncertainty estimates and are, therefore, approximate. In Trenberth et al. (2007), the uncertainty is given for these three datasets for different time periods in Table 3.3 and is about ±0.03°F (□ 0.017□C) for 1901-2005 and ±0.09°F (□ 0.05□C) for 1979-2005. These uncertainty estimates could reasonably be interpolated to the time series in this table.

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Temperature trend analysis over Antarctica is complicated due to large regional and interannual variability and sparse data coverage. Recent studies and assessments have led to some different conclusions. Trenberth et al. (2007) indicate cooling over most of interior Antarctica and strong warming over the peninsula. However, the NOAA report *State of the Climate in 2008* (Peterson and Baringer, 2009) refers to a recent study that finds Antarctic warming is much broader in spatial extent, extending to include West Antarctica. Alternatively, it refers to another study that indicates little change in near-surface temperatures during the past 50 years over most of the continent despite finding marked warming over the Antarctic Peninsula.

Global Upper Air Temperatures

Temperature measurements have also been made above the Earth's surface over the past 50 to 60 years using radiosondes (balloon-borne instruments) and for the past 28 years using satellites. These measurements support the analysis of trends and variability in the troposphere (surface to 6.2 to 10 mi [10 to 16 kilometers, km]) and stratosphere 6.2 to 31 mi [10 to 50 km] above the Earth's surface).

The CCSP prepared a report that assessed temperature changes in the atmosphere, differences in the changes at various levels in the atmosphere, and an explanation of the causes of these changes and differences. It concluded (Wigley et al., 2006): "…the most recent versions of all available data sets show that both the surface and troposphere have warmed, while the stratosphere has cooled. These changes are in accord with our understanding of the effects of radiative forcing agents and with the results from model simulations."

The IPCC (Trenberth et al., 2007) reaffirmed the major conclusions of this CCSP report finding:

- New analyses of radiosondes and satellite measurements of lower- and mid-tropospheric temperature show warming rates that are similar to those of the surface temperature record and are consistent within their respective uncertainties.

- The satellite tropospheric temperature record is broadly consistent with surface temperature trends. The range (due to different data sets) of global surface warming since 1979 is 0.29□F (0.16°C) to 0.32□F (0.18°C) per decade compared to 0.22□F (0.12°C) to 0.34□F (0.19°C) per decade for estimates of tropospheric temperatures measured by satellite.

- Lower-tropospheric temperatures measured by radiosondes have slightly greater warming rates than those at the surface over the period 1958 to 2005. The radiosonde record is markedly less spatially complete than the surface record and increasing evidence suggests that it is very likely that a number of records have a cooling bias, especially in the tropics.

Lower stratospheric temperatures have cooled since 1979. Estimates from adjusted radiosondes, satellites, and re-analyses are in qualitative agreement, suggesting a lower-stratospheric cooling of between 0.5□F (0.3°C) and 1□F (0.6°C) per decade since 1979.

The global upper air temperature trend analysis in IPCC (2007a) described above includes data through 2005. Three additional years of data have become available since then (2006–2008). The addition of these three years does not significantly alter the above trends. For example, in NOAA (2009b) the satellite mid-tropospheric temperature trend computed for 1979–2008 ranges from +0.20 to 0.27□F (+ 0.11°C to + 0.15°C) per decade compared to the estimate of +0.22 to +0.34□F (+ 0.12°C to + 0.19°C) per decade given in IPCC (2007a). Combining the radiosonde and satellite records of the troposphere, the

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State of the Climate in 2008 report estimates the trend is +0.261 □ 0.04□F (+0.145 ± 0.02°C) per decade for the period 1958–2008 with the range of the trends calculated from the various datasets (Peterson and Baringer, 2009). The report notes there is no indication of acceleration of the trend. As in the surface temperature data, the trend over the last seven to 10 years in these data is relatively flat, but this does not fundamentally alter the longer term warming signal.

The 2008 annual average temperature of the lower stratosphere was similar to that of the last dozen years according to the *State of the Climate in 2008* report (Peterson and Baringer, 2009). The report notes that globally the lower stratosphere has been about 2.7□F (1.5°C) cooler over the past decade than in the 1960s when the radiosonde network began to offer reasonable global monitoring. It finds the general evolution of global lower stratospheric temperature is robustly captured in all available radiosonde (1958–present) and satellite (1979–present) datasets. However, the datasets differ in detail. For example, of those that cover 1979–2008, 2008 ranks as the coldest year in three, the second coldest in one, and the eighth coldest in another (Peterson and Baringer, 2009).

Global Surface Temperatures Over the Last 2,000 Years

Instrumental surface temperature records only began in the late 19th century, when a sufficiently large global network of measurements was in place to reliably compute global mean temperatures. To estimate temperatures further back in time, scientists analyze proxy evidence from sources such as tree rings, corals, ocean and lake sediments, cave deposits, ice cores, boreholes, glaciers, and documentary evidence. A longer temperature record can help place the 20th century warming into a historical context.

NRC conducted a study to describe and assess the state of scientific efforts to reconstruct surface temperature records for the Earth over approximately the last 2,000 years and the implications of these efforts for understanding global climate change. It found (NRC, 2006b):

- Large-scale surface temperature reconstructions, as illustrated in Figure 4.3, yield a generally consistent picture of temperature trends during the preceding millennium, including relatively warm conditions centered around 1000 A.D. (identified by some as the "Medieval Warm Period") and a relatively cold period (or "Little Ice Age") centered around 1700.

- It can be said with a high level of confidence that global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period during the preceding four centuries. The observed warming in the instrumental record shown in Figure 4.2 supports this conclusion.

- Less confidence can be placed in large-scale surface temperature reconstructions for the period from 900 to 1600 A.D. Presently available proxy evidence indicates that temperatures at many, but not all, individual locations were higher during the past 25 years than during any period of comparable length since 900 A.D. The uncertainties associated with reconstructing hemispheric mean or global mean temperatures from these data increase substantially backward in time through this period and are not yet fully quantified.

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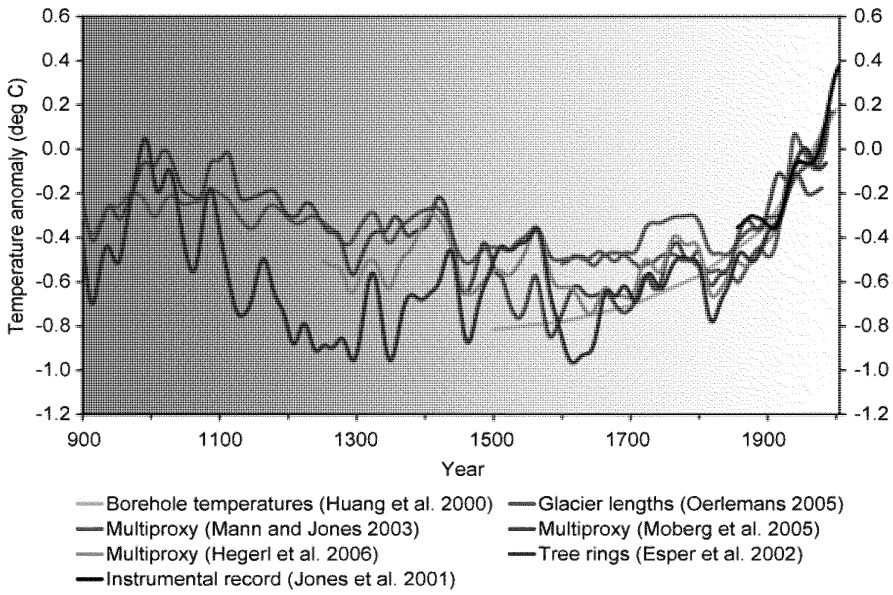
- Very little confidence can be assigned to statements concerning the hemispheric mean or global mean surface temperature prior to about 900 A.D. because of sparse data coverage and because the uncertainties associated with proxy data and the methods used to analyze and combine them are larger than during more recent time periods.

Figure 4.3: Reconstructions of (Northern Hemisphere Average or Global Average) Surface Temperature Variations from Six Research Teams



Source: NRC (2006b). Reconstructions of (Northern Hemisphere average or global average) surface temperature variations from six research teams (in different color shades), along with the instrumental record of global average surface temperature (in black). Each curve illustrates a somewhat different history of temperature changes, with a range of uncertainties that tend to increase backward in time (as indicated by the shading).

Considering this study and additional research, the IPCC (2007d) concluded: "Paleoclimatic information supports the interpretation that the warmth of the last half century is unusual in at least the previous 1,300 years." However, like NRC (2006b), IPCC cautions that uncertainty is significant prior to 1600 (Jansen et al., 2007).

4(c) U.S. Changes in Temperature

Like global mean temperatures, U.S. temperatures also warmed during the 20th and into the 21st century. According to NOAA (2009e) and data from NOAA[30]:

- U.S. average annual temperatures (for the contiguous United States or lower 48 states) are now approximately 1.25°F (0.69°C) warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years. The rate of warming for the entire period of record (1901–2008) is 0.13°F (0.072°C) per decade while the rate of warming increased to 0.58°F (0.32°C) per decade for the period 1979–2008.

- 2005, 2006, and 2007 were exceptionally warm years (among the top 10 warmest on record), while 2008 was slightly warmer than average (the 39th warmest year on record), 0.2°F (0.1°C) above the 20th century (1901-2000) mean (though 0.06°F (0.035°C) below the 1971-2000 mean).

[30] Data for contiguous U.S. temperature time series analysis obtained from NOAA's National Climatic Data Center (NCDC). Data may be downloaded from: http://www.epa.gov/climatechange/endangerment/data.html (see file: us-temps-time-series-1901-2008-noaa.pdf).

- The last 10 five-year periods (2004–2008, 2003–2007, 2002–2006, 2001–2005, 2000–2004, 1999–2003, 1998–2002, 1997–2001, 1996–2000, and 1995–1999), were the warmest five-year periods (i.e., pentads) in the period of record (since 1901), demonstrating the anomalous warmth of the last 15 years.

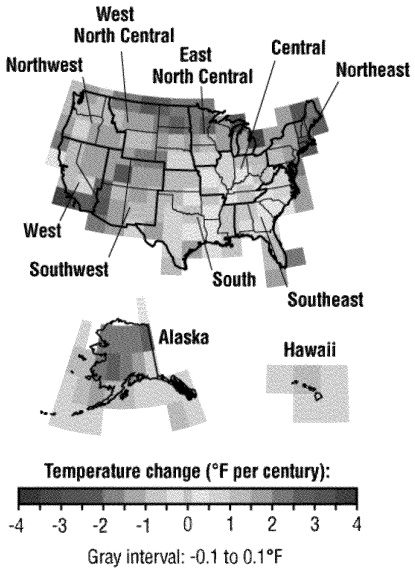
NASA's U.S. temperature dataset[31] for the lower 48 states indicates a somewhat lower warming trend (relative to NOAA) of 0.079°F (0.044°C) per decade for the period 1901–2008. But this warming trend increases to 0.47°F (0.26°C) per decade for the period 1979–2008 and the last eight five-year periods have been among the 10 warmest five-year periods on record. 1998 and 1934 are tied for the warmest year in NASA's U.S. record.

Over the past 50 years, Karl et al. (2009) report the U.S. average temperature has risen more than 2°F (1°C) over the past 50 years resulting in longer warm seasons and shorter, less-intense cold seasons.

Regional data[33] analyzed from NOAA through 2008, as illustrated in Figure 4.4, indicate warming has occurred throughout most of the United States, with all but four of the 11 climate regions showing an increase of more than 1ºF (0.6°C) since 1901 (NOAA, 2009d). As shown in Figure 4.4, the greatest temperature increase occurred in Alaska (for the period 1918–2008) and the Northeast (1.9°F [1.06°C] and 2.0°F [1.1°C] per century, respectively). The least warming occurred in the Southeast, where the trend was 0.26°F (0.14°C) per century.

Including all of North America in its assessment of regional temperatures, the IPCC (Field et al., 2007) stated:

Figure 4.4: Map of the United States, Depicting Regional U.S. Temperature Trends for the Period 1901 to 2008[32]



Red shades indicate warming over the period and blue shades indicate cooling over the period.

- For the period 1955–2005, the greatest warming occurred in Alaska and northwestern Canada, with substantial warming in the continental interior and modest warming in the southeastern United States and eastern Canada.

- Spring and winter show the greatest changes in temperature and daily minimum (nighttime) temperatures have warmed more than daily maximum (daytime) temperatures.

[31] NASA U.S. temperature data may be downloaded from: http://data.giss.nasa.gov/gistemp/graphs/Fig.D.txt.
[32] Data for U.S. temperature map obtained from NOAA's NCDC. Data may be downloaded from: http://www.epa.gov/climatechange/endangerment/data.html (see file: us-temps-map-fig4-4-1901-2008-noaa.pdf).
[33] Data for U.S. regional temperature time series analysis obtained from NOAA's NCDC. Data may be downloaded from: http://www.epa.gov/climatechange/endangerment/data.html (see file: us-regional-temps-time-series-1901-2008-noaa.pdf).

4(d) Global Changes in Precipitation

A consequence of rising temperature is increased evaporation, provided that adequate surface moisture is available (e.g., over the oceans and other moist surfaces). The average atmospheric water vapor content has increased since at least the 1980s over land and ocean, as well as in the upper troposphere (IPCC, 2007d). When evaporation increases, more water vapor is available for precipitation producing weather systems leading to precipitation increases in some areas. Conversely, enhanced evaporation and evapotranspiration from warming accelerates land surface drying and increases the potential incidence and severity of droughts in other areas.

Observations show that changes are occurring in the amount, intensity, frequency, and type of precipitation. Cautioning that precipitation is highly variable spatially and temporally, and data are limited in some regions, the IPCC highlighted the following trends (Trenberth et al., 2007):

- Long-term trends from 1900 to 2005 have been observed in precipitation amount over many large regions. Significantly increased precipitation has been observed in eastern parts of North and South America, northern Europe, and northern and central Asia.

- Drying has been observed in northern Africa, southern Eurasia, Canada, and Alaska (Trenberth et al., 2007). The IPCC notes the trend towards drying in northern Africa and the Sahel region, with a partial recovery since 1990, has been a common feature of climate in these regions in the paleoclimate record (Jansen et al., 2007).

- For 1961–1990, rising temperature have generally resulted in rain rather than snow in locations and seasons where climatological average temperatures were close to 32°F (0°C).

The trends described in the NOAA report *State of the Climate in 2008* (Peterson and Baringer, 2009) are largely consistent with the IPCC. The NOAA report finds on a century time scale, most of the globe has trended towards wetter conditions, and particularly the northern high latitudes. But it also finds notable exceptions. A trend towards drier conditions is found over the tropics and some other locations. These include parts of southern Europe, most of Africa (while noting the drying trend over the Sahel reversed in 1989), southwestern Australia, and the west coast of South America. It highlights two regions that have become significantly drier over the past two decades: the southwestern United States and southeastern Australia.

For information on changes in global precipitation extremes (heavy precipitation and drought), see Section 4(k).

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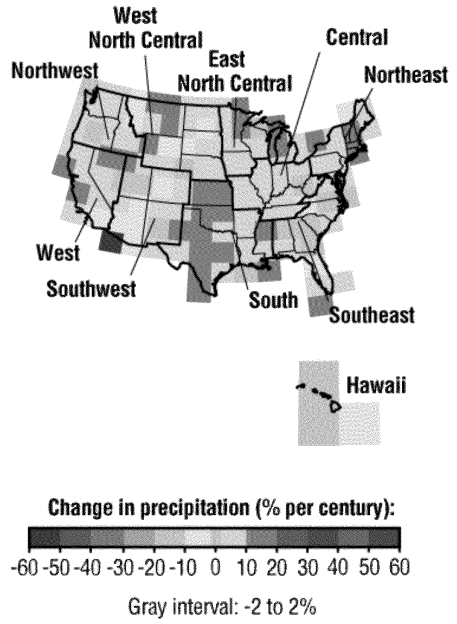
4(e) U.S. Changes in Precipitation

Data[35] analyzed from NOAA show that over the contiguous United States, total annual precipitation increased at an average rate of 6.1% per century from 1901–2008, and about 5% over the last 50 years (Karl et al., 2009). As shown in Figure 4.5 displaying regional data[36], the greatest increases in precipitation were in the East North Central climate region (9.6% per century), the Northeast (9.8% per century) and the South (10.5%). Precipitation increased in the Southeast by 1.3%, the Central United States by 7.2%, the West North Central by 4.0%, the Southwest by 3.7%, the West by 3.8%, and the Northwest by 4.1%.

Outside the contiguous United States, Hawaii experienced a decrease of 5.4% per century (since records begin in 1905). Precipitation over Alaska (not shown due to limited data coverage) has a decreasing long-term trend, but with significant variability over time and space.

Despite the overall national trend towards wetter conditions, a severe drought has affected the southwest United States from 1999 through 2008 (see Section 4(l)), which is indicative of significant variability in regional precipitation patterns over time and space.

Figure 4.5: Map of the United States, Depicting Precipitation Trends for the Contiguous United States 1901-2008 and Hawaii 1905-2008[34]



Green shades indicate a trend toward wetter conditions over the period, and brown shades indicate a trend toward dryer conditions. No data are available for areas shaded white.

4(f) Global Sea Level Rise and Ocean Heat Content

Global Sea Level Rise

There is strong evidence that global sea level gradually rose in the 20th century and is currently rising at an increased rate, after a period of little change between AD 0 and AD 1900 (IPCC, 2007a).

According to Bindoff et al. (2007), there is high confidence that the rate of sea level rise increased between the mid-19th and mid-20th centuries. The average rate of sea level rise measured by tide gauges from 1961 to 2003 was 0.071 □ 0.02 inch (0.18 □ 0.05 cm) per year (Bindoff et al., 2007). The global average rate of sea level rise measured by satellite altimetry during 1993 to 2003 was 0.12 □ 0.03 inch (0.31 □ 0.07 cm) per year (Bindoff et al., 2007). Coastal tide gauge measurements confirm this observation. It is unclear whether the faster rate for 1993 to 2003 is a reflection of short-term variability

[34] Data for U.S. precipitation map obtained from NOAA's NCDC. Data may be downloaded from: http://www.epa.gov/climatechange/endangerment/data.html (see file: us-precip-map-fig4-5-1901-2008-noaa.pdf).
[35] Data for contiguous U.S. precipitation time series analysis obtained from NOAA's National Climatic Data Center. Data may be downloaded from: http://www.epa.gov/climatechange/endangerment/data.html (see file: us-precip-time-series-1901-2008-noaa.pdf).
[36] Data for U.S. regional precipitation time series analysis obtained from NOAA's National Climatic Data Center. Data may be downloaded from: http://www.epa.gov/climatechange/endangerment/data.html (see file: us-regional-precip-time-series-1901-2008-noaa.pdf).

or an increase in the longer-term trend (Bindoff et al., 2007). The total 20th century sea level rise is estimated to be 6.7 □ 2 inches (17 ± 5 (cm)) (Bindoff et al., 2007). Sources of uncertainty in measuring global average sea level rise include the adjustment for vertical land movements in tide gauge data and the proper accounting for instrumental bias and drifts in satellite altimetry data (Bindoff et al., 2007).

Two major processes lead to changes in global mean sea level on decadal and longer time scales: i) thermal expansion, and ii) the exchange of water between oceans and other reservoirs (glaciers and ice caps, ice sheets, and other land water reservoirs). It is believed that on average, over the period from 1961 to 2003, thermal expansion contributed about one-quarter of the observed sea level rise, while melting of land ice accounted for less than half; the full magnitude of the observed sea level rise was not satisfactorily explained by the available data sets (Bindoff et al., 2007). During this period, global ocean temperature rose by 0.18□F (0.10°C) from the surface to a depth of 2,300 ft (700 m), contributing an average of 0.016 □ 0.004 inch (0.04 ± 0.01 cm) yr^{-1} to sea level rise (Bindoff et al., 2007). The contribution from ice was approximately 0.028 □ 0.02 inch (0.07 ± 0.05 cm) yr^{-1} (Lemke et al., 2007).

In recent years (1993–2003), during which the observing system has been much better, thermal expansion and melting of land ice each account for about half of the observed sea level rise, although there is some uncertainty in the estimates. Thermal expansion contributed about 0.063 □ 0.02 inch (0.16 ± 0.05 cm) per year, reflecting a high rate of warming for the period relative to 1961 to 2003 (Bindoff et al., 2007). The total contribution from melting ice to sea level change between 1993 and 2003 ranged from 0.047 □ 0.016 inch (0.12 ± 0.04 cm) per year. The rate increased over the 1993 to 2003 period primarily due to increasing losses from mountain glaciers and ice caps, from increasing surface melt on the Greenland Ice Sheet, and from faster flow of parts of the Greenland and Antarctic Ice Sheets (Lemke et al., 2007).

Thermal expansion and exchanges of water between oceans and other reservoirs cause changes in the global mean as well as geographically non-uniform sea level change. Other factors influence changes at the regional scale, including changes in ocean circulation or atmospheric pressure, and geologic processes (Bindoff et al., 2007). Satellite measurements (for the period 1993–2003) provide unambiguous evidence of regional variability of sea level change (Bindoff et al., 2007). In some regions, rates of rise have been as much as several times the global mean, while sea level is falling in other regions. According to the IPCC (Bindoff et al., 2007), the largest sea level rise since 1992 has taken place in the western Pacific and eastern Indian oceans, while nearly all of the Atlantic Ocean shows sea level rise during the past decade with the rate of rise reaching a maximum (over 0.08 inch [0.2 cm] yr^{-1}) in a band running east-northeast from the U.S. east coast. Sea level in the eastern Pacific and western Indian oceans has been falling.

Ocean Heat Content

The thermal expansion of sea water is an indicator of increasing ocean heat content. Ocean heat content is also a critical variable for detecting the effects of the observed increase in GHGs in the Earth's atmosphere and for resolving the Earth's overall energy balance (Bindoff et al., 2007). For the period 1955 to 2005, Bindoff et al. (2007) analyze multiple time series of ocean heat content and find an overall increase, while noting interannual and inter-decadal variations. NOAA's report *State of the Climate in 2008* (Peterson and Baringer, 2009), which incorporates data through 2008, finds "large" increases in global ocean heat content since the 1950s and notes that over the last several years, ocean heat content has reached consistently higher values than for all prior times in the record.

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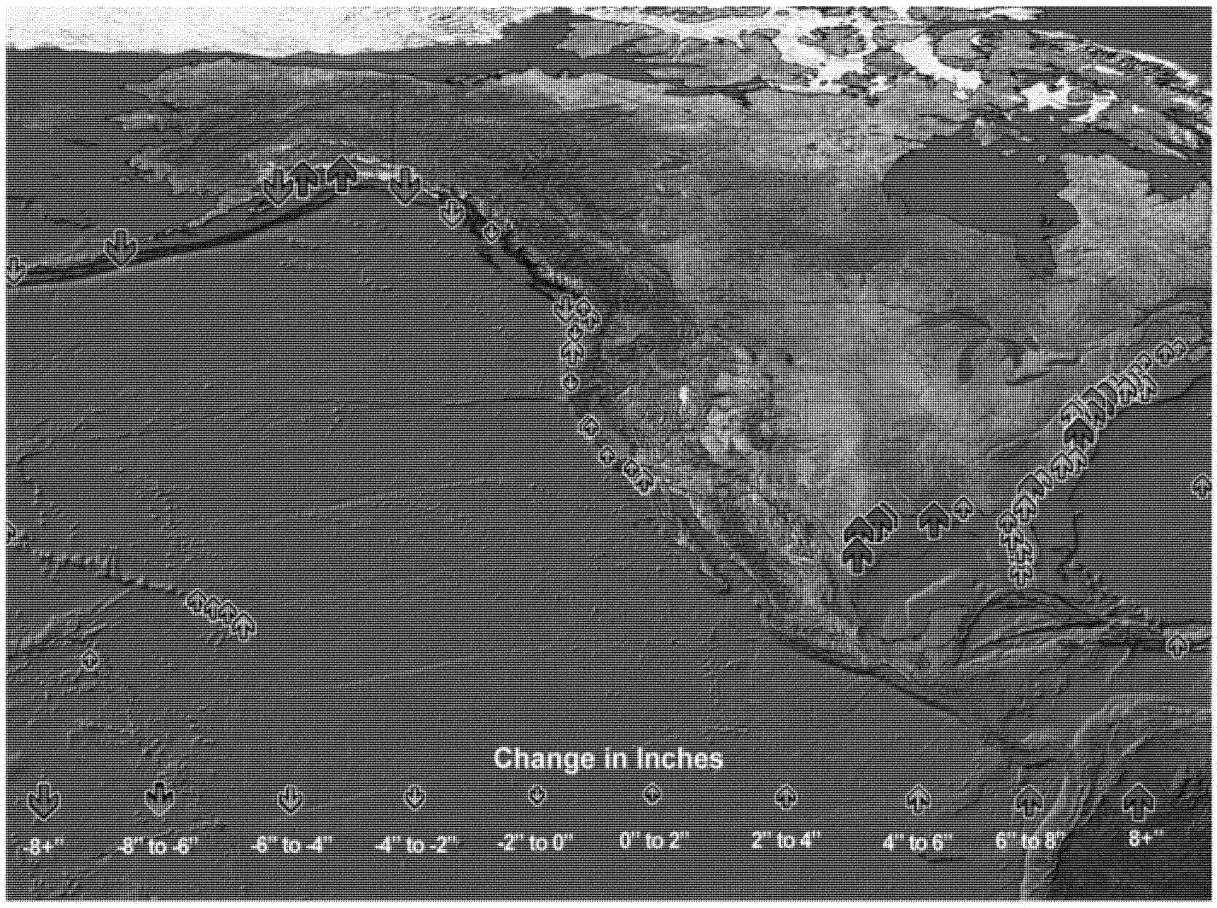
4(g) U.S. Sea Level Rise

Sea level[37] has been rising 0.08 to 0.12 inch yr^{-1} (0.2 to 0.3 cm yr^{-1}) along most of the U.S. Atlantic and Gulf coasts, as seen in Figure 4.6. During the past 50 years, sea level has risen up to 8 inches (20 cm) or more along some coastal areas, and has fallen in other locations (Karl et al., 2009). The rate of sea level rise varies from about 0.36 inch per year (1 cm yr^{-1}) along the Louisiana Coast (due to land sinking), to a drop of a few inches per decade in parts of Alaska (because land is rising). Records from the coast of California indicate that sea levels have risen almost 7.1 inches (18 cm) during the past century (California Energy Commission, 2006). According to the CCSP (2009b), in the Mid-Atlantic region from New York to North Carolina, tide-gauge observations indicate that relative sea level rise (the combination of global sea level rise and land subsidence) rates were higher than the global mean and generally ranged between 0.094 and 0.17 inch (0.24 and 0.44 cm) yr^{-1}, or about 1 inch (2.54 cm) over the 20th century.

Figure 4.6: Relative Sea Level Changes on United States Coastlines, 1958 to 2008.



Source: Karl et al. (2009) Observed changes in relative sea level from 1958 to 2008 for locations on the United States coast.

[37] U.S. sea level data obtained from the Permanent Service for Mean Sea Level (http://www.pol.ac.uk/psmsl/) of the the Proudman Oceanographic Laboratory.

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Rosenzweig et al. (2007) document studies that find 75% of the shoreline, when the influence of spits, tidal inlets, and engineering structures is removed, is eroding along the U.S. East Coast probably due to sea level rise. They also cite studies reporting losses in coastal wetlands observed in Louisiana, the Mid-Atlantic region, and in parts of New England and New York, in spite of recent protective environmental regulations.

4(h) Global Ocean Acidification

Ocean waters can absorb large amounts of CO_2 from the atmosphere because when the gas dissolves in water it forms a weak acid, and the minerals dissolved in the ocean have created, over geologic time, a slightly alkaline ocean, with surface pH ranging from 7.9 to 8.25. The amount of carbon contained in the oceans has increased due to the elevated atmospheric pressure of CO_2 from anthropogenic emissions (Denman et al., 2007). The IPCC estimates that the total inorganic carbon content of the oceans increased by 118 ± 19 gigatonnes of carbon (GtC) between 1750 and 1994 and continues to increase (Bindoff et al., 2007). This absorptive capacity of the oceans has resulted in atmospheric CO_2 concentrations substantially lower than they otherwise would be. Since the beginning of the Industrial Revolution, global average sea surface pH has dropped by about 0.1 pH units, with the lowest decrease (0.06) in the tropics and subtropics, and the highest decrease (0.12) at high latitudes, consistent with the lower buffer capacity of the high latitudes compared to the low latitudes (Bindoff et al., 2007). This average pH decline of 0.1 pH unit corresponds to a 30% increase in the concentration of hydrogen ions (Denman et al., 2007).

Ocean acidification is causing a series of cascading changes to the chemistry of ocean water, including a decrease in the saturation state of calcium carbonate. Marine calcifiers, such as corals, are dependent upon this mineral to form shells, skeletons, and other protective structures. Reduced availability of calcium carbonate can slow or even halt calcification rates in these organisms (Fischlin et al., 2007). The availability of carbonate is also important because it controls the maximum amount of CO_2 that the ocean is able to absorb (Bindoff et al., 2007, p. 406). More information regarding ocean acidification projections and effects on marine ecosystems can be found in Sections 6(b) and 14(a), respectively. Ocean acidification is a direct consequence of fossil fuel CO_2 emissions, which are also the main driver of the anticipated climate change (Denman et al., 2007).

4(i) Global Changes in Physical and Biological Systems

Physical and biological systems on all continents and in most oceans are already being affected by recent climate changes, particularly regional temperature increases (very high confidence) (Rosenzweig et al., 2007). Climatic effects on human systems, although more difficult to discern due to adaptation and non-climatic drivers, are emerging (medium confidence) (Rosenzweig et al., 2007). The majority of evidence comes from mid- and high latitudes in the Northern Hemisphere, while documentation of observed changes in tropical regions and the Southern Hemisphere is sparse (Rosenzweig et al., 2007). Hence, the findings presented in this section apply generally to the globe but most directly to Europe and North America (including the United States) where these observational studies were conducted. The extent to which observed changes discussed here can be attributed to anthropogenic GHG emissions is discussed in Section 5.

Cryosphere (Snow and Ice)

Observations of the cryosphere (the "frozen" component of the climate system) have revealed changes in sea ice, glaciers and snow cover, freezing and thawing, and permafrost. The following physical changes have been observed:

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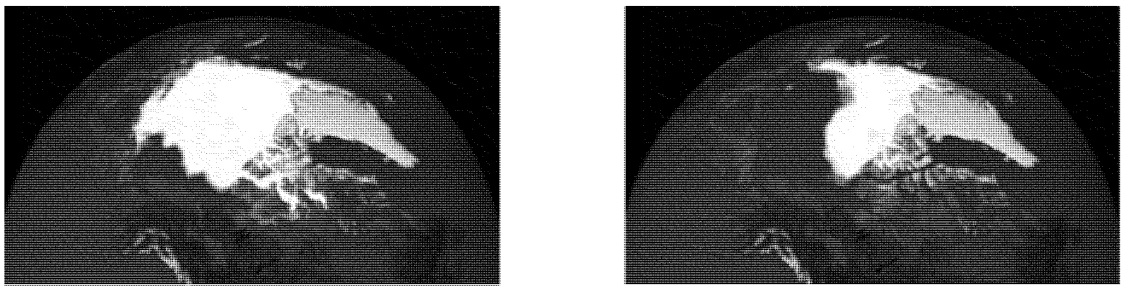
Ice cover in the Arctic began to diminish in the late 19th century, and this shrinkage has accelerated during the last several decades. Shrinkages that were both similarly large and rapid have not been documented over at least the last few thousand years, although the paleoclimatic record is sufficiently sparse that similar events might have been missed (Alley et al., 2009). Total annual Arctic sea ice extent has been declining at the rate of 4.1% (193,000 mi^2;~500,000 km^2) per decade for the period 1979–2008 (NSIDC, 2009a). The latest data from NASA indicate Arctic sea ice set a record low in September 2007, 38% below the 1979–2007 average (NASA Goddard Space Flight Center, 2007). The extent of the sea ice loss between 1979 and 2007 can be seen in Figure 4.7. In September 2008, Arctic sea ice reached its second lowest extent on record (NASA Goddard Space Flight Center, 2008). In September 2009, Arctic sea ice reached its third lowest extent on record (NSIDC, 2009b).

Figure 4.7: Arctic Sea Ice Concentrations Comparisons



1979 **2007**

Source: NASA (2007), Sea Ice Yearly Minimum 1979-2007. Available at: http://svs.gsfc.nasa.gov/vis/a000000/a003400/a003464/index.html. These two images, constructed from satellite data, compare arctic sea ice concentrations in September of 1979 and 2007 (Images courtesy of NASA).

- For the period 1979–2008, Antarctic sea ice underwent a not statistically significant increase of 0.9% (~100,000 km^2; 42,000 mi^2) per decade (NSIDC, 2009a).

- The average sea ice thickness in the central Arctic has very likely decreased by up to 1 m from 1987 to 1997, based upon submarine-derived data. Model-based reconstructions support this finding, suggesting an Arctic-wide reduction of 24 to 35 inches (60 to 90 cm) over the same period (Lemke et al., 2007).

- Mountain glaciers and snow cover have declined on average in both hemispheres with evidence of acceleration in glacier decline in the last decade (Karl et al., 2009).
  - Though the studies cited by the IPCC (in Lemke et al., 2007) demonstrate widespread large-scale retreat of glacier tongues since the 1800s and mass losses since the 1960s (when mass loss measurements began), IPCC cautions records of directly measured glacier mass balances are few, and that there is high spatial and temporal variability in glacier trends. For example, it discusses glaciers along the coast of Norway and in the New Zealand Alps that advanced in the 1990s and started to shrink around 2000. It also notes that whereas glaciers in the high mountains of Asia have generally shrunk, several high glaciers in the central Karakoram are reported to have advanced and/or thickened at their tongues.

  - Northern hemisphere snow cover observed by satellite over the 1966–2005 period decreased in every month except November and December, with a stepwise drop of 5% in the annual mean in the late 1980s (Lemke et al., 2007). The NOAA-led *State of the Climate in 2008* report indicated the snow cover extent over the Northern Hemisphere in 2008 was 0.42 million square miles (1.1

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million km^2) less than the 39-year average, the fourth least extensive cover on record (Peterson and Baringer, 2009) In the Southern Hemisphere, the few long records or proxies mostly show either decreases or no changes in the past 40 years or more.

- The freeze-up date for river and lake ice has occurred later at a rate of 5.8 ± 1.6 days per century, averaged over available data for the Northern Hemisphere spanning the past 150 years. The breakup date has occurred earlier at a rate of 6.5 ± 1.2 days per century (Lemke et al., 2007).

- Temperatures at the top of the permafrost layer have generally increased since the 1980s in the Arctic (by up to 5°F [3°C]). The permafrost base has been thawing at a rate ranging up to 1.6 inches (4 cm) yr^{-1} in Alaska since 1992 and 0.8 inch (2 cm) yr^{-1} on the Tibetan Plateau since the 1960s. The maximum area covered by seasonally frozen ground has decreased by 7% in the Northern Hemisphere since 1900, with a decrease in spring of up to 15% (Lemke et al., 2007).

There are additional effects related to changes in the cryosphere. Melting of highly reflective snow and ice reveals darker land and ocean surfaces, creating a positive feedback that increases absorption of the sun's heat and further warms the planet. Increases in glacial melt and river runoff add more freshwater to the ocean, raising global sea level.

Hydrosphere

The term "hydrosphere" refers to the component of the climate system comprising liquid surface and subterranean water, such as rivers, lakes, and underground water. Several changes in these features have been observed, as summarized by the IPCC (Rosenzweig et al., 2007):

- Documented trends in severe droughts and heavy rains show that hydrological conditions are becoming more intense in some regions. Globally, very dry areas (Palmer Drought Severity Index—PDSI—less than or equal to -3.0) have more than doubled since the 1970s due to a combination of ENSO events and surface warming. Very wet areas (PDSI greater than or equal to +3.0) declined by about 5% since the 1970s, with precipitation as the major contributing factor during the early 1980s and temperature more important thereafter. The areas of increasing wetness include the Northern Hemisphere high latitudes and equatorial regions.

- Climate change signals related to increasing runoff and streamflow have been observed over the last century in many regions, particularly in basins fed by glaciers, permafrost, and snowmelt. Evidence includes increases in average runoff of Arctic rivers in Eurasia, which has been at least partly correlated with climate warming, and earlier spring snowmelt and increase in winter base flow in North America and Eurasia due to enhanced seasonal snow melt associated with climate warming.

- Freshwater lakes and rivers are experiencing increased water temperatures and changes in water chemistry. Surface and deep lake-waters are warming, with advances and lengthening of periods of thermal stability in some cases associated with physical and chemical changes such as increases in salinity and suspended solids, and a decrease in nutrient content. Lake formation and subsequent disappearance in permafrost have been reported in the Arctic.

- Changes in river discharge as well as in droughts and heavy rains in some regions indicate that hydrological conditions have become more intense but significant trends in floods and in evaporation and evapotranspiration have not been detected globally. Some local trends in reduced ground water and lake levels have been reported, but studies have been unable to separate the effects of variations

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in temperature and precipitation from the effects of human interventions such as ground water management (Rosenzweig et al., 2007).

Biosphere

According to the IPCC, terrestrial ecosystems and marine and freshwater systems show that recent warming is strongly affecting natural biological systems (very high confidence) (Rosenzweig et al., 2007):

- The overwhelming majority of studies of regional climate effects on terrestrial species reveal consistent responses to warming trends, including poleward and elevational range shifts of flora and fauna. Changes in abundance of certain species, including limited evidence of a few local disappearances, and changes in community composition over the last few decades have been attributed to climate change.

- Responses of terrestrial species to warming across the Northern Hemisphere are well documented by changes in the timing of growth stages, especially the earlier onset of spring events, migration, and lengthening of the growing season. Changes in phenology (the timing of annual phenomena of animal and plant life) include clear temperature-driven extension of the growing season by up to two weeks in the second half of the 20th century in mid- and high northern latitudes, mainly due to an earlier spring, but partly due also to a later autumn. Egg-laying dates have advanced in many bird species, and many small mammals have been found to come out of hibernation and to breed earlier in the spring now than they did a few decades ago.

- Many observed changes in phenology and distribution of marine species have been associated with rising water temperatures, as well as other climate-driven changes in salinity, oxygen levels, and circulation. For example, plankton has moved poleward by 10° latitude over a period of four decades in the North Atlantic. While there is increasing evidence for climate change impacts on coral reefs, discerning the impacts of climate-related stresses from other stresses (e.g., overfishing and pollution) is difficult. Warming of lakes and rivers is affecting abundance and productivity, community composition, phenology, distribution, and migration of freshwater species (high confidence).

4(j) U.S. Changes in Physical and Biological Systems

Many of the global changes in physical and biological systems mentioned in Section 4(i) broadly apply to the United States. Some U.S.-specific changes in these systems cited in the IPCC's *Fourth Assessment Report* are described in this subsection, as well as in Section 11(a) for physical systems related to water resources and Section 14(a) related to biological systems. Of all the observed changes to physical systems assessed by the IPCC (Rosenzweig et al., 2007) for North America (totaling 355), 94% of them were consistent with changes one would expect with average warming. Similar consistency was found between observed biological system changes and warming for North America (see discussion below under *Biosphere*).

Furthermore, a CCSP (2008e) assessment reported that climate changes are very likely already affecting U.S. water resources, agriculture, land resources, and biodiversity as a result of climate variability and change. It noted that "[t]he number and frequency of forest fires and insect outbreaks are increasing in the interior West, the Southwest, and Alaska. Precipitation, streamflow, and stream temperatures are increasing in most of the continental United States. The western United States is experiencing reduced snowpack and earlier peaks in spring runoff. The growth of many crops and weeds is being stimulated. Migration of plant and animal species is changing the composition and structure of arid, polar, aquatic, coastal, and other ecosystems" (Backlund et al., 2008a)

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Additional findings from this CCSP assessment along with results presented in IPCC's Fourth *Assessment Report* are described in the following sections.

Cryosphere (Snow and Ice)

In North America, from 1915 to 2004, snow-covered area increased in November, December, and January due to increases in precipitation. However, snow cover decreased during the latter half of the 20th century, especially during the spring over western North America (Lemke et al., 2007). Eight-day shifts towards earlier melt since the mid-1960s were also observed in northern Alaska (Lemke et al., 2007). Consistent with these findings, Lettenmaier et al. (2008) note a trend toward reduced mountain snowpack, and earlier spring snowmelt runoff peaks across much of the western United States.

The IPCC (Lemke et al., 2007) cites a study documenting glacier mass balance loss in the northwest United States and Alaska, with losses especially rapid in Alaska after the mid-1990s. Rosenzweig et al. (2007) refer to a study documenting evidence of present crustal uplift in response to recent glacier melting in Alaska.

Hydrosphere

Lettenmaier et al. (2008) document increases in U.S. streamflow during the second half of the 20th century consistent with increases in precipitation described in Section 4(e).

Rosenzweig et al. (2007) indicate surface water temperatures have warmed by 0.4 to 4°F (0.2 to 2°C) in lakes and rivers in North America since the 1960s. They also discuss evidence for an earlier occurrence of spring peak river flows and an increase in winter base flow in basins with important seasonal snow cover in North America.

Biosphere

The IPCC (Rosenzweig et al., 2007) assessed a multitude of studies that find changes in terrestrial ecosystems and marine and freshwater systems in North America. Of 455 biological observations assessed from these studies, 92% were consistent with the changes expected due to average warming.

Backlund et al. (2008a) find:

- There has been a significant lengthening of the growing season and increase in net primary productivity (NPP) in the higher latitudes of North America. Over the last 19 years, global satellite data indicate an earlier onset of spring across the temperate latitudes by 10 to 14 days.

- In an analysis of 866 peer-reviewed papers exploring the ecological consequences of climate change, nearly 60% of the 1,598 species studied exhibited shifts in their distributions and/or phenologies over the 20- and 140-year timeframe.

- Subtropical and tropical corals in shallow waters have already suffered major bleaching events that are clearly driven by increases in sea surface temperatures.

In addition, Ryan et al. (2008) note that "[c]limate change has very likely increased the size and number of forest fires, insect outbreaks, and tree mortality in the interior West, the Southwest, and Alaska."

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4(k) Global Extreme Events

Climate is defined not simply as average temperature and precipitation but also by the type, frequency, and intensity of extreme events. The IPCC documents observed changes in climate extremes related to temperature, precipitation, tropical cyclones, and sea level. The changes described apply generally to all parts of the globe, including the United States, although there are some regional and local exceptions due to patterns of natural climate variability. Current observations are summarized here, projected trends are covered in Section 6, and the sectoral impacts of these changes are covered as relevant in Sections 7 to 15.

Temperature

Widespread changes in extreme temperatures have been observed in the last 50 years. Cold days, cold nights, and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent (IPCC, 2007d). A widespread reduction in the number of frost days in mid-latitude regions, an increase in the number of warm extremes and a reduction in the number of daily cold extremes are observed in 70 to 75% of the land regions where data are available. The most marked changes are for cold nights (lowest 10%, based on 1961–1990), which have become rarer over the 1951–2003 period. Warm nights (highest 10%) have become more frequent.

Heavy Precipitation and Drought

Trenberth et al. (2007) note the following observed changes in drought and heavy precipitation events across the globe:

- More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics. Increased drying linked with higher temperatures and decreased precipitation has contributed to changes in drought. The regions where droughts have occurred seem to be determined largely by changes in sea surface temperatures (SSTs), especially in the tropics, through associated changes in the atmospheric circulation and precipitation. Decreased snowpack and snow cover have also been linked to droughts.

- It is likely that there have been increases in the number of heavy precipitation events[38] within many land regions, even in those where there has been a reduction in total precipitation amount, consistent with a warming climate and observed significant increasing amounts of water vapor in the atmosphere. Increases have also been reported for rarer precipitation events (1-in-50-year return period), but only a few regions have sufficient data to assess such trends reliably (Trenberth et al., 2007).

Storms

Trenberth et al (2007) find there has *likely* been a net increase in frequency and intensity of strong low-pressure systems (also known as mid-latitude storms and/or extratropical cyclones) over Northern Hemisphere land areas, as well as a poleward shift in track since about 1950. They caution, however, that detection of long-term changes in cyclone measures is hampered by incomplete and changing observing systems. They also note longer records for the northeastern Atlantic suggest that the recent extreme period may be similar in level to that of the late 19th century.

[38] Heavy precipitation events refer to those in the 95th percentile of precipitation events.

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The CCSP (2008i) report on extreme events, in its section on tropical cyclones (i.e., tropical storms and hurricanes), states that there have been spatially inhomogeneous increases in the power dissipation index, a measure of potential tropical cyclone destructiveness, over the last few decades (Kunkel et al., 2008). However, there remain reliability issues with historical data. Kunkel et al. (2008) refer to a study that was not able to corroborate the presence of upward intensity trends over the last two decades in ocean basins other than the North Atlantic. The report cautions that quantifying tropical cyclone variability is limited, sometimes seriously, by a large suite of problems with the historical record of tropical cyclone activity. Correspondingly, there is no clear trend in the annual numbers of tropical cyclones (IPCC, 2007d).

The IPCC (2007a; Trenberth et al., 2007) concluded there is insufficient evidence to determine whether trends exist in small-scale phenomena such as thunderstorms, tornadoes, hail, lightning and dust-storms.

High Sea Level

Apart from non-climatic events such as tsunamis, extreme sea levels occur mainly in the form of storm surges generated by tropical or extra-tropical cyclones. There is evidence for an increase in extreme high sea level since 1975 based upon an analysis of 99th percentiles of hourly sea level at 141 stations over the globe (Bindoff et al., 2007).

4(l) U.S. Extreme Events

Many of the global changes in extreme events mentioned in Section 4(k) broadly apply to the United States. Additionally, the U.S. CCSP (2008i) published a report that focused on changing climate extremes in the United States and North America. It concluded (Karl et al., 2008 in CCSP, 2008i):

> Many extremes and their associated impacts are now changing. For example, in recent decades most of North America has been experiencing more unusually hot days and nights, fewer unusually cold days and nights, and fewer frost days. Heavy downpours have become more frequent and intense. Droughts are becoming more severe in some regions, though there are no clear trends for North America as a whole. The power and frequency of Atlantic hurricanes have increased substantially in recent decades, though North American mainland land-falling hurricanes do not appear to have increased over the past century. Outside the tropics, storm tracks are shifting northward and the strongest storms are becoming even stronger.

Many of these changes were also assessed in IPCC's *Fourth Assessment Report* and are described in this subsection.

Temperature

The IPCC (Trenberth et al., 2007) cites North America regional studies that all show patterns of changes in temperature extremes consistent with a general warming. Since 1950, the annual percent of days exceeding the 90th, 95th, and 97.5 percentile thresholds for both maximum (hottest daytime highs) and minimum (warmest nighttime lows) temperature have increased when averaged over all of North America (Kunkel et al., 2008). Karl et al. (2008) conclude the number of heat waves (extended periods of extremely hot weather) has been increasing over the past 50 years. This conclusion is based on the following findings in Kunkel et al. (2008):

- There was a highly statistically significant increase in the number of U.S. heat waves (defined as warm spells of 4 days in duration with mean temperature exceeding the threshold for a 1 in 10 year event) for the period 1960 to 2005

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- The annual number of warm spells (defined as at least three consecutive days above the 90th percentile threshold done separately for maximum and minimum temperature) averaged over all of North America has increased since 1950.
- The heat waves of the 1930s remain the most severe in the U.S. historical record and suggest the intense drought of the period played a large role in the extreme heat by depleting soil moisture and reducing the moderating effects of evaporation.

Changes in cold extremes (days falling below the 10th, 5th, and 1st percentile threshold temperatures) show decreases, particularly since 1960 (Kunkel et al., 2008). Trenberth et al. (2007) cite a study finding intense warming of the lowest daily minimum temperatures over western and central North America. Trenberth et al. (2007) caution the observed changes of the tails of the temperature distributions are often more complicated than a simple shift of the entire distribution would suggest. Kunkel et al. (2008) find some evidence of a downward linear trend in cold waves (extended periods of cold) for the period 1895-2005, but note the trend is not statistically significant, largely owing to multi-decadal variabilty. But they find the very recent period from 1998-2007 exhibited fewer severe cold snaps than any other 10-year period in the historical record dating back to 1895. Kunkel et al. (2008) also indicate a decrease in frost days and a lengthening of the frost-free season over the past century.

Heavy Precipitation and Drought

In the contiguous United States, Trenberth et al. (2007) cite studies finding statistically significant increases in heavy precipitation (the heaviest 5%) and very heavy precipitation (the heaviest 1%) of 14 and 20%, respectively. The increase in the frequency and intensity of heavy downpours was responsible for most of the observed increase in overall precipitation (see Section 4e) during the last 50 years (Karl et al., 2009). Much of the increase in heavy precipitation occurred during the last three decades of the 20th century and is most apparent over the eastern parts of the country (Trenberth et al., 2007; Karl et al., 2009).). There is also evidence from Europe and the United States that the relative increase in precipitation extremes is larger than the increase in mean precipitation (Trenberth et al., 2007). In fact, Karl et al. report there has been little change in the frequency of light and moderate precipitation during the past 30 years.

Lettenmaier et al. (2008) state that "[w]ith respect to drought, consistent with streamflow and precipitation observations, most of the continental United States experienced reductions in drought severity and duration over the 20th century. However, there is some indication of increased drought severity and duration in the western and southwestern United States…." For the past 50 years, Dole et al. (2008) conclude: "It is *unlikely* that a systematic change has occurred in either the frequency or area coverage of severe drought over the contiguous United States from the mid-twentieth century to the present."

Diminishing snow pack and subsequent reductions in soil moisture appear to be factors in recent drought conditions in the western United States (Trenberth et al., 2007). This drought has also been attributed to changes in atmospheric circulation associated with warming of the western tropical Pacific and Indian oceans as well as multidecadal fluctuations (Trenberth et al., 2007).

Jansen et al. (2007) find (based on paleoclimate studies) that there have been periods over the past 2,000 years during which drought in North America was "more frequent, longer and/or geographically more extensive ... than during the 20th century." They indicate some evidence suggests droughts were particularly extensive, severe, and frequent during intervals characterized by warmer than average summer temperatures in the Northern Hemisphere.

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Storms

Karl et al. (2008) indicate a northward shift in the tracks of strong low-pressure systems (also known as mid-latitude storms and/or extratropical cyclones) in both the North Atlantic and North Pacific over the past fifty years with increases in storm intensity noted in the Pacific (data inconclusive in the Atlantic). Correspondingly, they also find northward shift in snow storm occurrence, which is also consistent with the warming temperatures and a decrease in snow cover extent over the United States.

Assessing trends in tropical cyclone (i.e., tropical storms and/or hurricanes) frequency and/or intensity is complicated by uncertainties in the observational record. Confidence in the tropical storm and hurricane record increases after 1900 and is greatest during the satellite era, from 1965 to present (Karl et al., 2009). IPCC (2007d) and Karl et al. (2009) report observational evidence of an increase in intense tropical cyclone activity in the North Atlantic (where cyclones develop that affect the U.S. East and Gulf Coasts) since about 1970, correlated with increases of tropical sea surface temperatures of nearly 2ºF (1□C) in the main Atlantic hurricane development region (Karl et al., 2009). The strongest hurricanes (Category 4 and 5) have, in particular, increased in intensity (Karl et al., 2009).

The total number of Atlantic hurricanes and strongest hurricanes observed from 1881 through 2008 shows multi-decade periods of above-average activity in the 1800s, the mid-1900s, and since 1995 (Karl et al., 2009). During this period, there has been little change in the total number of land-falling hurricanes (Karl et al., 2009).

As in hurricanes, there are significant uncertainties in assessing long-term trends in thunderstorms and tornadoes due to changing observing systems. Kunkel et al. (2008) conclude: "There is no evidence for a change in the severity of tornadoes and severe thunderstorms, and the large changes in the overall number of reports make it impossible to detect if meteorological changes have occurred."

High Sea Level

Studies of the longest records of extremes in sea level are restricted to a small number of locations. Consistent with global changes, U.S.-based studies document increases in extreme sea level closely following the rise in mean sea level (Bindoff et al., 2007).

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Section 5

Attribution of Observed Climate Change to Anthropogenic Greenhouse Gas Emissions at the Global and Continental Scale

This section addresses the extent to which observed climate change at the global and continental or national scale (described in Section 4) can be attributed to *global* anthropogenic emissions of GHGs. Section 2 describes the share of the U.S. transportation sector to U.S. and global anthropogenic emissions of GHGs, and the resultant share of U.S. transportation emissions to global increases in atmospheric concentrations of GHGs.

Evidence of the effect of anthropogenic GHG emissions on the climate system, as well as climate-sensitive systems and sectors, has increased over the last 15 years or so and even since the previous IPCC assessment published in 2001. The evidence in the recent IPCC *Fourth Assessment Re*port (IPCC, 2007a) is based on analyses of global- and continental-scale temperature increases, changes in other climate variables and physical and biological systems, and the radiative forcing caused by anthropogenic versus natural factors.

5(a) Attribution of Observed Climate Change to Anthropogenic Emissions

The attribution of observed climate change to anthropogenic activities is based on multiple lines of evidence. The first line of evidence arises from the basic physical understanding of the effects of changing concentrations of GHGs, natural factors, and other human impacts on the climate system. The second line of evidence arises from indirect, historical estimates of past climate changes that suggest that the changes in global surface temperature over the last several decades are unusual (Karl et al, 2009). The third line of evidence arises from the use of computer-based climate models to simulate the likely patterns of response of the climate system to different forcing mechanisms (both natural and anthropogenic). Confidence in these models comes from their foundation in accepted physical principles and from their ability to reproduce observed features of current climate and past climate changes (IPCC, 2007a). For additional discussion on the strengths and limitations of models, see Section 6(b). Attribution studies evaluate whether observed changes are consistent with quantitative responses to different forcings (from GHGs, aerosols, and natural forcings such as changes solar intensity) represented in well-tested models and are not consistent with alternative physically plausible explanations.

Studies to detect climate change and attribute its causes using patterns of observed temperature change show clear evidence of human influences on the climate system (Karl et al., 2006). Discernible human influences extend to additional aspects of climate including ocean warming, continental-average temperatures, temperature extremes, and wind patterns (Hegerl et al., 2007).

Temperature

IPCC statements on the linkage between GHGs and temperatures have strengthened since the organization's early assessments (Solomon et al., 2007). The IPCC's *First Assessment Rep*ort in 1990 contained little observational evidence of a detectable anthropogenic influence on climate (IPCC, 1990). In its *Second Assessment Report* in 1995, the IPCC stated the balance of evidence suggests a discernible human influence on the climate of the 20th century (IPCC, 1996). The *Third Assessment Report* in 2001 concluded that most of the observed warming over the last 50 years is likely to have been due to the increase in GHG concentrations (IPCC, 2001b). The conclusion in IPCC's 2007 *Fourth Assessment Report* (2007b) is the strongest yet:

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Most of the observed increase in global average temperatures since the mid-20th century is very likely[39] due to the observed increase in anthropogenic GHG concentrations.

The IPCC (Hegerl et al., 2007) finds that anthropogenic GHG emissions were one of the influences contributing to temperature rise during the early part of the 20th century along with increasing solar output and a relative lack of volcanic activity. During the 1950s and 1960s, when temperature leveled off, increases in aerosols from fossil fuels and other sources are thought to have cooled the planet. For example, the eruption of Mt. Agung in 1963 put large quantities of reflective dust into the atmosphere. The rapid warming since the 1970s has occurred in a period when the increase in GHGs has dominated over all other factors (Hegerl et al., 2007).

The increased confidence in the GHG contribution to the observed warming results from (Hegerl. et al., 2007):

- An expanded and improved range of observations allowing attribution of warming to be more fully addressed jointly with other changes in the climate system.
- Improvements in the simulation of many aspects of present mean climate and its variability on seasonal to inter-decadal time scales.
- More detailed representations of processes related to aerosol and other forcings in models.
- Simulations of 20th-century climate change that use many more models and much more complete anthropogenic and natural forcings.
- Multi-model ensembles that increase confidence in attribution results by providing an improved representation of model uncertainty.

Box 5.1: The Relationship Between GHG Concentrations and Temperature Over Geologic Time and Implications for Attribution of Recent Global Temperature Trends

Direct and proxy measurements of past changes in biological, chemical, and physical indicators provide a means of reconstructing key aspects of past climates. These measurements show that past climates have been both warmer and colder than present, and that warmer periods have generally coincided with high atmospheric CO_2 levels (Jansen et al., 2007). While sources of uncertainty including inexact age models and possible seasonal biases remain a factor in paleoclimatic studies, recent methodological advances in, for example, multi-proxy approaches have led to increasingly confident reconstructions (Jansen et al., 2007).

Climate reconstructions reaching back in time beyond the reach of ice cores (i.e., prior to about one million years ago) are uncertain, but generally verify that warmer climates are to be expected with increased GHG concentrations (Jansen et al., 2007). Jansen et al. (2007) report that the major expansion of Antarctic glaciations starting around 35 to 40 million years ago (Ma) was likely a response, in part, to declining atmospheric CO_2, and that the major glaciations around 300 Ma likely coincided with low CO_2 concentrations relative to the surrounding periods. The mid-Pliocene (about 3.3 to 3.0 Ma) is the most recent time in Earth's history when global mean temperatures were substantially warmer than present for a prolonged period. Temperatures for mid-Pliocene are estimated by General Circulation Models (GCMs) to have been about 4 to 5□F (2 to 3□C) above pre-industrial levels (Jansen et al., 2007).

The ice core record extends for approximately 800,000 years and allows for higher-confidence assessments compared to the more distant past. According to the IPCC (Jansen et al., 2007), "The ice core record indicates that GHG co-varied with Antarctic temperature over glacial-interglacial time scales, suggesting a close link between natural atmospheric GHG concentrations and temperature." Evidence strongly suggests that the timing of glacial-interglacial periods are paced by the variations in the orbit of the earth; however, the large response of the climate system implies a strong positive amplification of the initial orbital forcing (Jansen et al., 2007). Jansen et al. (2007)

[39] According to IPCC terminology, "very likely" conveys a 90 to 99% probability of occurrence. See Box 1.2 for a full description of IPCC's uncertainty terms.

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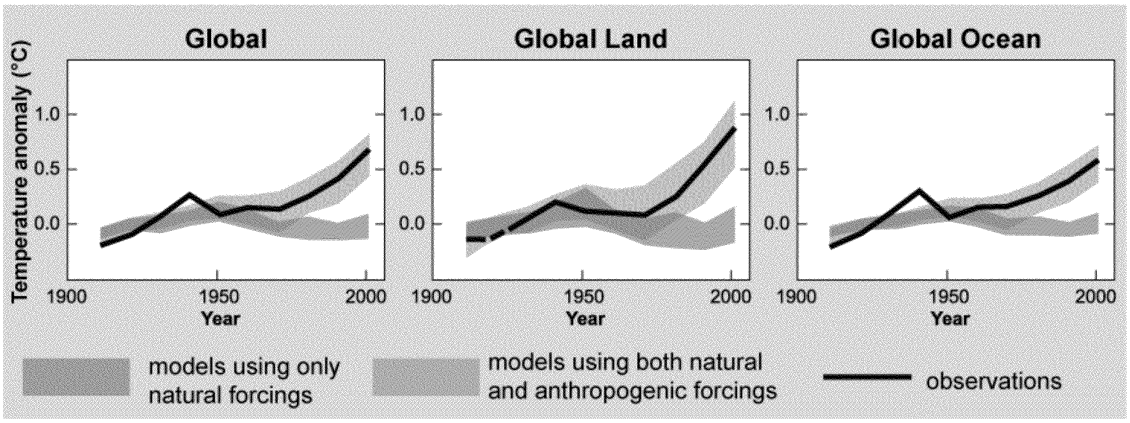
conclude: "It is *very likely* that glacial-interglacial CO_2 variations have strongly amplified climate variations, but it is *unlikely* that CO_2 variations have triggered the end of glacial periods. Antarctic temperatures started to rise several centuries before atmospheric CO_2 during past glacial terminations." CO_2 (and other GHG) changes over glacial to interglacial transitions, therefore, contribute to, but do not initiate, the temperature changes seen.

A variety of proxy records provide temporal and spatial information concerning climate change during the current interglacial, the Holocene, which began approximately 11.6 thousand years ago. Jansen et al. (2007) find evidence for local multi-centennial periods warmer than the last decades by up to several degrees in the early to mid-Holocene, but note that these local warm periods were very likely not globally synchronous and that the tendency for high-latitude summer temperature maxima to occur early in the Holocene (8,000-10,000 years ago) points to a direct influence of orbital forcing on temperature, rainfall, and sea ice extent. According to the IPCC (Jansen et al., 2007), current data limitations limit the ability to determine if there were multi-decadal periods of global warmth comparable to the last half of the 20th century prior to about 1,000 years ago.

The IPCC (Hegerl et al., 2007) reports that analyses of paleoclimate have increased confidence in the role of external influences on climate, and that key features of past climates have been reproduced by climate models using boundary conditions and radiative forcing for those periods.

Climate model simulations by the IPCC, shown in Figure 5.1, suggest natural forcings alone cannot explain the observed warming (for the globe, the global land and global ocean). The observed warming can only be reproduced with models that contain both natural and anthropogenic forcings.

Figure 5.1: Comparison of Observed Global-Scale Changes in Surface Temperature with Results Simulated by Climate Models Using Natural and Anthropogenic Forcings



Source: IPCC (2007d). Decadal averages of observations are shown for the period 1906 to 2005 (black line) plotted against the center of the decade and relative to the corresponding average for 1901to1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5 to 95% range for 19 simulations from five climate models to using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5–95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings.

Additional evidence documented in the IPCC report supports its statement linking warming to increasing concentrations of GHGs (Hegerl et al., 2007):

- Warming of the climate system has been detected in changes of surface and atmospheric temperatures, in the upper several hundred meters of the ocean (as evident by the observed increase in ocean heat content, see Section 4(f)), and in contributions to sea level rise. Attribution studies have established anthropogenic contributions to all of these changes.

- Analyses of paleoclimate data have increased confidence in the role of external influences on climate. Coupled climate models used to predict future climate have been used to reproduce key features of past climates using boundary conditions and radiative forcing for those periods.

The IPCC states that it is very unlikely that the global pattern of warming observed during the past half century is due to only known natural external causes (solar activity and volcanoes) since the warming occurred in both the atmosphere and ocean and took place when natural external forcing factors would likely have produced cooling (Hegerl et al., 2007). It also states GHG forcing alone would likely have resulted in warming greater than observed if there had not been an offsetting cooling effect from aerosols and natural forcings during the past half century (Hegerl et al., 2007). Solomon et al. (2007) and Karl et al. (2009) indicate the sum of solar and volcanic forcing in the past half century would likely have produced cooling, not warming.

Not only has an anthropogenic signal been detected for the surface temperatures, but evidence has also accumulated of an anthropogenic influence through the vertical profile of the atmosphere. Fingerprint studies[40] have identified GHG and sulfate aerosol signals in observed surface temperature records, a stratospheric ozone depletion signal in stratospheric temperatures, and the combined effects of these forcing agents in the vertical structure of atmospheric temperature changes (Karl et al., 2006). Karl et al. (2009) state that more recent studies have also found human fingerprints in the patterns of change in Arctic and Antarctic temperatures. However, an important inconsistency may have been identified in the tropics. In the tropics, most observational data sets show more warming at the surface than in the troposphere, while almost all model simulations have larger warming aloft than at the surface (Karl et al., 2006). Karl et al. (2009) state that when uncertainties in models and observations are properly accounted for, newer observational data sets are in agreement with climate model results.

The IPCC states that the substantial anthropogenic contribution to surface temperature increases likely applies to every continent except Antarctica (which has insufficient observational coverage to make an assessment) since the middle of the 20th century (Hegerl. et al., 2007). However, newer research led the USGCRP (Karl et al., 2009) to conclude that there are human fingerprints in the pattern of changes in Antarctic surface temperatures. Figure 5.2 indicates North America's observed temperatures over the last century can only be reproduced using model simulations containing both natural and anthropogenic forcings. In the CCSP (2008g) report *Reanalysis of Historical Climate Data for Key Atmospheric Features: Implications for Attribution of Causes of Observed Change*, Dole et al. (2008) find that for North America "more than half of this warming [for the period 1951–2006] is likely the result of human-caused GHG forcing of climate change."

[40] Fingerprint studies use rigorous statistical methods to compare the patterns of observed temperature changes with model expectations and determine whether or not similarities could have occurred by chance. Linear trend comparisons are less powerful than fingerprint analyses for studying cause-effect relationships but can highlight important differences and similarities between models and observations (as in Figures 5.1 and 5.2).

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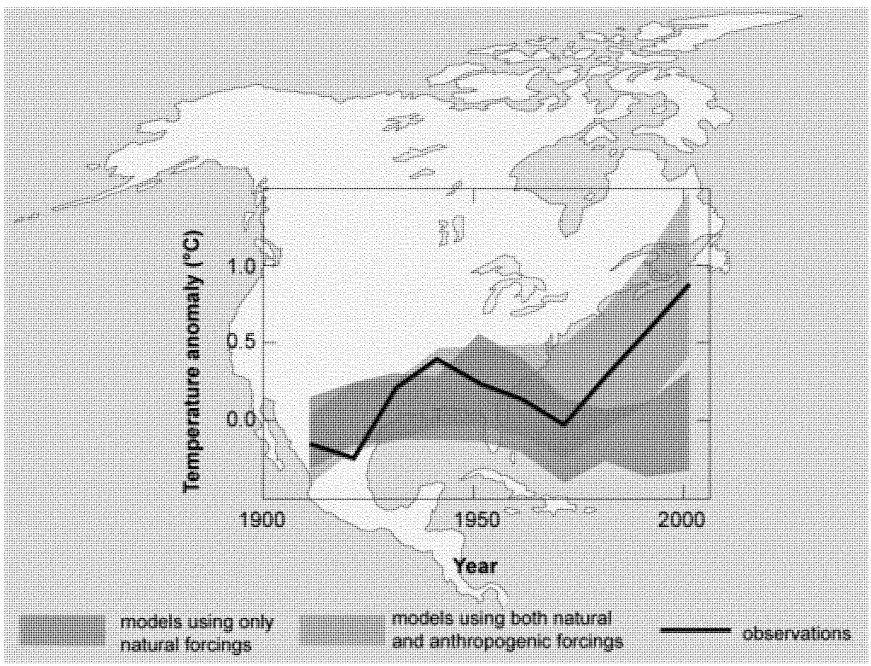
Temperature extremes have also likely been influenced by anthropogenic forcing. Many indicators of climate extremes, including the annual numbers of frost days, warm and cold days, and warm and cold nights, show changes that are consistent with warming (Hegerl et al., 2007). An anthropogenic influence has been detected in some of these indices, and there is evidence that anthropogenic forcing may have substantially increased the risk of extremely warm summer conditions regionally, such as the 2003 European heat wave (Hegerl et al., 2007). Karl et al. (2008) conclude the increase in human-induced emissions of GHGs is estimated to have substantially increased the risk of a very hot year in the United States, such as that experienced in 2006. They add that other aspects of observed increases in temperature extremes, such as changes in warm nights and frost days, have been linked to human influences.

Figure 5.2: Comparison of Observed North American Changes in Surface Temperature with Results Simulated by Climate Models Using Natural and Anthropogenic Forcings



Source: Hegerl et al. (2007). Decadal averages of observations are shown for the period 1906 to 2005 (black line) plotted against the center of the decade and relative to the corresponding average for 1901 to1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5 to 95% range for 19 simulations from five climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5 to 95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings.

The IPCC (Hegerl et al., 2007) cautions that difficulties remain in attributing temperature changes on smaller than continental scales and over time scales of less than 50 years. It states that attribution at these scales, with limited exceptions, has not yet been established. It further explains (Hegerl et al., 2007):

> Averaging over smaller regions reduces the natural variability less than does averaging over large regions, making it more difficult to distinguish between changes expected from different external forcings, or between external forcing and variability. In addition, temperature changes associated with some modes of variability are poorly simulated by models in some regions and seasons. Furthermore, the small-scale details of external forcing, and the response simulated by models are less credible than large-scale features.

Changes arising from internally generated variations in the climate system can influence surface and atmospheric temperatures substantially; however, climate models indicate that global-mean unforced variations on multidecadal timescales are likely to be smaller than the 20th century global-mean increase in surface temperature (Karl et al., 2006). The IPCC reports that global mean and hemispheric scale temperatures on multi-decadal time scales are largely controlled by external forcing (Hegerl et al., 2007).

Hegerl et al. (2007) note that "many observed changes in surface and free atmospheric temperature, ocean temperature, and sea ice extent, and some large-scale changes in the atmospheric circulation over the 20th century are distinct from internal variability and consistent with the expected response to anthropogenic forcing."

Additional Climate Variables

There is evidence of anthropogenic influence in other parts of the climate system. The IPCC and CCSP noted the following examples:

- Anthropogenic forcing has *likely* contributed to the recent decreases in Arctic sea ice extent while noting large-scale modes of variability contribute to interannual variations in ice formation (Hegerl et al., 2007). Karl et al. (2009) also state year-to-year changes in sea ice extent are influenced by natural variations but add that the observed decline in Arctic sea ice has been more rapid than projected by climate models, and clear linkages between rising GHG concentrations and declines in Arctic sea ice have been identified.

- It is very likely that the response to anthropogenic forcing contributed to sea level rise during the latter half of the 20th century. Models including anthropogenic and natural forcing simulate the observed thermal expansion since 1961 reasonably well. Anthropogenic forcing dominates the surface temperature change simulated by models and has likely contributed to the observed warming of the upper ocean and widespread glacier retreat (Hegerl et al., 2007).

- Hegerl et al. (2007) find trends over recent decades in the Northern and Southern Annular Modes[41], which correspond to sea level pressure reductions over the poles, are likely related in part to human activity, affecting storm tracks, winds, and temperature patterns in both hemispheres. Models reproduce the sign of the Northern Annular Mode trend, but the simulated response is smaller than observed. Models including both GHG and stratospheric ozone changes simulate a realistic trend in the Southern Annular Mode, leading to a detectable human influence on global sea level pressure patterns.

- According to the IPCC (Hegerl et al., 2007), a human influence has not been detected in global precipitation. However, the latitudinal pattern of change in land precipitation and observed increases in heavy precipitation over the 20th century appear to be consistent with the anticipated response to anthropogenic forcing. Karl et al. (2009) further state that increased extremes of summer dryness and winter wetness that have been observed are consistent with future projections of anthropogenic warming.

As with temperature, attributing changes in precipitation to anthropogenic forcing at continental or smaller scales is more challenging. One reason is that as spatial scales considered become smaller, the uncertainty becomes larger because internal climate variability is typically larger than the expected responses to forcing on these scales (Gutowski et al., 2008). For example, there is considerable evidence that modes of internal variability (such as ENSO, the Pacific Decadal Oscillation[42], and NAM)

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[41] Annular modes are preferred patterns of change in atmospheric circulation corresponding to changes in the zonally averaged mid-latitude westerly winds. The Northern Annular Mode has a bias to the North Atlantic and has a large correlation with the North Atlantic Oscillation (see footnote 48). The Southern Annular Mode occurs in the Southern Hemisphere.

[42] The Pacific Decadal Oscillation (PDO) is a pattern of Pacific climate variability that shifts phases on at least inter-decadal time scale, usually about 20 to 30 years. The PDO is detected as warm or cool surface waters in the Pacific

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substantially affect the likelihood of extreme temperature, droughts, and short-term precipitation extremes over North America (Gutowski et al., 2008).

Karl et al. (2008) find that heavy precipitation events averaged over North America have increased over the past 50 years at a rate higher than total precipitation increased, consistent with the observed increases in atmospheric water vapor, which have been associated with human-induced increases in GHGs. Clark et al. (2008) state that recent drought in the Southwest is consistent with projections of increasing subtropical aridity and recent trends in increasing precipitation intensity are also consistent with projected trends. However, Clark et al. caution that there is considerable natural variability in the hydroclimate in the Southwest and conclude that: "There is no clear evidence to date of human-induced global climate change on North American precipitation amounts."

Regarding tropical cyclones (i.e., hurricanes and tropical storms), the IPCC (Hegerl et al., 2007) finds it is more likely than not that anthropogenic influence has contributed to increases in the frequency of the most intense storms. However, the IPCC (Hegerl et al., 2007) cautions that detection and attribution of observed changes in hurricane intensity or frequency due to external influences remains difficult because of deficiencies in theoretical understanding of tropical cyclones, their modeling, and their long-term monitoring. In the Atlantic basin, Gutowski et al. (2008, as cited in the CCSP, 2008i) likewise find evidence suggesting a human contribution to recent tropical cyclone activity in the Atlantic basin. Similar to IPCC, they caution that a confident assessment of human influence on hurricanes will require further studies using models and observations, with emphasis on distinguishing natural from human-induced changes in hurricane activity through their influence on factors such as historical sea surface temperatures, wind shear, and atmospheric vertical stability.

An anthropogenic influence has not yet been detected in extra-tropical cyclones owing to large internal variability and problems due to changes in observing systems (Hegerl et al., 2007).

5(b) Attribution of Observed Changes in Physical and Biological Systems

In addition to attributing the observed changes in average global- and continental-scale temperature and other climate variables to anthropogenic GHG forcing, a similar attribution can be made between anthropogenic GHG forcing and observed changes in physical systems (e.g., melting glaciers) and biological systems and species (e.g., geographic shift of species), which are shown to change as a result of recent warming.

This section includes the observed changes in physical and biological systems in North America and in other parts of the world.

The IPCC (2007b) concluded that "[o]bservational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases." Furthermore, the IPCC states that "[a] global assessment of data since 1970 has shown it is likely that anthropogenic warming has had a discernible influence on many physical and biological systems." As detailed in Section 5(a), recent warming of the last 50 years is very likely the result of the accumulation of anthropogenic GHGs in the atmosphere.

Climate variability and non-climate drivers (e.g., land-use change, habitat fragmentation) need to be considered in order to make robust conclusions about the role of anthropogenic climate change in affecting biological and physical systems. The IPCC (Rosenzweig et al., 2007) reviewed a number of

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Ocean, north of 20° N. During a "warm", or "positive", phase, the west Pacific becomes cool and part of the eastern ocean warms; during a "cool" or "negative" phase, the opposite pattern occurs.

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joint attribution studies that linked responses in some physical and biological systems directly to anthropogenic climate change using climate, process, and statistical models. The conclusion of these studies is that "the consistency of observed significant changes in physical and biological systems and observed significant warming across the globe likely cannot be explained entirely due to natural variability or other confounding non-climate factors (Rosenzweig et al., 2007)."

The physical systems undergoing significant change include the cryosphere (snow and ice systems), hydrological systems, water resources, coastal zones and the oceans. These effects (reported with high confidence by the IPCC (Rosenzweig et al., 2007) include ground instability in mountain and permafrost regions, a shorter travel season for vehicles over frozen roads in the Arctic, enlargement and increase of glacial lakes in mountain regions and destabilization of moraines damming these lakes, changes in Arctic flora and fauna including the sea-ice biomes and predators higher in the food chain, limitations on mountain sports in lower-elevation alpine areas, and changes in indigenous livelihoods in the Arctic.

Backlund et al. (2008a) specifically note: "There is a trend toward reduced mountain snowpack and earlier spring snowmelt runoff peaks across much of the western United States. This trend is very likely attributable at least in part to long-term warming, although some part may have been played by decadal-scale variability, including a shift in the phase of the Pacific Decadal Oscillation in the late 1970s."

Regarding biological systems, the IPCC (Rosenzweig et al., 2007) reports with very high confidence that the overwhelming majority of studies of regional climate effects on terrestrial species reveal trends consistent with warming, including poleward and elevational range shifts of flora and fauna; the earlier onset of spring events, migration, and lengthening of the growing season; changes in abundance of certain species, including limited evidence of a few local disappearances; and changes in community composition.

Human system responses to climate change are more difficult to identify and isolate due to the larger role that non-climate factors play (e.g., management practices in agriculture and forestry, and adaptation responses to protect human health against adverse climatic conditions) (Rosenzweig et al., 2007).

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Section 6

Projected Future Greenhouse Gas Concentrations and Climate Change

According to the IPCC (2007d), "continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely[43] be larger than those observed during the 20th century." This section describes future GHG emissions scenarios, the associated changes in atmospheric concentrations and radiative forcing, and the resultant changes in temperature, precipitation and sea level at global and U.S. scales.

Scenarios are story lines regarding possible futures. These storylines are designed to be internally consistent in their assumptions regarding population and economic growth, implementation of policies, technology change and adoption, and other factors that will influence emissions. Scenarios are not predictions of the future but are used to illustrate how the future might look if a given set of events occurred and policies implemented. All future GHG emissions scenarios described in this section assume no new explicit GHG mitigation policies—neither in the United States nor in other countries—beyond those which were already enacted at the time the scenarios were developed. Future risks and impacts associated with the climate change projections are addressed in Part IV for domestic impacts and Part V for impacts in other regions of the world.

6(a) Global Emission Scenarios and Associated Changes in Concentrations and Radiative Forcing

Greenhouse Gas Emissions

As described in Section 4(a), a number of different GHGs and other factors, including aerosols, cause radiative forcing changes and thus contribute to climate change. This section discusses the range of published global reference (or baseline) future emission projections for which no explicit GHG mitigation policies beyond those currently enacted are assumed.

The IPCC's most recent future climate change projections from the *Fourth Assessment Report* (IPCC, 2007a) (discussed in Section 6(b)) are based on the GHG emissions scenarios from the IPCC *Special Report on Emissions Scenarios (SRES)* (IPCC, 2000). Box 6.1 provides background information on the different SRES emissions scenarios. The SRES developed a range of long-term (to the year 2100) global reference scenarios for the major GHGs directly emitted by human activities and for some aerosols. The IPCC SRES scenarios do not explicitly account for implementation of the Kyoto Protocol. Figure 6.1 presents the global IPCC SRES projections for the two most significant anthropogenic GHGs: CO_2 emissions primarily from the burning of fossil fuels, and CH_4 emissions.

[43] According to IPCC terminology, "very likely" conveys a 90 to 99% probability of occurrence. See Box 1.2 for a full description of IPCC's uncertainty terms.

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Box 6.1: IPCC Reference Case Emission Scenarios from the Special Report on Emission Scenarios (SRES)

A1. The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building, and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B) (where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end-use technologies).

A2. The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in a continuously increasing population. Economic development is primarily regionally oriented, and per capita economic growth and technological change is more fragmented and slower than other storylines.

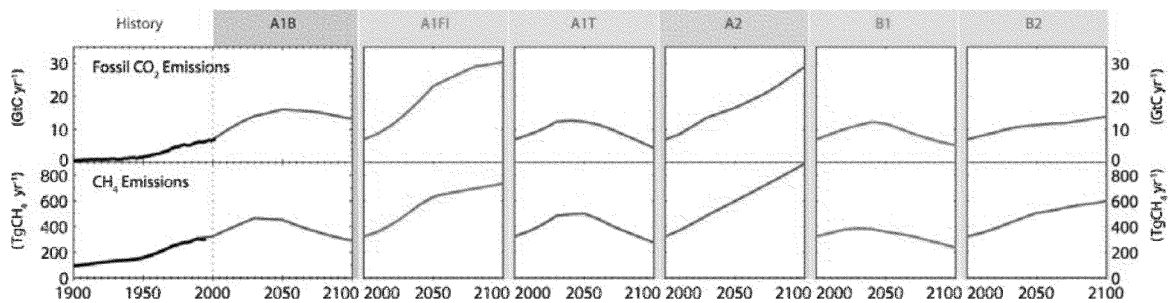
B1. The B1 storyline and scenario family describes a convergent world with the same global population that peaks in mid-century and declines thereafter as in the A1 storyline, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives.

B2. The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with continuously increasing global population (at a rate lower than A2), intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels.

An illustrative scenario was chosen for each of the six scenario groups-A1B, A1FI, A1T, A2, B1 and B2. All should be considered equally sound.

The SRES scenarios do not include additional climate initiatives, which means that no scenarios are included that explicitly assume implementation of the United Nations Framework Convention on Climate Change or the emission targets of the Kyoto Protocol.

Figure 6.1: Observed, and Projected Global CO_2 and CH_4 Emissions for the IPCC SRES Scenarios



Source: Meehl et al. (2007). Projected fossil CO_2 and CH_4 emissions for six illustrative SRES non-mitigation emissions scenarios. Historical emissions (black lines) are shown for fossil and industrial CO_2, and for CH_4.

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The main drivers of emissions are population, economic growth, technological change, and land-use activities including deforestation. The detailed underlying assumptions (including final and primary energy by major fuel types) across all scenarios, and across all modeling teams that produced the scenarios, can be found in IPCC (2000). The range of GHG emissions in the scenarios widen over time to reflect uncertainties in the underlying drivers. Similar future GHG emissions can result from different socio-economic developments. The IPCC (2000) SRES did not assign probabilities or likelihood to the scenarios, as it was stated that there is no single most likely, central, or best-guess scenario, either with respect to SRES scenarios or to the underlying scenario literature. This is why IPCC (2000) has recommended using a range of SRES scenarios with a variety of underlying assumptions for use in analysis.

Despite the range in future emissions scenarios, the majority of all reference-case scenarios project an increase of GHG emissions across the century and show that CO_2 remains the dominant GHG over the course of the 21st century. For 2030, projections of the six key GHGs (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6) consistently show an increase of 25-90% compared with 2000, with more recent projections higher than earlier ones. Total *cumulative* (1990 to 2100) CO_2 emissions across the SRES scenarios range from 2,826 gigatonnes of CO_2 ($GtCO_2$) (or 770 GtC) to approximately 9,322 $GtCO_2$ (or 2,540 GtC) (IPCC, 2007c).[44]

Since the IPCC SRES (2000), new scenarios have been published in the literature. The emissions scenario range from the recent literature is similar to the range in the IPCC SRES. The IPCC (2007c) reported that baseline annual emissions scenarios published since SRES are comparable in range to those presented in the SRES scenarios (25 to 135 GtCO2eq per year in 2100). Studies since SRES used lower values for some drivers for emissions, notably population projections. However, for those studies incorporating these new population projections, changes in other drivers, such as economic growth, resulted in little change in overall emission levels (IPCC, 2007c).

For comparison, Figure 6.2 provides global projections of CO_2 emissions from the burning of fossil fuels and industrial sources from the three reference-case scenarios developed by the CCSP (CCSP, 2007b). Box 6.2 provides background information on the reference case scenarios developed by the CCSP. The CCSP scenarios, because they were developed more recently than the IPCC SRES scenarios, account for the implementation of the Kyoto Protocol for participating countries but no explicit GHG mitigation policies beyond the Kyoto Protocol. Emissions in 2100 are approximately 88 $GtCO_2$ (24 GtC). This level of emissions is above the post-SRES IPCC median of 60 $GtCO_2$ (16 GtC) but well within the 90th percentile of the IPCC range. The three reference scenarios developed by CCSP display a larger share of emissions growth outside of the Annex I nations.

[44] 1 gigatonne (Gt) = 1 billion metric tons.

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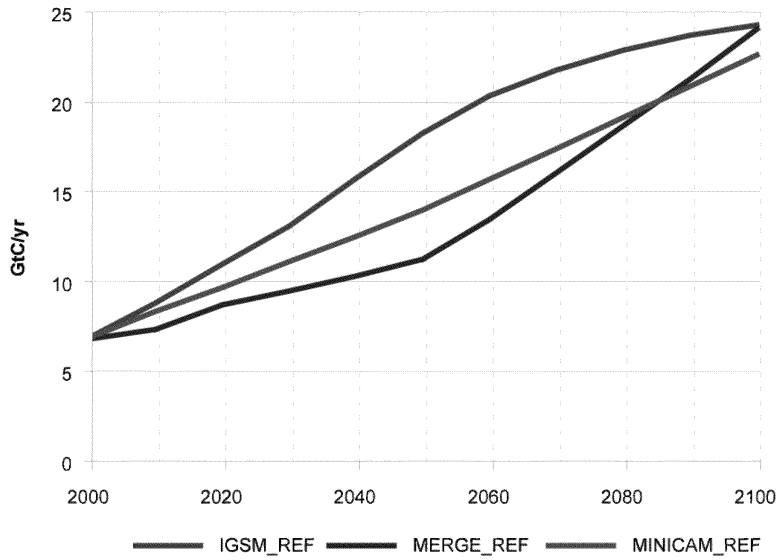
Figure 6.2: Projected Global Emissions of CO_2 from Fossil Fuels and Industrial Sources Across CCSP Reference Scenarios



Source: CCSP (2007b). Global emissions of CO_2 from fossil fuel combustion and other industrial sources, mainly cement production, increase over the century in all three reference scenarios. By 2100 emissions reach 22.5 GtC yr^{-1} to 24.0 GtC yr^{-1}.

Box 6.2: CCSP (2007b) Reference Case Emission Scenarios from Synthesis and Assessment Product 2.1

The scenarios in this report were developed using three integrated assessment models (IAMs). These models integrate socioeconomic and technological determinants of the emissions of GHGs with models of the natural science of earth system response, including the atmosphere, oceans, and terrestrial biosphere. The three IAMs used are:

- The Integrated Global Systems Model (IGSM) of the Massachusetts Institute of Technology's Joint Program on the Science and Policy of Global Change.
- The Model for Evaluating the Regional and Global Effects (MERGE) of GHG reduction policies developed jointly at Stanford University and the Electric Power Research Institute.
- The MiniCAM Model of the Joint Global Change Research Institute, a partnership between the Pacific Northwest National Laboratory and the University of Maryland. The MiniCAM model was also used to generate IPCC SRES scenarios.

Each modeling group produced a reference scenario under the assumption that no climate policies are imposed beyond current commitments, namely the 2008-2012 first period of the Kyoto Protocol and the U.S. goal of reducing GHG emissions per unit of its gross domestic product by 18% by 2012. The resulting reference cases are not predictions or best-judgment forecasts, but scenarios designed to provide clearly defined points of departure for studying the implications of alternative stabilization goals. The modeling teams used model input assumptions they considered *meaningful and plausible*. The resulting scenarios provide insights into how the world might evolve without additional efforts to constrain GHG emissions, given various assumptions about principal drivers of these emissions, such as population increase, economic growth, land and labor productivity growth, technological options, and resource endowments.

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Figure 6.3 illustrates reference case emission projections for CO_2, CH_4, N_2O, and the fluorinated gases in aggregate (HFCs, PFCs, and SF_6 or "F-gases"). The emission projections in Figure 6.3 are from the 21st Study of Stanford University's Energy Modeling Forum (EMF) on multigas mitigation, as referenced by Fisher et al. (2007). Eighteen models participated in the EMF-21 study and the emission ranges in Figure 6.3 are representative of the literature. The broad ranges of EMF-21 emission projections in Figure 6.3, especially for N_2O and the fluorinated gases, illustrate the uncertainties in projecting these future emissions, which is generally consistent with the range found in SRES.

Emissions of ozone-depleting substances controlled under the Montreal Protocol (including CFCs and HCFCs) increased from a low level in 1970 to about 7.5 $GtCO_2$ in 1990, but then decreased to about 1.5 $GtCO_2$ in 2004, and are projected to decrease further due to the phase-out of CFCs in developing countries (IPCC, 2007c).

Modeling groups have developed a multiplicity of projections for the emissions of aerosol species. Within the IPCC process, all the SRES scenarios specified sulfate emissions. The inclusion, magnitude, and temporal evolution of other forcing agents such as nitrates and carbonaceous aerosols were left to the discretion of the individual modeling groups. There are still large uncertainties associated with current inventories of black carbon and organic carbon and the ad hoc scaling methods used to produce future emissions, and considerable variation among estimates of the optical properties of carbonaceous aerosols. Given these uncertainties, future projections of forcing by black carbon and organic carbon are quite dependent on the model and emissions assumptions (Meehl et al., 2007). Similarly, the CCSP (2008d) concluded that one of the most important uncertainties in characterizing the potential climate impact of aerosols is the projection of their future emissions.

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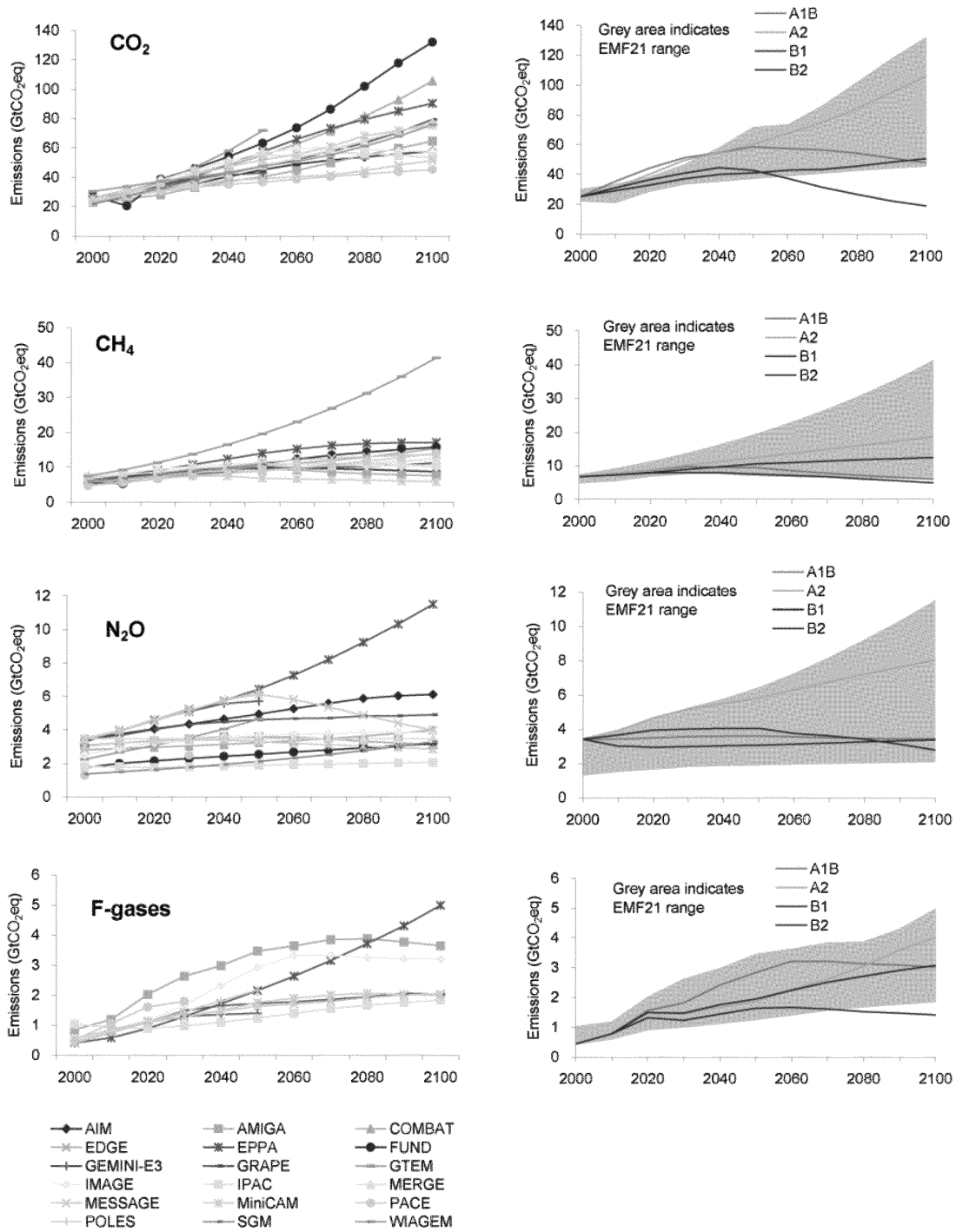
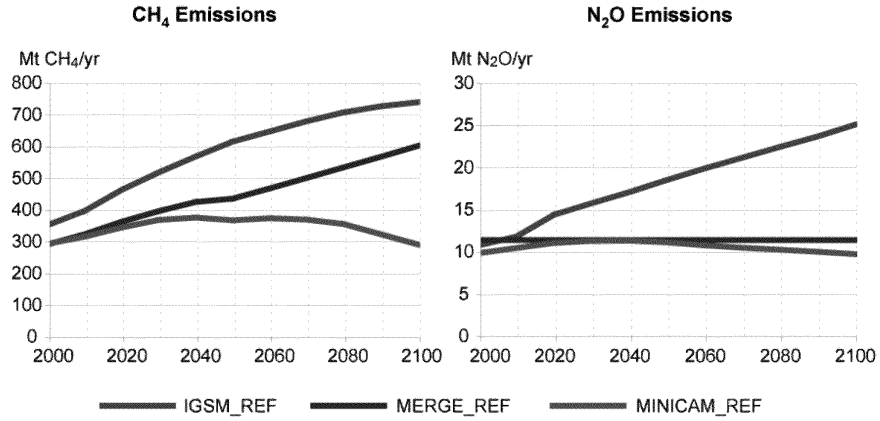
Figure 6.3: EMF-21 and IPCC Global Emission Projections for CO_2, CH_4, N_2O, and the Fluorinated Gases



Source: CCSP (2007b). Development of baseline emissions in EMF-21 scenarios developed by a number of different modeling teams (left) and a comparison between EMF-21 and SRES scenarios (right).

For comparison, Figure 6.4 provides the global CH_4 and N_2O projections from the three CCSP reference-case scenarios (CCSP, 2007b).

Figure 6.4: Projected Global CH_4 and N_2O Emissions Across Three CCSP Reference Scenarios



Source: CCSP (2007b). Global anthropogenic emissions of CH_4 and N_2O vary widely among the reference scenarios. There is uncertainty in CH_4 emissions for 2000, with MIT's IGSM reference scenario ascribing more of the emissions to human activity and less to natural sources. Differences in scenarios reflect, to a large extent, different assumptions about whether current emission rates will be reduced significantly for other reasons (for example, whether higher natural gas prices will stimulate capture of CH_4 for use as a fuel.)

Future Concentration and Radiative Forcing Changes

For a given emission scenario, various biogeochemical models are used to calculate concentrations of constituents in the atmosphere and various radiation schemes and parameterizations are required to convert these concentrations to radiative forcing. The formulation of, and interaction with, the carbon cycle in climate models also introduces important feedbacks. Uncertainty arises at each of these steps (Meehl et al. 2007). Historically, the airborne fraction of CO_2 (the increase of CO_2 concentrations relative to the emissions from fossil fuel and cement production) has shown no long term trend though it does vary from year to year mainly due to the effect of interannual variability in land uptake (Denman et al., 2007). However, for future projections, Meehl et al. (2007) found "unanimous agreement among the coupled climate carbon cycle models driven by emission scenarios run so far that future climate change would reduce the efficiency of the Earth system (land and ocean) to absorb anthropogenic CO_2. As a result, an increasingly large fraction of anthropogenic CO_2 would stay airborne in the atmosphere under a warmer climate."

Figure 6.5 shows the latest IPCC projected increases in atmospheric CO_2, CH_4, and N_2O concentrations for the SRES scenarios, and Figure 6.6 shows the associated radiative forcing for these CO_2 scenarios. In general, reference concentrations of CO_2 and other GHGs are projected to increase. Concentrations of long-lived gases increase even for those scenarios where annual emissions toward the end of the century are assumed to be lower than current annual emissions. The CCSP scenarios show a similar picture of how atmospheric concentrations of the main GHGs and total radiative forcing change over time.

CO_2 is projected to be the largest contributor to total radiative forcing in all periods, and the radiative forcing associated with CO_2 is projected to be the fastest growing. The radiative forcing associated with the non-CO_2 GHGs is still significant and growing over time.

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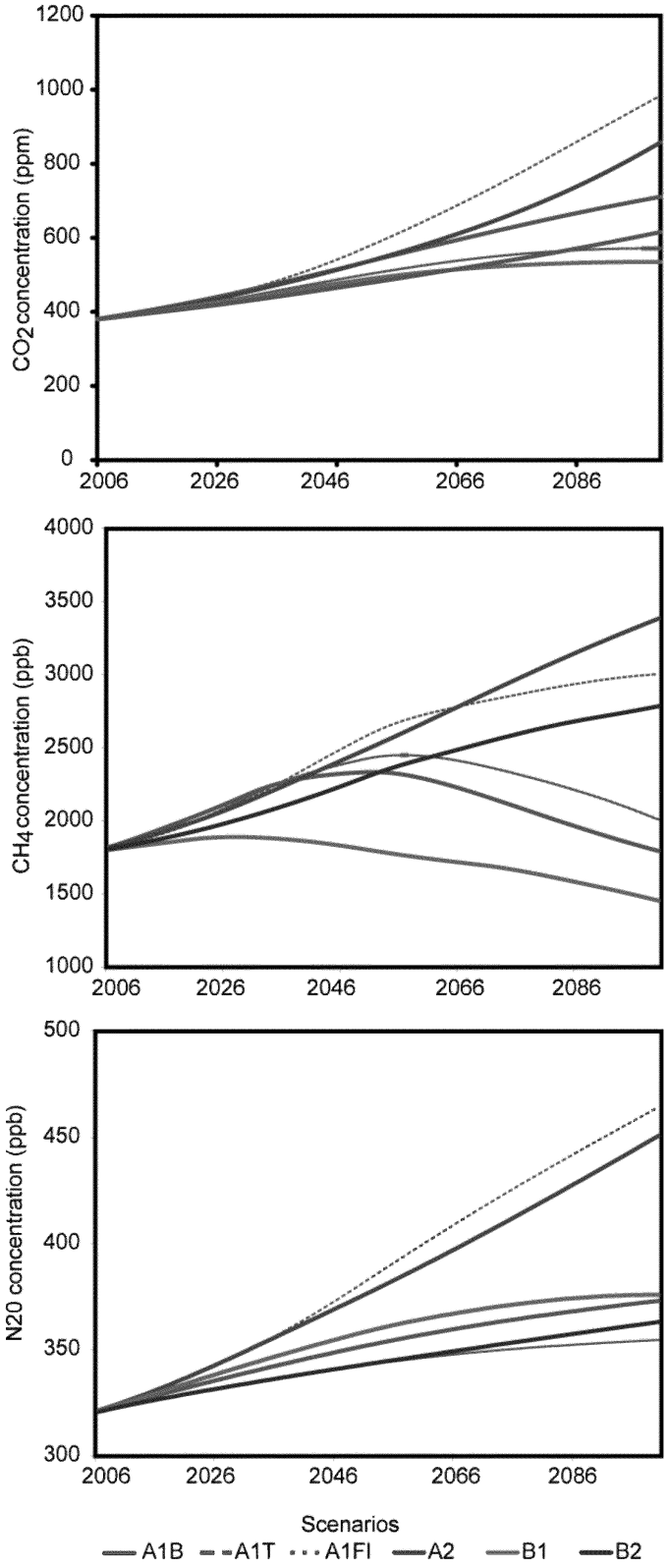
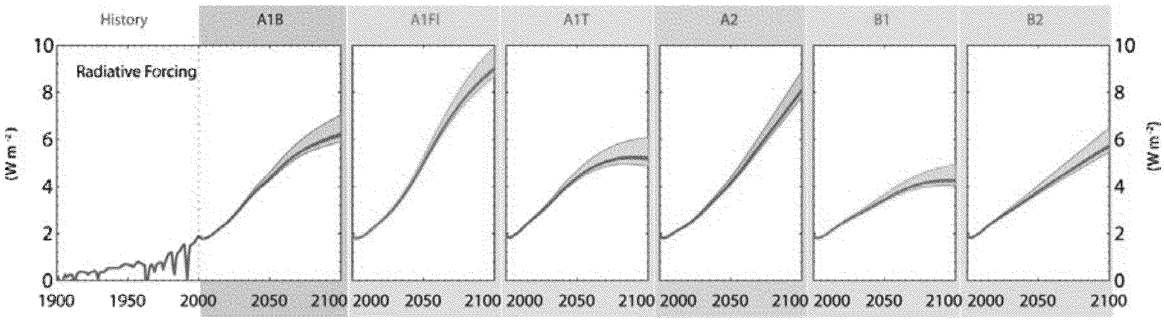
Figure 6.5: Projected Global CO_2, CH_4 and N_2O Concentrations for the IPCC SRES Scenarios



Source: Meehl et al. (2007). Projected fossil CO_2, CH_4, and N_2O concentrations for six illustrative SRES non-mitigation emissions scenarios as produced by a simple climate model tuned to 19 atmosphere-ocean general circulations models (AOGCMs).

Figure 6.6: Projected Radiative Forcing from CO_2 for the IPCC SRES Scenarios



Source: Meehl et al. (2007). Projected radiative forcing from CO_2 for six illustrative SRES non-mitigation emissions scenarios as produced by a simple climate model tuned to 19 AOGCMs. The lighter shaded areas depict the change in this uncertainty range, if carbon cycle feedbacks are assumed to be lower or higher than in the medium setting.

6(b) Projected Changes in Global Temperature, Precipitation Patterns, Sea Level Rise, and Ocean Acidification

Using the emissions scenarios described in Section 6(a), computer models project future changes in temperature, precipitation, and sea level at global and regional scales. According to the IPCC (Meehl at al., 2007):

"[C]onfidence in models comes from their physical basis, and their skill in representing observed climate and past climate changes. Models have proven to be extremely important tools for simulating and understanding climate, and there is considerable confidence that they are able to provide credible quantitative estimates of future climate change, particularly at larger scales. Models continue to have significant limitations, such as in their representation of clouds, which lead to uncertainties in the magnitude and timing, as well as regional details, of predicted climate change. Nevertheless, over several decades of model development, they have consistently provided a robust and unambiguous picture of significant climate warming in response to increasing greenhouse gases."[45]

Confidence decreases in changes projected by global models at smaller spatial scales. Many important small-scale processes cannot be represented explicitly in models and so must be included in approximate form as they interact with larger-scale features (Randall et al., 2007). Some of the most challenging aspects of understanding and projecting regional climate changes relate to possible changes in the circulation of the atmosphere and oceans, and their patterns of variability (Christensen et al., 2007). Nonetheless, the IPCC (2007d) concluded that recent advances in regional-scale modeling lead to higher confidence in projected patterns of warming and other regional-scale features, including changes in wind patterns, precipitation, and some aspects of extremes and of ice.

The CCSP (2008c) report *Climate Models: An Assessment of Strengths and Limitations* finds that models "have been steadily improving over the past several decades," "show many consistent features in their simulations and projections for the future," and "are able to simulate the recorded 20th century global mean temperature in a plausible way." However, it cautions that projections of precipitation in some

[45] A number of climate models are developed and run at academic institutions and government-supported research laboratories in the United States and other countries. The IPCC helps coordinate modeling efforts to facilitate comparisons across models and synthesizes results published by several modeling teams.

cases remain "problematic" (especially at the regional scale) and that "uncertainties in the climatic effects of manmade aerosols (liquid and solid particles suspended in the atmosphere) constitute a major stumbling block" in certain modeling experiments. It adds that "uncertainties related to clouds increase the difficulty in simulating the climatic effects of aerosols, since these aerosols are known to interact with clouds and potentially can change cloud radiative properties and cloud cover."

Global Temperature

The latest IPCC assessment uses a larger number of simulations available from a broader range of models to project future climate relative to earlier assessments (IPCC, 2007d). All of the simulations performed by the IPCC project warming for the full range of emissions scenarios.

For the next two decades, a warming of about 0.4°F (0.2°C) per decade is projected for a range of SRES emissions scenarios (IPCC, 2007d). Even if the concentrations of all GHGs and aerosols had been kept constant at year 2000 levels (see the "Year 2000 Constant Concentrations" scenario in Figure 6.7), a further warming of about 0.2°F (0.1°C) per decade would be expected because of the time it takes for the climate system, particularly the oceans, to reach equilibrium (with year 2000 GHG levels). Through about 2030, the warming rate is mostly insensitive to choices between the SRES A2, A1B, or B1 scenarios and is consistent with that observed for the past few decades. Possible future variations in natural forcings (e.g., a large volcanic eruption) could change these values somewhat (Meehl et al., 2007). Large changes in emissions of short-lived gases could also have a near-term effect on temperatures, especially on the regional scale (CCSP, 2008d).

According to IPCC (see Figure 6.7), by mid-century (2046–2065), the choice of scenario becomes more important for the magnitude of the projected warming, with average values of 2.3°F (1.3°C), 3.2°F (1.8°C), and 3.1°F (1.7°C) from the models for scenarios B1 (low-emission growth), A1B (medium-emission growth) and A2 (high-emission growth), respectively (Meehl et al., 2007). About a third of that warming is projected to be due to climate change that is already committed (as shown in the "Year 2000 Constant Concentrations" scenario). By the 2090–2099 period (relative to the 1980–1999 range), projected warming varies significantly by emissions scenario. The full suite of SRES scenarios (given below) provides a warming range of 3.2°F to 7.2°F (1.8°C to 4.0°C) with an uncertainty range of 2.0°F to 11.5°F (1.1°C to 6.4°C). The multi-model average warming and associated uncertainty ranges for the 2090–2099 period (relative to 1980–1999) for each scenario, as illustrated in Figure 6.7 are shown in Table 6.1:

Table 6.1: Multi-model Average warming for the 2090-2099 Period

Scenario	Average Global Warming by End of Century Relative to ~1990	Uncertainty Range
B1	3.2°F (1.8°C)	2.0°F to 5.2°F (1.1°C to 2.9°C)
A1T	4.3°F (2.4°C)	2.5°F to 6.8°F (1.4°C to 3.8°C)
B2	4.3°F (2.4°C)	2.5°F to 6.8°F (1.4°C to 3.8°C)
A1B	5.0°F (2.8°C)	3.1°F to 7.9°F (1.7°C to 4.4°C)
A2	6.1°F (3.4°C)	3.6°F to 9.7°F (2.0°C to 5.4°C)
A1FI	+7.2°F (+4.0°C)	4.3°F to 11.5°F (2.4°C to 6.4°C)

The wide range of uncertainty in these estimates reflects the different assumptions about future concentrations of GHGs and aerosols in the various scenarios considered by the IPCC and the differing climate sensitivities of the various climate models used in the simulations (NRC, 2001a; Meehl et al., 2007; Karl et al., 2009).

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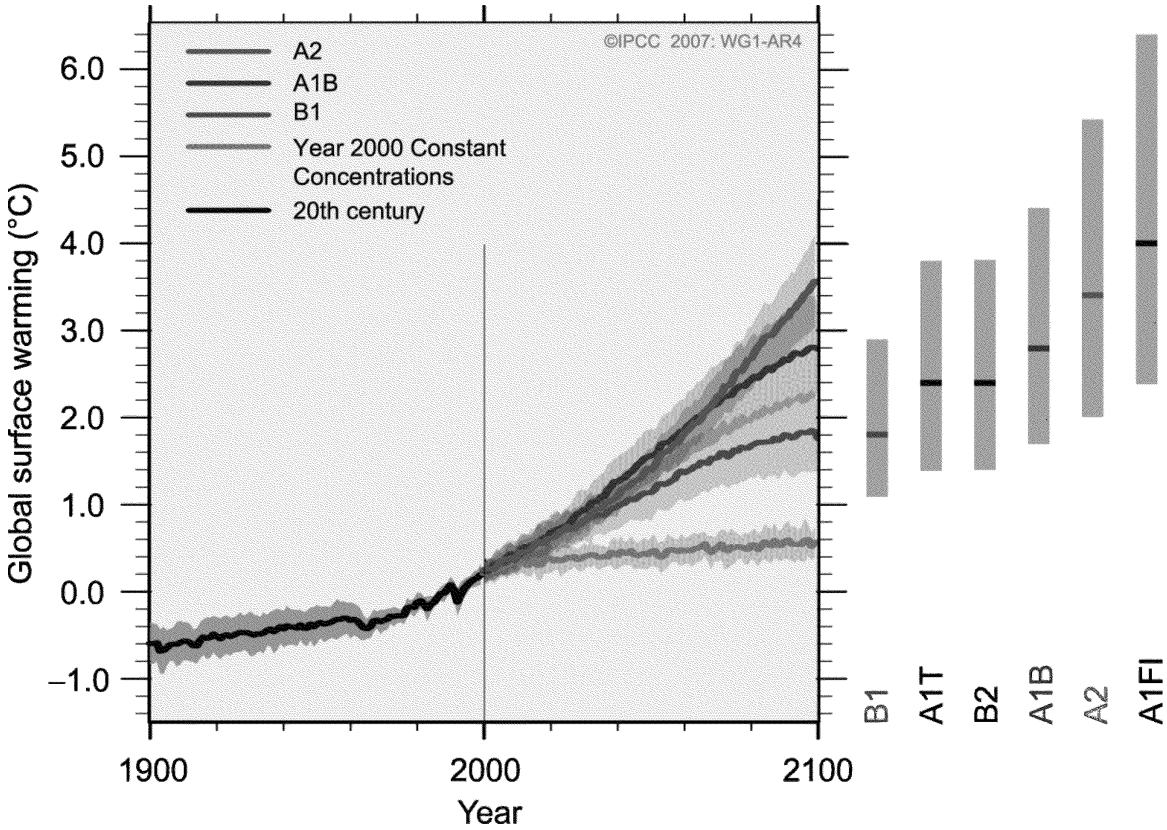
Figure 6.7: Multi-Model Averages and Assessed Ranges for Surface Warming



Source: IPCC (2007d). Solid lines are multi-model global averages of surface warming (relative to 1980–1999) for the scenarios A2, A1B, and B1, shown as continuations of the 20th century simulations. Shading denotes the ±1 standard deviation range of individual model annual averages. The orange line is for the experiment where concentrations were held constant at 2000 values. The grey bars at right indicate the best estimate (solid line within each bar) and the likely range assessed for the six SRES marker scenarios. The assessment of the best estimate and likely ranges in the grey bars includes the AOGCMs in the left part of the figure, as well as results from a hierarchy of independent models and observational constraints.

Box 6.3: Climate Sensitivity

The sensitivity of the climate system to a forcing is commonly expressed in terms of the global mean temperature change that would be expected after a time sufficiently long enough for both the atmosphere and ocean to come to equilibrium with the change in climate forcing (NRC, 2001a). Since IPCC's Third Assessment Report (IPCC, 2001b), the levels of scientific understanding and confidence in quantitative estimates of equilibrium climate sensitivity have increased substantially (Meehl et al., 2007).

Solomon et al. (2007) indicate there is increased confidence of key processes that are important to climate sensitivity due to improved comparisons of models to one another and to observations. Water vapor changes dominate the feedbacks affecting climate sensitivity and are now better understood. Observational and model evidence support a combined water vapor-lapse rate (the rate at which air temperature decreases with altitude) feedback that corresponds to about a 50% amplification of global mean warming. Cloud feedbacks remain the largest source of uncertainty.

Basing their assessment on a combination of several independent lines of evidence, including observed climate change and the strength of known feedbacks simulated in general circulation models, the authors concluded that the global mean equilibrium warming for doubling CO_2 (a concentration of approximately 540 ppm), or "equilibrium climate sensitivity", very likely is greater than 2.7°F (1.5°C) and likely to lie in the range 4 to 8.1°F (2 to 4.5°C), with a most likely value of about 5°F (3°C). For fundamental physical reasons, as well as data limitations, the IPCC states a climate sensitivity higher than 8.1□F (4.5°C) cannot be ruled out, but that agreement for these values with observations and proxy data is generally worse compared to values in the 4 to 8.1□F (2 to 4.5°C) range (Meehl et al., 2007).

IPCC Climate Sensitivity Probabilities

Less than 2.7□F (1.5°C)	10% or less probability
Less than 3.6□F (2.0°C)	5-17% probability
4 to 8.1□F (2 to 4.5°C)	66-90% probability
Greater than 8.1□F (4.5°C)	5-17% probability

The overwhelming majority of the impacts literature assessed in IPCC analyzes the effects of warming for climate sensitivities within the most likely range (4 to 8.1□F [2 to 4.5°C]), not at the tails of the distribution. As such, the effects information summarized in Chapter IV, Sections 6-14 of this document focuses on the plausible climate change effects assessed for climate sensitivities within the most likely range. Section 5(d) does address the state of knowledge pertaining to low probability effects of climate change that may be triggered by abrupt (non-linear) processes that become more likely at higher rates of climate forcing (NRC, 2002). However, abrupt climate change processes cannot be predicted with confidence and the thresholds linked to risks for social systems are at least as uncertain (Schneider et al., 2007).

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Geographical patterns of projected warming show greatest temperature increases over land (roughly twice the global average temperature increase) and at high northern latitudes, and less warming over the southern oceans and North Atlantic, consistent with observations (see Section 4b) during the latter part of the 20th century (Meehl et al., 2007).

According to the NOAA report *The State of the Climate in 2008* (Peterson and Baringer, 2009), the recent slowdown in observed climate warming (see Box 4.1) in some datasets has led some to question climate predictions of substantial 21st century warming. The study finds that climate models possess internal mechanisms of variability capable of reproducing the current slowdown in global temperature rise. It concludes that "[g]iven the likelihood that internal variability contributed to the slowing of global temperature rise in the last decade, we expect that warming will resume in the next few years, consistent with predictions from near-term climate forecasts."

Global Precipitation

Models simulate that global mean precipitation increases with global warming (Meehl et al., 2007). However, there are substantial spatial and seasonal variations. Increases in the amount of precipitation are *very likely* in high latitudes, while decreases are *likely* in most subtropical land regions, continuing observed patterns in recent trends in observations. According to Solomon et al. (2007):

- In the Northern Hemisphere, a robust pattern of increased subpolar and decreased subtropical precipitation dominates the projected precipitation pattern for the 21st century over North America and Europe, while subtropical drying is less evident over Asia.
- In the Southern Hemisphere, there are few land areas in the zone of projected supolar moistening during the 21st century, with the subtropical drying more prominent.
- Projections of the precipitation over tropical land regions are more uncertain than those at higher latitudes.

Global Sea Level Rise

By the end of the century (2090–2099), sea level is projected by IPCC (2007d) to rise between 7.1 and 23 inches (18 and 59 cm) relative to the base period (1980–1999). These numbers represent the lowest and highest projections of the 5 to 95% ranges for all SRES scenarios considered collectively and include neither uncertainty in carbon cycle feedbacks nor rapid dynamical changes in ice sheet flow. In all scenarios, the average rate of sea level rise during the 21st century very likely exceeds the 1961 to 2003 average rate (0.071 to 0.02 inch [0.18 □ 0.05 cm] yr^{-1}). Even if GHG concentrations were to be stabilized, sea level rise would continue for centuries due to the time scales associated with climate processes and feedbacks (IPCC, 2007d). Thermal expansion of ocean water contributes 70 to 75% of the central estimate for the rise in sea level for all scenarios (Meehl et al., 2007). Glaciers, ice caps, and the Greenland Ice Sheet are also projected to add to sea level. The IPCC projects a range of sea level rise contributions from all glaciers, ice caps, and ice sheets between 2 to 9.1 inches (4 to 23 cm), not including the possibility of rapid dynamical changes. The Antarctic ice sheet is estimated to be a negative contributor to sea level rise over the next century under these assumptions (Meehl et al., 2007).

General circulation models indicate that the Antarctic ice sheet will receive increased snowfall without experiencing substantial surface melting, thus gaining mass and reducing sea level rise according to IPCC (Meehl et al., 2007). However, Meehl et al. (2007) note further accelerations in ice flow of the kind recently observed in some Greenland outlet glaciers and West Antarctic ice streams could substantially increase the contribution from the ice sheets, a possibility not reflected in the projections above. For example, if ice discharge from these processes were to increase in proportion to global average surface

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temperature change, it would add 3.9 to 7.9 inches (10 to 20 cm) to the upper bound of sea level rise by 2090 to 2099. Dynamic processes related to ice flow not included in current models but suggested by recent observations could increase the vulnerability of the ice sheets to warming, increasing future sea level rise.

In the CCSP (2008a) report on abrupt climate change, Clark et al. (2008) find that "[r]ecent rapid changes at the edges of the Greenland and West Antarctic ice sheets show acceleration of flow and thinning, with the velocity of some glaciers increasing more than twofold." They add that "[i]nclusion of these processes in models will likely lead to sea level projections for the end of the 21st century that substantially exceed the projections presented in the IPCC AR4 [Fourth Assessment] report."

The CCSP (2009b) sea level rise report notes that a recent study and other climate scientists have indicated that a global sea level rise of 39 inches (100 cm) is plausible within this century if increased melting of ice sheets in Greenland and Antarctica is added to the factors included in the IPCC estimates. It concludes: "Therefore, thoughtful precaution suggests that a global sea level rise of 39 inches (100 cm) to the year 2100 should be considered for future planning and policy discussions." Though few studies have assessed the issue, Karl et al. (2009) report there is some evidence to suggest that it would be virtually impossible for the upper bound of sea level rise this century to exceed about 78 inches (198 cm).

The CCSP (2008c) report on the strengths and limitations of models notes that models of glacial ice are "in their infancy" and that "recent evidence for rapid variations in this glacial outflow indicates that more-realistic glacial models are needed to estimate the evolution of future sea level."

Sea level rise during the 21st century is projected by IPCC to have substantial geographic variability due to factors that influence changes at the regional scale, including changes in ocean circulation or atmospheric pressure, and geologic processes (Meehl et al., 2007). The patterns in different models are not generally similar in detail, but have some common features, including smaller than average sea level rise in the Southern Ocean, larger than average sea level rise in the Arctic, and a narrow band of pronounced sea level rise stretching across the southern Atlantic and Indian oceans.

Global Ocean Acidification

The oceans have absorbed, and will continue to absorb, CO_2 emissions associated with anthropogenic activities. Surface ocean pH has decreased by 0.1 units due to oceanic absorption of CO_2, and it is predicted to decrease by an additional 0.3–0.4 units by 2100 (Fischlin et al., 2007). This projected rate of decline may lead to ocean pH levels within a few centuries that have not been observed for a few hundred million years (Denman et al., 2007). Acidification is affecting calcium carbonate saturation in ocean waters and is thereby reducing calcification rates of organisms that rely on the minerals for development. Future acidification is projected to result in under-saturated ocean waters (see Box 14.1 for information on the effects of this undersaturation). Polar and subpolar surface waters and the Southern Ocean will be aragonite (a form of calcium carbonate) undersaturated by 2100, and Arctic waters will be similarly threatened (Fischlin et al., 2007). According to a model experiment using a "business as usual" emissions scenario (IPCC -IS92a), biocalcification will be reduced by 2100, in particular within the Southern Ocean, and by 2050 for aragonite-producing organisms (Denman et al., 2007).

6(c) Projected Changes in U.S. Temperature, Precipitation Patterns, and Sea Level Rise

IPCC's *Fourth Assessment Report* includes projections for changes in temperature, precipitation, and sea level rise for North America—which can be generalized for the United States—as well as some U.S.-specific information. These projections are summarized in this section.

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U.S. Temperatures

According to the IPCC, all of North America is very likely to warm during this century, as shown in Figures in 6.8 and 6.9, and warm more than the global mean warming in most areas (Christensen et al., 2007). For scenario A1B (moderate emission growth), the largest warming through 2100 is projected to occur in winter over northern parts of Alaska, reaching 13 to 18°F (7 to 10°C) in the northernmost parts, as shown in Figure 6.9, due to the positive feedback from a shorter season of snow cover. In western, central, and eastern regions of North America, the projected warming has less seasonal variation and is not as large, especially near the coast, consistent with less warming over the oceans. The average warming in the United States through 2100 is projected by nearly all the models used in the IPCC assessment to exceed 4°F (2°C) for all scenarios (see Figure 6.8), with five out of 21 models projecting average warming in excess of 7°F (4°C) for the A1B (mid-range) emissions scenario.

The CCSP (2008e) report *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity* provides shorter-term temperature projections for the United States for the year 2030. It projects a warming of approximately 2°F (1°C) in the southeastern United States, to more than 4°F (2°C) in Alaska and northern Canada, with other parts of North America having intermediate values (Backlund et al., 2008b).

By the end of the century, Karl et al. (2009) project average U.S. temperature to increase by approximately 7 to 11°F (4 to 6.1°C) under a high-emissions scenario (SRES A1FI) and by approximately 4 to 6.5°F (2 to 3.6°C) under a low-emissions scenario (SRES B1). On a seasonal basis, most of the United States is projected to experience greater warming in summer than in winter, while Alaska experiences far more warming in winter than summer (Karl et al., 2009).

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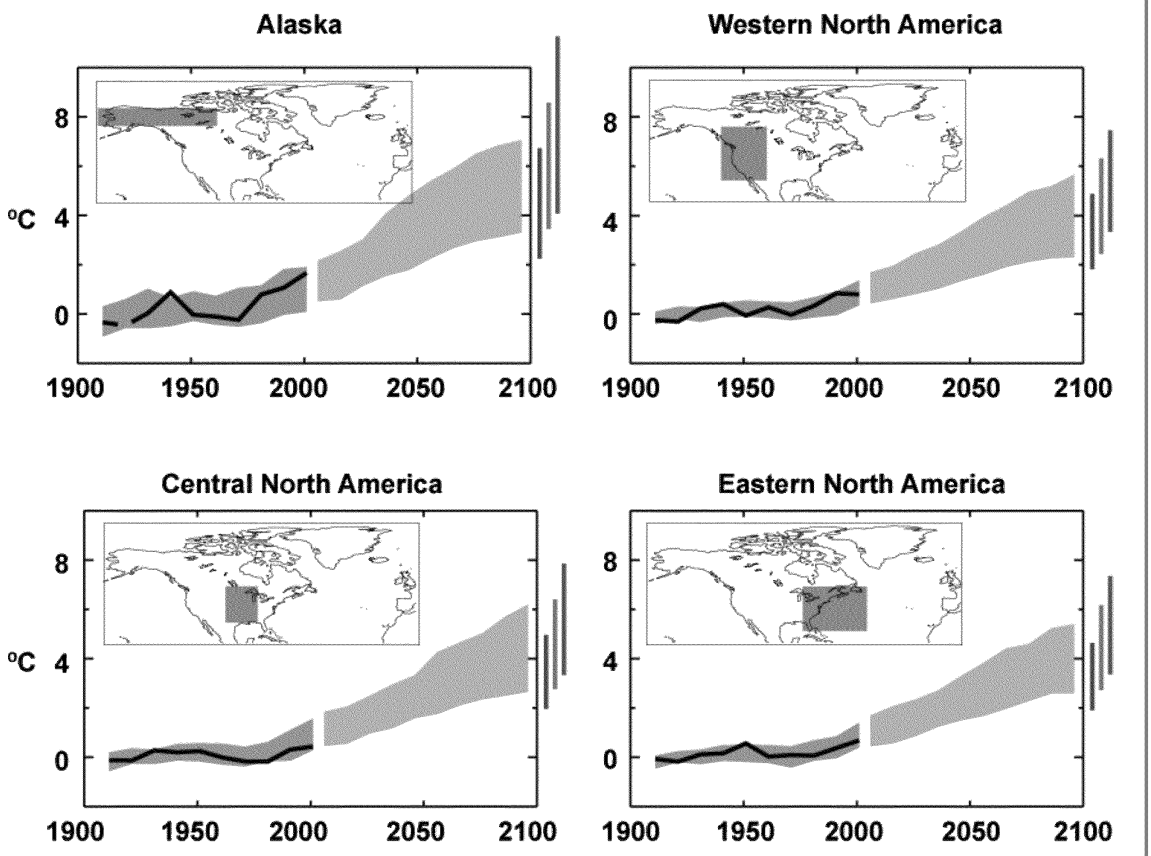
Figure 6.8: Temperature Anomalies With Respect to 1901 to 1950 for Four North American Land Regions



Source: Christensen et al. (2007). Temperature anomalies with respect to 1901 to 1950 for four North American land regions (the "Alaska" region includes a portion of northwest Canada) for 1906 to 2005 (black line) and as simulated (red envelope) by multi-model dataset (MMD) models incorporating known forcings; and as projected for 2001 to 2100 by MMD models for the A1B scenario (orange envelope). The bars at the end of the orange envelope represent the range of projected changes for 2091 to 2100 for the B1 scenario (blue), the A1B scenario (orange), and the A2 scenario (red). The black line is dashed where observations are present for less than 50% of the area in the decade concerned.

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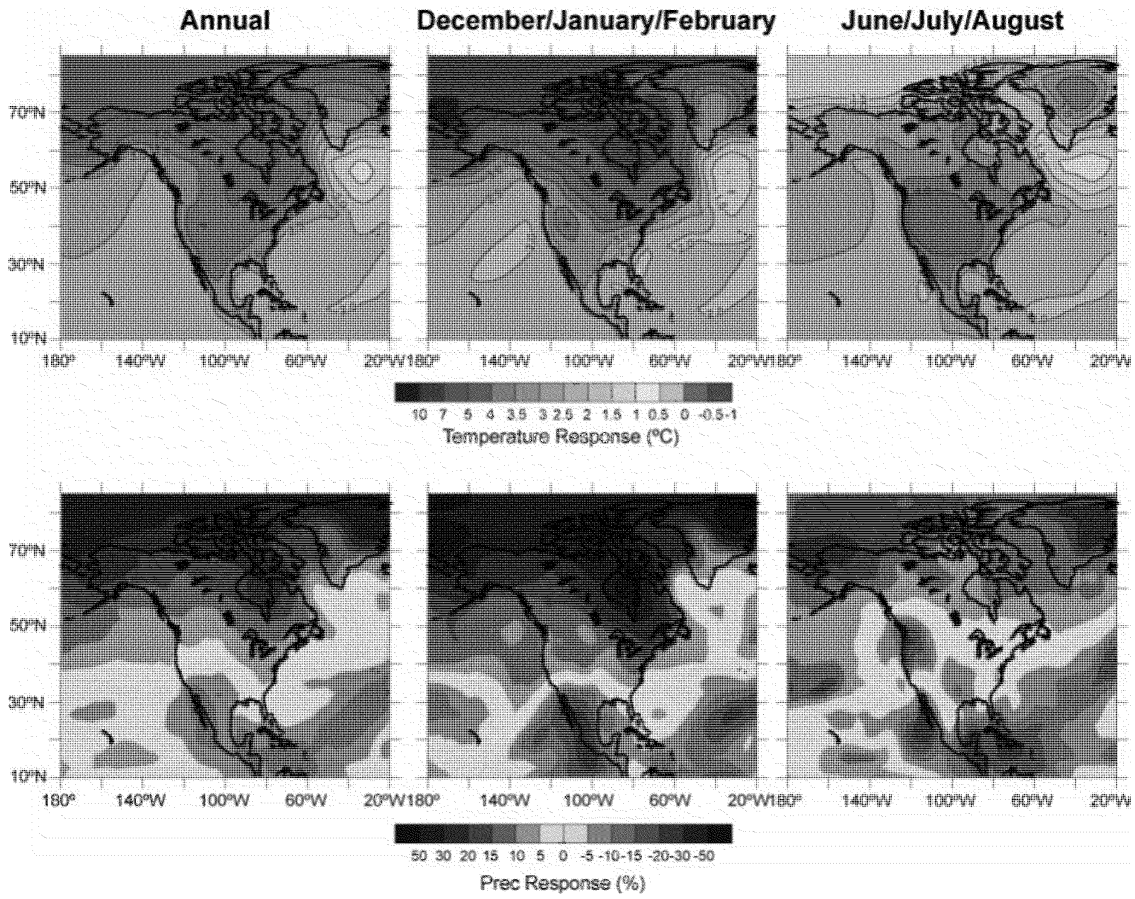
Figure 6.9: Projected Temperature and Precipitation Changes Over North America From the MMD-A1B Simulations



Source: Christensen et al. (2007). Top row: Annual mean, December-January-February, and June-July-August temperature between 1980 to 1999 and 2080 to 2099, averaged over 21 models. Bottom row: same as top, but for fractional change in precipitation.

U.S. Precipitation

A widespread increase in annual precipitation is projected by IPCC over most of the North American continent except the south and southwestern part of the United States and over Mexico, largely consistent with trends in recent decades (as described in Section 4) (Christensen et al., 2007). The largest increases are projected over northern North America (i.e., Canada and Alaska) associated with a poleward shift in storm tracks where precipitation increases by the largest amount in autumn and by the largest fraction in winter, as shown in Figure 6.9. In western North America, modest changes in annual mean precipitation are projected, but the majority of models indicate an increase in winter and a decrease in summer. Models show greater consensus on winter increases to the north and on summer decreases to the south. These decreases are consistent with enhanced subsidence and flow of drier air masses in the southwest United States and northern Mexico. Accordingly, some models project drying in the southwest United States, with more than 90% of the models projecting drying in northern and particularly western Mexico. On the windward slopes of the mountains in the West, precipitation increases are likely to be enhanced

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due to orographic lifting[46]. Overall, annual mean precipitation in the northeastern United States is very likely to increase and likely to decrease in the southwestern United States

Karl et al (2009) report model projections of future precipitation in the United States generally indicate northern areas will become wetter, and southern areas, particularly in the West, will become drier. In some northern areas, warmer conditions will result in more precipitation falling as rain and less as snow. In southern areas, significant reductions in precipitation are projected in winter and spring as the subtropical dry belt expands, particularly in the Southwest (Karl et al, 2009).

U.S. Sea Level Rise

For North American coasts, emissions scenario A1B shows sea level rise values close to the global mean, with slightly higher rates in eastern Canada and western Alaska, and stronger positive anomalies in the Arctic. The projected rate of sea level rise off the low-lying U.S. South Atlantic and Gulf coasts is also higher than the global average. Vertical land motion from geologic processes may decrease (uplift) or increase (subsidence) the relative sea level rise at any site (Nicholls et al., 2007).

Impact of Short-Lived Species on U.S. Temperature and Precipitation

Modeling results suggest that changes in short-lived species (mainly sulfates and black carbon) may significantly influence 21st century climate. A Geophysical Fluid Dynamics Laboratory (GFDL) simulation of SRES scenario A1B shows that changes in short-lived species could be responsible for up to 40% of the continental U.S. summertime warming projected to occur in this scenario by 2100 along with a statistically significant decrease in precipitation, mainly due to a combination of domestic sulfate emission reductions and increases in Asian black carbon emissions (CCSP, 2008d). However, the CCSP study concludes that "we could not find a consensus in this report on the duration, magnitude, or even sign (warming or cooling) of the climate change due to future levels of the short-lived gases and particles" due to uncertainties about different pollution control storylines.

6(d) Cryosphere (Snow And Ice) Projections, Focusing on North America and the United States

Snow season length and snow depth are very likely to decrease in most of North America as illustrated in Figure 6.10, except in the northernmost part of Canada where maximum snow depth is likely to increase (Christensen et al., 2007). Widespread increases in thaw depth are projected over most permafrost regions globally (IPCC, 2007d).

Lettenmaier et al. (2008) find where shifts to earlier snowmelt peaks and reduced summer and fall low flows have already been detected, continuing shifts in this direction are very likely.

Meehl et al (2007) conclude that as the climate warms, glaciers will lose mass, owing to dominance of summer melting over winter precipitation increases, contributing to sea level rise.

[46] Orographic lifting is defined as the ascent of air from a lower elevation to a higher elevation as it moves over rising terrain.

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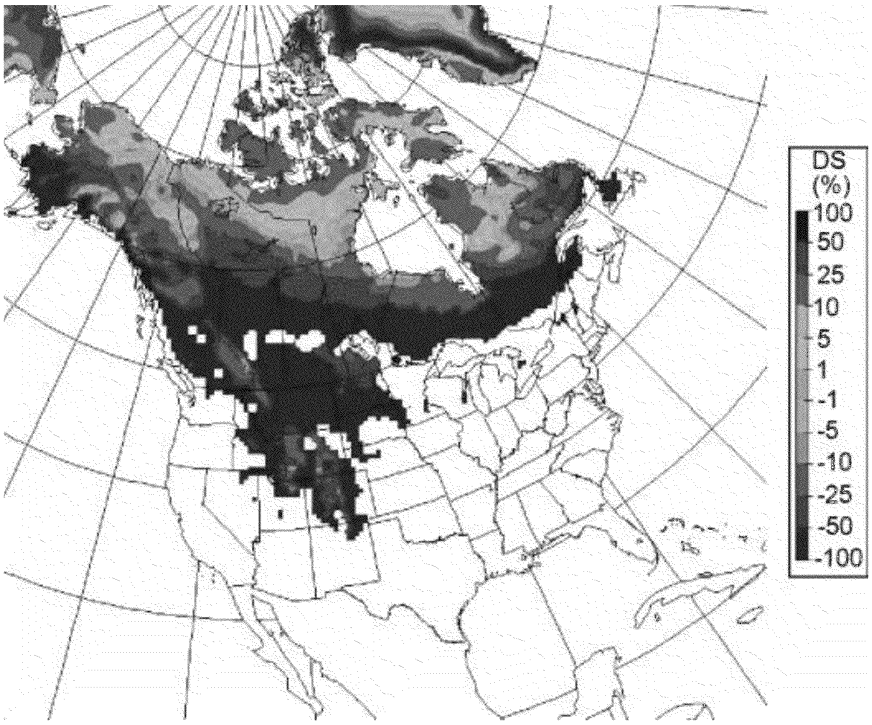
Sea ice is projected to shrink in both the Arctic and the Antarctic under all SRES scenarios. In some projections, Arctic late-summer sea ice disappears almost entirely by the latter part of the 21st century (IPCC, 2007d). Taking into account recent late summer sea ice loss, Polyak et al (2009) indicate that the Arctic Ocean may become seasonally ice free as early as 2040.

Figure 6.10: Percent Snow Depth Changes in March



Source: Christensen et al. (2007). Percent snow depth changes in March (only calculated where climatological snow amounts exceed 5 mm of water equivalent), as projected by the Canadian Regional Climate Model (CCRM), driven by the Canadian General Circulation Model (CGCM), for 2041 to 2070 under SRES A2 compared to 1961 to 1990.

6(e) Extreme Events, Focusing on North America and the United States

Models suggest that human-induced climate change is expected to alter the prevalence and severity of many extreme events such as heat waves, cold waves, storms, floods, and droughts. This section describes CCSP (2008i) and IPCC's projections for extreme events focusing on North America and the United States. Sections 7 to 14 summarize some of the sectoral impacts of extreme events for the United States.

Temperature

According to the IPCC, it is very likely that heat waves globally will become more intense, more frequent, and longer lasting in a future warm climate, whereas cold episodes are projected to decrease significantly. (Meehl, G.A. et al., 2007). Meehl et al. (2007) report on a study finding that the pattern of future changes in heat waves, with greatest intensity increases over western Europe, the Mediterranean, and the southeast and western United States, is related in part to circulation changes resulting from an increase in GHGs.

The IPCC cites a number of studies that project changes in temperature extremes in the United States (Christensen et al., 2007). One study finds that the frequency and the magnitude of extreme temperature events changes dramatically under a high-end emissions scenario (SRES A2), with increases in extreme hot events and decreases in extreme cold events. Another study examines changes in temperature extremes in their simulations centered on California and finds increases in extreme temperature events, prolonged hot spells, and increased diurnal temperature range. A third study finds increases in diurnal temperature range in six sub-regions of the western United States in summer.

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Karl et al. (2008) find for a mid-range scenario (A1B) of future GHG emissions, a day so hot that it is currently experienced only once every 20 years would occur every three years by the middle of the century over much of the continental United States; by the end of the century, it would occur every other year or more. The number of days exceeding 90°F (32□C) is projected to increase throughout the country with parts of the South that currently average 60 days per year with temperatures above 90°F (32□C) increasing to 150 or more such days by the end of the century under a high-emissions scenario (SRES A1FI) (Karl et al., 2009).

Some implications for human health resulting from these projected changes in temperature extremes are discussed in Section 7(b).

Heavy Precipitation and Drought

Intensity of precipitation events is projected to increase globally, particularly in tropical and high latitude areas that experience increases in mean precipitation (Meehl et al., 2007). Even in areas where mean precipitation decreases (most subtropical and mid-latitude regions), precipitation intensity is projected to increase but there would be longer periods between rainfall events. Meehl et al. (2007) note that increases in heavy precipitation events have been linked to increases in flooding.

The IPCC projects a tendency for drying in mid-continental areas during summer, indicating a greater risk of droughts in those regions (Meehl et al., 2007). Extreme drought increases from 1% of present-day land area to 30% by the end of the century in the A2 (high-emission growth) scenario according to a study assessed in Meehl et al. (2007). In the United States, Karl et al. (2009) conclude droughts are likely to become more frequent and severe in some regions, particularly the Southwest, as well as that the lightest precipitation is projected to decrease.

Several regional studies in the IPCC project changes in precipitation extremes in parts of the United States, ranging from a decrease in heavy precipitation in California to an increase during winter in the northern Rocky, Cascade, and Sierra Nevada mountain ranges (Christensen et al., 2007). For the contiguous United States, a study in Christensen et al. (2007) finds widespread increases in extreme precipitation events under SRES A2 (high-emission growth). Climate models consistently project that parts of the eastern United States will experience increased runoff, which accumulates as streamflow and can cause flooding when heavy precipitation persists for weeks to months in large river basins (Karl et al., 2009).

Karl et al. (2009) report that climate models project continued increases in the heaviest downpours during this century, and heavy downpours that are now one-in-20-year occurrences are projected to occur about every four to 15 years by the end of this century, depending on location. The intensity of downpours is projected to increase by 10 to 25% by the end of the century relative to today (Karl et al., 2009).

Storms

The IPCC (Meehl et al., 2007) concludes model projections show fewer mid-latitude storms (or extra-tropical, primarily cold season) averaged over each hemisphere, associated with the poleward shift of the storm tracks that is particularly notable in the Southern Hemisphere, with lower central pressures for these poleward shifted storms. Over North America, Gutowski et al. (2008) indicate strong mid-latitude storms will be more frequent though the overall number of storms may decrease.

Based on a range of models, it is likely that tropical cyclones (tropical storms and hurricanes) will become more intense, with stronger peak winds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures (IPCC, 2007d). Karl et al. (2008) analyze model simulations and find

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that for each 1.8ºF (1ºC) increase in tropical sea surface temperatures, core rainfall rates will increase by 6 to 18%, and the surface wind speeds of the strongest hurricanes will increase by about 1 to 8%. Storm surge levels are likely to increase because of increasing hurricane intensity coupled with sea level rise (Karl et al., 2009).

Karl et al. (2008) indicate projections in frequency changes in tropical cyclones are currently too uncertain for confident projections. Some modeling studies have projected a decrease in the number of tropical cyclones globally due to increased stability of the tropical atmosphere in a warmer climate, characterized by fewer weak storms and greater numbers of intense storms (Meehl et al., 2007). A number of modeling studies have also projected a general tendency for more intense but fewer storms outside the tropics, with a tendency towards more extreme wind events and higher ocean waves in several regions associated with these deepened cyclones (Meehl et al., 2007).

Sources of uncertainty involved with projecting changes in tropical cyclone activity include the limited capacity of climate models to adequately simulate intense tropical cyclones and potential changes in atmospheric stability and circulation (Karl et al., 2008). Taking these uncertainties into account, Karl et al. (2009) reached the following conclusion on the basis of both model- and theory-based evidence: "As ocean temperatures continue to increase in the future, it is likely that hurricane rainfall and wind speeds will increase in response to human-caused warming."

Possible implications of extreme precipitation events in the United States for health are described in Section 7, for food production and agriculture in Section 9, for water resources in Section 11, for coastal areas in Section 12, and for ecosystems and wildlife in Section 14.

6(f) Abrupt Climate Change and High-Impact Events

The CCSP (2008a), in its report on abrupt climate change, defines this phenomenon as a "large-scale change in the climate system that takes place over a few decades or less, persists (or is anticipated to persist) for at least a few decades, and causes substantial disruptions in human and natural systems." Abrupt climate changes are an important consideration because, if triggered, they could occur so quickly and unexpectedly that human or natural systems would have difficulty adapting to them (NRC, 2002). Potential abrupt climate change implications in the United States are not discussed in Sections 7 through 14 (the U.S. sectoral impacts) because they cannot be predicted with confidence, particularly for specific regions. This section therefore focuses on the general risks of abrupt climate change globally, with some discussion of potential regional implications where information is available.

According to NRC (2002): "Technically, an abrupt climate change occurs when the climate system is forced to cross some threshold, triggering a transition to a new state at a rate determined by the climate system itself and faster than the cause." Crossing systemic thresholds may lead to large and widespread consequences (Schneider et al., 2007). The triggers for abrupt climate change can be forces that are external and/or internal to the climate system including (NRC, 2002):

- Changes in the Earth's orbit.[47]
- A brightening or dimming of the sun.
- Melting or surging ice sheets.
- Strengthening or weakening of ocean currents.

[47] According to the National Research Council (2002), changes in the Earth's orbit occur too slowly to be prime movers of abrupt change but might determine the timing of events. Abrupt climate changes of the past were especially prominent when orbital processes were forcing the climate to change during the cooling into and warming out of ice ages (NRC, 2002).

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- Emissions of climate-altering gases and particles into the atmosphere.

More than one of these triggers can operate simultaneously, since all components of the climate system are linked.

Scientific data show that abrupt changes in the climate at the regional scale have occurred throughout history and are characteristic of the Earth's climate system (NRC, 2002). During the last glacial period, abrupt regional warmings 14 to 30□F (8 to 16°C) within decades over Greenland) and coolings occurred repeatedly over the North Atlantic region (Jansen et al., 2007). These warmings likely had some large-scale effects such as major shifts in tropical rainfall patterns and redistribution of heat within the climate system, but it is unlikely that they were associated with large changes in global mean surface temperature.

NRC concluded that anthropogenic forcing may increase the risk of abrupt climate change (NRC, 2002):

"…greenhouse warming and other human alterations of the Earth system may increase the possibility of large, abrupt, and unwelcome regional or global climatic events. The abrupt changes of the past are not fully explained yet, and climate models typically underestimate the size, speed, and extent of those changes. Hence, future abrupt changes cannot be predicted with confidence, and climate surprises are to be expected."

Changes in weather patterns (sometimes referred to as weather regimes or natural modes) can result from abrupt changes that might occur spontaneously due to dynamic interactions in the atmosphere-ice-ocean system, or from the crossing of a threshold from slow external forcing (as described previously) (Meehl et al., 2007). In a warming climate, changes in the frequency and amplitudes of these patterns might not only evolve rapidly but also trigger other processes that lead to abrupt climate change (NRC, 2002). Examples of these patterns include ENSO and the North Atlantic Oscillation/Arctic Oscillation (NAO/OA).[48]

ENSO has important linkages to patterns of tropical sea surface temperatures, which historically have been strongly tied to drought, including "megadroughts" that likely occurred between 900 and 1600 A.D. over large regions of the southwestern United States and Great Plains (Clark et al., 2008). The possibility of severe drought as an abrupt change resulting from changes in sea surface temperatures in a warming world is assessed by Clark et al. (2008). They find that under greenhouse warming scenarios, the cause of model-projected subtropical drying is an overall widespread warming of the ocean and atmosphere, in contrast to the causes of historic droughts (linked specifically to sea surface temperature). But they note models may not correctly represent the ENSO patterns of tropical SST change that could create impacts on global hydroclimate (e.g., drought) in addition to those caused by overall warming. The current model results do show drying over the southwestern United States, potentially increasing the likelihood of severe and persistent drought there in the future. Clark et al. (2008) note this drying has already begun (see also Section 4k) but caution that it is not clear if the present drying is outside the range of natural variability and linked to anthropogenic causes.

Scientists have investigated the possibility of an abrupt slowdown or shutdown of the Atlantic meridional overturning circulation (MOC) triggered by GHG forcing. The MOC transfers large quantities of heat to the North Atlantic and Europe, so an abrupt change in the MOC could have important implications for the

[48] The North Atlantic Oscillation (NAO) is the dominant mode of winter climate variability in the North Atlantic region ranging from central North America to Europe and much into Northern Asia. The NAO is a large-scale see-saw in atmospheric mass or pressure between the subtropical high and the polar low. Similarly, the Arctic Oscillation (AO) refers to opposing atmospheric pressure patterns in northern middle and high latitudes. The NAO and AO are different ways of describing the same phenomenon.

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climate of this region (Meehl et al., 2007). However, according to Meehl et al. (2007), the probability of an abrupt change in (or shutdown of) the MOC is low: "It is very unlikely that the MOC will undergo a large abrupt transition during the 21st century. Even further into the future, Clark et al. (2008) note that "it is unlikely that the Atlantic MOC will collapse beyond the end of the 21st century because of global warming, although the possibility cannot be entirely excluded." While models project a slowdown in the MOC over the 21st century and beyond, it is so gradual that the resulting decrease in heat transport to the North Atlantic and Europe would not be large enough to reverse the warming that results from the increase in GHGs (Clark et al., 2008). Clark et al. (2008) caution that while a collapse of the MOC is unlikely, the potential consequences of this event could be severe if it were to happen. Potential impacts include a southward shift of the tropical rainfall belts, additional sea level rise around the North Atlantic, and disruptions to marine ecosystems.

The rapid disintegration of the Greenland Ice Sheet (GIS), which would raise sea levels 23 feet (7 meters), is another commonly discussed abrupt change. Clark et al. (2008) report that observations demonstrate that it is extremely likely that the Greenland Ice Sheet is losing mass and that this loss has very likely been accelerating since the mid-1990s. In the CCSP (2009c) report *Past Climate Variability and Change in the Arctic and at High Latitudes*, Alley et al. (2009) find a threshold for ice-sheet removal from sustained summertime warming of 9□F (5°C), with a range of uncertainties from 3.6 to 12.6□F (2° to 7°C). Meehl et al. (2007), in the IPCC report, suggest the complete melting of the GIS would only require sustained warming in the range of 3.4 to 8.3□F (1.9°C to 4.6°C) (relative to the pre-industrial temperatures) but suggest it would take many hundreds of years to complete.

A collapse of the West Antarctic Ice Sheet (WAIS), which would raise seas 16 to 20 feet (5 to 6 meters), has been discussed as a low probability, high-impact response to global warming (NRC, 2002; Meehl et al., 2007). The weakening or collapse of ice shelves, caused by melting on the surface or by melting at the bottom by a warmer ocean, might contribute to a potential destabilization of the WAIS. Recent satellite and in situ observations of ice streams behind disintegrating ice shelves highlight some rapid reactions of ice sheet systems (Lemke et al., 2007). Clark et al. (2008) indicate that while ice is thickening over some higher elevation regions of Antarctica, substantial ice losses from West Antarctica and the Antarctic Peninsula are very likely occurring and that Antarctica is losing ice on the whole. Ice sheet models are only beginning to capture the small-scale dynamic processes that involve complicated interactions with the glacier bed and the ocean at the perimeter of the ice sheet (Meehl et al., 2007). These processes are not represented in the models used by the IPCC to project sea level rise. These models suggest Antarctica will gain mass due to increasing snowfall (although recent studies find no significant continent-wide trends in snow accumulation over the past several decades; Lemke et al., 2007), reducing sea level rise. But it is possible that acceleration of ice discharge could become dominant, causing a net positive contribution. Given these competing factors, there is presently no consensus on the long-term future of the WAIS or its contribution to sea level rise (Meehl et al., 2007).

Considering the Greenland and West Antarctic ice sheets together, Schneider et al. (2007) find paleoclimatic evidence suggests that Greenland and possibly the WAIS contributed to a sea level rise of 13 to 20 feet (4 to 6 meters) during the last interglacial, when polar temperatures were 5.4 to 9□F (3 to 5°C) warmer, and the global mean was not notably warmer than at present. Accordingly, they conclude with medium confidence that at least partial deglaciation of the Greenland Ice Sheet, and possibly the WAIS, would occur over a period of time ranging from centuries to millennia for a global average temperature increase of 2 to 7□F (1 to 4°C) (relative to 1990–2000), causing a contribution to sea level rise of 13 to 20 feet (4 to 6 meters) or more.

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Another potential abrupt change of concern assessed by CCSP (2008a) is the catastrophic release of methane from clathrate hydrates in the sea floor and, to a lesser extent, in permafrost soils. Clark et al. (2008) find the following:

- The size of the hydrate reservoir is uncertain, perhaps by up to a factor of 10, making judgments about risk difficult to assess.

- Although there are a number of suggestions in the literature about the possibility of a dramatic abrupt release of methane to the atmosphere, modeling and isotopic fingerprinting of ice-core methane do not support such a release to the atmosphere over the last 100,000 years or in the near future.

Clark et al (2008) conclude:

> "While the risk of catastrophic release of methane to the atmosphere in the next century appears very unlikely, it is very likely that climate change will accelerate the pace of persistent emissions from both hydrate sources and wetlands. Current models suggest that wetland emissions could double in the next century. However, since these models do not realistically represent all the processes thought to be relevant to future northern high-latitude CH_4 emissions, much larger (or smaller) increases cannot be discounted. Acceleration of persistent release from hydrate reservoirs is likely, but its magnitude is difficult to estimate."

6(g) Effects on/from Stratospheric Ozone

Substances that deplete stratospheric ozone, which protects the Earth's surface from much of the sun's biologically harmful ultraviolet radiation, are regulated under Title VI of the Clean Air Act. According to the World Meteorological Organization (WMO, 2007), climate change that results from changing GHG concentrations will affect the evolution of the ozone layer through changes in chemical transport, atmospheric composition, and temperature. In turn, changes in the stratospheric ozone can have implications for the weather and climate of the troposphere. The coupled interactions between the changing climate and ozone layer are complex, and scientific understanding is incomplete (WMO, 2007). Specific information on climate change effects on/from stratospheric ozone in the United States has not been assessed. Except where indicated, the findings in this section apply generally to the globe, with a focus on polar regions.

Effects of Elevated Greenhouse Gas Concentrations on Stratospheric Ozone

WMO's *2006 Scientific Assessment of Ozone Depletion* (2007) concluded that future concentrations of stratospheric ozone are sensitive to future levels of the well-mixed GHGs. According to the WMO (2007):

- Future increases of GHG concentrations, primarily CO_2, will contribute to the average cooling in the stratosphere. Stratospheric cooling is expected to slow gas-phase ozone depletion reactions and increase ozone.
- Enhanced methane emission (from warmer and wetter soils) is expected to enhance ozone production in the lower stratosphere.
- An increase in nitrous oxide emissions is expected to reduce ozone in the middle and high stratosphere.

Two-dimensional models that include coupling between all of these well-mixed GHGs and temperature project that ozone levels between 60° S and 60° N will return to 1980 values up to 15 years earlier than in

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models that are uncoupled (Bodeker et al., 2007). The impact of stratospheric cooling on ozone might be the opposite in polar regions where cooling could cause increases in polar stratospheric clouds, which, given enough halogens, would increase ozone loss (Bodeker et al., 2007).

Concentrations of stratospheric ozone are also sensitive to stratospheric water vapor concentrations which may remain relatively constant or increase (Baldwin et al., 2007). Increases in water vapor would cause increases in hydrogen oxide (HO_x) radicals, affecting ozone loss processes (Baldwin et al., 2007). Several studies cited in Baldwin et al. (2007) suggest increasing stratospheric water vapor would delay ozone layer recovery. Increases in stratospheric water vapor could also increase springtime ozone depletion in the polar regions by raising the temperature threshold for the formation of polar stratospheric clouds (WMO, 2007).

The possible effects of climate change on stratospheric ozone are further complicated by possible changes in climate dynamics. Climate change can affect temperatures, upper level winds, and storm patterns which, in turn, impact planetary waves[49] that affect the stratosphere (Baldwin et al., 2007). Changes in the forcing and propagation of planetary waves in the polar winter are a major source of uncertainty for predicting future levels of Arctic ozone loss (Baldwin et al., 2007).

The CCSP (2008h) report *Trends in Emissions of Ozone-Depleting Substances, Ozone Layer Recovery, and Implications for Ultraviolet Radiation Exposure* includes results from two-dimensional chemistry transport models and three-dimensional climate chemistry models estimating the recovery of the ozone layer under a GHG scenario. It finds:

- From 60°N to 60°S, global ozone is expected to return to its 1980 value up to 15 years earlier than the halogen recovery date because of stratospheric cooling and changes in circulation associated with GHG emissions. Global ozone abundances are expected to be 2% above the 1980 values by 2100 with values at mid-latitudes as much as 5% higher.

- Model simulations show that the ozone amount in the Antarctic will reach the 1980 values 10 to 20 years earlier (i.e., from 2040 to 2060) than the 2060 to 2070 timeframe of when the ozone-depleting substances reach their 1980 levels in polar regions.

- Most climate chemistry models show Arctic ozone values by 2050 to be larger than the 1980 values, with the recovery date between 2020 and 2040.

Climate Change Effects from Stratospheric Ozone

The WMO (2007) found changes to the temperature and circulation of the stratosphere affect climate and weather in the troposphere. The dominant tropospheric response, simulated in models and identified in analyses of observations, comprises changes in the strength of mid-latitude westerly winds. The mechanism for this response is not well-understood.

Modeling experiments (that simulate observed changes in stratospheric ozone and combined stratospheric ozone depletion and GHG increases) also suggest that Antarctic ozone depletion, through its effects on the lower stratospheric vortex, has contributed to the observed surface cooling over interior Antarctica and warming of the Antarctic Peninsula, particularly in summer (Baldwin et al., 2007). While the physics of these effects are not well-understood, the simulated pattern of warming and cooling is a robust result seen in many different models, and well-supported by observational studies.

[49] A planetary wave is a large horizontal atmospheric undulation that is associated with the polar-front jet stream and separates cold, polar air from warm, tropical air.

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As the ozone layer recovers, tropospheric changes that have occurred as a result of ozone depletion are expected to reverse (Baldwin et al., 2007).

6(h) Land Use and Land Cover Change

Changes in land surface (vegetation, soils, water) resulting from human activities can significantly affect local climate through shifts in radiation, cloudiness, surface roughness, and surface temperature.

Solomon et al. (2007) find the impacts of land-use change on climate are expected to be locally significant in some regions, but are small at the global scale in comparison with greenhouse warming. Similarly, the release of heat from anthropogenic energy production can be significant over urban areas but is not significant globally (Solomon et al., 2007).

The CCSP report (2008e) on the effects of climate change on agriculture, land resources, water resources, and biodiversity in the United States concludes that global climate change effects will be superimposed on and modify those resulting from land use and land cover patterns in ways that are as of yet uncertain.

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Part IV

U.S. Observed and Projected Human Health and Welfare Effects From Climate Change

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Section 7

Human Health

Warm temperatures and extreme weather already cause and contribute to adverse human health outcomes through heat-related mortality and morbidity, storm-related fatalities and injuries, and disease. In the absence of effective adaptation, these effects are likely to increase with climate change. Depending on progress in health care and access, infrastructure, and technology, climate change could increase the risk of heat wave deaths, respiratory illness through exposure to aeroallergens and ozone (discussed in Section 8), and certain diseases (CCSP, 2008b; Confalonieri et al, 2007). Studies in temperate areas (which would include large portions of the United States) have shown that climate change is projected to bring some benefits, such as fewer deaths from cold exposure. The balance of positive and negative health impacts as a result of climate change will vary from one location to another and will alter over time as climate change continues (CCSP, 2008b).

In its *Third Assessment Report*, the IPCC produced a number of key findings summarizing the likely climate change health effects in North America. These effects, which were reaffirmed in the IPCC *Fourth Assessment Report* (Field et al., 2007), include:

- Increased deaths, injuries, infectious diseases, and stress-related disorders and other adverse effects associated with social disruption and migration from more frequent extreme weather.
- Increased frequency and severity of heat waves leading to more illness and death, particularly among the young, elderly, and frail.
- Expanded ranges of vector-borne and tick-borne diseases in North America but with moderating influence by public health measures and other factors.

The more recent CCSP (2008b) report on human health stated as one of its conclusions: "The United States is certainly capable of adapting to the collective impacts of climate change. However, there will still be certain individuals and locations where the adaptive capacity is less and these individuals and their communities will be disproportionally impacted by climate change."

There are few studies that address the interactive effects of multiple climate change impacts or of interactions between climate change health impacts and other kinds of local, regional, and global socio-economic changes (Field et al., 2007). For example, climate change impacts on human health in urban areas will be compounded by aging infrastructure, maladapted urban form and building stock, urban heat islands, air pollution, population growth, and an aging population (Field et al., 2007).

Vulnerability is the summation of all the factors of risk and resilience that determine whether individuals experience adverse health impacts. Specific subpopulations may experience heightened vulnerability for climate-related health effects. Climate change is very likely to accentuate the disparities already evident in the American health care systems, as many of the expected health effects are likely to fall disproportionately on the poor, the elderly, the disabled, and the uninsured (Ebi et al., 2008).

The IPCC concludes that human health risks from climate change will be strongly modulated by changes in health care, infrastructure, technology, and accessibility to health care (Field et al., 2007). The aging of the population and patterns of immigration and/or emigration will also strongly influence risks (Field et al., 2007).

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This section describes the literature on the impacts of climate change on human health in four areas: temperature effects, extreme events, climate sensitive diseases, and aeroallergens. The health impacts resulting from climate change effects on air quality are discussed in Section 8.

7(a) Temperature Effects

According to the IPCC (2007d), it is very likely[50] that there were warmer and fewer cold days and nights and warmer and more frequent hot days over most land areas during the late 20th century (see Section 4(b)). It is virtually certain that these trends will continue during the 21st century (see Section 6(b)). As a result of the projected warming, the IPCC projects increases in heat-related mortality and morbidity globally (IPCC, 2007b). The projected warming is also expected to result in fewer cold-related deaths. It is not clear whether reduced mortality from cold will be greater or less than increased heat-related mortality in the United States due to climate change (Gamble et al., 2008). Local factors, such as climate, topography, heat-island magnitude, demographic and health characteristics of the population, and policies that affect the social and economic structures of communities, including urban design, energy policy, water use and transportation planning are important in determining the underlying temperature-mortality relationship in a population (Confalonieri et al, 2007; Ebi et al., 2008).

Increased heat exposure

Extreme heat is associated with marked short-term increases in mortality (Confalonieri et al, 2007). Hot temperatures have also been associated with increased morbidity. A study cited in Field et al. (2007) indicates increased hospital admissions for cardiovascular disease and emergency room visits have been documented in parts of North America during heat events. The populations most vulnerable to hot temperatures are older adults, the chronically sick, the very young, city-dwellers, those taking medications that disrupt thermoregulation, the mentally ill, those lacking access to air conditioning, those working or playing outdoors, and the socially isolated (Ebi et al., 2008; IPCC, 2007b).

Exposure to heat is already the leading cause of weather-related deaths in the United States and more than 3,400 deaths between 1999 and 2003 were reported as resulting from exposure to extreme heat (Karl et al., 2009). The Centers for Disease Control and Prevention (CDC, 2006) indicate heat-related deaths can be difficult to identify when illness onset or death is not witnessed by a clinician and that the criteria used to determine heat-related causes of death vary among states. This can lead to underreporting of heat-related deaths or to reporting heat as a factor contributing to death rather than the underlying cause.

The excess mortality during the extreme heat wave in Europe in 2003 demonstrates the lethality of such events, which led to approximately 15,000 deaths in France alone (Confalonieri et al., 2007). Karl et al. (2009) report that an analysis of the European summer heat wave of 2003 found that the risk of such a heat wave is now roughly four times greater than it would have been in the absence of human-induced climate change.

Given projections for climate warming, heat-related morbidity and mortality are projected to increase globally (including in the United States) with climate warming (Confalonieri et al, 2007; Karl et al., 2009). Heat exposures vary widely, and current studies do not quantify the years of life lost due to high temperatures. Estimates of heat-related mortality attributable on extreme heat days are reduced but not eliminated when assumptions about acclimatization and adaptation are included in models. Confalionieri et al. (2007) cite a series of studies that suggests populations in the United States became less sensitive to high temperatures over the period 1964–1998, in part, due to these factors. However, Ebi et al. (2008)

[50] According to IPCC terminology, "very likely" conveys a 90 to 99% probability of occurrence. See Box 1.2 for a full description of IPCC's uncertainty terms.

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suggest these results do not imply future increases in heat-related mortality may not occur in the United States, because the percentage of the population with access to air conditioning is high in most regions (thus with limited possibilities for increasing access). In fact, Karl et al. (2009) note air-conditioning is reaching near saturation and report that a recent study shows that the general decline in heat-related deaths that had been observed since the 1970s leveled off in the mid-1990s.

Growing numbers of older adults will increase the size of the population at risk because of a decreased ability to thermoregulate that is a normal part of the aging process (Confalonieri et al, 2007). In addition, according to a study in Confalonieri et al. (2007), almost all the population growth in the next 50 years is expected to occur in cities where temperatures tend to be higher due to the urban heat island[51] effect, increasing the total number of people at risk of adverse health outcomes from extreme heat conditions. In other words, non-climatic factors related to demographics will have a significant influence on future heat-related mortality.

Across North America, the population over the age of 65—those most at-risk of dying from heat waves—will increase slowly to 2010, and then grow dramatically as the Baby Boomers age (Field et al., 2007). Field et al. (2007) also find that severe heat waves are projected to intensify in magnitude and duration over the portions of the United States where these events already occur (high confidence). The IPCC documents the following U.S. regional scenario projections of increases in heat and/or heat-related effects (Confalonieri et al, 2007; Field et al., 2007):

- By the 2080s, in Los Angeles, the number of heat wave days (at or above 90ºF [32 ºC]) increases four-fold under the B1 emissions scenario (low growth) and six- to eight-fold under A1FI emissions scenario (high growth). Annual number of heat-related deaths in Los Angeles increases from about 165 in the 1990s to 319 to 1,182 for a range of emissions scenarios.
- Chicago is projected to experience 25% more frequent heat waves annually by the period spanning 2080–2099 for a business-as-usual (A1B) emissions scenario.

Additional projections for changes in extreme heat in the U.S. can be found in Section 15 on United States regional climate impacts.

Reduced Cold Exposure

Cold waves continue to pose health risks in northern latitudes in temperature regions where very low temperatures can be reached in a few hours and extend over long periods (Confalonieri et al, 2007). Accidental cold exposure occurs mainly outdoors, among socially deprived people (e.g., alcoholics, the homeless), workers, and the elderly in temperate and cold climates, but cold waves also affect health in warmer climates (Confalonieri et al, 2007). Living in cold environments in polar regions is associated with a range of chronic conditions in the non-indigenous population with acute risk from frostbite and hypothermia (Confalonieri et al, 2007). In countries with populations well-adapted to cold conditions, cold waves can still cause substantial increases in mortality if electricity or heating systems fail (Confalonieri et al, 2007).

Ebi et al. (2008) cite a study reporting that from 1979 to 2002, an average of 689 reported deaths per year (range 417 to 1,021) in the United States, totaling 16,555 over the period, were attributed to exposure to excessive cold temperatures on death certificates. The cold during these events also contributes to deaths caused by respiratory and cardiovascular diseases, so the overall mortality burden is likely underestimated (Ebi et al., 2008).

[51] A heat island refers to urban air and surface temperatures that are higher than nearby rural areas. Many U.S. cities and suburbs have air temperatures up to 10°F (5.6°C) warmer than the surrounding natural land cover.

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The IPCC projects reduced human mortality from cold exposure through 2100 (Confalonieri et al, 2007). Projections of cold-related deaths, and the potential for decreasing their numbers due to warmer winters, can be overestimated unless they take into account the effects of season and influenza, which is not strongly associated with monthly winter temperature (Ebi et al., 2008; Confalonieri et al, 2007). Ebi et al. (2008) report many factors contribute to winter mortality, making the question of how climate change could affect mortality highly uncertain. They report no projections have been published for the United States that incorporate critical factors such as the influence of influenza outbreaks.

Aggregated Changes in Heat and Cold Exposure

The IPCC (2007a) does not explicitly assess studies since the *Third Assessment Report*, which analyzes changes in *both* heat- and cold-related mortality in the United States in the observed climate or for different future climate scenarios. Given the paucity of recent literature on the subject and the challenges in estimating and projecting weather-related mortality, IPCC concludes additional research is needed to understand how the balance of heat- and cold-related deaths might change globally under different climate scenarios (Confalonieri et al, 2007). Similarly, Ebi et al. (2008) find net changes in mortality are difficult to estimate.

The most recent USGCRP assessment (Karl et al., 2009) refers to a study that analyzed daily mortality and weather data in 50 U.S. cities from 1989 to 2000 and found that, on average, cold snaps in the United States increased death rates by 1.6%, while heat waves triggered a 5.7% increase in death rates. The study concludes that increases in heat-related mortality due to global warming are unlikely to be compensated for by decreases in cold-related mortality.

7(b) Extreme Events

In addition to the direct effects of temperature on heat- and cold-related mortality, projected trends in climate change-related exposures of importance to human health will increase the number of people (globally, including in the United States) suffering from disease and injury due to floods, storms, droughts, and fires (high confidence) (Confalonieri et al, 2007). Vulnerability to weather disasters depends on the attributes of the people at risk (including where they live, age, income, education, and disability) and on broader social and environmental factors (level of disaster preparedness, health sector responses, and environmental degradation) (Ebi et al., 2008).

Floods and Storms

The IPCC projects a very likely increase in heavy precipitation event frequency over most areas as described in Section 6(b) and Section 6(c). Increases in the frequency of heavy precipitation events are associated with increased risk of deaths and injuries as well as infectious, respiratory and skin diseases (IPCC, 2007b). Floods are low-probability, high-impact events that can overwhelm physical infrastructure, human resilience, and social organization (Confalonieri et al, 2007). Flood health impacts include deaths, injuries, infectious diseases, intoxications, and mental health problems (Confalonieri et al, 2007). Karl et al. (2009) indicate flooding rains can increase incidence of waterborne diseases due to pathogens such as *Cryptosporidium* and *Giardia*. Flooding may also lead to contamination of waters with dangerous chemicals, heavy metals, or other hazardous substances from storage or from chemicals already in the environment (Confalonieri et al, 2007). In addition, heavy downpours can trigger sewage overflows, contaminating drinking water (Karl et al., 2009)

The IPCC (2007d) also projects likely increases in intense tropical cyclone activity as described in Section 6(b). Increases in tropical cyclone intensity are linked to increases in the risk of deaths, injuries,

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waterborne and foodborne diseases, as well as post-traumatic stress disorders (IPCC, 2007b). Drowning by storm surge, heightened by rising sea levels and more intense storms (as projected by IPCC), is the major killer in coastal storms where there are large numbers of deaths (Confalonieri et al, 2007). High-density populations in low-lying coastal regions such as the U.S. Gulf of Mexico experience a high health burden from weather disasters, particularly among lower income groups. In 2005, Hurricane Katrina claimed more than 1,800 lives in the vicinity of the low-lying United States. Gulf Coast and lower income groups were disproportionately affected (Graumann et al., 2005; Nicholls et al., 2007; Confalonieri et al., 2007). While Katrina was a Category 3 hurricane, and its path was forecast well in advance, there was a secondary failure of the levee system. This illustrates that multiple factors contribute to making a disaster and that adaptation measures may not fully avert adverse consequences (Ebi et al., 2008). Additional information about U.S. vulnerability to the potential for more intense tropical cyclones can be found in Section 12(b).

Droughts

Areas affected by droughts are likely to increase according to the IPCC (2007d) as noted in Section 6(e). The health impacts associated with drought tend to most affect semi-arid and arid regions, poor areas and populations, and areas with human-induced water scarcity; hence, many of these effects are likely to be experienced in developing countries and not directly in the United States. Information about the effects of increasing drought on U.S. agriculture can be found in Section 9(c).

Wildfires

In some regions, changes in the mean and variability of temperature and precipitation are projected to increase the size and severity of fire events, including in parts of the United States (Easterling et al., 2007). Wildfires can increase eye and respiratory illnesses and injuries, including burns and smoke inhalation (Ebi et al., 2008). A study cited in Confalonieri et al. (2007) indicates large fires are also accompanied by an increased number of patients seeking emergency services for inhalation of smoke and ash. The IPCC (Field et al., 2007) noted a number of observed changes in U.S. wildfire size and frequency. Additional information on the effects of forest fires can be found in Sections 8(b) and 10(b).

7(c) Climate-Sensitive Diseases

The IPCC (2007b) notes that many human diseases are sensitive to weather. Similarly Karl et al. (2009) reports that important disease-causing agents commonly transmitted by food, water, or animals are susceptible to changes in replication, survival, persistence, habitat range, and transmission as a result of changing climatic conditions such as increasing temperature, precipitation, and extreme weather events. They conclude some diseases transmitted by food, water, and insects are likely to increase.

The incidence of airborne infectious diseases (e.g., coccidioidomycosis) varies seasonally and annually, due partly to climate variations such as drought, which is projected to increase in the southwestern United States (Field et al., 2007; Karl et al., 2008).

Waterborne disease outbreaks are distinctly seasonal (which suggests potential underlying environmental or weather control), clustered in particular watersheds, and associated with heavy precipitation. IPCC (Confalonieri et al., 2007) reports that the risk of infectious disease following flooding in high-income countries is generally low, although increases in respiratory and diarrheal diseases have been reported after floods. However, CCSP (Peterson et al., 2008) finds that analyses of the United States indicate that the assumption that developed countries have low vulnerability may be premature, citing to studies that "have repeatedly concluded that water and food-borne pathogens (that cause diarrhea) will likely increase with projected increases in regional flooding events, primarily by contamination of main waterways." In

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another report, CCSP (2008b) notes that flooding can overwhelm sanitation infrastructure and lead to water-related illnesses. A U.S. study documented that 51% of waterborne disease outbreaks were preceded by precipitation events in the top 10% of occurrences, with 68% of outbreaks preceded by precipitation in the top 20% (Peterson et al., 2008). After hurricanes Katrina and Rita in 2005, contamination of water supplies with fecal bacteria led to many cases of diarrheal illness and some deaths (Ebi et al., 2008; CDC, 2005; Confalonieri et al., 2007).

Foodborne diseases show some relationship with temperature (e.g., increased temperatures have been associated with increased cases of Salmonellosis) (Confalonieri et al, 2007). *Vibrio* spp. infections from shellfish consumption may also be influenced by temperature (Confalonieri et al, 2007). For example, Confalonieri et al. (2007) cited a study documenting a 2004 outbreak of *V. parahaemolyticus* linked to atypically high temperatures in Alaskan coastal waters.

According to the CCSP (2008b) report, for the U.S., it is not anticipated that climate change will lead to loss of life or years of life due to chronic illness or injury from waterborne or foodborne illnesses. However, it notes there will likely be an increase in the spread of several foodborne and waterborne pathogens among susceptible populations depending on the pathogens' survival, persistence, habitat range, and transmission under changing climate and environmental conditions. While the United States has successful programs to protect water quality under the Safe Drinking Water Act and the Clean Water Act, some contamination pathways and routes of exposure do not fall under regulatory programs (e.g., dermal absorption from floodwaters, swimming in lakes and ponds with elevated pathogen levels). The primary climate-related factors that affect these pathogens include temperature, precipitation, extreme weather events, and shifts in ecological regimes. Consistent with the latest understanding of climate change on human health, the impact of climate on foodborne and waterborne pathogens will seldom be the only factor determining the burden of human injuries, illness, and death (CCSP 2008b).

The sensitivity of many zoonotic[52] diseases to climate fluctuations is also highlighted by the IPCC (Field et al., 2007). Saint Louis encephalitis has a tendency to appear during hot, dry La Nina years according to a study cited in Field et al. (2007). Associations between temperature and precipitation and tick-borne Lyme disease are also noted by IPCC (Field et al., 2007). A study cited in Field et al. (2007) found that the northern range limit of *Ixodes scapularis*, the tick that carries Lyme disease, could shift north by 120 mi (200 km) by the 2020s and 620 mi (1,000 km) by the 2080s. According to Ebi et al. (2008), studies suggest that higher minimum temperatures generally were favorable to the potential of expanding tick distributions and greater local abundance of these vectors. However, Ebi et al. (2008) add that: "changing patterns of tick-borne disease in Europe are not consistently related to changing climate (Randolph, 2004a). Climate change is projected to decrease the geographic range of TBE (tick-borne encephalitis) in areas of lower latitude and elevation as transmission expands northward (Randolph and Rogers, 2000)".

A study discussed in Field et al. (2007) linked above-average temperatures in the United States during the summers of 2002–2004 to the greatest transmissions of West Nile virus. Karl et al. (2009) refer to a study that suggests greater risks from West Nile virus may result from increases in the frequency of heatwaves, though the risk will also depend on the effectiveness of mosquito control programs.

Although large portions of the United States may be at potential risk for diseases such as malaria based on the distribution of competent disease vectors, locally acquired cases have been virtually eliminated, in part due to effective public health interventions, including vector and disease control activities. (Ebi et al., 2008; Confalonieri et al, 2007).

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[52]A zoonotic disease is any infectious disease that is able to be transmitted from an animal or nonhuman species to humans. The natural reservoir is a nonhuman reservoir.

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7(d) Aeroallergens

Climate change, including changes in CO_2 concentrations, could impact the production, distribution, dispersion and allergenicity of aeroallergens and the growth and distribution of weeds, grasses, and trees that produce them (McMichael. et al., 2001; Confalonieri et al., 2007). These changes in aeroallergens and subsequent human exposures could affect the prevalence and severity of allergy symptoms. However, the scientific literature does not provide definitive data or conclusions on how climate change might impact aeroallergens and subsequently the prevalence of allergenic illnesses in the United States In addition, there are numerous other factors that affect aeroallergen levels and the prevalence of associated allergenic illnesses, such as changes in land use, air pollution, and adaptive responses, many of which are difficult to assess (Ebi et al., 2008).

It has generally been observed that the presence of elevated CO_2 concentrations and temperatures stimulates plants to increase photosynthesis, biomass, water use efficiency, and reproductive effort. The IPCC concluded that pollens are likely to increase with elevated temperature and CO_2 (Field et al., 2007). Laboratory studies cited by Field et al. (2007) stimulated increased ragweed-pollen production by over 50% using a doubling of CO_2. A U.S.-based field study referenced by Field et al. (2007), which used existing temperature/CO_2 concentration differences between urban and rural areas as a proxy for climate change, found that ragweed grew faster, flowered earlier, and produced significantly greater aboveground biomass and ragweed pollen at urban locations than at rural locations.

The IPCC (Confalonieri et al, 2007) noted that climate change has caused an earlier onset of the spring pollen season in North America and that there is limited evidence that the length of the pollen season has increased for some species. However, it is unclear whether the allergenic content of these pollens has changed. The IPCC concluded that introductions of new invasive plant species with high allergenic pollen present important health risks, noting that ragweed (*Ambrosia artemisiifolia*) is spreading in several parts of the world (Confalonieri et al, 2007).

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Section 8

Air Quality

Surface air concentrations of air pollutants are highly sensitive to winds, temperature, humidity, and precipitation (Denman et al., 2007). Climate change can be expected to influence the concentration and distribution of air pollutants through a variety of direct and indirect processes, including the modification of biogenic emissions, the change of chemical reaction rates, wash-out of pollutants by precipitation, and modification of weather patterns that influence pollutant buildup. In summarizing the impact of climate change on ozone and particulate matter (PM), the IPCC (Denman et al., 2007) states that "future climate change may cause significant air quality degradation by changing the dispersion rate of pollutants, the chemical environment for ozone and PM generation and the strength of emissions from the biosphere, fires and dust."

This section describes how climate change may alter ambient concentrations of ozone and PM with associated impacts on public health and welfare in the United States.

8(a) Tropospheric Ozone

According to the IPCC (Denman et al., 2007), climate change is expected to lead to increases in regional ozone pollution in the United States and other countries. Ozone impacts on pubic health and welfare are described in EPA's *Air Quality Criteria Document for Ozone* (U.S. EPA, 2006). Breathing ozone at sufficient concentrations can reduce lung function, thereby aggravating asthma or other respiratory conditions. Ozone exposure at sufficient concentrations has been associated with increases in respiratory infection susceptibility, medicine use by asthmatics, emergency department visits, and hospital admissions. Ozone exposure may contribute to premature death, especially in susceptible populations. In contrast to human health effects, which are associated with short-term exposures, the most significant ozone-induced plant effects (e.g., biomass loss, yield reductions) result from the accumulation of ozone exposures over the growing season, with differentially greater impact resulting from exposures to higher concentrations and/or longer durations.

Tropospheric ozone is both naturally occurring and, as the primary constituent of urban smog, a secondary pollutant formed through photochemical reactions involving nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight. As described below, climate change can affect ozone by modifying 1) emissions of precursors, 2) atmospheric chemistry, and 3) transport and removal (Denman et al., 2007). There is now consistent evidence from models and observations that 21st century climate change will worsen summertime surface ozone in polluted regions of North America compared to a future with no climate change (Jacob and Winner, 2009).

The IPCC (Denman et al., 2007) states that, for all world regions, "climate change affects the sources of ozone precursors through physical response (lightning), biological response (soils, vegetation, and biomass burning) and human response (energy generation, land use, and agriculture)." NO_x emissions due to lightning are expected to increase in a warmer climate (Denman et al., 2007). Additionally, studies using general circulation models (GCM) concur that influx of ozone from the stratosphere to the troposphere could increase due to large-scale atmospheric circulation shifts (i.e., the Brewer-Dobson circulation) in response to climate warming (Denman et al., 2007). The sensitivity of microbial activity in soils to temperature also points toward a substantial increase in the nitric oxide emissions (Brasseur et al., 2006). As described below, biogenic VOC emissions increase with increasing temperature.

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Climate-induced changes of biogenic VOC emissions alone may be regionally substantial and cause significant increases in ozone concentrations (Hauglustaine et al., 2005; Hogrefe et al., 2004; European Commission, 2003). Sensitivity simulations for the 2050s, relative to the 1990s suggest under the A2 (high-end) climate scenario that increased biogenic emissions alone add 1 to 3 ppb to summertime average daily maximum 8-hour ozone concentrations in the Midwest and along the eastern seaboard (Hogrefe et al., 2004). The IPCC (Meehl et al., 2007) reports that biogenic emissions are projected to increase by between 27 and 59%, contributing to a 30 to 50% increase in ozone formation over northern continental regions (for the 2090–2100 timeframe, relative to 1990–2000).

Consistent with this, for nearly all simulations in the EPA Interim Assessment (2009a), climate change is associated with increases in biogenic VOC emissions over most of the United States, with especially pronounced increases in the Southeast. These biogenic emissions increases do not necessarily correspond with ozone concentration increases, however. The report suggests that the response of ozone to changes in biogenic emissions depends on how isoprene chemistry is represented in the models—models that recycle isoprene nitrates back to NO_x will tend to simulate significant ozone concentration increases in regions with biogenic emissions increases, while models that do not recycle isoprene nitrates will tend to simulate small changes, or even ozone decreases.

Climate change impacts on temperature could affect ozone chemistry significantly (Denman et al., 2007). A number of studies in the United States have shown that summer daytime ozone concentrations correlate strongly with temperature. That is, ozone generally increases at higher temperatures. This correlation appears to reflect contributions of comparable magnitude from 1) temperature-dependent biogenic VOC emissions, as mentioned previously, 2) thermal decomposition of peroxyacetylnitrate (PAN), which acts as a reservoir for NO_x, as described immediately below, and 3) association of high temperatures with regional stagnation, also discussed below (Denman et al., 2007).

The EPA Interim Assessment (IA) (2009a), however, reports that considering a single meteorological variable, such as temperature, may not provide a sufficient basis for determining future ozone risks due to climate change in every region. This is consistent with the potential for different competing effects in different regions. The modeling studies found some regions of the country where simulated increases in cloud cover, and hence decreases in the amount of sunlight reaching the surface, partially counteracted the effects of warming temperatures on ozone concentrations in these regions, to go along with the many regions where the effects of temperature and cloud cover reinforced each other in producing ozone increases.

Climate change is projected to increase surface layer ozone concentrations in both urban and polluted rural environments due to decomposition of PAN at higher temperatures (Sillman and Samson, 1995; Liao and Seinfeld, 2006). Warming enhances decomposition of PAN, releasing NO_x, an important ozone precursor (Stevenson et al., 2005). Model simulations (using the high-end A2 emissions scenario) with higher temperatures for the year 2100 showed that enhanced PAN thermal decomposition caused this species to decrease by up to 50% over source regions and ozone net production to increase (Hauglustaine et al., 2005).

Atmospheric circulation can be expected to change in a warming climate and, thus, modify pollutant transport and removal. The CCSP (2008b) reports that stagnant air masses related to climate change are likely to degrade air quality in some densely populated areas. More frequent occurrences of stagnant air events in urban or industrial areas could enhance the intensity of air pollution events, although the importance of these effects is not yet well quantified (Denman et al., 2007). The IPCC (2007d) concluded that "extra-tropical storm tracks are projected to move poleward, with consequent changes in wind, precipitation, and temperature patterns, continuing the broad pattern of observed trends over the last half-century."

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The IPCC (Denman et al., 2007) cites a study for the eastern United States that found an increase in the severity and persistence of regional pollution episodes due to the reduced frequency of ventilation by storms tracking across Canada. This study found that surface cyclone activity decreased by approximately 10 to 20% in a future simulation (for 2050, under the mid-range IPCC A1B scenario), in general agreement with a number of observational studies over the northern mid-latitudes and North America. Northeast U.S. summer pollution episodes are projected in this study to increase in severity and duration; pollutant concentrations in episodes increase 5 to 10%, and episode durations increase from two to three or four days. Analysis of historical data supports both the trend in decreasing frequency of ventilation and the increase in summer pollution episodes (Leibensperger et al., 2008).

Regarding the role water vapor plays in tropospheric ozone formation, the IPCC (Denman et al., 2007) reports that simulations for the 21st century indicate a decrease in the lifetime of tropospheric ozone due to increasing water vapor. The projected increase in water vapor both decelerates the chemical production and accelerates the chemical destruction of ozone (Meehl et al., 2007). Overall, the IPCC states that climate change is expected to decrease background tropospheric ozone due to higher water vapor and to increase regional and urban-scale ozone pollution due to higher temperatures and weaker air circulation (Denman et al., 2007; Confalonieri et al., 2007).

For North America, the IPCC (Field et al., 2007) reports that surface ozone concentration may increase with a warmer climate. For the continental United States, the CCSP (2008b) report states that the northern latitudes are likely to experience the largest increases in average temperatures, and they will also bear the brunt of increases in ground-level ozone and other airborne pollutants.

Modeling studies discussed in EPA's IA (U.S. EPA, 2009a) show that simulated climate change causes increases in summertime ozone concentrations over substantial regions of the country, though this was not uniform, and some areas showed little change or decreases, though the decreases tend to be less pronounced than the increases. For those regions that showed climate-induced increases, the increase in maximum daily 8-hour average ozone concentration, a key metric for regulating U.S. air quality, was in the range of 2 to 8 ppb, averaged over the summer season. The increases were substantially greater than this during the peak pollution episodes that tend to occur over a number of days each summer. While the results from the different research groups agreed on the above points, their modeling systems did not always simulate the same regional patterns of climate-induced ozone changes across the United States. Certain regions show greater agreement than others: for example, there is more agreement on climate-induced increases for the eastern half of the country than for the West. Parts of the Southeast also show strong disagreements across the modeling groups. Where climate-change-induced increases in ozone do occur, damaging effects on ecosystems, agriculture, and health are expected to be especially pronounced, due to increases in the frequency of extreme pollution events.

The EPA IA (U.S. EPA, 2009a) suggests that climate change effects on ozone grow continuously over time, with evidence for significant increases emerging as early as the 2020s.

The results in the IA demonstrate that O_3 responds to climate change in a qualitatively consistent manner across the simulations from multiple research groups. The patterns of relative changes in regional climate vary across the same simulations. Figure 3-11 of the IA graphically illustrates the net change in daily average ozone values across the research results for summertime ozone. Ozone concentrations increase across most areas of the country with decreases limited to some parts of the Southwest. The net increases of ozone concentrations in the large population centers of the northeastern and middle Atlantic United States are the results with the highest confidence. The net increases in the Southeast and the small net changes in the Northwest are the features with the lower confidence.

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The IA and the IPCC (Field et al., 2007; Wilbanks et al., 2007) cite a study that evaluates the effects of climate change on regional ozone in 15 U.S. cities, finding that average summertime daily 8-hour maximum ozone concentrations could increase by 2.7 ppb in the 2020s and by 4.2 ppb in the 2050s under the A2 (high-end) scenario.

Studies reviewed in the IA and Jacob and Winner (2009) indicate the largest increases in ozone concentrations due to climate change occur during peak pollution events. The locations of peak ozone episodes tend to be large metropolitan areas such as Los Angeles, Houston, and the Northeast corridor, suggesting higher increases of potentially dangerous levels of ozone over significant population centers. Mickley et al. (2004) find that climate change projected to occur under the A1B (mid-range) scenario results in significant changes that occur at the high end of the pollutant concentration distribution (episodes) in the Midwest and Northeast between 2000 and 2050 given constant levels of criteria pollutant emissions. Using the A2 (high-end) emissions scenario, Hogrefe et al. (2004) find that while regional climate change in the eastern United States causes the summer average daily maximum 8-hour ozone concentrations to increase by 2.7, 4.2, and 5.0 ppb in 2020s, 2050s, and 2080s (compared to 1990s), respectively, regional climate changes causes the fourth-highest summertime daily maximum 8-hour ozone concentrations to increase by 5.0, 6.4, and 8.2 ppb for the 2020s, 2050s, and 2080s, respectively (compared to 1990s) (Hogrefe et al., 2004). The CCSP (2008b) also reports climate change is projected to have a much greater impact on extreme values and to shift the distribution of ozone concentrations towards higher values, with larger relative increases in future decades. In addition, simulations reviewed in the IA showed that, for parts of the country with a defined summertime ozone season, climate change expanded its duration into the fall and spring. These findings raise particular health concerns.

The IPCC (Field et al., 2007) states that, "warming and climate extremes are likely to increase respiratory illness, including exposure to pollen and ozone." And the IPCC further states that "severe heat waves, characterized by stagnant, warm air masses and consecutive nights with high minimum temperatures will intensify in magnitude and duration over the portions of the United States and Canada, where they already occur (high confidence) (Field et al., 2007)." Further, as described in CCSP (2008b), there is some evidence that combined effects of heat stress and air pollution may be greater than simple additive effects and historical data show relationships between mortality and temperature extremes.

Holding population, dose-response characteristics, and pollution prevention measures constant, ozone-related deaths from climate change in the New York City metropolitan area are projected to increase by approximately 4.5% from the 1990s to the 2050s (under the high-end IPCC A2 scenario) (Field et al., 2007). According to the IPCC (Field et al., 2007), the "large potential population exposed to outdoor air pollution translates this small relative risk into a substantial attributable health risk." In New York City, health impacts could be further exacerbated by climate change interacting with urban heat island effects (Field et al., 2007). For A2 scenario in the 2050s, Bell et al. (2007) report that the projected effects of climate change on ozone in 50 eastern U.S. cities increased the number of summer days exceeding the 8-hour EPA standard by 68%. On average across the 50 cities, the summertime daily 8-hour maximum increased 4.4 ppb. Elevated ozone levels correspond to approximately a 0.11% to 0.27% increase in daily total mortality. The largest ozone increases are estimated to occur in cities with present-day high pollution.

As noted in CCSP (2008b), the influence of climate change on air quality will play out against a backdrop of ongoing regulatory control of both ozone and PM that will shift the baseline concentrations of these two important pollutants. Both emissions and climate changes can significantly affect ozone and PM concentrations. Thus, modeling of future emission control programs coupled with climate change does not isolate the impact of GHGs on air quality. Modeling of future climate change without future emission

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control programs does isolate this impact of GHGs on air quality. Further, the range of plausible short-lived emission projections is very large. For example, emission projections used in CCSP (2008d) and in the IPCC *Fourth Assessment Report* (IPCC, 2007a) differ on whether black carbon particle and nitrogen oxides emission trends continue to increase or decrease. Improvements in our ability to project social, economic, and technological developments affecting future emissions are needed. Additionally, most studies to date that have examined potential future climate change impacts on air quality isolate the climate effect by holding precursor air pollutant emissions constant over time. For the above reasons, the analyses referenced in this TSD generally held emissions constant while varying meteorological factors consistent with future climate change.

The National Ambient Air Quality Standards (NAAQS) for ozone and their accompanying regulations have helped to reduce the dangers from ozone in the United States. However, half of all Americans—158 million people—live in counties where air pollution exceeds national health standards (U.S. EPA 2008). To predict future conditions, models are essential tools. As noted in the IA, coupling atmospheric chemical processes and the climate system presents considerable challenges because of the large number of physical, chemical, and biological processes involved, many of which are poorly understood, all interacting in complex ways. The types of modeling systems developed under this assessment permit the detailed exploration of the potential responses of air quality to climate change over the next few decades in a way that would be difficult or impossible with other approaches. They permit the systematic investigation of the multiple competing climate- and weather-related drivers of air quality interactions on the regional scale, which produce aggregate patterns of air quality change. The IPCC reports (Denman et al., 2007) that "the current generation of tropospheric ozone models is generally successful in describing the principal features of the present-day global ozone distribution." The IPCC (Denman et al., 2007) also states that "there are major discrepancies with observed long-term trends in ozone concentrations over the 20th century" and "resolving these discrepancies is needed to establish confidence in the models."

In addition to human health effects, elevated levels of tropospheric ozone have significant adverse effects on crop yields in the United States and other world regions, pasture and forest growth, and species composition (Easterling et al., 2007). Furthermore, the effects of air pollution on plant function may indirectly affect carbon storage; recent research showed that tropospheric ozone resulted in significantly less enhancement of carbon sequestration rates under elevated CO_2, due to negative effects of ozone on biomass productivity and changes in litter chemistry (Easterling et al., 2007).

8(b) Particulate Matter

Particulate matter (PM) effects on public health and welfare are described in EPA's *Air Quality Criteria Document for Particulate Matter* (U.S. EPA, 2004). Particulate matter is a complex mixture of anthropogenic, biogenic, and natural materials, suspended as aerosol particles in the atmosphere. When inhaled, the smallest of these particles can reach the deepest regions of the lungs. Scientific studies have found an association between exposure to PM and significant health problems, including aggravated asthma, chronic bronchitis, reduced lung function, irregular heartbeat, heart attack, and premature death in people with heart or lung disease. Particle pollution also is the main cause of visibility impairment in the nation's cities and national parks.

The overall directional impact of climate change on PM levels in the United States remains uncertain (CENR, 2008), as too few data yet exist on PM to draw firm conclusions about the direction or magnitude of climate impacts (CCSP, 2008b). However, preliminary results of modeling analyses reported in the EPA IA are listed below. These analyses show a range of increases and decreases in PM concentrations in different regions and for different component chemical species in the same region:

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1. Precipitation is a more important primary meteorological driver of PM than of ozone, due to its role in removing PM from the atmosphere (wet deposition). Precipitation, however, is particularly difficult to model and shows greater disagreement across simulations than other variables.
2. Aerosol chemical processes, especially those concerning the formation of organic aerosols, are not fully understood and therefore not well characterized in current regional air quality models.
3. Preliminary simulation results suggest that, globally, PM generally decreases as a result of simulated climate change, due to increased atmospheric humidity and increased precipitation.
4. Regionally, simulated 2050 climate change produces increases and decreases in PM (on the order of a few percent), depending on region. For the United States, the largest simulated increases are found in the Midwest and Northeast.
5. This PM response reflects the combined climate change responses of the individual species that make up PM (e.g., sulfate, nitrate, ammonium, black carbon, organic carbon). Depending on the region, these individual responses can be in competing directions.
6. Increase in wildfire frequency associated with a warmer climate has the potential to increase PM levels in certain regions.

Further, Jacob and Winner (2009) summarize the current state of knowledge as:

"The response of PM to climate change is more complicated than that for ozone because of the diversity of PM components, compensating effects, and general uncertainty in GCM projections of the future hydrological cycle. Observations show little useful correlation of PM with climate variables to guide inferences of the effect of climate change. Rising temperature is expected to have a mild negative effect on PM due to volatilization of semi-volatile components (nitrate, organic), partly compensated by increasing sulfate production. Increasing stagnation should cause PM to increase. Precipitation frequency, which largely determines PM loss, is expected to increase globally but to decrease in southern North America and southern Europe. PM is highly sensitive to mixing depths but there is no consensus among models on how these will respond to climate change… Increases in wildfires driven by climate change could significantly increase PM concentrations beyond the direct effect of changes in meteorological variables."

PM and PM precursor emissions are affected by climate change through physical response (windblown dust), biological response (forest fires and vegetation type/distribution), and human response (energy generation). Most natural aerosol sources are controlled by climatic parameters like wind, moisture, and temperature; thus, human-induced climate change is expected to affect the natural aerosol burden. Biogenic organic material is directly emitted into the atmosphere and produced by VOCs. All biogenic VOC emissions are highly sensitive to changes in temperature and are also highly sensitive to climate-induced changes in plant species composition and biomass distributions. Denman et al. (2007) cite a study in which biogenic emission rates are predicted to increase on average across world regions by 10% per 1°C increase in surface temperature. The response of biogenic secondary organic carbon aerosol production to a temperature change, however, could be considerably lower than the response of biogenic VOC emissions since aerosol yields can decrease with increasing temperature (Denman et al., 2007).

Particulate matter emissions from forest fires can contribute to acute and chronic illnesses of the respiratory system, particularly in children, including pneumonia, upper respiratory diseases, asthma, and chronic obstructive pulmonary diseases (Confalonieri et al., 2007). The IPCC (Field et al., 2007) reported with very high confidence that in North America, disturbances like wildfire are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons. Forest fires with their associated decrements to air quality and pulmonary effects are likely to increase in frequency, severity, distribution, and duration in the Southeast, the Intermountain West, and the West compared to a future with no climate change (CCSP, 2008b). Pollutants from forest fires can affect air quality for thousands of kilometers (Confalonieri et al., 2007). A study cited in Field et al. (2007) found that in the last three

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decades the wildfire season in the western United States has increased by 78 days, and burn durations of large fires have increased from 7.5 to 37.1 days, in response to a spring-summer warming of 1.6°F (0.87°C). It also found earlier spring snowmelt has led to longer growing seasons and drought, especially at higher elevations, where the increase in wildfire activity has been greatest. Analysis by the state of California suggests that large wildfires could become up to 55% more frequent in some areas toward the end of the century due to continued global warming (California Climate Change Center, 2006).

PM chemistry is affected by changes in temperature brought about by climate change. Temperature is one of the most important meteorological variables influencing air quality in urban atmospheres because it directly affects gas and heterogeneous chemical reaction rates and gas-to-particle partitioning. The net effect that increased temperature has on airborne particle concentrations is a balance between increased production rates for secondary particulate matter (increases particulate concentrations) and increased equilibrium vapor pressures for semi-volatile particulate compounds (decreases particulate concentrations). Increased temperatures may either increase or decrease the concentration of semi-volatile secondary reaction products such as ammonium nitrate depending on ambient conditions.

Denman et al., 2007 note that there has been less work on the sensitivity of aerosols to meteorological conditions. It cites a study that produces regional model simulations for Southern California on September 25, 1996, projecting decreases in 24-hour average $PM_{2.5}$ concentrations with increasing temperatures for inland portions of the South Coast air basin, and projecting increases for coastal regions. In CCSP (2008b), using the New York Climate and Health Project (NYCHP)-integrated model, $PM_{2.5}$ concentrations are projected to increase with climate change, with the effects differing by component species, with sulfates and primary PM increasing markedly and with organic and nitrated components decreasing, mainly due to movement of these volatile species from the particulate to the gaseous phase.

The transport and removal of PM is highly sensitive to winds and precipitation. Removal of PM from the atmosphere occurs mainly by wet deposition (NRC, 2005). Sulfate lifetime, for example, is estimated to be reduced from 4.7 days to 4.0 days as a result of increased wet deposition (Liao and Seinfeld, 2006). Precipitation also affects soil moisture, with impacts on dust source strength and on stomatal opening/closure of plant leaves, hence affecting biogenic emissions (Denman et al., 2007). Precipitation has generally increased over land north of 30°N over the period 1900 to 2005, and it has become significantly wetter in eastern parts of North America (Trenberth et al., 2007). However, model parameterizations of wet deposition are highly uncertain and not fully realistic in their coupling to the hydrological cycle (NRC, 2005). For models to simulate accurately the seasonally varying pattern of precipitation, they must correctly simulate a number of processes (e.g., evapotranspiration, condensation, transport) that are difficult to evaluate at a global scale (Randall et al., 2007).

In 1997 (62 FR 38680), EPA concluded that particulate matter produces adverse effects on visibility, and that visibility impairment is experienced (though not necessarily attributed to climate change) throughout the United States, in multi-state regions, urban areas, and remote Federal Class I areas[53]. Visibility impairment depends strongly on ambient relative humidity (NARSTO, 2004). Although surface specific humidity globally has generally increased after 1976 in close association with higher temperatures over both land and ocean, observations suggest that relative humidity has remained about the same overall, from the surface throughout the troposphere (Trenberth et al., 2007). Nevertheless, increases in PM due to increases in wildfires induced by climate change might increase visibility impairment.

[53] The Clean Air Act defines mandatory Federal Class I areas as certain national parks (greater than 6,000 acres), wilderness areas (greater than 5,000 acres), national memorial parks (greater than 5,000 acres), and international parks that were in existence as of August 7, 1977.

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8(c) Health Effects Due to CO_2-Induced Increases in Tropospheric Ozone and Particulate Matter

In addition to the analyses described previously of climate change impacts on air quality, one study specifically examined the more direct effect of CO_2 on air pollution mortality. As described in the CCSP (2008b) report, using a coupled climate-air pollution three-dimensional model, a study compared the health effects of pre-industrial vs. present-day atmospheric concentrations of CO_2. The results suggest that increasing concentrations of CO_2 increased tropospheric ozone and $PM_{2.5}$, which increased mortality by about 1.1% per degree temperature increase over the baseline rate; the study estimated that about 40% of the increase was due to ozone and the rest to particulate matter. The estimated mortality increase was higher in locations with poorer air quality.

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Section 9

Food Production and Agriculture

Food production and the agricultural sector within the United States are sensitive to short-term climate variability and long-term climate change. This section addresses how observed and projected climate change may affect U.S. food production and agriculture. Food production and agriculture here include crop yields and production, livestock production (e.g., milk and meat), freshwater fisheries, and key climate-sensitive issues for this sector including drought risk and pests and weeds.

In addition to changes in average temperatures and precipitation patterns, this section also addresses how U.S. food production and agriculture may be affected directly by elevated CO_2 levels, as well as the frequency and severity of extreme events, such as droughts and storms. Climate change-induced effects on tropospheric ozone levels and their impacts on agriculture are discussed briefly in Section 8 on Air Quality.

Vulnerability of the U.S. agricultural sector to climate change is a function of many interacting factors including pre-existing climatic and soil conditions, changes in pest competition, water availability, and the sector's capacity to respond to climate change through management practices, improved seed and cultivar technology, and changes in economic competition among regions.

The CCSP report on U.S. agriculture (Backlund et al., 2008a) made the following general conclusions for the United States:

- With increased CO_2 and temperature, the life cycle of grain and oilseed crops will likely progress more rapidly. But, as temperature rises, these crops will increasingly begin to experience failure, especially if climate variability increases and precipitation lessens or becomes more variable.

- The marketable yield of many horticultural crops (e.g., tomatoes, onions, fruits) is very likely to be more sensitive to climate change than grain and oilseed crops.

- Climate change is likely to lead to a northern migration of weeds. Many weeds respond more positively to increasing CO_2 than most cash crops, particularly C3 "invasive" weeds[54]. Recent research also suggests that glyphosate, the most widely used herbicide in the United States, loses its efficacy on weeds grown at the increased CO_2 levels likely in the coming decades.

- Disease pressure on crops and domestic animals will likely increase with earlier springs and warmer winters, which will allow proliferation and higher survival rates of pathogens and parasites. Regional variation in warming and changes in rainfall will also affect spatial and temporal distribution of disease.

- Projected increases in temperature and a lengthening of the growing season will likely extend forage production into late fall and early spring, thereby decreasing need for winter season forage reserves. However, these benefits will very likely be affected by regional variations in water availability.

[54] C3 and C4 refer to different carbon fixation pathways in plants during photosynthesis. C3 is the most common pathway, and C3 crops (e.g., wheat, soybeans and rice) are more responsive than C4 crops such as maize.

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- Climate change-induced shifts in plant species are already underway in rangelands. Establishment of perennial herbaceous species is reducing soil water availability early in the growing season. Shifts in plant productivity and type will likely also have significant impact on livestock operations.

- Higher temperatures will very likely reduce livestock production during the summer season, but these losses will very likely be partially offset by warmer temperatures during the winter season. For ruminants, current management systems generally do not provide shelter to buffer the adverse effects of changing climate; such protection is more frequently available for non-ruminants (e.g., swine and poultry).

The IPCC (2007b) made the following general conclusion about food production and agriculture for North America:

- Moderate climate change in the early decades of the century is projected to increase aggregate yields of rain-fed agriculture (water demand met primarily derived from precipitation) by 5 to 20% , but with important variability among regions. Future trends in precipitation are difficult to project but will be associated with strong regional and seasonal variation, which means some areas in United States will continue to get wetter (e.g., Northeast and large parts of the Midwest) while some areas particularly, in the West, will become drier. Major challenges are projected for crops that are near the warm end of their suitable range or depend on highly utilized water resources [high confidence].[55]

9(a) Crop Yields and Productivity

Observational evidence shows that, over the last century, aggregate yields of major U.S. crops have been increasing (USDA, 2007; Field et al., 2007), with significant regional and temporal variation. Multiple factors contribute to these long-term trends, including seed technology, use of fertilizers, management practices, and climate change (i.e., lengthening of the growing season).

For projected climate change effects, the IPCC summary conclusion of net beneficial effects in the early decades in the United States under moderate climate change, with significant regional variation, is supported by a number of recent assessments for most major crops, and is consistent with the previous IPCC Third Assessment (2001) conclusion.[56] Moderate climate change for temperate regions such as the United States is described as local increases in temperature of ~2 to 5ºF (~1 to 3ºC), which may occur within the next few decades or past mid-century depending on scenario (see Section 6 for temperature projections). Increased average warming leads to an extended growing season, especially for northern regions of the United States. Further warming, however, is projected to have increasingly negative impacts in all regions (meaning both temperate, including the United States, and tropical regions of the world) (Easterling et al. 2007).

The CCSP report on agriculture (Hatfield et al., 2008) provides further crop-specific detail about optimum temperatures in order to assess the effects of future climate change. Crops are characterized by an upper failure-point temperature at which pollination and grain-set processes fail. Considering these aspects, Hatfield et al., (2008) detail the following optimum mean temperatures for grain yields of the major agronomic crops: 64 to 72□F (18 to 22ºC) for maize, 72 to 75□F (22 to 24ºC) for soybean, 59□F (15ºC) for

[55] According to IPCC terminology, "high confidence" conveys an 8 out of 10 chance of being correct. See Box 12 for a full description of IPCC's uncertainty terms.

[56] The North America chapter from the IPCC Third Assessment Report (Cohen et al., 2001) concluded: "Food production is projected to benefit from a warmer climate, but there probably will be strong regional effects, with some areas in North America suffering significant loss of comparative advantage to other regions (high confidence)."

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wheat, 73 to 79□F (23 to 26ºC) for rice, 77□F (25ºC) for sorghum, 77 to 79□F (25 to 26ºC) for cotton, 68 to 79□F (20 to 26ºC) for peanut, 73 to 75□F (23 to 24ºC) for dry bean, and 72 to 77□F (22 to 25ºC) for tomato.

Given the variable responses of different crops to temperature (and other climatic) changes and the fact that different areas of the country specialize in different crops and have different regional climates, the variable future climate change effects among regions and crops are important to consider. The southeastern United States may be more vulnerable to increases in average temperature than more northern regions due to pre-existing temperatures that are already relatively high. Likewise, certain crops that are currently near climate thresholds (e.g., wine grapes in California) are likely to experience decreases in yields, quality, or both, even under moderate climate change scenarios (Field et al., 2007). As cited by USGCRP (Karl et al., 2009), a seemingly paradoxical impact of warming is that it appears to be increasing the risk of plant frost damage. Mild winters and warm, early springs, which are beginning to occur more frequently as climate warms, induce premature plant development and blooming, resulting in exposure of vulnerable young plants and plant tissues to subsequent late-season frosts. The 2007 spring freeze in the eastern United States caused widespread devastation of crops and natural vegetation because the frost occurred during the flowering period of many trees and during early grain development on wheat plants

Without the benefit of CO_2, the anticipated 2.2□F (1.2ºC) rise in temperature over the next 30 years (a baseline assumption assumed in the CCSP (Hatfield et al., 2008) report) is projected to decrease maize, wheat, sorghum, and dry bean yields by 4.0, 6.7, 9.4, and 8.6%, respectively, in their major production regions. For soybean, the 2.2□F (1.2ºC) temperature rise is projected to increase yield 2.5% in the Mid-west where temperatures during July, August, and September average 72.5□F (22.5ºC), but will decrease yield 3.5% in the South, where mean temperature during July, August, and September averages 80□F (26.7ºC). Likewise, in the South, that same mean temperature will result in reduced rice, cotton, and peanut yields, which will decrease 12.0, 5.7, and 5.4%, respectively (Hatfield et al., 2008). An anticipated CO_2 increase from 380 to 440 ppm is projected to increase maize and sorghum yield by only 1%, whereas the listed C3 crops will increase yield by 6.1 to 7.4%, except for cotton, which shows a 9.2% increase (Hatfield et al., 2008).

Changes in precipitation patterns will play a large role in determining the net impacts of climate change at the national and sub-national scales, where there is considerable variation and precipitation changes remain difficult to predict. Information on regional precipitation patterns in the United States is provided in Section 15. The IPCC (Field et al., 2007) reviewed integrated assessment modeling studies exploring the interacting impacts of climate and economic factors on agriculture, water resources, and biome boundaries in the United States and concluded that scenarios with decreased precipitation create important challenges, restricting the availability of water for irrigation and at the same time increasing water demand for irrigated agriculture, as well as urban and ecological uses. The critical importance of specific agro-climatic events, such as last frost, also introduces uncertainty in future projections (Field et al., 2007).

There is still uncertainty about the sensitivity of crop yields in the United States and other world regions to the direct effects of elevated CO_2 levels. The IPCC (Easterling et al., 2007) concluded that elevated CO_2 levels are expected to contribute to small beneficial impacts on crop yields. The IPCC confirmed the general conclusions from its previous *Third Assessment Report* in 2001. Experimental research on crop responses to elevated CO_2 through the FACE (Free Air CO_2 Enrichment)[57] experiments indicate that, at ambient CO_2 concentrations of 550 ppm (approximately double the concentration from pre-industrial

[57] http://www.bnl.gov/face/

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times), crop yields increase under unstressed conditions by 10 to 25% for C3 crops and by 0 to 10% for C4 crops (medium confidence). Crop model simulations under elevated CO_2 are consistent with these ranges (high confidence) (Easterling et al., 2007). Carbon dioxide also makes some plants more water-use efficient, meaning they produce more plant material, such as grain, on less water. This is a benefit in water-limited areas and in seasons with less than normal rainfall (Karl et al., 2009). High temperatures, water and nutrient availability, and ozone exposure, however, can significantly limit the direct stimulatory CO_2 response.

Hatfield et al. (2008) provides further detail about individual crop species responses to elevated CO_2 concentrations and the interactive effects with other climate change factors. Overall, the benefits of CO_2 rise over the next 30 years are projected to mostly offset the negative effects of temperature for most C3 crops except rice and bean, while the C4 crop yields are reduced by rising temperature because they have little response to the CO_2 rise (Hatfield et al., 2008). Thus, according to Hatfield et al. (2008), the 30-year outlook for U.S. crop production is relatively neutral. However, the outlook for U.S. crop production over the next 100 years would not be as optimistic, if temperature continues to rise along with climbing CO_2 concentrations, because the C3 response to rising CO_2 is reaching a saturating plateau, while the negative temperature effects will become progressively more severe (Hatfield et al., 2008).

There are continual changes in the genetic resources of crop varieties and horticultural crops that will provide increases in yield due to increased resistance to water and pest stresses. These need to be considered in any future assessments of the climatic impacts; however, the genetic modifications have not altered the basic temperature response or CO_2 response of the biological system (Hatfield et al., 2008).

Although horticultural crops (fruits, vegetables and nuts) account for more than 40% of total crop market value in the United States (2002 Census of Agriculture), there is relatively little information on their response to CO_2, and few reliable crop simulation models for use in climate change assessments compared to that which is available for major grain and oilseed crops (Hatfield et al., 2008). The marketable yield of many horticultural crops is likely to be more sensitive to climate change than grain and oilseed crops because even short-term, minor environmental stresses can negatively affect visual and flavor quality (Hatfield et al., 2008).

9(b) Irrigation Requirements

The impacts of climate change on irrigation water requirements may be large (Easterling et al., 2007). The IPCC considered this to be a new, robust finding since the *Third Assessment Report* in 2001. The increase in irrigation demand due to climate change is expected in the majority of world regions including the United States due to decreased rainfall in certain regions and/or increased evaporation arising from increased temperatures. Longer growing seasons may contribute to the increased irrigation demands as well. Hatfield et al. (2008) describe studies that examine changes in irrigation required for the United States under climate change scenarios. For corn, a study cited in Hatfield et al. (2008) calculated that by 2030, irrigation requirements will change from -1 (Lower Colorado Basin) to +451% (Lower Mississippi Basin), because of rainfall variation. Given the variation in the sizes and baseline irrigation requirements of U.S. basins, a representative figure for the overall U.S. increase in irrigation requirements is 64% if stomatal effects are ignored, or 35% if they are included. Similar calculations were made for alfalfa, for which overall irrigation requirements are predicted to increase 50 and 29% in the next 30 years in the cases of ignoring and including stomatal effects, respectively. These increases are more likely due to the decrease in rainfall during the growing season and the reduction in soil water availability.

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9(c) Climate Variability and Extreme Events

Weather events are a major factor in annual crop yield variation. The projected impacts of climate change often consider changes in *average* temperature and precipitation patterns alone, while not reflecting the potential for altered variability in events such as droughts and floods. The potential for these events to change in frequency and magnitude introduces a key uncertainty regarding future projections of changes in agricultural and food production due to climate change. On this issue, the IPCC (Easterling et al. 2007) drew the following conclusion: "Recent studies indicate that climate change scenarios that include increased frequency of heat stress, droughts and flooding events reduce crop yields and livestock productivity beyond the impacts due to changes in mean variables alone, creating the possibility for surprises. Climate variability and change also modify the risks of fires, and pest and pathogen outbreaks, with negative consequences for food, fiber and forestry (high confidence)." The adverse effects on crop yields due to droughts and other extreme events may offset the beneficial direct effects of elevated CO_2, moderate temperature increases over the near term and longer growing seasons.

Drought events are already a frequent occurrence, especially in the western United States Vulnerability to extended drought is, according to IPCC (Field et al., 2007), increasing across North America as population growth and economic development increase demands from agricultural, municipal, and industrial uses, resulting in frequent over-allocation of water resources. Though droughts occur more frequently and intensely in the western part of the United States, the East is not immune from droughts and attendant reductions in water supply, changes in water quality and ecosystem function, and challenges in allocation (Field et al., 2007).

Average annual precipitation is projected to decrease in the southwestern United States but increase over the rest of North America (Christensen et al., 2007). Some studies project widespread increases in extreme precipitation (Christensen et al., 2007), with greater risks of not only flooding from intense precipitation, but also droughts from greater temporal variability in precipitation. Increased runoff due to intense precipitation on crop fields and animal agriculture operations may result in an increased contribution of sediments, nutrients, pathogens, and pesticides in surface waters (Kundzewicz et al., 2007).

One economic consequence of excessive rainfall is delayed spring planting, which jeopardizes profits for farmers paid a premium for early season production of high-value horticultural crops such as melon, sweet corn, and tomatoes (Hatfield et al., 2008). Field flooding during the growing season causes crop losses associated with anoxia, increases susceptibility to root diseases, increases soil compaction (due to use of heavy farm equipment on wet soils), and causes more runoff and leaching of nutrients and agricultural chemicals into ground water and surface water (Hatfield et al., 2008).

9(d) Pests and Weeds

Pests and weeds can reduce crop yields, cause economic losses to farmers, and require management control options. How climate change (elevated CO_2, increased temperatures, altered precipitation patterns, and changes in the frequency and intensity of extreme events) might affect the prevalence of pests and weeds is an issue of concern for food production and the agricultural sector. Recent warming trends in the United States have led to earlier insect spring activity and proliferation of some species (Easterling, et al., 2007).

The growth of many crops and weeds is being stimulated (Backlund et al., 2008a). Weeds generally respond more positively to increasing CO_2 than most cash crops, particularly C3 invasive weeds; and while there are many weed species that have the C4 photosynthetic pathway and therefore show a smaller response to atmospheric CO_2 relative to C3 crops, in most agronomic situations, crops are in competition

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with both C3 and C4 weeds (Backlund et al., 2008a). The IPCC (Easterling et al., 2007) concluded, with high confidence, that climate variability and change modify the risks of fires, and pest and pathogen outbreaks, with negative consequences for food, fiber, and forestry across all world regions.

Climate change is likely to lead to a northern migration of weeds (Backlund et al, 2008a). Recent research also suggests that glyphosate, the most widely used herbicide in the United States, loses its efficacy on weeds grown at the increased CO_2 levels likely in the coming decades (Backlund et al., 2008a).

Disease pressure on crops and domestic animals will likely increase with earlier springs and warmer winters, which will allow proliferation and higher survival rates of pathogens and parasites. Regional variation in warming and changes in rainfall will also affect the spatial and temporal distribution of diseases (Backlund et al., 2008a).

Most studies, however, continue to investigate pest damage as a separate function of either elevated ambient CO_2 concentrations or temperature. Pests and weeds are additional factors that, for example, are often omitted when projecting the direct stimulatory effect of elevated CO_2 on crop yields. Research on the combined effects of elevated CO_2 and climate change on pests, weeds and disease is still insufficient for U.S. and world agriculture (Easterling et al., 2007).

9(e) Livestock

Hatfield et al. (2008) describe how temperature changes and environmental stresses can result in declines in physical activity and an associated decline in eating and grazing activity (for ruminants and other herbivores) or elicit a panting or shivering response, which increases maintenance requirements of the animal and contributes to decreases in animal productivity.

Climate change has the potential to influence livestock productivity in a number of ways. Elevated CO_2 concentrations can affect forage quality; thermal stress can directly affect the health of livestock animals; an increase in the frequency or magnitude of extreme events can lead to livestock loss; and climate change may affect the spread of animal diseases. The IPCC has generated a number of new conclusions in this area compared to the *Third Assessment Report* in 2001. These conclusions (Easterling et al., 2007), along with those from the more recent CCSP report (Hatfield et al., 2008) include:

- Higher temperatures will very likely reduce livestock production during the summer season, but these losses will very likely be partially offset by warmer temperatures during the winter season. For ruminants, current management systems generally do not provide shelter to buffer the adverse effects of a changing climate; such protection is more frequently available for non-ruminants (e.g., swine and poultry).

- Based on expected vegetation changes and known environmental effects on forage protein, carbohydrate, and fiber contents, both positive and negative changes in forage quality are possible as a result of atmospheric and climatic change. Elevated CO_2 can increase the carbon-to-nitrogen ratio in forages and thus reduce the nutritional value of those grasses, which in turn affects animal weight and performance. Under elevated CO_2, a decrease of C4 grasses and an increase of C3 grasses (depending upon the plant species that remain) may occur, which could potentially reduce or alter the nutritional quality of the forage grasses available to grazing livestock; however the exact effects on both types of grasses and their nutritional quality still needs to be determined.

- Increased climate variability (including extremes in both heat and cold) and droughts may lead to livestock loss. The impact on animal productivity due to increased variability in weather patterns will likely be far greater than effects associated with the average change in climatic conditions.

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9(f) Freshwater and Marine Fisheries

Freshwater fisheries are sensitive to changes in temperature and water supply, which affect flows of rivers and streams, as well as lake levels. Climate change can interact with other factors that affect the health of fish and productivity of fisheries (e.g., habitat loss, land-use change).

The IPCC (Field et al., 2007 and references therein) reviewed a number of North American studies showing how freshwater fish are sensitive to, or are being affected by, observed changes in climate:

- Cold- and cool-water fish, especially salmonids, have been declining as warmer/drier conditions reduce their habitat. The sea-run salmon stocks are in steep decline throughout much of North America.
- Pacific salmon have been appearing in Arctic rivers.[58]
- Salmonid species have been affected by warming in U.S. streams.
- Success of adult spawning and survival of fry brook trout is closely linked to cold ground water seeps, which provide preferred temperature refuges for lake-dwelling populations. Rates of fish egg development and mortality increase with temperature rise within species-specific tolerance ranges.

Regarding the impacts of future climate change, IPCC concluded, with high confidence for North America, that cold-water fisheries will likely be negatively affected; warm-water fisheries will generally benefit; and the results for cool-water fisheries will be mixed, with gains in the northern and losses in the southern portions of ranges (Field et al., 2007). A number of specific impacts by fish species and region in North America are projected (Field et al., 2007 and references therein):

- Salmonids, which prefer cold water, are likely to experience the most negative impacts.
- Arctic freshwaters will likely be most affected, as they will experience the greatest warming.
- Many warm-water and cool-water species will shift their ranges northward or to higher altitudes.
- In the continental United States, cold-water species will likely disappear from all but the deeper lakes, cool-water species will be lost mainly from shallow lakes, and warm water species will thrive except in the far south, where temperatures in shallow lakes will exceed survival thresholds.

Climate variability and change can also impact fisheries in coastal and estuarine waters, although non-climatic factors, such as overfishing and habitat loss and degradation, are already responsible for reducing fish stocks (Nicholls et al., 2007). Coral reefs, for example, are vulnerable to a range of stresses and for many reefs, thermal stress thresholds will be crossed, resulting in bleaching, with severe adverse consequences for reef-based fisheries (Nicholls et al., 2007). Increased storm intensity, temperature, and salt-water intrusion in coastal water bodies can also adversely impact coastal fisheries production.

[58] Arctic includes large regions of Alaska, and the Alaskan indigenous population makes up largest indigenous population of the Arctic (see ACIA, 2004).

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Section 10

Forestry

This section addresses how climate change may affect forestry, including timber yields, wildfires and drought risk, forest composition, and pests in the United States

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The CCSP report addressing forestry and land resources (Ryan et al., 2008) notes climate strongly influences forest productivity, species composition, and the frequency of and magnitude of disturbances that impact forests and made the following general conclusions for the United States:

- Climate change has very likely increased the size and number of forest fires, insect outbreaks, and tree mortality in the interior West, the Southwest, and Alaska, and will continue to do so. An increased frequency of disturbance (such as drought, storms, insect outbreaks, and wildfire) is at least as important to ecosystem function as incremental changes in temperature, precipitation, atmospheric CO_2, nitrogen deposition, and ozone pollution. Disturbances partially or completely change forest ecosystem structure and species composition, cause short-term productivity and carbon storage loss, allow better opportunities for invasive alien species to become established, and command more public and management attention and resources.

- Rising CO_2 will very likely increase photosynthesis for forests, but the increased photosynthesis will likely only increase wood production in young forests on fertile soils.

- Nitrogen deposition and warmer temperatures have very likely increased forest growth where water is not limiting and will continue to do so in the near future.

- The combined effects of expected increased temperature, CO_2, nitrogen deposition, ozone, and forest disturbance on soil processes and soil carbon storage remain unclear.

Globally, the IPCC (Easterling et al., 2007) concludes that modeling studies predict increased global timber production but that regional production will exhibit large variability. However, it notes CO_2 enrichment effects may be overestimated in models.

For North America, the IPCC (Field et al., 2007) concludes:

- Overall forest growth in North America will likely increase modestly (10 to 20%) as a result of extended growing seasons and elevated CO_2 over the next century but with important spatial and temporal variation (medium confidence).[59]

- Disturbances like wildfire and insect outbreaks are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons (very high confidence). Although recent climate trends have increased vegetation growth, continuing increases in disturbances are likely to limit carbon storage, facilitate invasive species, and disrupt ecosystem services.

- Over the 21st century, pressure for tree species to shift north and to higher elevations will fundamentally rearrange North American ecosystems. Differential capacities for range shifts and

[59] According to IPCC terminology, "medium confidence" conveys a 5 out of 10 chance of being correct. See Box 1.2 for a full description of IPCC's uncertainty terms.

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constraints from development, habitat fragmentation, invasive species, and broken ecological connections will alter ecosystem structure, function, and services.

10(a) Forest Productivity

Forestry productivity is known to be sensitive to changes in climate variables (e.g. temperature, radiation, precipitation, water vapor pressure in the air, and wind speed), as these affect a number of physical, chemical, and biological processes in forest systems (Easterling, et al., 2007). However, as noted in a CCSP report addressing the forest sector (Ryan et al., 2008), it is difficult to separate the role of climate from other potentially influencing factors, particularly because these interactions vary by location.

For the United States as a whole, forest growth and productivity have been observed to increase since the middle of the 20th century, in part due to observed climate change. Nitrogen deposition and warmer temperatures have very likely increased forest growth where water is not limiting (Ryan et al., 2008). The IPCC (Field et al., 2007 and references therein) outlines a number of studies demonstrating the observed connection between changes in U.S. forest growth and changes in climate variables:

- Forest growth appears to be slowly accelerating (less than 1% per decade) in regions where tree growth has historically been limited by low temperatures and short growing seasons.
- The length of the vegetation growing season has increased an average of two days per decade since 1950 in the conterminous United States, with most of the increase resulting from earlier spring warming.
- Growth is slowing in areas subject to drought.
- On dry south-facing slopes in Alaska, growth of white spruce has decreased over the last 90 years, due to increased drought stress.
- In semi-arid forests of the southwestern United States, growth rates have decreased since 1895, correlated with drought from warming temperatures.
- Mountain forests are increasingly encroached upon from other species native to adjacent lowlands, while simultaneously losing high altitude habitats due to warming (Fischlin et al., 2007).
- In Colorado, aspen have advanced into the more cold-tolerant spruce-fir forests over the past 100 years.
- A combination of warmer temperatures and insect infestations has resulted in economically significant losses of the forest resource base in Alaska.

Forest productivity gains may result through: 1) the direct stimulatory CO_2 fertilization effect (although the magnitude of this effect remains uncertain over the long term and can be curtailed by other changing factors); 2) warming in cold climates, given concomitant precipitation increases to compensate for possibly increasing water vapor pressure deficits; and 3) precipitation increases under water-limited conditions (Fischlin et al., 2007). Most trees and shrubs use the C3 photosynthetic pathway, which means they respond more favorably to CO_2 enrichment than plants that use the C4 pathway increasing the competitive ability of C3 versus C4 plants in water-limited systems (Ryan et al., 2008).

New studies suggest that direct CO_2 effects on tree growth may be lower than previously assumed (Easterling et al., 2007). Additionally, the initial increase in growth increments may be limited by competition, disturbance, air pollutants (primarily tropospheric ozone), nutrient limitations, ecological processes, and other factors, and the response is site- and species-specific (Easterling et al., 2007). Similarly, Ryan et al. (2008) stated that, where nutrients are not limiting, rising CO_2 increases photosynthesis and wood production (with younger stands responding most strongly), but that on infertile soils the extra carbon from increased photosynthesis will be quickly respired.

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The general findings from a number of recent syntheses using data from the three American and one European CO_2-enrichment FACE study sites show that North American forests will absorb more CO_2 and might retain more carbon as atmospheric CO_2 increases. The increase in the rate of carbon sequestration will be highest (mostly in wood) on nutrient-rich soils with no water limitation and will decrease with decreasing fertility and water supply. Several yet unresolved questions prevent a definitive assessment of the effect of elevated CO_2 on other components of the carbon cycle in forest ecosystems (Ryan et al., 2008).

Precipitation and weather extremes are key to many forestry impacts, accounting for part of the regional variability in forest response (Easterling et al., 2007). Ryan et al. (2008) note forest productivity varies with annual precipitation across broad gradients and with interannual variability within sites. They conclude if existing trends in precipitation continue:

- Forest productivity will likely decrease in the Interior West, the Southwest, eastern portions of the Southeast, and Alaska.
- Forest productivity will likely increase in the northeastern United States, the Lake States, and in western portions of the Southeast.

They also state an increase in drought events will very likely reduce forest productivity wherever these events occur.

As with crop yields, ozone pollution will modify the effects of elevated CO_2 and any changes in temperature and precipitation, but these multiple interactions are difficult to predict because they have been poorly studied (Ryan et al., 2008). Nitrogen deposition has likely increased forest growth rates over large areas, and interacts positively to enhance the forest growth response to increasing CO_2. These effects are expected to continue in the future as nitrogen deposition and rising CO_2 continue.

For the projected temperature increases over the next few decades, most studies support the conclusion that a modest warming of a few degrees Celsius will lead to greater tree growth in the United States Simulations with yield models show that climate change can increase global timber production through location changes of forests and higher growth rates, especially when positive effects of elevated CO_2 concentration are taken into consideration (Easterling et al., 2007). There are many causes for this enhancement including direct physiological CO_2 effects, a longer growing season, and potentially greater mineralization of soil nutrients. Because different species may respond somewhat differently to warming, the competitive balance of species in forests may change. Trees will probably become established in formerly colder habitats (more northerly, higher altitude) than at present (Ryan et al., 2008).

Productivity gains in one area can occur simultaneously with productivity losses in other areas. For a widespread species like lodgepole pine, a 3ºC temperature increase would increase growth in the northern part of its range, decrease growth in the middle, and decimate southern forests (Field et al., 2007). Climate change is expected to increase California timber production by the 2020s because of stimulated growth in the standing forest. In the long run (up to 2100), these productivity gains would be offset by reductions in productive area for softwoods growth. Risks of losses from southern pine beetle likely depend on the seasonality of warming, with winter and spring warming leading to the greatest damage (Easterling et al., 2007 and references therein).

10(b) Wildfire and Drought Risk

While in some cases a changing climate may have positive impacts on the productivity of forest systems, changes in disturbance patterns are expected to have a substantial impact on overall gains or losses. More prevalent forest fire disturbances have recently been observed in the United States and other world

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regions (Fischlin, et al., 2007). According to a study cited in the recent USGCRP report (Karl et al., 2009), Alaska has experienced large increases in fire, with the area burned more than doubling in recent decades, and as in the western United States higher, air temperature is a key factor. Wildfires and droughts, among other extreme events (e.g., hurricanes) that can cause forest damage, pose the largest threats over time to forest ecosystems.

Several lines of evidence suggest that large, stand-replacing wildfires will likely increase in frequency over the next several decades because of climate warming (Ryan et al., 2008). General climate warming encourages wildfires by extending the summer period that dries fuels, promoting easier ignition and faster spread (Field et al., 2007).

The IPCC (Field et al., 2007 and references therein) noted a number of observed changes to U.S. wildfire size and frequency, often associating these changes with changes in average temperatures:

- Since 1980, an average of about 22,000 km^2 yr^{-1} (8,500 mi^2 yr^{-1}) has burned in wildfires, almost twice the 1920–1980 average of about 13,000 km^2 yr^{-1} (5,020 mi^2 yr^{-1}).
- The forested area burned in the western United States from 1987–2003 is 6.7 times the area burned from 1970-1986.
- Human vulnerability to wildfires has increased, with a rising population in the wildland-urban interface.
- In the last three decades, the wildfire season in the western United States has increased by 78 days, and burn durations of fires greater than 1,000 hectares (ha) (2,470 acres) have increased from 7.5 to 37.1 days, in response to a spring/summer warming of 1.6°F (0.87°C).
- Earlier spring snowmelt has led to longer growing seasons and drought, especially at higher elevations, where the increase in wildfire activity has been greatest.
- In the southwestern United States, fire activity is correlated with ENSO positive phases (La Niña) and higher Palmer Drought Severity Indices.[60] El Niño events tend to bring wetter conditions to the southwest, enhancing the production of fine fuels[61] and, La Niña events tend to bring drier conditions. Major fire years tend to follow the switching from El Niño to La Niña conditions due to buildup of material during wet years followed by desiccation during a dry year, whereas small fires are strongly associated directly with previous year drought. Other modes of atmospheric and oceanic variability are known to impact temperature and precipitation (Gutowski et al., 2008) and hence wildfire patterns and activity.
- Increased temperature in the future will likely extend fire seasons throughout the western United States, with more fires occurring earlier and later than is currently typical, and will increase the total area burned in some regions.

Though fires and extreme events are not well represented in models, current climate modeling studies suggest that increased temperatures and longer growing seasons will elevate fire risk in connection with increased aridity. Some research identifies the possibility of a 10% increase in the seasonal severity of fire hazard over much of the United States under climate change (Easterling, et al., 2007). For Arctic regions, forest fires are expected to increase in frequency and intensity (ACIA, 2004). In California, the risk of increased wildfires as a result of climate change has been identified as a significant issue (California Energy Commission, 2006).

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[60] The Palmer Drought Severity Index (PSDI), used by NOAA, uses a formula that includes temperature and rainfall to determine dryness. It is most effective in determining long-term drought. Positive PDSI indicates wet conditions, and negative PDSI indicates dry conditions.

[61] Fine fuels are defined as fast-drying fuels which are less than 1/4-inch (0.64 cm) in diameter. These fuels (e.g., grass, leaves, needles) ignite readily and are consumed rapidly by fire when dry.

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10(c) Forest Composition

Climate change and associated changes in disturbance regimes will cause shifts in the distributions of tree species and alter forest species composition. With warming, forests will extend further north and to higher elevations. Over currently dry regions, increased precipitation may allow forests to displace grasslands and savannas. Changes in forest composition in turn can alter the frequencies, intensities, and impacts of disturbances such as fire, insect outbreaks, and disease.

In Alaska and neighboring Arctic regions, there is strong evidence of recent vegetation composition change, as outlined by the IPCC (Anisimov et al., 2007 and references therein):

- Aerial photographs show increased shrub abundance in 70% of 200 locations.
- Along the Arctic to sub-Arctic boundary, the tree-line has moved about 6 mi (10 km) northwards, and 2% of Alaskan tundra on the Seward Peninsula has been displaced by forest in the past 50 years.
- The pattern of northward and upward tree-line advances is comparable with earlier Holocene changes.
- Analyses of satellite images indicate that the length of growing season is increasing by three days per decade in Alaska.

Likely rates of migration northward and to higher elevations are uncertain and depend not only on climate change but also on future land-use patterns and habitat fragmentation, which can impede species migration. Evidence of shifts in tree species has been observed in the Green Mountains of Vermont where temperatures have risen 2 to 4°F (4 to 7°C) in the last 40 years. As reported by USGCRP, the ranges of some mountain tree species in this region have shifted to higher elevations by 350 feet (107 m) in the last 40 years (Karl et al., 2009). Tree communities were relatively unchanged at low and high elevations but in mid-elevation transition zones, the changes have been dramatic. Tree species suited to cold conditions in the Green Mountains declined from 43 to 18% while species suited to warmer conditions increased from 57 to 82%.

Bioclimate modeling based on outputs from five general circulation models suggests increases in tree species richness in the Northwest and decreases in the Southwest on long time scales (millennia). Over the next century, however, even positive long-term species richness may lead to short-term decreases because species that are intolerant of local conditions may disappear relatively quickly while migration of new species into the area may be quite slow (Field, et al., 2007). The Arctic Climate Impact Assessment (ACIA, 2004) also concluded that vegetation zones are projected to migrate northward, with forests encroaching on tundra and tundra encroaching on polar deserts. Limitations in amount and quality of soils are likely to hinder these poleward shifts.

10(d) Insects and Diseases

Insects and diseases are a natural part of forested ecosystems and outbreaks often have complex causes. The effects of insects and diseases can vary from defoliation and retarded growth, to timber damage, to massive forest diebacks. Insect life cycles can be a factor in pest outbreaks; and insect life cycles are sensitive to climate change. Many northern insects have a two-year life cycle, and warmer winter temperatures allow a larger fraction of overwintering larvae to survive. Recently, spruce budworm in Alaska has completed its life cycle in one year, rather than the previously observed duration of two years (Field et al., 2007). Recent warming trends in the United States have led to earlier spring activity of insects and proliferation of some species, such as the mountain pine beetle (Easterling et al., 2007). During the 1990s, Alaska's Kenai Peninsula experienced an outbreak of spruce bark beetle over 6,200 square miles (16,000 km^2) with 10 to 20% tree mortality (Anisimov et al., 2007). Also following recent

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warming in Alaska, spruce budworm has reproduced farther north reaching problematic numbers (Anisimov et al., 2007). Climate change may indirectly affect insect outbreaks by affecting the overall health and productivity of trees. For example, susceptibility of trees to insects is increased when multi-year droughts degrade the trees' ability to generate defensive chemicals (Field, et al., 2007). Warmer temperatures have already enhanced the opportunities for insect spread across the landscape in the United States and other world regions (Easterling et al., 2007).

The IPCC (Easterling et al., 2007) stated that modeling of future climate change impacts on insect and pathogen outbreaks remains limited. Nevertheless, the IPCC (Field et al., 2007) states with high confidence that, across North America, impacts of climate change on commercial forestry potential are likely to be sensitive to changes in disturbances from insects and diseases, as well as wildfires.

The CCSP report (Ryan et al., 2008) states that the ranges of the mountain pine beetle and southern pine beetle are projected to expand northward as a result of average temperature increases. Increased probability of spruce beetle outbreak as well as increase in climate suitability for mountain pine beetle attack in high-elevation ecosystems has also been projected in response to warming (Ryan et al., 2008).

Climate change can shift the current boundaries of insects and pathogens and modify tree physiology and tree defense. An increase in climate extremes may also promote plant disease and pest outbreaks (Easterling et al., 2007).

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Section 11

Water Resources

This section covers climate change effects on U.S. water supply, water quality, extreme events affecting water resources, and water uses. Information about observed trends as well as projected impacts is provided.

The vulnerability of freshwater resources in the United States to climate change varies from region to region. Although water management practices in the United States are generally advanced, particularly in the West, the reliance on past conditions as the basis for current and future planning may no longer be appropriate, as climate change increasingly creates conditions well outside of historical observations (Lettenmaier et al., 2008). Examples of large U.S. water bodies where climate change raises a concern include the Great Lakes, Chesapeake Bay, Gulf of Mexico, and the Columbia River Basin.

For North America, the IPCC (Field et al., 2007) concluded:

- Climate change will constrain North America's overallocated water resources, increasing competition among agricultural, municipal, industrial, and ecological uses (very high confidence)[62]. Rising temperatures will diminish snowpack and increase evaporation, affecting seasonal availability of water. Higher demand from economic development, agriculture and population growth will further limit surface and ground water availability. In the Great Lakes and major river systems, lower levels are likely to exacerbate challenges relating to water quality, navigation, recreation, hydropower generation, water transfers, and binational relationships.

11(a) Water Supply and Snowpack

Surface Water and Snowpack

The semi-humid conditions of the eastern United States transition to drier conditions in the West that are interrupted by the Rocky Mountains. The driest climates, however, exist in the Intermountain West and Southwest, becoming more humid toward the west and north to more humid conditions on the upslope areas of the Cascade and coastal mountain ranges, especially in the Pacific Northwest (Lettenmaier et al., 2008).

The IPCC and USGCRP reviewed a number of studies showing trends in U.S. precipitation patterns, surface water supply, and snowpack, and how climate change may be contributing to some of these trends (Field et al., 2007; Karl et al., 2009):

- On average, annual precipitation has increased throughout most of North America. However, much of the Southeast and West has experienced reductions in precipitation and increases in drought severity and duration, especially in the Southwest (Field et al., 2007).
- Streamflow in the eastern United States has increased 25% in the last 60 years but has decreased by about 2% per decade in the central Rocky Mountain region over the last century (Field et al., 2007).
- Since 1950, stream discharge in both the Colorado and Columbia river basins has decreased (Field et al., 2007).

[62] According to IPCC terminology, "very high confidence" conveys a 9 out of 10 chance of being correct. See Box 1.2 for a full description of IPCC's uncertainty terms.

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- Over the past 50 years, there have been widespread temperature-related reductions in snowpack in the West, with the largest reductions occurring in lower elevation mountains in the Northwest and California where snowfall occurs at temperatures close to the freezing point (Karl et al., 2009).
- In regions with winter snow, warming has shifted the magnitude and timing of hydrologic events. The fraction of annual precipitation falling as rain (rather than snow) increased at 74% of the weather stations studied in the western mountains of the United States from 1949 to 2004 (Field et al., 2007). Runoff in snowmelt-dominated areas is occurring up to 20 days earlier or more in the West, and up to 14 days earlier in the Northeast (Karl et al., 2009).
- Spring and summer snow cover has also decreased in the U.S. West (Field et al., 2007).
- Break-up of river and lake ice across North America advanced by 0.2 to 12.9 days over the last 100 years (Field et al., 2007).

In the Arctic, precipitation has increased by about 8% on average over the past century. Much of the increase has fallen as rain, with the largest increases occurring in autumn and winter. Later freeze-up and earlier break-up of river and lake ice have combined to reduce the ice season by one to three weeks in some areas. Glaciers throughout North America are melting, and the particularly rapid retreat of Alaskan glaciers represents about half of the estimated loss of glacial mass worldwide (ACIA, 2004). Permafrost plays a large role in the hydrology of lakes and ponds. The spatial pattern of lake disappearance strongly suggests that permafrost thawing is driving the changes. These changes to Arctic precipitation, ice extent, and glacial abundance will affect key regional biophysical systems, act as climatic feedbacks (primarily by changing surface albedo), and have socioeconomic impacts (high confidence) (Anisimov et al., 2007).

In regions including the Colorado River, Columbia River, and Ogallala Aquifer, surface and/or ground water resources are intensively used and subject to competition from agricultural, municipal, industrial, and ecological needs. This increases the potential vulnerability to future changes in timing and availability of water (Field et al., 2007).

Climate change has already altered, and will continue to alter, the water cycle, affecting where, when, and how much water is available for all uses (Karl et al., 2009). With higher temperatures, the water-holding capacity of the atmosphere and evaporation into the atmosphere increase, and this favors increased climate variability, with more intense precipitation and more droughts (Kundzewicz et al., 2007). Projections for the western mountains of the United States suggest that warming, and changes in the form, timing, and amount of precipitation will very likely (high confidence) lead to earlier melting and significant reductions in snowpack by the middle of the 21st century (Lettenmaier et al., 2008; Field et al., 2007). In mountainous snowmelt-dominated watersheds, projections suggest advances in the timing of snowmelt runoff, increases in winter and early spring flows (raising flooding potential), and substantially decreased summer flows. Heavily utilized water systems of the western United States that rely on capturing snowmelt runoff, such as the Columbia River system, will be especially vulnerable (Field et al., 2007). Reduced snowpack has been identified as a major concern for the state of California (California Energy Commission, 2006).

Globally, current water management practices are very likely to be inadequate to reduce the negative impacts of climate change on water supply reliability, flood risk, and aquatic ecosystems (very high confidence) (Kundzewicz et al., 2007). Less reliable supplies of water are likely to create challenges for managing urban water systems as well as for industries that depend on large volumes of water. It is projected that the negative impacts of climate change on freshwater systems outweigh its benefits (high confidence). Areas in which runoff is projected to decline are likely to face a reduction in the value of the services provided by water resources (very high confidence). The beneficial impacts of increased annual runoff in other areas will be tempered by the negative effects of increased precipitation variability and

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seasonal runoff shifts on water supply, water quality, and flood risks (high confidence) (Kundzewicz, 2007).

U.S. water managers currently anticipate local, regional, or state-wide water shortages over the next 10 years. Threats to reliable supply are complicated by high population growth rates in western states where many resources are at or approaching full utilization. In eastern North America, daily precipitation so heavy that it now occurs only once every 20 years is projected to occur approximately every eight years by the end of this century, under a mid-range emissions scenario (CCSP, 2008i). Potential increases in heavy precipitation, with expanding impervious surfaces, could increase urban flood risks and create additional design challenges and costs for stormwater management (Field et al., 2007). The IPCC (Field et al., 2007 and references therein) reviewed several regional-level studies on climate change impacts to U.S. water management which showed:

- In the Great Lakes–St. Lawrence Basin, many, but not all, assessments project lower net basin supplies and lake water levels. Lower water levels are likely to influence many sectors, with multiple, interacting impacts (IPCC: high confidence). Atmosphere–lake interactions contribute to the uncertainty in assessing these impacts.
- Urban water supply systems in North America often draw water from considerable distances, so climate impacts need not be local to affect cities. By the 2020s, 41% of the water supply to southern California is likely to be vulnerable due to snowpack loss in the Sierra Nevadas and Colorado River basin.
- The New York area will likely experience greater water supply variability. New York City's system can likely adapt to future changes, but the region's smaller systems may be vulnerable, leading to a need for enhanced regional water distribution plans.

In the Arctic, river discharge to the ocean has increased during the past few decades, and peak flows in the spring are occurring earlier. These changes are projected to accelerate with future climate change. Snow cover extent in Alaska is projected to decrease by 10 to 20% by the 2070s, with greatest declines in spring (ACIA, 2004 and reference therein).

The IPCC concluded with high confidence that under most climate change scenarios, water resources in small islands around the globe are likely to be seriously compromised (Mimura et al., 2007). Most small islands have a limited water supply, and water resources in these islands are especially vulnerable to future changes and distribution of rainfall. Reduced rainfall typically leads to decreased surface water supply and slower recharge rates of the freshwater lens[63], which can result in prolonged drought impacts. Many islands in the Caribbean (which include U.S. territories of Puerto Rico and U.S. Virgin Islands) and Pacific (including American Samoa, the Marshall Islands, and Republic of Palau) are likely to experience increased water stress as a result of climate change. Under all SRES scenarios, reduced rainfall in summer is projected for the Caribbean, making it unlikely that the demand for water resources will be met. Increased rainfall in winter is unlikely to compensate for these water deficits due to lack of storage capacity (Mimura et al., 2007).

Ground Water

Ground water systems generally respond more slowly to climate change than surface water systems. Limited data on existing supplies of ground water makes it difficult to understand and measure climate

[63] Freshwater lens is defined as a relatively thin layer of freshwater within island aquifer systems that floats on an underlying mass of denser seawater. Numerous factors control the shape and thickness of the lens, including the rate of recharge from precipitation, island geometry, and geologic features such as the permeability of soil layers.

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effects. In general, ground water levels correlate most strongly with precipitation, but temperature becomes more important for shallow aquifers, especially during warm periods. In semi-arid and arid areas, ground water resources are particularly vulnerable because precipitation and streamflow are concentrated over a few months, year-to-year variability is high, and deep ground water wells or reservoirs generally do not exist (Kundzewicz et al., 2007).

With climate change, availability of ground water is likely to be influenced by changes in withdrawals (reflecting development, demand, and availability of other sources) and recharge (determined by temperature, timing, and amount of precipitation, and surface water interactions) (medium confidence). In general, simulated aquifer levels respond to changes in temperature, precipitation, and the level of withdrawal. According to IPCC, base flows were found to decrease in scenarios that are drier or have higher pumping rates, and increase in wetter scenarios on average across world regions (Kundzewicz et al., 2007). Changes in vegetation and soils that occur as temperature changes or due to fire or pest outbreaks are also likely to affect recharge by altering evaporation and infiltration rates. More frequent and larger floods are likely to increase ground water recharge in semi-arid and arid areas, where most recharge occurs through dry streambeds after heavy rainfalls and floods (Karl et al., 2009).

Projections suggest that efforts to offset declining surface water availability by increasing ground water withdrawals will be hampered by decreases in ground water recharge in some water-stressed regions, such as the southwest United States. Vulnerability in these areas is also often exacerbated by the rapid increase of population and water demand (high confidence) (Kundzewicz et al., 2007). Projections for the Ogallala aquifer region suggest that natural ground water recharge decreases more than 20% in all simulations with different climate models and future warming scenarios of 4.5°F (2.5°C) or greater (Field et al., 2007 and reference therein).

In addition, sea level rise will extend areas of salinization of ground water and estuaries, resulting in a decrease in freshwater availability for humans and ecosystems in coastal areas. For a discussion of these impacts, see Section 12.

11(b) Water Quality

The IPCC concluded with high confidence that higher water temperatures, increased precipitation intensity, and longer periods of low flows exacerbate many forms of water pollution and can impact ecosystems, human health, and water system reliability and operating costs (Kundzewicz et al., 2007). A CCSP (2008e) report also acknowledges that water quality is sensitive to both increased water temperatures and changes in precipitation; however, most water quality changes observed so far in the United States are likely attributable to causes other than climate change.

Pollutants of concern particularly relevant to climate change effects include sediment, nutrients, organic matter, pathogens, pesticides, salt, and thermal pollution (Kundzewicz et al., 2007). The IPCC (Kundzewicz et al., 2007) reviewed several studies discussing the observed impacts of climate change on water quality that showed:

- In lakes and reservoirs, climate change effects are primarily caused by water temperature variations. These variations can be caused by climate change or indirectly through increases in thermal pollution as a result of higher demand for cooling water in the energy sector. This affects, for the United States and all world regions, dissolved oxygen regimes, redox potentials[64], lake stratification, mixing rates, and the development of aquatic biota, as they all depend on water temperature. Increasing water

[64] Redox potential is defined as the tendency of a chemical species to acquire electrons and therefore be reduced.

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temperature affects the self-purification capacity of rivers by reducing the amount of dissolved oxygen available for biodegradation.

- Water pollution problems are exacerbated during low flow conditions where small water quantities result in less dilution and greater concentrations of pollutants.

- Heavy precipitation frequencies in the United States were at a minimum in the 1920s and 1930s and have increased through the 1990s (Field, et al., 2007). Increases in intense rain events result in the introduction of more sediment, nutrients, pathogens, and toxics into water bodies from non-point sources but these events also provide the pulse flow needed for some ecosystems.

North American simulations of future surface and bottom water temperatures of lakes, reservoirs, rivers, and estuaries consistently increase, with summer surface temperatures exceeding 86°F (30°C) in Midwestern and southern lakes and reservoirs. The IPCC projects that warming is likely to extend and intensify summer thermal stratification in surface waters, further contributing to oxygen depletion (Field et al., 2007 and references therein). Oxygen is essential for most living things, and its availability is reduced at higher temperatures both because the amount that can be dissolved in water is lower and because respiration rates of living things are higher. Low oxygen stresses aquatic animals such as coldwater fish and the insects and crustaceans on which they feed. Lower oxygen levels also decrease the self-purification capabilities of rivers (Karl et al., 2009).

Climate models consistently project that the eastern United States will experience increased runoff, while there will be substantial declines in the interior West, especially the Southwest. While this represents the projected general trends, important regional and seasonal differences exist, and there is less agreement among model projections for some areas (e.g., the Southeast). Projections for runoff in California and other parts of the West also show reductions, although less than in the interior West (Karl et al., 2009). Higher water temperature and variations in runoff are likely to produce adverse changes in water quality affecting human health, ecosystems, and water uses. Elevated surface water temperatures will promote algal blooms and increases in bacteria and fungi levels. Increases in water temperature can also make some contaminants, such as ammonia (U.S. EPA, 1999), more toxic for some species and foster the growth of microbial pathogens in sources of drinking water. Warmer waters also transfer volatile and semi-volatile compounds (ammonia, mercury, polychlorinated biphenyls [PCBs], dioxins, pesticides) from surface water bodies to the atmosphere more rapidly (Kundzewicz et al., 2007). Although this transfer will improve water quality, this may have implications for air quality.

Lowering of the water levels in rivers and lakes can lead to re-suspension of bottom sediments and liberating compounds, with negative effects on water supplies (Field et al., 2007 and references therein). These impacts can lead to a bad odor and taste in chlorinated drinking water and greater occurrence of toxins. More intense rainfall will lead to increases in suspended solids (turbidity) and pollutant levels in water bodies due to soil erosion (Kundzewicz et al., 2007). Moreover, even with enhanced phosphorus removal in wastewater treatment plants, algal growth in water bodies may increase with warming over the long term. Increasing nutrient and sediment loads due to more intense runoff events will negatively affect water quality, requiring additional treatment to render it suitable for drinking water.

In coastal areas, precipitation increases on land have increased river runoff, polluting coastal waters with more nitrogen and phosphorous, sediments, and other contaminants (Karl et al., 2009). The direct influence of sea level rise on freshwater resources comes principally from seawater intrusion into surface waters and coastal aquifers and further encroachment of saltwater into estuaries and coastal river systems. These changes can have significant impacts on coastal populations relying on surface water or coastal aquifers for drinking water (Nicholls et al., 2007).

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Climate change is likely to make it more difficult to achieve existing water quality goals for sediment (IPCC: high confidence) because hydrologic changes affect many geomorphic processes including soil erosion, slope stability, channel erosion, and sediment transport (Field et al., 2007). IPCC reviewed a number of region-specific studies on U.S. water quality and projected that:

- Changes in precipitation may increase nitrogen loads from rivers in the Chesapeake and Delaware Bay regions by up to 50% by 2030 (Kundzewicz et al., 2007 and reference therein).

- Decreases in snow cover and increases in winter rain on bare soil will likely lengthen the erosion season and enhance erosion intensity. This will increase the potential for sediment-related water quality impacts in agricultural areas without appropriate soil management techniques (Field et al., 2007 and reference therein). All studies on soil erosion suggest that increased rainfall amounts and intensities will lead to greater rates of erosion, within the United States and in other regions, unless protection measures are taken (Kundzewicz et al., 2007). Soil management practices (e.g., crop residue, no-till) in some regions (e.g., the Corn Belt) may not provide sufficient erosion protection against future intense precipitation and associated runoff (Field et al., 2007).

11(c) Extreme Events

There are a number of climatic and non-climatic drivers influencing flood and drought impacts. Whether risks are realized depends on several factors. Floods can be caused by intense and/or long-lasting precipitation events, rapid snowmelt, dam failure, or reduced conveyance due to ice jams or landslides. Flood magnitude and spatial extent depend on the intensity, volume, and time of precipitation, and the antecedent conditions of rivers and their drainage basins (e.g., presence of snow and ice, soil composition, level of human development, existence of dikes, dams, and reservoirs) (Kundzewicz et al., 2007).

Precipitation intensity will increase across the United States, but particularly at mid- and high latitudes where mean precipitation also increases. This increase will affect the risk of flash flooding and urban flooding (Kundzewicz et al., 2007). Some studies project widespread increases in extreme precipitation with greater risks of not only flooding from intense precipitation but also droughts from greater temporal variability in precipitation. In general, projected changes in precipitation extremes are larger than changes in mean precipitation (Field et al., 2007).

It is likely that anthropogenic warming has increased the impacts of drought over North America in recent decades, but the magnitude of the effect is uncertain (CCSP, 2008g). The socioeconomic impacts of droughts arise from the interaction between climate, natural conditions, and human factors such as changes in land use. In dry areas, excessive water withdrawals from surface and ground water sources can exacerbate the impacts of drought (Kundzewicz et al., 2007). Although drought has been more frequent and intense in the western part of the United States, the East is also vulnerable to droughts and attendant reductions in water supply, changes in water quality and ecosystem function, and challenges in allocation (Field et al., 2007).

An additional impact of greenhouse warming is a likely increase in evapotranspiration during drought episodes, thus sustaining and amplifying impacts, because of warmer land surface temperatures. This effect would not have initiated drought conditions but would be an additional factor, one that is likely to grow as climate warms and result in longer, more intense droughts. Hence, by adding additional water stress, warming can exacerbate naturally occurring droughts, in addition to influencing the meteorological conditions responsible for drought (Hoerling et al., 2008).

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In addition to the effects on water supply, extreme events, such as floods and droughts, will likely reduce water quality. Increased erosion and runoff rates during flood events will wash pollutants (e.g., organic matter, fertilizers, pesticides, heavy metals) from soils into water bodies, with subsequent impacts to species and ecosystems. Heavy rains and floods beyond the design capacity of water treatment systems will likely cause overflows of combined sewer systems[65] and untreated wastewater discharges from overwhelmed or damaged wastewater treatment plants, resulting in impaired water quality and risks to human health (Karl et al., 2009). During drought events, the lack of precipitation and subsequent low flow conditions will impair water quality by reducing the amount of water available to dilute pollutants. These effects from floods and droughts will make it more difficult to achieve pollutant discharge limits and water quality goals (Kundzewicz et al., 2007).

11(d) Implications for Water Uses

There are many competing water uses in the United States that will be adversely impacted by climate change impacts to water supply and quality. Furthermore, the past century is no longer a reasonable guide to the future for water management (Karl et al., 2009). The IPCC reviewed a number of studies describing the impacts of climate change on water uses in the United States that showed:

- Decreased water supply and lower water levels are likely to exacerbate challenges relating to navigation in the United States (Field et al., 2007). Some studies have found that low-flow conditions may restrict ship loading in shallow ports and harbors (Kundzewicz et al., 2007). However, navigational benefits from climate change exist as well. For example, the navigation season for the North Sea Route is projected to increase from the current 20 to 30 days per year to 90 to 100 days by 2080 (ACIA, 2004 and references therein).
- Climate change impacts to water supply and quality will affect agricultural practices, including the increase of irrigation demand in dry regions and the aggravation of non-point source water pollution problems in areas susceptible to intense rainfall events and flooding (Field et al., 2007). For more information on climate change impacts to agriculture, see Section 9.
- The U.S. energy sector, which relies heavily on water for generation (hydropower) and cooling capacity, will be adversely impacted by changes to water supply and quality in reservoirs and other water bodies (Wilbanks et al., 2007). For more information on climate change impacts to the energy sector, see Section 13.
- Climate-induced environmental changes (e.g., loss of glaciers, reduced river discharge in some regions, reduced snow fall in winter) will affect park tourism, winter sport activities, inland water sports (e.g., fishing, rafting, boating), and other recreational uses dependent upon precipitation (Field et al., 2007). While the North American tourism industry acknowledges the important influence of climate, its impacts have not been analyzed comprehensively.
- Ecological uses of water could be adversely impacted by climate change. Temperature increases and changed precipitation patterns alter flow and flow timing. These changes will threaten aquatic ecosystems (Kundzewicz et. al., 2007). For more information, on climate change impacts on ecosystems and wildlife, see Section 14.
- By changing the existing patterns of precipitation and runoff, climate change will further stress existing water disputes across the United States. Disputes currently exist in the Klamath River, Sacramento Delta, Colorado River, Great Lakes region, and Apalachicola-Chattahoochee-Flint River system (Karl et al., 2009).

[65] Combined sewer systems are an older infrastructure design that carries storm water and sewage in the same pipes. During heavy rains, these systems often cannot handle the volume, and untreated sewage is discharged into lakes or waterways, including drinking water supplies and places where people swim.

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Section 12

Sea Level Rise and Coastal Areas

This section discusses areas in the United States vulnerable to sea level rise, associated interactions with coastal development, important coastal processes, observed and projected impacts, and how climate change effects on extreme events will impact coastal areas. Information on the observed and projected rates of sea level rise due to climate change can be found in Sections 4(g) and 6(c), respectively. Information on ocean acidification is discussed in Sections 4(l), 6(b), and 14(a).

The IPCC (Field et al., 2007) concluded the following when considering how climate change effects, including sea level rise, may result in impacts to North American coasts:

- Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution (very high confidence).[66] Sea level is rising along much of the coast, and the rate of change will increase in the future, exacerbating the impacts of progressive inundation, storm-surge flooding, and shoreline erosion.
- Storm impacts are likely to be more severe, especially along the Gulf and Atlantic coasts. Salt marshes, other coastal habitats, and dependent species are threatened by sea level rise, fixed structures blocking landward migration, and changes in vegetation. Population growth and rising value of infrastructure in coastal areas increases vulnerability to climate variability and future climate change.

12(a) Vulnerable Areas

Interaction With Coastal Zone Development

Coastal population growth in deltas, barrier islands, and estuaries has led to widespread conversion of natural coastal landscapes to agriculture and aquaculture as well as industrial and residential uses. According to NOAA (Crossett et al., 2004), approximately 153 million people (53% of the total population) lived in the 673 U.S. coastal counties[67] in 2003. This represents an increase of 33 million people since 1980, and by 2008, the number was projected to rise to 160 million. This population growth, the rising value of coastal property, and the projected increases in storm intensity have increased the vulnerability of coastal areas to climate variability and future climate change (IPCC, 2007b).

For small islands, the coastline is long, relative to island area. As a result, many resources and ecosystem services are threatened by a combination of human pressures and climate change effects, including sea level rise, increases in sea surface temperature, and possible increases in extreme weather events (Mimura et al., 2007).

Coastal and ocean activities contribute more than $1 trillion to the U.S. gross domestic product (Karl et al., 2009). Although climate change is impacting coastal systems, non-climate human impacts have been more damaging over the past century. The major non-climate impacts for the United States and other world regions include drainage of coastal wetlands, resource extraction[68], deforestation, introductions of invasive species, shoreline protection, and the discharge of sewage, fertilizers, and contaminants into

[66] According to IPCC terminology, "very high confidence" conveys a 9 out of 10 chance of being correct. See Box 1.2 for a full description of IPCC's uncertainty terms.
[67] "Coastal county" is generally defined in NOAA reports as a county in which at least 15% of its total land area is located within a coastal watershed.
[68] Resource extraction activities in coastal areas include sand/coral mining, hydrocarbon production, and commercial and recreational fishing.

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coastal waters (Nicholls et al., 2007). The cumulative effect of these non-climate, anthropogenic impacts increases the vulnerability of coastal systems to climate-related stressors.

Coastal Processes

Climate change and sea level rise affect sediment transport in complex ways. Erosion and ecosystem loss is affecting many parts of the U.S. coastline, but it remains unclear to what extent these losses result from climate change instead of land loss associated with relative sea level rise due to subsidence and other human drivers (Nicholls et al., 2007).

Coastal wetland loss is also being observed in the United States where these ecosystems are squeezed between natural and artificial landward boundaries and rising sea levels, a process known as "coastal squeeze" (Field et al., 2007). The degradation of coastal ecosystems, especially wetlands and coral reefs, can have serious implications for the well-being of societies dependent on them for goods and services (Nicholls et al., 2007). For more information regarding climate change impacts to coral reefs, see Section 14.

Engineering structures, such as bulkheads, dams, channelizations, and diversions of coastal waterways, limit sediment supply to coastal areas. Wetlands are especially threatened by sea level rise when insufficient amounts of sediment from upland watersheds are deposited on them. If sea level rises slowly, the balance between sediment supply and morphological adjustment can be maintained if a salt marsh vertically accretes[69], or a lagoon infills, at the same rate. However, an acceleration in the rate of sea level rise may mean that coastal marshes and wetlands cannot keep up, particularly where the supply of sediment is limited (e.g., where coastal floodplains are inundated after natural levees or artificial embankments are overtopped) (Nicholls et al., 2007).

Although open coasts have been the focus of research on erosion and shore stabilization technology, sheltered coastal areas in the United States are also vulnerable and suffer secondary effects from rising seas (NRC, 2006a). For example, barrier island erosion in Louisiana has increased the height of waves reaching the shorelines of coastal bays. This has enhanced erosion rates of beaches, tidal creeks, and adjacent wetlands. The impacts on gravel beaches have received less attention than sandy beaches; however these systems are threatened by sea level rise, even under high wetland accretion rates. The persistence of gravel and cobble-boulder beaches will also be influenced by storms, tectonic events, and other factors that build and reshape these highly dynamic shorelines (Nicholls et al., 2007).

Observed Changes

According to the IPCC, most of the world's sandy shorelines retreated during the past century, and climate change-induced sea level rise is one underlying cause. Over the past century in the United States, more than 50% of the original salt marsh habitat has been lost. In Mississippi and Texas, over half of the shorelines eroded at average rates of 8.5 to 10 feet yr^{-1} (2.6 to 3.1 m yr^{-1}) since the 1970s, while 90% of the Louisiana shoreline eroded at a rate of 39 feet yr^{-1} (12.0 m yr^{-1}) (Nicholls et al., 2007 and references therein). High rates of relative sea level rise, coupled with cutting off the supply of sediments from the Mississippi River and other human alterations, have resulted in the loss of 1,900 square miles (4900 km^2) of Louisiana's coastal wetlands during the past century, weakening their capacity to absorb the storm surge of hurricanes such as Katrina (Karl et al., 2009).

[69] The term "vertical accretion" is defined as the accumulation of sediments and other materials in a wetland habitat that results in build-up of the land in a vertical direction.

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In the Great Lakes where sea level rise is not a concern, both extremely high and low water levels resulting from changes to the hydrological cycle have been damaging and disruptive to shoreline communities (Nicholls et al., 2007). Future changes to the hydrological cycle brought on by climate change may exacerbate these effects (Field et al., 2007; Bates et al., 2008). High lake water levels increase storm surge flooding, accelerate shoreline erosion, and damage industrial and commercial infrastructure located on the shore. Conversely, low lake water levels can pose problems for navigation, expose intake/discharge pipes for electrical utilities and municipal water treatment plants, and cause unpleasant odors.

In the Arctic, coastal stability is affected by factors common to all areas (e.g., shoreline exposure, relative sea level change, climate, and local geology), and by factors specific to the high latitudes (e.g., low temperatures, ground ice, and sea ice) (Anisimov et al., 2007). Adverse impacts have already been observed along Alaskan coasts, and traditional knowledge points to widespread coastal change in Alaska. Rising temperatures in Alaska are reducing the thickness and spatial extent of sea ice. This creates more open water and allows for winds to generate stronger waves, which increase shoreline erosion. Sea level rise and thawing of coastal permafrost exacerbate this problem. Higher waves will create even greater potential for this kind of erosion damage (ACIA, 2004).

Projected Impacts

The U.S. coastline is long and diverse with a wide range of coastal characteristics. Sea level rise changes the shape and location of coastlines by moving them landward along low-lying contours and exposing new areas to erosion (NRC, 2006a). Coasts subsiding due to natural or human-induced causes will experience larger relative rises in sea level. In some locations, such as deltas and coastal cities (e.g., the Mississippi delta and surrounding cities), this effect can be significant (Nicholls et al., 2007). Rapid development, including an additional 25 million people in the coastal United States over the next 25 years, will further reduce the resilience of coastal areas to rising sea levels (Field et al., 2007). Superimposed on the impacts of erosion and subsidence, the effects of rising sea level will exacerbate the loss of waterfront property and increase vulnerability to inundation hazards (Nicholls et al., 2007). Cities such as New Orleans, Miami, and New York are particularly at risk, and could have difficulty coping with the sea level rise projected by the end of the century under a higher emissions scenario (Karl et al., 2009).

If sea level rise occurs over the next century at a rate consistent with the higher range of the 2007 IPCC scenarios (i.e., 1.6 to 2.0 feet (50 to 60 cm) rise in sea level by 2100), it is about as likely as not that some barrier island coasts in the mid-Atlantic region will cross a geomorphic threshold and experience significant changes. Such changes include more rapid landward migration or barrier island segmentation (Gutierrez et al., 2009).

Up to 21% of the remaining coastal wetlands in the U.S. Mid-Atlantic region are potentially at risk of inundation between 2000 and 2100 (Field et al., 2007 and reference therein). Rates of coastal wetland loss, in the Chesapeake Bay and elsewhere, will increase with accelerated sea level rise, in part due to "coastal squeeze" (IPCC: high confidence). It is virtually certain that those tidal wetlands already experiencing submergence by sea level rise, and associated high rates of loss will continue to lose area in the future due to both accelerated rates sea level rise as well as changes in other environmental and climate drivers (Cahoon et al., 2009). Salt-marsh biodiversity is likely to decrease in northeastern marshes through expansion of non-native species such as cordgrass (*Spartina alterniflora*), at the expense of high-marsh species (Field et al., 2007). The IPCC (Field et al., 2007) projects that many U.S. salt marshes in less developed areas can potentially keep pace with sea level rise through vertical accretion. Furthermore, the CCSP concluded that those wetlands keeping pace with 20th century rates of sea level rise would survive a 0.08 inch (0.2 cm) yr^{-1} acceleration of sea level rise only under optimal hydrology

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and sediment supply conditions, and would not survive a 0.3 inch (0.7 cm) yr^{-1} acceleration of sea level rise (Cahoon et al., 2009).

Climate change is likely to have a strong impact on saltwater intrusion into coastal sources of ground water in the United States and other world regions. Sea level rise and high rates of water withdrawal promote the intrusion of saline water into the ground water supplies, which adversely affects water quality. Reduced ground water recharge associated with decreases in precipitation and increased evapotranspiration[70] will exacerbate sea level rise effects on salinization rates (Kundzewicz et al., 2007). This effect could impose enormous costs on water treatment infrastructure (i.e., costs associated with relocating infrastructure or building desalinization capacity), especially in densely populated coastal areas. Saltwater intrusion is also projected to occur in freshwater bodies along the coast. Estuarine and mangrove ecosystems can withstand a range of salinities on a short term basis; however, they are unlikely to survive permanent exposure to high salinity environments. Saltwater intrusion into freshwater rivers has already been linked with the decline of bald cypress forests in Louisiana and cabbage palm forests in Florida. Given that these ecosystems provide a variety of ecosystem services and goods (e.g., spawning habitat for fish, pollutant filtration, sediment control, storm surge attenuation), the loss of these areas could be significant (Kundzewicz et al., 2007).

The vulnerable nature of coastal indigenous communities to climate change arises from their geographical location, reliance on the local environment for aspects of everyday life such as diet and economy, and the current state of social, cultural, economic, and political change taking place in these regions (Anisimov et al., 2007). Sea ice extent in the Arctic Ocean is expected to continue to decrease and may even disappear entirely during summer months in the coming decades. This reduction of sea ice increases extreme coastal erosion in Arctic Alaska, due to the increased exposure of the coastline to strong wave action (CCSP, 2008i). These effects, along with sea level rise, will accelerate the already high coastal erosion rates in permafrost-rich areas of Alaska's coastline, thereby forcing the issue of relocation for threatened settlements. It has been estimated that relocating the village of Kivalina, Alaska, to a nearby site would cost $54 million (Anisimov et al., 2007).

For small islands, some studies suggest that sea level rise could reduce island size, particularly in the Pacific, raising concerns for Hawaii and other U.S. territories (Mimura et al., 2007). In some cases, accelerated coastal erosion may lead to island abandonment, as has been documented in the Chesapeake Bay. Island infrastructure tends to predominate in coastal locations. In the Caribbean and Pacific islands, more than 50% of the population lives within 0.9 mi (1.5 km) of the shore. International airports, roads, capital cities, and other types of infrastructure are typically sited along the coasts of these islands as well. Therefore, the socioeconomic well-being of island communities will be threatened by inundation, storm surge, erosion, and other coastal hazards resulting from climate change (high confidence) (Mimura et al., 2007).

12(b) Extreme Events

Although increases in mean sea level over the 21st century and beyond will inundate unprotected, low-lying areas, the most devastating impacts are likely to be associated with storm surge. Superimposed on accelerated sea level rise, the present storm and wave climatology and storm surge frequency distributions suggest more severe coastal flooding and erosion hazards (Nicholls et al., 2007). Higher sea level provides an elevated base for storm surges to build upon and diminishes the rate at which low-lying areas drain, thereby increasing the risk of flooding from rainstorms (CCSP, 2009b). In New York City and

[70] Evapotranspiration is defined as the total amount of evaporation from surface water bodies (e.g., lakes, rivers, reservoirs), soil, and plant transpiration. In this context, warmer temperatures brought on by climate change will drive greater levels of evapotranspiration.

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Long Island, flooding from a combination of sea level rise and storm surge could be several meters deep (Field et al., 2007). Projections suggest that the return period of a 100-year flood event in this area might be reduced to 19 to 68 years, on average, by the 2050s, and to four to 60 years by the 2080s (Wilbanks et al., 2007; and references therein).

Additionally, some major urban centers in the United States are situated in low-lying flood plains. For example, areas of New Orleans and its vicinity are 59 to 118 inches (150 to 300 cm) below sea level. Considering the rate of subsidence and using a mid-range estimate of 19 inches (48 cm) sea level rise by 2100, it is projected that this region could be 98 to 157 inches (250 to 400 cm) or more below mean sea level by 2100 (Field et al., 2007). In this scenario, a storm surge from a Category 3 hurricane (estimated at 118 to 157 inches (300 to 400 cm) without waves) could be 20 to 23 feet (6 to 7 m) above areas that were heavily populated in 2004 (Field et al., 2007 and references therein).

The IPCC discusses a number of other extreme event scenarios and observations with implications for coastal areas of the United States (see also Section 6(f) for a discussion of abrupt changes and sea level rise):

- Very large sea level rises that would result from widespread deglaciation of Greenland and West Antarctic ice sheets imply major changes in coastlines and ecosystems, and inundation of low-lying areas, with greatest effects in river deltas. Relocating populations, economic activity, and infrastructure would be costly and challenging (IPCC, 2007b).
- Under El Niño conditions, high water levels combined with changes in winter storms along the Pacific coast have produced severe coastal flooding and storm impacts. In San Francisco, 140 years of tide-gauge data suggest an increase in severe winter storms since 1950, and some studies have detected accelerated coastal erosion (Field et al., 2007).
- Recent winters with less ice in the Great Lakes and Gulf of St. Lawrence have increased coastal exposure to damage from winter storms (Field et al., 2007).
- Recent severe tropical and extra-tropical storms demonstrate that North American urban centers with assumed high adaptive capacity remain vulnerable to extreme events (Field et al., 2007).

Demand for waterfront property and building land in the United States continues to grow, increasing the value of property at risk. Of the $19 trillion value of all insured residential and commercial property in the U.S. states exposed to North Atlantic hurricanes, $7.2 trillion (41%) is located in coastal counties[71]. According to a study referenced in Field et al. (2007), this economic value includes 79% of the property in Florida, 63% of property in New York, and 61% of the property in Connecticut. The devastating effects of hurricanes Ivan in 2004 and Katrina, Rita, and Wilma in 2005 illustrate the vulnerability of North American infrastructure and urban systems that were not designed or not maintained to adequate safety margins. When protective systems fail, impacts can be widespread and multi-dimensional (Field et al., 2007).

[71] "Coastal county" is generally defined in NOAA reports as a county in which at least 15% of its total land area is located within a coastal watershed.

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Section 13

Energy, Infrastructure, and Settlements

According to the IPCC (Wilbanks et al., 2007), "[i]ndustries, settlements and human society are accustomed to variability in environmental conditions, and in many ways they have become resilient to it when it is a part of their normal experience. Environmental changes that are more extreme or persistent than that experience, however, can lead to vulnerabilities, especially if the changes are not foreseen and/or if capacities for adaptation are limited."

Climate change is likely[72] to affect U.S. energy use and energy production, physical infrastructures, and institutional infrastructures and will likely interact with and possibly exacerbate ongoing environmental change and environmental pressures in settlements (Wilbanks et al., 2007), particularly in Alaska where indigenous communities are facing major environmental and cultural impacts on their historic lifestyles (ACIA, 2004). Climate warming will be accompanied by decreases in demand for heating energy and increases in demand for cooling energy (Karl et al., 2009). These changes will vary by region and by season, but they will affect household and business energy costs and their demands on energy supply institutions. The latter will result in significant increases in electricity use and higher peak demand in most regions (Karl et al., 2009). Other effects on energy consumption are less clear (CCSP, 2007a).

13(a) Heating and Cooling Requirements

With climate warming, less heating is required for industrial, commercial, and residential buildings in the United States, but more cooling is required, with changes varying by region and by season. Net energy demand at a national scale will be influenced by the structure of the energy supply. The main source of energy for cooling is electricity, while coal, oil, gas, biomass, and electricity are used for space heating. Regions with substantial requirements for both cooling and heating could find that net annual electricity demands increase while demands for other heating energy sources decline. Critical factors for the United States are the relative efficiency of space cooling in summer compared to space heating in winter and the relative distribution of populations in colder northern or warmer southern regions. Seasonal variation in total demand is also important. In some cases, due to infrastructure limitations, peak demand could go beyond the maximum capacity of the electricity transmission system (Wilbanks et al., 2007). An increase in peak demand can lead to a disproportionate increase in energy infrastructure investment (Karl et al., 2009).

Recent North American studies generally confirm earlier work showing a small net change (increase or decrease, depending on methods, scenarios, and location) in net demand for energy in buildings but a significant increase in demand for electricity for space cooling, with further increases caused by additional market penetration of air conditioning (high confidence) (Field et al., 2007). Generally speaking, the net effects of climate change in the United States on total energy demand are projected to amount to between perhaps a 5% increase and decrease in demand per 1ºC in warming in buildings. Existing studies do not agree on whether there would be a net increase or decrease in energy consumption with changed climate because a variety of methodologies have been used (CCSP, 2007a).

In California, if temperatures rise according to a high scenario range (8 to 10.5ºF [~4.5 to 5.6ºC]), annual electricity demand for air conditioning could increase by as much as 20% by the end of the century (relative to the 1961–1990 base period, assuming population remains unchanged and limited

[72] According to IPCC terminology, "likely" conveys a 66 to 90% probability of occurrence. See Box 1.2 for a full description of IPCC's uncertainty terms.

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implementation of efficiency measures) (California Energy Commission, 2006)[73]. In Alaska, there will be savings on heating costs; modeling has predicted a 15% decline in the demand for heating energy in the populated parts of the Arctic and sub-Arctic and up to one month decrease in the duration of a period when heating is needed (Anisimov et al., 2007).

Overall, both net delivered energy and net primary energy consumption increase or decrease only a few percent with a 2 or 4ºF [1 or 2ºC] warming; however, there is a robust result that, in the absence of an energy efficiency policy directed at space cooling, climate change would cause a significant increase in the demand for electricity in the United States, which would require the building of additional electricity generation capacity (and probably transmission facilities) worth many billions of dollars (CCSP, 2007a).

Beyond the general changes described above, general temperature increases can mean changes in energy consumption in key climate-sensitive sectors of the economy, such as transportation, construction, agriculture, and others. Furthermore, there may be increases in energy used to supply other resources for climate-sensitive processes, such as pumping water for irrigated agriculture and municipal uses (CENR, 2008).

13(b) Energy Production

Climate change could affect U.S. energy production and supply a) if extreme weather events become more intense, b) where regions dependent on water supplies for hydropower and/or thermal power plant cooling face reductions or increases in water supplies, c) where changed conditions affect facility siting decisions, and d) where climatic conditions change (positively or negatively) for biomass, wind power, or solar energy production (Wilbanks et al., 2007; CCSP 2007a).

Significant uncertainty exists about the potential impacts of climate change on energy production and distribution, in part because the timing and magnitude of climate impacts are uncertain. Nonetheless, every existing source of energy in the United States has some vulnerability to climate variability. Renewable energy sources tend to be more sensitive to climate variables, but fossil energy production can also be adversely effected by air and water temperatures, and the thermoelectric cooling process that is critical to maintaining high electrical generation efficiencies also applies to nuclear energy. In addition, extreme weather events have adverse effects on energy production, distribution, and fuel transportation (CCSP, 2007a).

Fossil and Nuclear Energy

Climate change impacts on U.S. electricity generation at fossil and nuclear power plants are likely to be similar. The most direct climate impacts are related to power plant cooling and water availability. As currently designed, power plants require significant amounts of water, and they are vulnerable to fluctuations in water supply. Regional-scale changes would likely mean that some areas would see significant increases in water availability while other regions would see significant decreases. In those areas seeing a decline, the impact on power plant availability or even siting new capacity could be significant. Plant designs are flexible and new technologies for water reuse, heat rejection, and use of alternative water sources are being developed; but, at present, some impact—significant on a local level—can be foreseen (CCSP, 2007a).

[73] Temperature projections for the state of California are based on IPCC global emissions scenarios as discussed in Section 6(a).

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Renewable Energy

Because renewable energy depends directly on ambient natural resources such as hydrological resources, wind patterns and intensity, and solar radiation, it is likely to be more sensitive to climate variability than fossil or nuclear energy systems that rely on geological stores. Renewable energy systems in the United States are also vulnerable to damage from extreme weather events (CCSP, 2007a).

Hydropower generation is sensitive to the amount, timing, and geographical pattern of precipitation as well as temperature (rain or snow, timing of melting). Reduced streamflows are expected to jeopardize hydropower production in some areas of the United States, whereas greater streamflows, depending on their timing, might be beneficial (Wilbanks et al., 2007; Bates et al., 2008). In California, where hydropower now comprises about 15% of in-state energy production, diminished snow melt flowing through dams will decrease the potential for hydropower production by up to 30% if temperatures rise to the medium warming range by the end of the century (~5.5 to 8ºF [~3.1 to 4.4ºC] increase in California) and precipitation decreases by 10 to 20%. However, future precipitation projections are quite uncertain so it is possible that precipitation may increase and expand hydropower generation (California Energy Commission, 2006).

North American wind and solar resources are about as likely as not to increase (medium confidence). Studies to date project wind resources that are either unchanged by climate change, or reduced by 0 to 40%. Future changes in cloudiness could slightly increase the potential for solar energy in North America south of 60°N, but one study projected that increased cloudiness will likely decrease the output of photovoltaics by 0 to 20% (Field et al., 2007).

Bioenergy potential is climate-sensitive through direct impacts on crop growth and availability of water for irrigation and biofuel processing purposes. Warming and precipitation increases are expected to allow the bioenergy crop switchgrass, for instance, to compete effectively with traditional crops in central United States (Field et al., 2007). Renewable energy production is highly susceptible to localized and regional changes in the resource base. As a result, the greater uncertainties on regional impacts under current climate change modeling pose a significant challenge in evaluating medium to long-term impacts on renewable energy production (CCSP, 2007a).

Energy Supply and Transmission

Extreme weather events can threaten coastal energy infrastructures and electricity transmission and distribution infrastructures in the United States and other world regions (Wilbanks et al., 2007). Hurricanes, in particular, can have severe impacts on energy infrastructure. In 2004, Hurricane Ivan destroyed seven Gulf of Mexico oil drilling platforms and damaged 102 pipelines, while Hurricanes Katrina and Rita in 2005 destroyed more than 100 platforms and damaged 558 pipelines (CCSP, 2007a). Though it is not possible to attribute the occurrence of any singular hurricane to climate change, projections of climate change suggest that extreme weather events are very likely to become more intense. If so, then the impacts of Katrina may be a possible indicator of the kinds of impacts that could manifest as a result of climate change (CCSP, 2007a).

In addition to the direct effects on operating facilities themselves, U.S. networks for transport, electric transmission, and delivery would be susceptible to changes due to climate change in streamflow, annual and seasonal precipitation patterns, storm severity, and even temperature increases (e.g., pipelines handling supercritical fluids may be impacted by greater heat loads) (CCSP, 2007a). It is not yet possible to project effects of climate change on the grid, because so many of the effects would be more localized than current climate change models can depict, but weather-related grid disturbances are recognized as a challenge for strategic planning and risk management (Karl et al., 2009).

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A significant fraction of the U.S. energy infrastructure is located near the coasts. In these locations, rising sea levels are likely to lead to direct losses (e.g., equipment damage from flooding) as well as indirect effects such as the costs associated with raising vulnerable assets to higher levels. The U.S. East Coast and Gulf Coast have been identified as particularly vulnerable to sea level rise because the land is relatively low with respect to mean sea level and also sinking in many places (Karl et al., 2009).

U.S. rail transportation lines, which transport approximately two-thirds of the coal to the nation's power plants (CCSP, 2007a), often closely follow riverbeds. More severe rainstorms can lead to flooding of rivers which then can wash out or degrade the nearby roadbeds. Flooding may also disrupt the operation of inland waterways, the second-most important method of transporting coal. With utilities carrying smaller stockpiles and projections showing a growing reliance on coal for a majority of the nation's electricity production, any significant disruption to the transportation network has serious implications for the overall reliability of the grid as a whole (CCSP, 2007a).

In the Arctic, soil subsidence caused by the melting of permafrost is a risk to gas and oil pipelines, electrical transmission towers, and natural gas processing plants (Wilbanks et al., 2007). Along the Beaufort Sea in Alaska, climate impacts on oil and gas development in the region are likely to result in both financial benefits and costs in the future. For example, offshore oil exploration and production are likely to benefit from less extensive and thinner sea ice, although equipment will have to be designed to withstand increased wave forces and ice movement (ACIA, 2004).

13(c) Infrastructure and Settlements

Climate change vulnerabilities of industry, settlement, and society are mainly related to extreme weather events rather than to gradual climate change. The significance of gradual climate change (e.g., increases in the mean temperature) lies mainly in changes in the intensity and frequency of extreme events, although gradual changes can also be associated with thresholds beyond which impacts become significant, such as in the capacities of infrastructures (Field et al., 2007). Such climate-related thresholds for human settlements in the United States are currently not well understood (Wilbanks et al., 2008).

Extreme weather events could threaten U.S. coastal energy infrastructure and electricity transmission and distribution infrastructures. Moreover, soil subsidence caused by the melting of permafrost in the Arctic region is a risk to gas and oil pipelines, and electrical transmission towers. Vulnerabilities of industry, infrastructures, settlements, and society to climate change are generally greater in certain high-risk locations, particularly coastal and riverine areas, and areas whose economies are closely linked with climate-sensitive resources, such as agricultural and forest product industries, water demands, and tourism. These vulnerabilities tend to be localized but are often large and growing (high confidence) (Wilbanks et al., 2007). Additionally, infrastructures are often connected, meaning that an impact on one can also affect others. For example, an interruption in energy supply can increase heat stress for vulnerable populations (Wilbanks et al., 2008). As noted previously, rising sea levels are likely to result in direct losses and indirect effects for the significant portion of the U.S. energy infrastructure located near the coasts (Karl et al., 2009).

A few studies have projected increasing vulnerability of U.S. infrastructure to extreme weather related to climate warming unless adaptation is effective (high confidence). Examples include the New York Metropolitan Region, the Mid-Atlantic Region, and the urban transportation network of the Boston metropolitan area (Wilbanks et al., 2007). In Alaska, examples where infrastructure is projected to be at "moderate to high hazard" in the mid-21st century include Shishmaref, Nome, Barrow, the Dalton Highway, and the Alaska Railroad (Field et al., 2007). Where extreme weather events become more

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intense and/or more frequent with climate change, the economic and social costs of those events will increase (high confidence) (Wilbanks et al., 2007).

Buildings and Construction

In some Arctic areas, interactions between climate warming and inadequate engineering are causing problems. The weight of buildings on permafrost is an important factor; while many heavy, multi-story buildings of northern Russia have suffered structural failures, the lighter-weight buildings of North America have had fewer such problems as permafrost has warmed. Continuous repair and maintenance is also required for building on permafrost, a lesson learned because many of the buildings that failed were not properly maintained. The problems now being experienced in Russia may be expected to occur elsewhere in the Arctic if buildings are not designed and maintained to accommodate future warming (ACIA, 2004).

The cost of rehabilitating community infrastructure damaged by thawing permafrost could be significant. Even buildings designed specifically for permafrost environments may be subject to severe damage if design criteria are exceeded. The impervious nature of ice-rich permafrost has been relied on for contaminant-holding facilities, and thawing such areas could result in severe contamination of hydrological resources and large cleanup costs, even for relatively small spills (Anisimov et al., 2007). A significant number of Alaskan airstrips are built on permafrost and will require major repairs or relocation if their foundations are compromised by thawing. Overall, the cost of maintaining Alaska's public infrastructure is projected to increase by 10 to 20% by 2030 due to warming, costing the state an additional $4 billion to $6 billion, with roads and airports accounting for about half of this cost (Karl et al., 2009).

The construction season in the northern United States likely will lengthen with warming. In permafrost areas in Alaska, increasing the depth of the "active layer" or loss of permafrost can lead to substantial decreases in soil strength. Construction methods are likely to require changes in areas currently underlain by permafrost, potentially increasing construction and maintenance cost (high confidence) (Field et al., 2007).

Transportation

In a 2008 report entitled *Potential Impacts of Climate Change on U.S. Transportation*, the National Research Council (NRC) issued the following finding:

> Climate change will affect transportation primarily through increases in several types of weather and climate extremes, such as very hot days; intense precipitation events; intense hurricanes; drought; and rising sea levels, coupled with storm surges and land subsidence. The impacts will vary by mode of transportation and region of the country, but they will be widespread and costly in both human and economic terms and will require significant changes in the planning, design, construction, operation, and maintenance of transportation systems (NRC, 2008).

NRC states that transportation infrastructure was designed for typical weather patterns, reflecting local climate and incorporating assumptions about a reasonable range of temperatures and precipitation levels (NRC, 2008). Stronger hurricanes would lead to a higher probability of such infrastructure failures as displacement of highway and rail bridge decks, or railroad tracks being washed away. The increase in heavy precipitation will cause increases in weather-related accidents, delays, and traffic disruptions in a network that is already being challenged by increasing congestion (Karl et al., 2009).

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An increase in the frequency, intensity, or duration of heat spells in the United States and other world regions could cause railroad tracks to buckle and affect roads through softening and traffic-related rutting. Warmer or less snowy winters will likely reduce delays, improve ground and air transportation reliability, and decrease the need for winter road maintenance. More intense winter storms could, however, increase risk for traveler safety and require increased snow removal. Continuation of the declining fog trend in at least some parts of North America should benefit transport (Field et al., 2007).

Warming will likely affect infrastructure for surface transport at high northern latitudes, such as Alaska. Permafrost degradation reduces surface bearing capacity and potentially triggers landslides. While the season for transport by barge is likely to be extended, the season for ice roads will likely be compressed. Other types of roads are likely to incur costly improvements in design and construction (Field et al., 2007).

Similarly, NRC found the following:

> Potentially, the greatest impact of climate change for North America's transportation systems will be flooding of coastal roads, railways, transit systems, and runways because of global rising sea levels, coupled with storm surges and exacerbated in some locations by land subsidence (NRC, 2008).

An example of this vulnerability lies in the fact that an estimated 60,000 miles (96,600 km) of coastal highway in the United States are already exposed to periodic flooding from coastal storms and high waves (Karl et al., 2009).

Because of warming, the number of days per year in which travel on the tundra is allowed under Alaska Department of Natural Resources standards has dropped from more than 200 to about 100 in the past 30 years, resulting in a 50% reduction in days that oil and gas exploration and extraction can occur (ACIA, 2004). Forestry is another industry in the Arctic region that requires frozen ground and rivers. Higher temperatures mean thinner ice on rivers and a longer period during which the ground is thawed. This leads to a shortened period during which timber can be moved from forests to sawmills and increasing problems associated with transporting wood (ACIA, 2004).

Lakes and river ice have historically provided major winter transportation routes and connections to smaller settlements in the Arctic. Reductions in ice thickness will reduce the load-bearing capacity, and shortening of the ice season will shorten period of access. Where an open-water network is viable, it will be sensible to increase reliance on water transport. In land-locked locations, construction of all-weather roads may be the only viable option, with implications for significantly increased costs. Similar issues will impact the use of sea ice roads primarily used to access offshore facilities (Anisimov et al., 2007). Loss of summer sea ice will bring an increasingly navigable Northwest Passage. Increased marine navigation and longer summers will improve conditions for tourism and travel associated with research (Anisimov et al., 2007). Along with rising water temperatures, however, increased shipping will also multiply the risk of marine pests and pollution (Anisimov et al., 2007). Sea ice reduction will likely increase erosion rates on land as well, thereby raising the maintenance costs for ports and other transportation infrastructure (Karl et al., 2009).

Negative impacts on transportation very likely will include coastal and riverine flooding and landslides. Although offset to some degree by fewer ice threats to navigation, reduced water depth in the Great Lakes would lead to "light loading" and adverse economic impacts (Field et al., 2007). A recent study found that the projected reduction in Great Lakes water levels would increase shipping costs for Canadian commercial navigation by an estimated 13 to 29% by 2050, all else remaining equal (Karl et al., 2009).

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Of all the possible impacts on transportation, the greatest in terms of cost is that of flooding. The costs of delays and lost trips would be relatively small compared with damage to the infrastructure and to other property (Wilbanks et al., 2007).

The central Gulf Coast is particularly vulnerable to climate variability and change because of the frequency with which hurricanes strike, because much of its land is sinking relative to mean sea level and because much of its natural protection—in the form of barrier islands and wetlands—has been lost. While difficult to quantify, the loss of natural storm buffers will likely intensify many climate impacts, particularly in relation to storm damage (CCSP, 2008f).

Since much of the land in the Gulf Coast is sinking, this area is facing much higher increases in relative sea level rise (the combination of local land surface movement and change in mean sea level) than most other parts of the U.S. coast. A CCSP report found that relative sea level rise in the study area is very likely to increase by at least 12 inches (30 cm) across the region and possibly as much as 7 feet (2 m) in some parts of the study area over the next 50 to 100 years. The analysis of even a middle range of potential sea level rise of 12 to 35 inches (30 to 90 cm) indicates that a vast portion of the Gulf Coast from Houston to Mobile may be inundated in the future. The projected rate of relative sea level rise for the region during the next 50 to 100 years is consistent with historical trends, region-specific analyses, and the IPCC *Fourth Assessment Report* (IPCC, 2007a) findings, which assume no major changes in ice-sheet dynamics (CCSP, 2008f).

Twenty-seven percent of the major roads, 9% of the rail lines, and 72% of the ports in the region are at or below 48 inches (122 cm) in elevation, although portions of the infrastructure are guarded by protective structures such as levees and dikes. These protective structures could mitigate some impacts, but considerable land area is still at risk to permanent flooding from rising tides, sinking land, and erosion during storms. Furthermore, the crucial connectivity of the intermodal system in the area means that the services of the network can be threatened even if small segments are inundated (CCSP, 2008f).

A great deal of the Gulf Coast study area's infrastructure is subject to temporary flooding associated with storm surge. More than half of the area's major highways (64% of interstates, 57% of arterials), almost half of the rail miles, 29 airports, and virtually all of the ports are subject to flooding based on the study of a 18- and 23-feet (5.5- and 7.0-m) storm surge (CCSP, 2008f). The national importance of this area's transportation infrastructure is borne out by the fact that seven of the nation's 10 largest ports (by tons of traffic) are located along the Gulf Coast. Additionally, approximately two-thirds of U.S. oil imports are transported through this region (Karl et al., 2009).

Aviation may also be affected. Increases in precipitation and the frequency of severe weather events could negatively affect aviation. Higher temperatures affect aircraft performance and increase the necessary runway lengths. Some of these risks are expected to be offset by improvements in technology and information systems (CENR, 2008). Sea level rise and storm surge will increase the risk to coastal airports, and several of the nation's busiest airports that lie in coastal zones face the potential for closure or restrictions. Rising temperatures will affect airport ground facilities and runways similar to how roads will be affected. Airports in some areas will likely benefit through reduction in the cost of snow and ice removal and the impacts of salt and chemical use, though some locations have seen increases in snowfall (Karl et al., 2009).

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Settlements

Since societies and their built environments have developed under a climate that has fluctuated within a relatively confined range of conditions, most impacts of a rapidly changing climate will present challenges. Society is especially vulnerable to extremes, many of which are increasing as climate changes. While there are likely to be some benefits and opportunities in the early stages of warming, negative impacts are projected to dominate as climate continues to change. Additionally, climate change impacts do not affect society in isolation but rather are exacerbated when combined with the effects of an aging and growing population, pollution, poverty, and natural environmental fluctuations (Karl et al., 2009).

According to the IPCC (2007b), "[t]he most vulnerable industries, settlements and societies are generally those in coastal and river flood plains, those whose economies are closely linked with climate-sensitive resources, and those in areas prone to extreme weather events, especially where rapid urbanization is occurring (high confidence). Poor communities can be especially vulnerable, in particular those concentrated in high-risk areas. They tend to have more limited adaptive capacities, and are more dependent on climate-sensitive resources such as local water and food supplies (high confidence)".

Effects of climate change on human settlements in the United States are very likely to vary considerably according to location-specific vulnerabilities, with the most vulnerable areas likely to include Alaska, flood-risk coastal zones and river basins, arid areas with associated water scarcity, and areas where the economic base is climate sensitive (CCSP, 2007a).

In Alaska and elsewhere in the Arctic, indigenous communities are facing major economic and cultural impacts. Many indigenous peoples depend on hunting polar bear, walrus, seals, and caribou, and herding reindeer, fishing and gathering, not only for food and to support the local economy but also as the basis for cultural and social identity. Changes in species' ranges and availability, access to these species, a perceived reduction in weather predictability, and travel safety in changing ice and weather conditions present serious challenges to human health and food security, and possibly even the survival of some cultures (ACIA, 2004). More than 100 coastal villages in Alaska are subject to increased flooding and erosion due to warming (Karl et al., 2009).

More broadly, Native American communities possess unique vulnerabilities to climate change. Native Americans who live on established reservations are restricted to reservation boundaries and therefore have limited relocation options. Southwest native cultures are especially vulnerable to water quality and availability impacts (Karl et al., 2009).

Communities in risk-prone U.S. regions have reason to be particularly concerned about any potential increase in severe weather events. The combined effects of severe storms and sea level rise in coastal areas or increased risks of fire in drier arid areas are examples of how climate change may increase the magnitude of challenges already facing risk-prone communities. Vulnerabilities may be especially great for rapidly growing and/or larger metropolitan areas, where the potential magnitude of both impacts and coping requirements are likely to be very large. On the other hand, such regions have greater opportunity to put more adaptable infrastructure in place and make decisions that limit vulnerability (CCSP, 2007a).

Climate change has the potential not only to affect U.S. communities directly but also through undermining their economic bases. In particular, some regional economies are dependent on sectors highly sensitive to changes in climate: agriculture, forestry, water resources, or tourism. Climate change can add to stress on social and political structures by increasing management and budget requirements for public services such as public health care, disaster risk reduction, and even public safety. As sources of stress grow and combine, the resilience of social and political structures are expected to suffer, especially

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in locales with relatively limited social and political capital (CCSP, 2007a). Additionally, as noted in Wilbanks et al. (2008), "[h]uman settlements are the foci for many economic, social, and governmental processes, and historical experience has shown that catastrophes in cities can have significant economic, financial, and political effects much more broadly."

Within settlements experiencing climate change, certain parts of the population may be especially vulnerable. These include the poor, the elderly, those already in poor health, the disabled, those living alone, and/or indigenous populations dependent on one or a few resources. Environmental justice issues are clearly raised through examples such as warmer temperatures in urban areas having a more direct impact on those without air-conditioning (Wilbanks et al., 2008). Notably, vulnerable groups represent a more significant portion of the total population in some regions and localities than others (Karl et al., 2009).

More than 80% of the U.S. population currently resides in urban areas, which are becoming increasingly spread out, complex, and interconnected with regional and national economies and infrastructure. Climate-related changes will add further stress to an existing host of social problems that cities experience, including neighborhood degradation, traffic congestion, crime, unemployment, poverty, and inequities in health and well-being. Climate change impacts on cities are further compounded by aging infrastructure, buildings, and populations, as well as air pollution and population growth (Karl et al., 2009).

Finally, growth and development is generally moving toward areas more likely to be vulnerable to the effects of climate change. Overlaying projections of future climate change and its impacts on expected changes in U.S. population and development patterns reveals that more Americans will be living in the areas most vulnerable to climate change (Karl et al., 2009). For example, approximately half of the U.S. population—160 million people—were projected to live in one of 673 coastal counties by 2008. Coastal residents—particularly those on gently sloping coasts—should be concerned about sea level rise in the longer term, especially if these areas are subject to severe storms and storm surges and/or if their regions are showing gradual land subsidence. Areas that have been classified as highly vulnerable to climate change (based on measures of physical vulnerability and adaptive capacity) include counties lying along the East and West coasts and Great Lakes, with medium vulnerability counties mostly inland in the Southeast, Southwest, and Northeast (CCSP, 2007a).

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Section 14

Ecosystems and Wildlife

This section of the document covers: 1) ecosystem and species-level impacts due to climate change and elevated CO_2 levels, 2) implications for ecosystem services, 3) how climate change effects on extreme event frequency and intensity may impact ecosystems, 4) implication for tribes, and 5) implications for tourism.

For North America, the IPCC (Field et al., 2007; Fischlin et al., 2007[74]) concluded:

- Disturbances such as wildfire and insect outbreaks are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons (very high confidence).[75] Although recent climate trends have increased vegetation growth, continuing increases in disturbances are likely to limit carbon storage, facilitate invasive species, and disrupt ecosystem services. Over the 21st century, changes in climate will cause species to shift north and to higher elevations and fundamentally rearrange North American ecosystems. Differential capacities for range shifts and constraints from development, habitat fragmentation, invasive species, and broken ecological connections will alter ecosystem structure, function, and services.

14(a) Ecosystems and Species

Ecosystems, plants, and animals are sensitive to climate variability and always have been. Three clearly observable connections between climate and terrestrial ecosystems are the seasonal timing of life cycle events (referred to as phenology), responses of plant growth or primary production, and the biogeographic distribution of species (see Figure 14.1). However, climate change effects on ecosystems do not occur in isolation. Ecosystems are increasingly being subjected to other human-induced pressures, such as land-use change, extractive use of goods, increasing degradation of natural habitats, air pollution, wildfires, and competition with invasives (Field et al., 2007; Fischlin et al., 2007). In the medium term (i.e., decades), climate change will increasingly exacerbate these human-induced pressures, causing a progressive decline in biodiversity (Fischlin et al., 2007).

The IPCC reviewed a number of studies describing observations of climate change effects on plant species (Field, et al., 2007 and references therein):

- Between 1981 and 2000, global daily satellite data indicate earlier onset of spring "greenness" by 10 to 14 days, particularly across temperate latitudes of the Northern Hemisphere. Field studies conducted in the same areas confirm these satellite observations.
  - Leaves are expanding earlier (e.g., apple and grape plants by two days per decade at 72 sites in Northeastern United States).
  - Flowering plants are blooming earlier (e.g., lilac by 1.8 days per decade earlier from 1959 to 1993, at 800 sites across North America; honeysuckle by 3.8 days per decade earlier in the western United States).

[74] Fischlin et al., 2007 citation refers to Chapter 4, "Ecosystems, Their Properties, Goods, and Services" in IPCC's 2007 *Fourth Assessment Report*, Working Group II.
[75] According to IPCC terminology, "very high confidence" conveys a 9 out of 10 chance of being correct. See Box 1.2 for a full description of IPCC's uncertainty terms.

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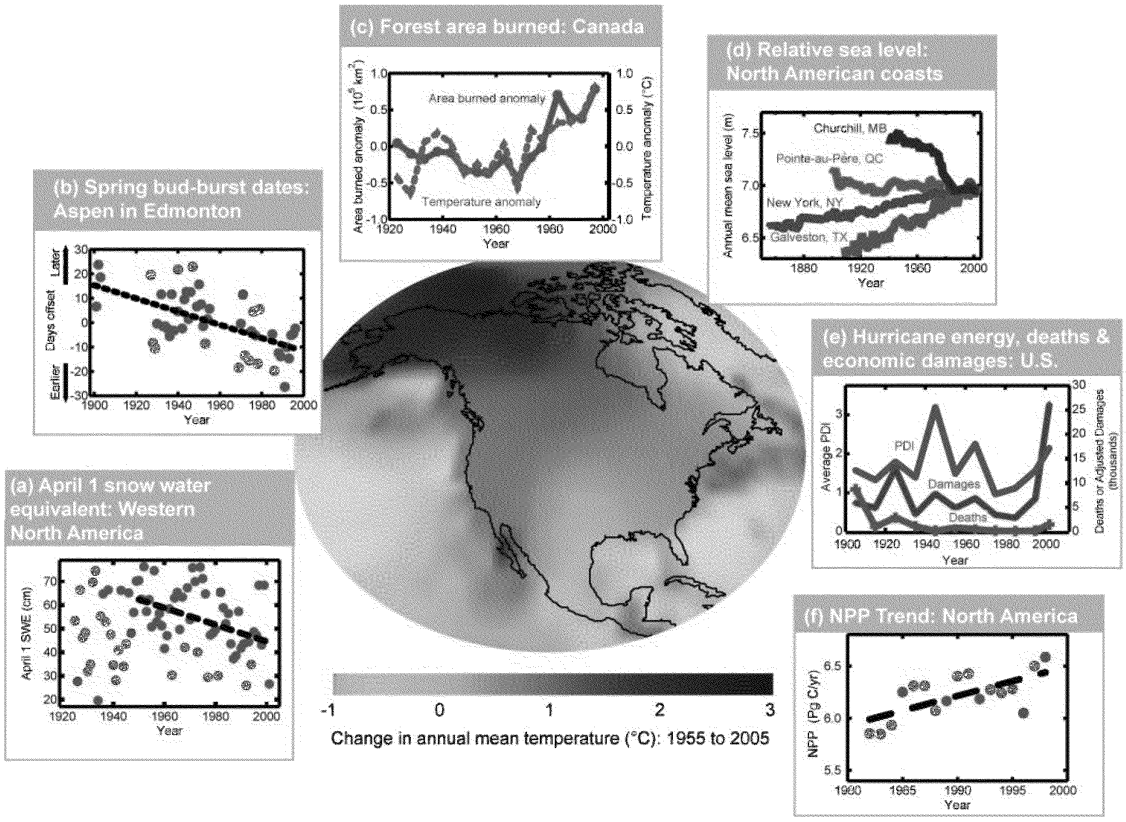
Figure 14.1: North American Observations



Source: Field, et al. (2007). Observed trends in some biophysical and socioeconomic indicators. Background: change in annual mean temperature from 1955 to 2005. Insets: (a) trend in April 1 SWE across western North America from 1925 to2002, with a linear fit from 1950 to 2002, (b) spring bud-burst dates for trembling aspen in Edmonton since 1900, (c) anomaly in five-year mean area burned annually in wildfires in Canada since 1930, plus observed mean summer air temperature anomaly, weighted for fire areas, relative to 1920 to 1999, (d) relative sea level rise from 1850 to 2000 for Churchill, MB; Pointe-au-Père, QB; New York, NY; and Galveston, TX, (e) hurricane energy (PDI), economic damages, and deaths from Atlantic hurricanes since 1900, and (f) trend in North American NPP (Net Primary Productivity) from 1981 to 1998. The 10 studies on which the data of this figure is based are summarized and referenced in Field et al. (2007).

- The timing of autumn leaf senescence[76] across the continental United States, which is controlled by a combination of temperature, photoperiod, and water deficits, shows weaker trends.

The IPCC also discussed several studies showing how North American animals are responding to climate change, with effects on phenology, migration, reproduction, dormancy, and geographic range (Field, et al., 2007 and references therein):

- Warmer springs have led to earlier nesting for 28 migrating bird species on the East Coast of the United States and to earlier egg laying for Mexican jays and tree swallows.
- Several frog species now initiate breeding calls 10 to 13 days earlier than a century ago in the Upstate New York region.
- In lowland California, 16 of 23 butterfly species advanced the date of first spring flights an average 24 days over 31 years.
- Reduced water depth, related to recent warming, in Oregon lakes has increased exposure of toad eggs to ultraviolet (UV) radiation (UV-B), leading to increased mortality from a fungal parasite.
- The Edith's checkerspot butterfly has become locally extinct in the southern, low elevation portion of its western North American range, but has extended its range 56 mi (90 km) north and 394 feet (120 m) higher in elevation.

Changes in phenology vary between species, and the life cycles of plants, prey animals, and predators may shift out of sync, causing species to become decoupled from their resource requirements. For example, the decline of long-distance migratory birds in the United States may originate in mistiming of breeding and food abundance due to differences in phenological shifts in response to climate change (Scott et al., 2008). As warming drives changes in timing and geographic ranges for various species, it is important to note that entire communities of species do not shift intact (Karl et al., 2009). Many changes in phenology are occurring faster than the abilities of ecosystems and species to resist adverse impacts (Fischlin et al., 2007).

Many North American species, like the Edith's checkerspot butterfly, have shifted their ranges, typically to the north or to higher elevations (Field, et al., 2007). Migrating to higher elevations with more suitable temperatures can be an effective strategy for species if habitat connectivity[77] exists and other biotic and abiotic conditions are appropriate. However, many organisms cannot shift their ranges fast enough to keep up with the current pace of climate change (Fischlin et al., 2007). For example, migration rates of tree species from paleoecological records are on average 660 to 980 feet (200 to 300 m) yr^{-1}, which is significantly slower that what would be required to respond to anticipated climate change, which has been estimated to be greater than 0.6 mi (1 km) yr^{-1} (Fischlin et al., 2007). In addition, species that require higher elevation habitat (e.g., alpine pikas), or assemblages for which no substrate may exist at higher latitudes (e.g., coral reefs), often have nowhere to migrate (Fischlin et al., 2007). Major changes have already been observed in alpine pika, as previously reported populations have disappeared entirely as climate has warmed over recent decades (Karl et al., 2009). Cold- and cool-water fisheries, especially salmonids, have been declining as warmer/drier conditions reduce their habitat (Field et al., 2007). The rates of changing conditions and the resulting habitat shifts, changes in phenology, and timing of migration generally have adverse effects on species, including decreased productivity and fitness (Fischlin et al., 2007).

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[76] The term "senescence" is defined as the last stage of leaf development that includes changes in pigment expression, cell death, and eventual leaf drop.

[77] Connectivity is defined as the degree to which a habitat is physically linked with other suitable areas for a particular species.

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The direct effects of elevated CO_2 concentrations and climate change to marine ecosystems include ocean warming, increased thermal stratification, reduced upwelling, sea level rise, increased wave height and frequency, loss of sea ice, and decreases in the pH and carbonate ion concentration of the surface oceans (see Box 14.1). With lower pH, aragonite (calcium carbonate) that is used by many organisms to make their shells or skeletons will decline or become undersaturated, affecting coral reefs and other marine calcifiers (e.g., pteropods-marine snails). Additional compounding effects, such as higher seawater temperatures leading to bleaching events, or higher seawater temperatures and nutrients leading to increased risk of diseases in marine biota will make these ecosystems even more vulnerable to changes in ocean chemistry along the United States and other world regions (Fischlin, et al., 2007). Subtropical and tropical coral reefs in shallow waters have already suffered major bleaching events that are clearly driven by increases in sea surface temperatures (Janetos et al., 2008). The effects of various other stressors, particularly human impacts such as overfishing, pollution, and the introduction of invasive species, appear to be exacerbating the thermal stresses on reef systems and, at least on a local scale, exceeding the thresholds beyond which coral is replaced by other organisms (Nicholls, et al., 2007). As a result of bleaching events and the subsequent disease outbreaks among those coral that survived the bleaching, approximately 50% of the corals in Virgin Islands National Park have died (Karl et al., 2009).

Box 14.1: Ocean Acidification Effects on Marine Calcifiers

Elevated atmospheric concentrations of GHGs impact the health of marine calcifiers by changing the physical and chemical properties of the oceans. Calcifiers play important roles in marine ecosystems by serving as the base of food chains, providing substrate, and helping to regulate biogeochemical cycles (Fischlin et al., 2007).

Ocean acidification lowers the saturation of calcium carbonate ($CaCO_3$) in sea water, making it more difficult for marine calcifiers to build shells and skeletons (Fischlin et al., 2007). The IPCC (Denman et al., 2007) made the following statements regarding ocean acidification:

- The biological production of corals, as well as calcifying photoplankton and zooplankton within the water column, may be inhibited or slowed down as a result of ocean acidification;
- Cold-water corals are likely to show large reductions in geographic range this century.
- The dissolution of $CaCO_3$ at the ocean floor will be enhanced, making it difficult for benthic calcifiers to develop protective structures.
- Acidification can influence the marine food web at higher trophic levels.

The impacts of elevated CO_2 concentrations on oceanic chemistry will likely be greater at higher latitudes (Fischlin et al., 2007). Carbonate decreases at high latitudes and particularly in the Southern Ocean may have particularly adverse consequences for marine ecosystems because the current saturation horizon is closer to the surface than in other basins (Bindoff et al., 2007). Polar and sub-polar surface waters and the southern ocean are projected to be aragonite (a form of $CaCO_3$) under-saturated by 2100, and Arctic waters will be similarly threatened (Denman et al., 2007). These impacts will likely threaten ecosystem dynamics in these areas where marine calcifiers play dominant roles in the food web and in carbon cycling (Fischlin et al., 2007).

The overall reaction of marine biological carbon cycling and ecosystems to a warm and high-CO_2 world is not yet well understood. In addition, the response of marine biota to ocean acidification is not yet clear, both for the physiology of individual organisms and for ecosystem functioning as a whole (Denman et al., 2007).

In the Bering Sea along the Alaskan coast, rising air and sea water temperatures have caused reductions in sea ice cover and primary productivity in benthic ecosystems[78] (Anisimov et al., 2007). A change from Arctic to sub-Arctic conditions is happening with a northward movement of the pelagic-dominated marine ecosystem that was previously confined to the southeastern Bering Sea (Anisimov, et al., 2007).

[78] Benthic is defined as the deepest environment of a water body, which usually includes the seabed or lake floor.

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Climate-related impacts observed in the Bering Sea include significant reductions in seabird and marine mammal populations, increases in pelagic fish, occurrences of previously rare algal blooms, abnormally high water temperatures, and smaller salmon runs in coastal rivers (ACIA, 2004). Plants and animals in polar regions are also vulnerable to attacks from pests and parasites that develop faster and are more prolific in warmer and moister conditions (Anisimov, et al., 2007). See Box 14.2 for more information on potential climate change impacts to polar bears.

Box 14.2: Polar Bears (adapted from Box 4.3 in Fischlin et al., 2007)

There are an estimated 20,000 to 25,000 polar bears (*Ursus maritimus*) worldwide, mostly inhabiting the annual sea ice over the continental shelves and inter-island archipelagos of the circumpolar Arctic. Polar bears are specialized predators that hunt ice-breeding seals and are therefore dependent on sea ice for survival. After emerging in spring from a five to seven month fast in nursing dens, females require immediate nourishment and thus, depend on close proximity between land and sea ice before the sea ice breaks up. Continuous access to sea ice allows bears to hunt throughout the year, but in areas where the sea ice melts completely each summer, they are forced to spend several months in tundra fasting on stored fat reserves until freeze-up (Fischlin et al., 2007).

Polar bears face great challenges from the effects of climatic warming, as projected reductions in sea ice will drastically shrink marine habitat for polar bears, ice-inhabiting seals, and other animals (Fischlin, et al., 2007). The two Alaskan populations (Chukchi Sea: ~2,000 individuals in 1993, Southern Beaufort Seas: ~1,500 individuals in 2006) are vulnerable to large-scale dramatic seasonal fluctuations in ice movements because of the associated decreases in abundance and access to prey and increases in the energy costs of hunting (FWS, 2007). The IPCC projects that with a warming of 5□F (2.8□C) above pre-industrial temperatures and associated declines in sea ice, polar bears will face a high risk of extinction. Other ice-dependent species (e.g., walruses [for resting location]; small whales [for protection from predators]) face similar consequences, not only in the Arctic but also in the Antarctic (Fischlin et al., 2007).

In 2005, the World Conservation Union's (IUCN) Polar Bear Specialist Group concluded that the IUCN Red List classification for polar bears should be upgraded from *Least Concern* to *Vulnerable* based on the likelihood of an overall decline in the size of the total population of more than 30% within the next 35 to 50 years (Fischlin et al., 2007). In May 2008, the U.S. Fish and Wildlife Service listed the polar bear as a threatened species under the Endangered Species Act. This decision was based on scientific evidence showing that sea ice loss threatens, and will likely continue to threaten, polar bear habitat (FWS, 2008).

One consequence of longer and warmer growing seasons and less extreme cold in winter is that opportunities are created for many insect pests and disease pathogens to flourish. Accumulating evidence links the spread of some disease pathogens to a warming climate (Karl et al., 2009).

Ecosystem-Level Projections

For terrestrial ecosystems across all world regions, the IPCC concluded that substantial changes in structure and functioning of terrestrial ecosystems are very likely to occur with a global warming greater than 4 to 5□F (2 to 3°C) above pre-industrial levels (high confidence) (Fischlin, et al., 2007). Furthermore, changes in ecosystem structure and function, ecological interactions, and species' geographical ranges are projected to have predominantly negative consequences for biodiversity and the provisioning of ecosystem goods and services (IPCC, 2007b). Fischlin et al. (2007) concludes that ecosystems are expected to tolerate some level of future climate change and, in some form or another, will continue to persist, as they have done repeatedly with palaeoclimatic changes. A key issue, however, is whether ecosystem resilience[79] inferred from these responses will be sufficient to tolerate future

[79] Ecosystem resilience is the disturbance an ecosystem can tolerate before it shifts into a different state.

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anthropogenic climate change (Fischlin et al., 2009). In North America, disturbances like wildfire and insect outbreaks are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons (very high confidence) (Field, et al., 2007).

At high latitudes, several models project longer growing seasons and increased net primary productivity (NPP) as a result of forest expansion into tundra ecosystems. In the mid-latitudes, simulated changes in NPP are variable, depending on whether there is sufficient enhancement of precipitation to offset increased evapotranspiration in a warmer climate. By the end of the 21st century, ecosystems in the northeast and southeast United States are projected to become carbon sources, while the western United States remains a carbon sink (Field, et al., 2007). Figure 14.1 shows the observed NPP trend in North America between 1981 and 1998.

The areal extent of drought-limited ecosystems is projected to increase 11% per degree celsius warming in the continental United States Climate change and direct human land-use pressures are both likely to have adverse impacts on desert ecosystems and species. Increases in plant productivity resulting from the direct effects of rising atmospheric CO_2 concentrations may partially offset these adverse effects. In California, temperature increases greater than 4°F (2°C) may lead to the conversion of shrubland into desert and grassland ecosystems and evergreen conifer forests into mixed deciduous forests (Fischlin, et al., 2007). Climate models suggest a warmer, drier future climate for the Prairie Pothole Region, which would result in a reduction in, or elimination of, wetlands that provide waterfowl breeding habitat (CCSP, 2009d). These types of regional impacts are indicative of the kinds of changes that can be expected across large parts of the country.

The sea ice biome accounts for a large proportion of primary production in polar waters and supports a substantial food web. In the Northern Hemisphere, projections of ocean biological response to climate warming by 2050 show contraction of the highly productive marginal sea ice biome by 42% (Fischlin, et al., 2007). In the Bering Sea, primary productivity in surface waters is projected to increase, the ranges of some cold-water species will shift north, and ice-dwelling species (e.g., polar bears and walruses) will experience habitat loss (ACIA, 2004).

Species-Level Projections

After reviewing studies on the projected impacts of climate change on species, IPCC concluded that on a global scale (Fischlin et al., 2007 and references therein):

- Projected impacts on biodiversity are significant and of key relevance, since global losses in biodiversity are irreversible (very high confidence).
- Endemic species[80] richness is highest where regional palaeoclimatic changes have been subtle, providing circumstantial evidence of their vulnerability to projected climate change (medium confidence). With global average temperature changes of 4°F (2°C) above pre-industrial levels, many terrestrial, freshwater, and marine species (particularly endemics across the globe) are at a far greater risk of extinction than in the geological past (medium confidence).
- Approximately 20 to 30% of species (global uncertainty range from 10 to 40%, but varying among regional biota from as low as 1% to as high as 80%) will be at increasingly high risk of extinction by 2100.

In North America, climate change impacts on inland aquatic ecosystems will range from the direct effects of increased temperature and CO_2 concentration to indirect effects associated with alterations in

[80] Endemic species are unique to their location or region and are not found anywhere else on Earth.

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hydrological systems resulting from changes to precipitation regimes and melting glaciers and snow pack (Fischlin et al., 2007). For many freshwater animals, such as amphibians, migration to breeding ponds and the production of eggs is intimately tied to temperature and moisture availability. Asynchronous timing of breeding cycles and pond drying due to the lack of precipitation can lead to reproductive failure. Differential responses among species in arrival or persistence in ponds will likely lead to changes in community composition and nutrient flow in ponds (Fischlin et al., 2007). Many warm-water and cool-water (freshwater) fish species will shift their ranges northward and to higher altitudes. In the continental United States, cold-water species will likely disappear from all but the deeper lakes, cool-water species will be lost mainly from shallow lakes, and warm water species will thrive except in the far South, where temperatures in shallow lakes will exceed survival thresholds (Field et al., 2007). See also Section 9(f) for a discussion of climate change impacts to freshwater and marine fish populations.

Bioclimate modeling based on output from five general circulation models (GCMs) suggests that on the long (millennial) timescale there may be decreases of bird and mammal species richness in warmer, low elevation areas, but increases in cold high elevation zones, and increases of reptile species richness in all areas. IPCC found that climate change impacts will vary regionally and across biomes and will lead to increasing levels of global biodiversity loss, as expressed through area reductions of wild habitats and declines in the abundance of wild species, putting those species at risk of extinction. Overall, climate change has been estimated to be a major driver of biodiversity loss in cool conifer forests, savannas, mediterranean-climate systems, tropical forests, in the Arctic tundra, and in coral reefs (Fischlin et al., 2007). In the United States, some common forests types are projected to expand, such as oak-hickory; others are projected to contract, such as maple-beech-birch. Still others, such as spruce-fir, are likely to disappear from the contiguous United States (Karl et al., 2009). Changes in plant species composition in response to climate change can increase ecosystem vulnerability to other disturbances, including fire and biological invasion. There are other possible, and even probable, impacts and changes in biodiversity-related relationships (e.g., disruption of the interactions between pollinators, such as bees, and flowering plants), for which there is not a substantial observational database (Janetos et al., 2008).

On small oceanic islands with cloud forests or high elevation ecosystems, such as the Hawaiian Islands, extreme elevation gradients exist, ranging from nearly tropical to alpine environments. In these ecosystems, anthropogenic climate change, land-use changes, and biological invasions will work synergistically to drive several species (e.g., endemic birds) to extinction (Mimura et al., 2007).

Coastal waters in the United States are very likely to continue to warm. In the Northeast, water temperatures may increase by as much 4 to 8°F (2 to 4°C) in this century, both in summer and winter. This will result in a northward shift in the geographic distribution of marine life along the coasts, which is already being observed in some areas. The shift occurs because some species cannot tolerate the higher temperatures and others are outcompeted by species moving in from more southerly locations. Warming also opens the door to invasion by species that humans are intentionally or unintentionally transporting around the world, for example in the ballast water carried by ships. Species that were previously unable to establish populations because of cold winters are likely to find the warmer conditions more suitable and gain a foothold, particularly as native species are under stress from climate change and other human activities. Non-native clams and small crustaceans have already had major effects on the San Francisco Bay ecosystem and the health of its fishery resources (Karl et al., 2009).

According to the IPCC, climate change (very high confidence) and ocean acidification (see Box 14.1) due to the direct effects of elevated CO_2 concentrations (medium confidence) will impair a wide range of planktonic and other marine organisms that use aragonite to make their shells or skeletons (Fischlin et al., 2007). Average pH for the ocean surface is projected to decrease by up to 0.3 to 0.4 units by 2100 (Fischlin et al., 2007). These impacts could result in potentially severe ecological changes to tropical and coldwater marine ecosystems where carbonate-based phytoplankton and corals are the foundation for the

trophic system (Schneider et al., 2007). Calcification rates in aragonitic corals may decline by 20 to 60% under a doubling of atmospheric CO_2 concentrations, with erosion outpacing reef formation at even lower concentrations (Fischlin et al., 2007). The IPCC concluded that it is very likely that a projected future sea surface temperature increase of 2 to 5□F (1 to 3°C) will result in more frequent bleaching events and widespread mortality, if there is not thermal adaptation or acclimatization by corals and their algal symbionts (Nicholls et al., 2007). The ability of coral reef ecosystems to withstand the impacts of climate change will depend to a large degree on the extent of degradation from other anthropogenic pressures (Nicholls et al., 2007). Furthermore, the migration of corals to higher latitudes with more optimal sea surface temperatures is unlikely, due to latitudinally decreasing aragonite concentrations, projected acidification from increasing CO_2 in the atmosphere, and the lack of available substrate (Fischlin et al., 2007).

For the Arctic, the IPCC (Anisimov et al., 2007 and references therein) concluded that:

- Decreases in the abundance of keystone species[81] are expected to be the primary factor in causing ecological cascades[82] and other changes to ecological dynamics.
- Arctic animals are likely to be most vulnerable to warming-induced drying of small water bodies; changes in snow cover and freeze-thaw cycles that affect access to food (e.g., polar bear dependence on sea ice for seal hunting; see Box 14.2) and protection from predators (e.g., snow rabbit camouflage in snow); changes that affect the timing of behavior (e.g., migration and reproduction); and influx of new competitors, predators, parasites, and diseases.
- In the past, sub-arctic species have been unable to live at higher latitudes because of harsh conditions. Climate-change-induced warming will increase the rate at which sub-arctic species are able to establish. Some non-native species, such as the North American mink, will become invasive, while other species that have already colonized some Arctic areas are likely to expand into other regions. The spread of non-native, invasive plants will likely have adverse impacts on native plant species. For example, experimental warming and nutrient addition has shown that native mosses and lichens become less abundant when non-native plant biomass increases.
- Bird migration routes and timing are likely to change as the availability of suitable habitat in the Arctic decreases.
- Loss of sea ice will impact species, such as harp seals, which are dependent on it for survival.
- Climate warming is likely to increase the incidence of pests, parasites, and diseases such as musk ox lung worm and abomasal nematodes of reindeer.

14(b) Ecosystem Services

Ecosystems provide many goods and services that are of vital importance for biosphere function and provide the basis for the delivery of tangible benefits to humans. These services include: maintenance of biodiversity, nutrient regulation, shoreline protection, food and habitat provisioning, sediment control, carbon sequestration, regulation of the water cycle and water quality, protection of human health, and the production of raw materials (Fischlin et al., 2007). Climate change is projected to have an increasing effect on the provisioning of ecosystem services in the United States. Increasing temperatures and shifting precipitation patterns, along with the direct effects of elevated CO_2 concentrations, sea level rise, and changes in climatic variability, will affect the quantity and quality of these services. By the end of the

[81] Keystone species are species that have a disproportionate effect on their environment relative to their abundance or total biomass. Typically, ecosystems experience dramatic changes with the removal of such species.
[82] Ecological cascades are defined as sequential chains of ecological effects, including starvation and death, beginning at the bottom levels of the food chain and ascending to higher levels, including apex predators.

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21st century, climate change and its impacts may be the dominant driver of biodiversity loss and changes in ecosystem services globally (Millennium Ecosystem Assessment-Synthesis, 2005).

Many U.S. ecosystems and the services they provide are already threatened by natural and anthropogenic non-climate stressors. Climate-related effects on ecosystems services will amplify the effects of non-climate stressors. Multiple U.S. industries, such as timber, fisheries, travel, tourism, and agriculture that are already threatened could face substantially greater impacts with concurrent effects on financial markets (Ryan et al., 2008; Field et al., 2007).

14(c) Extreme Events

Many significant impacts of climate change on U.S. ecosystems and wildlife may emerge through changes in the intensity and the frequency of extreme weather events. Extreme events, such as hurricanes, can cause mass mortality in wildlife populations and contribute significantly to alterations in species distribution and abundance following the disturbance. For example, the aftermath of a hurricane can cause coastal forest to die from storm surge-induced salt deposition, leading to habitat loss. More intense hurricanes may therefore increase coastal flooding resulting in a larger extent of forest dieback (Karl et al., 2009).

Droughts play an important role in forest dynamics as well, causing pulses of tree mortality in the North American woodlands. Greater intensity and frequency of extreme events may alter disturbance regimes in North American coastal ecosystems leading to changes in diversity and ecosystem functioning (Field et al., 2007; Fischlin et al., 2007). Species inhabiting saltmarshes, mangroves, and coral reefs are likely to be particularly vulnerable to these effects (Fischlin et al., 2007). Higher temperatures, increased drought, and more intense thunderstorms will very likely increase erosion and promote invasion of exotic grass species in arid lands (Ryan et al., 2008).

14(d) Implications for Tribes

North American indigenous communities whose health, economic well-being, and cultural traditions depend upon the natural environment will likely be affected by the degradation of ecosystem goods and services associated with climate change (Field et al., 2007). Among the most climate-sensitive North American communities are those of indigenous populations dependent on one or a few natural resources. About 1.2 million (60%) of U.S. tribal members live on or near reservations, and many pursue lifestyles with a mix of traditional subsistence activities and wage labor (Field et al., 2007).

In Alaska and elsewhere in the Arctic, indigenous communities are facing major economic and cultural impacts. Many indigenous peoples depend on hunting polar bear, walrus, seals, and caribou, and herding reindeer, fishing and gathering, not only for food and to support the local economy, but also as the basis for cultural and social identity. These livelihoods are already being threatened by multiple climate-related factors, including reduced or displaced populations of marine mammals, caribou, seabirds, and other wildlife; losses of forest resources due to insect damage; and reduced/thinner sea ice, making hunting more difficult and dangerous (ACIA, 2004).

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14(e) Implications for Tourism

The United States ranks among the top 10 nations for international tourism receipts (US$112 billion), with domestic tourism and outdoor recreation markets that are several times larger than most other countries. Nature-based tourism is a major market segment in North America, with more than 900 million visitor-days in national/provincial/state parks in 2001. Climate variability affects many segments of this growing economic sector. For example, wildfires in Colorado (2002) caused tens of millions of dollars in tourism losses by reducing visitation and destroying infrastructure. Similar economic losses during that same year were caused by drought-affected water levels in rivers and reservoirs in the western United States and parts of the Great Lakes. The 10-day closure and clean-up following Hurricane Georges (September 1998) resulted in tourism revenue losses of approximately $32 million in the Florida Keys. While the North American tourism industry acknowledges the important influence of climate, its impacts have not been analyzed comprehensively (Field et al., 2007 and references therein).

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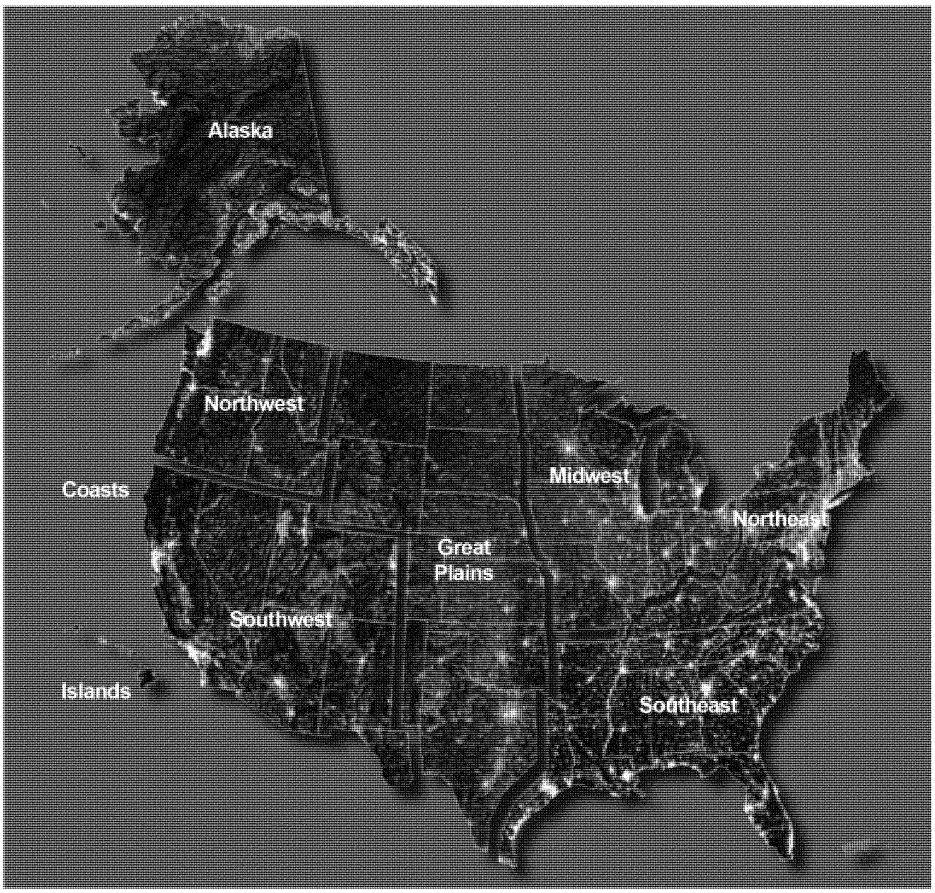
Section 15

U.S. Regional Climate Change Impacts

This section summarizes the present and future impacts of climate change on the different regions of the United States. The information presented here is taken from a recent report by the USGCRP entitled *Global Climate Change Impacts in the United States* (Karl et al., 2009), which includes key conclusions from all 21 CCSP synthesis and assessment products. All of the information presented in this section derives from this comprehensive assessment report. The discussion of impacts is divided into the nine regions used in Karl et al., (2009): Northeast, Southeast, Midwest, Great Plains, Southwest, Northwest, Alaska, and Islands (Figure 15.1). Information about observed trends as well as projected impacts is provided. In some cases, a range of potential future impacts is described, reflecting lower and higher emissions scenarios.[83]

Figure 15.1: Map of U.S. Regions Discussed in USGCRP



Source: Karl et al. (2009). This section summarizes key climate change impacts on specific regions of the United States.

[83] Karl et al. (2009) use "lower emission scenario" to refer to the IPCC SRES B1 and "higher emission scenario" to refer to A2. The SRES emission scenarios are described in Section 6(a).

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15(a) Northeast

According to studies cited in Karl et al. (2009), the annual average temperature in the Northeast has increased by 2°F (1□C) (relative to a 1960-1979 base period) since 1970; winter temperatures have risen by 4°F (2□C); and there are more frequent days with temperatures above 90°F (32□C). Temperatures in the Northeast are projected to rise an additional 2.5 to 4°F (1.4 to 2□C) in winter and 1.4 to 3.4°F (0.78 to 1.9□C) in summer over the next several decades (across low and high emissions scenarios). Precipitation changes are likely[84] to include an increase in heavy rainfall events and less winter precipitation falling as snow and more as rain.

Water and Coastal Resources

Given the anticipated changes in temperature and precipitation, the Northeast is likely to experience reduced snowpack in the mountains, earlier breakup of winter ice on lakes and rivers, and earlier spring snowmelt resulting in earlier peak river flows. These projected changes in regional hydrology would impact summer water storage and availability, and could cause short-term (one- to three-month) droughts to occur as frequently as once each summer across the New England states and in the Catskill and Adirondack Mountains.

The densely populated coasts of the Northeast are particularly vulnerable to sea level rise, which is projected to rise more than the global average and increase the frequency and severity of damaging storm surges, coastal flooding, and related impacts like erosion, property damage, and loss of wetlands. New York State alone has more than $2.3 trillion in insured coastal property, but some major insurance companies are beginning to withdraw coverage in coastal areas of the Northeast, including New York City. A coastal flood in New York City currently considered a once-in-a-century event (also known as a 100-year flood) is projected to occur every 10 to 22 years on average by late this century, depending on a higher or lower emissions scenario.

Human Health

Rising temperatures will impact human health, particularly among vulnerable populations like children, the elderly, and the economically disadvantaged. Under a high-emissions scenario, hot summer conditions are projected to arrive three weeks earlier and last three weeks longer into the fall by late this century. Cities that presently experience on average few days over 100°F (38□C) each summer would experience 20 such days on average by late this century. Certain cities such as Hartford and Philadelphia would average nearly 30 days over 100°F (38□C) (under a high emissions scenario). Heat waves are currently rare in the Northeast but are likely to become much more commonplace. In addition, the number of days that fail to meet federal air quality standards is projected to increase with rising temperatures if there are no additional controls on ozone-causing pollutants.

Key Economic Sectors

Rising temperatures will extend the growing season for the region's agriculture, but are also likely to make large areas unsuitable for growing apples, blueberries, and cranberries typical of the Northeast. The maple-beech-birch forests of the Northeast are projected to shift dramatically northward as temperatures rise, affecting the viability of maple sugar businesses. An important agricultural sector in the Northeast—the dairy industry—is projected to experience a 10 to 20% decline in milk production by the end of the

[84] Kart et al. (2009) use the term "likely" to reflect at least a two-thirds chance of occurring and "very likely" to reflect at least a 90% chance of occurring.

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century in the southern parts of the region. Winter recreation industries including downhill and cross-country skiing and snowshoeing will be adversely affected by the projected decline in snow cover. The region's lobster and cod fishing industry may also be impacted by rising ocean temperatures and subsequent northward shift of species in search of cooler waters.

15(b) Southeast

The annual average temperature in the Southeast has risen about 2°F (1□C) since 1970, with the greatest seasonal increase in winter (Karl et al., 2009). On average, there have been four to seven fewer freezing days per year for most of the region since the mid-1970s. Under a lower future emissions scenario, average temperatures in the region are projected to rise by about 4.5°F (2.5□C) by the 2080s. Under a higher emissions scenario, climate models project a temperature increase of 9°F (5□C) on average, with about a 10°F (5.8□C) increase in summer. Current precipitation trends indicate an increase in autumn rainfall in some parts of the region. Winter and spring rainfall is projected to decline across most of the Southeast, with greater reductions expected in Gulf Coast states compared with the more northern states in the region.

Water and Coastal Resources

The extent of the region experiencing moderate to severe spring and summer drought has increased by 12% and 14%, respectively, since the mid-1970s. The future frequency, duration, and intensity of droughts are likely to increase. Increasing evaporation and plant water loss rates could affect the amount of runoff and groundwater recharge, which would likely lead to saltwater intrusion into shallow aquifers in many parts of the Southeast. Any increase in groundwater pumping would further stress or deplete aquifers, which could in turn place additional strain on surface water resources.

Major hurricanes already pose a severe risk to people, personal property, and public infrastructure in the Southeast, particularly in low-lying coastal ecosystems and coastal communities along the Gulf and South Atlantic coasts. The intensity of Atlantic hurricanes has increased since 1970, correlated with an increase in ocean surface temperature; however, a similar correlation has not been established for the frequency of hurricanes making landfall. The intensity of Atlantic hurricanes is likely to increase during this century with higher peak wind speeds, rainfall intensity, and storm surge height and strength. Even with no increase in hurricane intensity, more frequent storm surge flooding, shoreline retreat, and permanent inundation of coastal ecosystems and communities is likely. An increase in average sea level of up to 24 inches (60 cm) or more is projected for the Southeast, with greatest impact expected in low-lying areas such as those along the central Gulf Coast where the land surface is sinking.

Human Health and Ecosystems

Climate changes and associated impacts projected to occur in the Southeast, including increases in water scarcity, sea level rise, extreme weather events, and heat stress, have implications for health and quality of life. The number of very hot days is projected to rise at a greater rate than the average temperature (Figure 15.2), and both heat stress and heat-stress related deaths in the summer months are likely to increase. While fewer cold-related deaths are expected, this is not expected to offset the increase in heat-related deaths.

Ecosystem impacts from projected temperature increases may include altered distribution of native plants and animals; local extinction of many threatened and endangered species; displacement of native species by invasive species; more frequent and intense wildfires, forest pest outbreaks (such as the southern pine beetle); and loss of lakes, ponds, and wetlands from intense droughts. Sea level rise and associated

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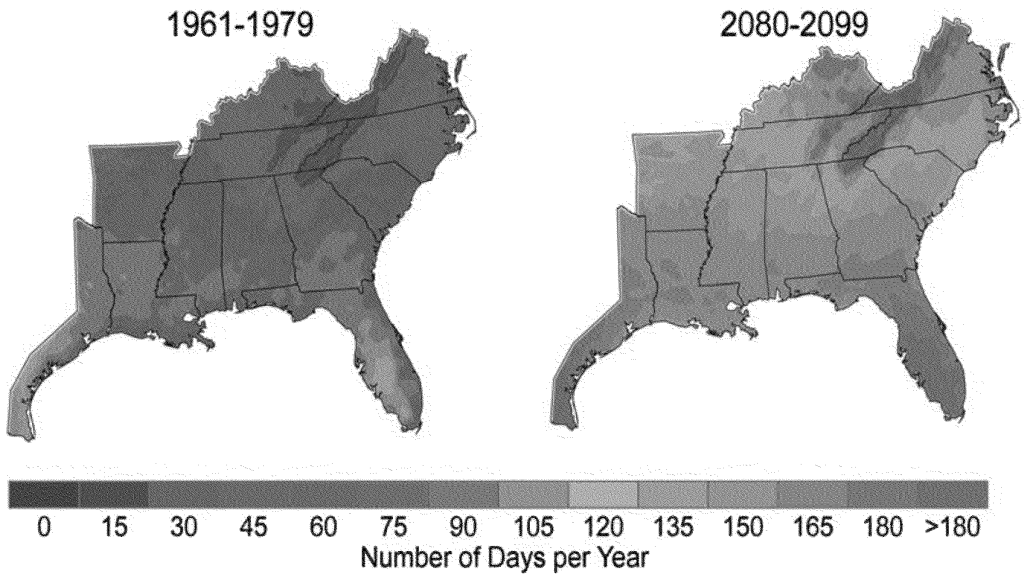
impacts are also likely to increase the salinity of estuaries, coastal wetlands, and tidal rivers. Salinity changes may reduce viable habitat and displace native plant and animal species farther inland (if no migration barriers exist).

Figure 15.2: Number of Very Hot Days Per Year in the Southeast United States



Source: Karl et al. (2009). The number of days per year with peak temperature over 90ºF (32□C).

Key Economic Sectors

The Southeast's projected rate of warming over the next 50 to 100 years would contribute to heat-related stress for trees and crop species. Warmer water temperatures reduce dissolved oxygen in stream, lakes, and shallow aquatic habitats, potentially leading to fish kills and negatively impacting the region's fisheries. Beef cattle production is negatively affected at continuous temperatures in the 90 to 100°F (32 to 38□C) range; cattle and other rangeland livestock may also experience significant production declines. Although the poultry and swine industries primarily use indoor operations, projected temperature increases could significantly increase energy requirements.

15(c) Midwest

In recent decades, an increase in average temperatures in the Midwest has been observed despite the strong year-to-year variations (Karl et al., 2009). The greatest increase has been measured in winter, reducing lake ice and extending the length of the frost-free or growing season by more than one week. Heat waves have been more frequent in the Midwest in the last three decades than any time in the last century outside of the Dust Bowl years of the 1930s. Climate models indicate that summer average temperature in Illinois and Michigan is expected to feel progressively more like summers currently experienced in the southeastern states. The last three decades have been the wettest period in a century, with above average summer and winter precipitation. Precipitation in the Midwest is projected to increase in winter and spring, but decrease in summer in some parts of the region. Heavy downpours are

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now twice as frequent as they were a century ago, and the intensity of rainfall events is also expected to increase in the future.

Human Health

Rising temperatures will increase the frequency of hot days as well as the frequency, severity, and duration of heat waves in the Midwest. Warmer air temperatures, more stagnant air, and more emissions from vegetation could contribute to increased ground-level ozone (a component of smog) and affect air quality throughout the region unless the emissions of ozone-forming pollutants are significantly reduced. Increased tick and mosquito survival during warmer winters may contribute to the spread of diseases like West Nile virus. Warmer water temperatures may increase the risk of waterborne diseases as many pathogens thrive in warmer conditions. The projected increase in heavy downpours may overload drainage systems and water treatment facilities, which can result in beach closures to reduce the risk of disease transmission. Additionally, warmer water and low-oxygen conditions can more readily mobilize mercury and other persistent pollutants in contaminated lake sediment. These contaminants can then be taken up in the aquatic food chain, increasing the health risks for humans and wildlife that eat fish from the lakes. Expected positive benefits of warming include improved traffic safety due to fewer days with snow on the ground and decreased heating oil demand.

Water Resources and Ecosystems

Projected increases in evaporation rates and longer periods between rainfalls in the summer may decrease ground water recharge and surface water flows, and increase the likelihood of drought in the Midwest. Water levels in rivers, streams, lakes, and wetlands are likely to decline, which may degrade aquatic and wetland habitat for native plants and animals. Water levels in the Great Lakes are projected to fall up to 12 inches (30 cm) by the end of the century under a lower emissions scenario and between 12 and 24 inches (30 and 60 cm) under a higher emissions scenario. In some lakes, warming water temperatures also contribute to the creation of oxygen-poor or oxygen-free "dead zones" that kill fish and other species. Populations of cold-water fish, such as brook trout, lake trout, and whitefish, are expected to decline dramatically while cool-water and warm-water fish such as muskie, smallmouth bass, and bluegill would benefit from warmer water temperatures. Non-native and invasive aquatic species, which tend to thrive under a wide range of environmental conditions, may displace native species that are adapted to a narrower range of conditions.

In response to warming temperatures, plants native to the Southeast are likely to shift their ranges northward and become established throughout the Midwest by the end of the century. The ability of plants and animals native to the Midwest to shift their ranges northward to keep pace with the changing climate will be inhibited by migration barriers such as major urban areas and the Great Lakes. Likely climate change impacts on forests include both the positive effects of higher CO_2 and nitrogen levels acting as fertilizers as well as the negative effects of decreasing air quality, more frequent droughts and wildfire hazards, and an increase in insect pests like gypsy moths.

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Regional Infrastructure and Economy

The Midwest has experienced two record-breaking floods in the past 15 years, and this trend is expected to continue given projected future increases in winter and spring precipitation combined with greater frequency of heavy downpours. More frequent flooding is likely to cause increased property damage, insurance rates, emergency management costs, and clean-up and rebuilding costs. High electricity demand for air conditioning during heat waves may stress energy production systems and increase the likelihood of electricity shortages, brownouts, and blackouts. Positive benefits of rising temperatures include a decreased demand for heating oil and gas in the winter. Projected reductions in water levels in the Great Lakes and Mississippi and Missouri river systems may impact and increase costs associated with dredging, infrastructure, river barge traffic, and shipping (low water levels reduce a ship's ability to carry freight). Climate change impacts on agriculture include both the positive effects of longer growing seasons and CO_2 fertilization as well as the negative effects of increased flooding, disease-causing pathogens, insect pests, and weeds. The livestock industry is expected to face higher costs as higher temperatures stress livestock and decrease production.

15(d) Great Plains

Studies cited by Karl et al. (2009) indicate that average temperatures in the Great Plains region have increased approximately 1.4°F (0.78°C) relative to a 1960s and 1970s baseline, with the largest changes occurring in winter months and over the northern states. Relatively cold days are becoming less frequent and relatively hot days more frequent. By the end of the century, temperatures are projected to continue to increase by 2.5°F (1.4°C) to more than 13°F (7.2°C) compared with the 1960 to 1979 baseline, depending on future emissions. Summer warming is projected to be greater than that in winter throughout the southern and central Great Plains. Increased spring precipitation and overall wetter conditions are expected in the northern part of the region, while the South is projected to experience decreased spring precipitation and overall drier conditions by the end of the century (Figure 15.3).

Water Resources

The High Plains aquifer (sometimes called the Ogallala aquifer, after its largest formation) stretches from South Dakota to Texas and supplies the Great Plains with most of its drinking and irrigation water. Current water use on the Great Plains is unsustainable, with more water withdrawn (19 billion gallons daily on average) than the rate of recharge. Projected changes including increasing temperatures, faster evaporation rates, and more sustained droughts will further stress the region's ground water resources. The region will likely be challenged with supplying water for agriculture, ranching, and the region's rapidly growing cities. The largest effects are expected in heavily irrigated areas in the southern Great Plains, already experiencing unsustainable water use and greater frequency of extreme heat.

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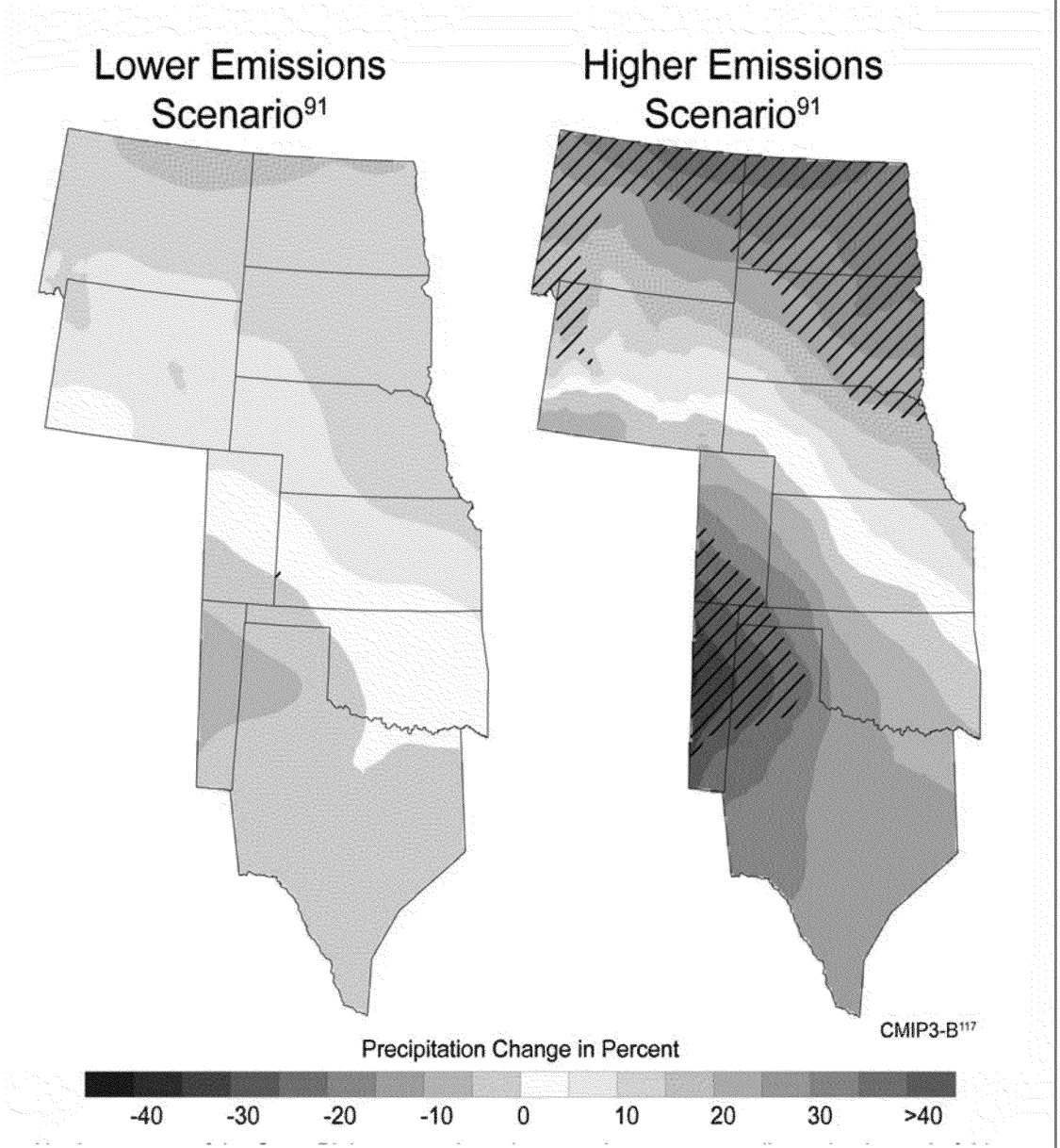
Figure 15.3: Projected Spring Precipitation Change (2080-2099) in the Great Plains Region



Source: Karl et al. (2009). Percentage change in March-April-May precipitation for 2080-2099 compared to 1960-1979 in the Great Plains region of the United States. Confidence in the projected changes is highest in the hatched areas.

Ecosystems

Changes in temperature and precipitation affect the composition and diversity of native animals and plants by altering their breeding patterns, water and food supply, and habitat availability. Climate-driven changes combined with other human-induced stresses are likely to further increase the vulnerability of ecosystems to pests, invasive species, and loss of native species. Some pest populations such as red fire ants and rodents are projected to increase because they are better adapted to a warmer climate. Key

ecosystems like grasslands and wetlands are already threatened by urban sprawl and certain agriculture and ranching practices and may be further impacted by future heat and water stress. These ecosystems provide crucial habitat for grassland and plains birds, migratory waterfowl and shorebirds, and some threatened and endangered species, all of which may experience significant shifts and reductions in their ranges as a result of climate change.

Regional Economy and Human Health

As temperatures increase over this century, agriculture will be affected as optimal areas for growing particular crops shift. Insect pests that were historically unable to survive in the Great Plains' cooler areas are expected to increase in population and spread northward. Rising CO_2 levels in the atmosphere can increase crop growth, but also make some types of weeds grow even faster. Projected precipitation increases in the northern Great Plains are unlikely to be sufficient to offset decreasing soil moisture and aquifer depletion. Some areas are expected to be unable to sustain even current agricultural usage given projections of future water supply.

Many rural areas in the Great Plains region have relatively large populations of very old and very young people, who are at greater risk of health impacts from climate change. Urban populations, particularly the young, elderly, and economically disadvantaged, may also be disproportionately affected by heat.

15(e) Southwest

According to studies cited in Karl et al. (2009), the average annual temperature in the Southwest has increased 1.4°F (0.78□C) compared to a 1960–1979 baseline. Average annual temperature across the region is projected to rise approximately 4°F to 10°F (2 to 5.6□C) above the historical baseline by the end of the century, depending on emissions scenarios. Summer temperature increases are projected to be greater than the annual average increases in some parts of the region. Spring precipitation is expected to decline across most of the region (Figure. 15.4), but future changes in the summer rainy season remain uncertain.

Water Resources

Since 1999, the Southwest has experienced the most severe drought in over a century, which has been exacerbated by recent temperature increases. Studies cited by Karl et al. (2009) point to an increasing probability of future drought for the region. Warm, dry conditions have reduced spring snowpack levels and flows of major rivers like the Colorado. Droughts are features of the region's natural climate variability, but human-induced climate change may increase the incidence and severity of prolonged drought and amplify impacts to water resources. Climate impacts may also be intensified by the region's rapid population growth and increased demand for water, which has already lowered water tables in some areas due to ground water pumping. Current climate trends in addition to population growth suggest that water supplies will likely be substantially diminished in the future. Water shortages will necessitate trade-offs among competing uses—for example, agriculture, hydroelectricity, ecosystems, and urban areas.

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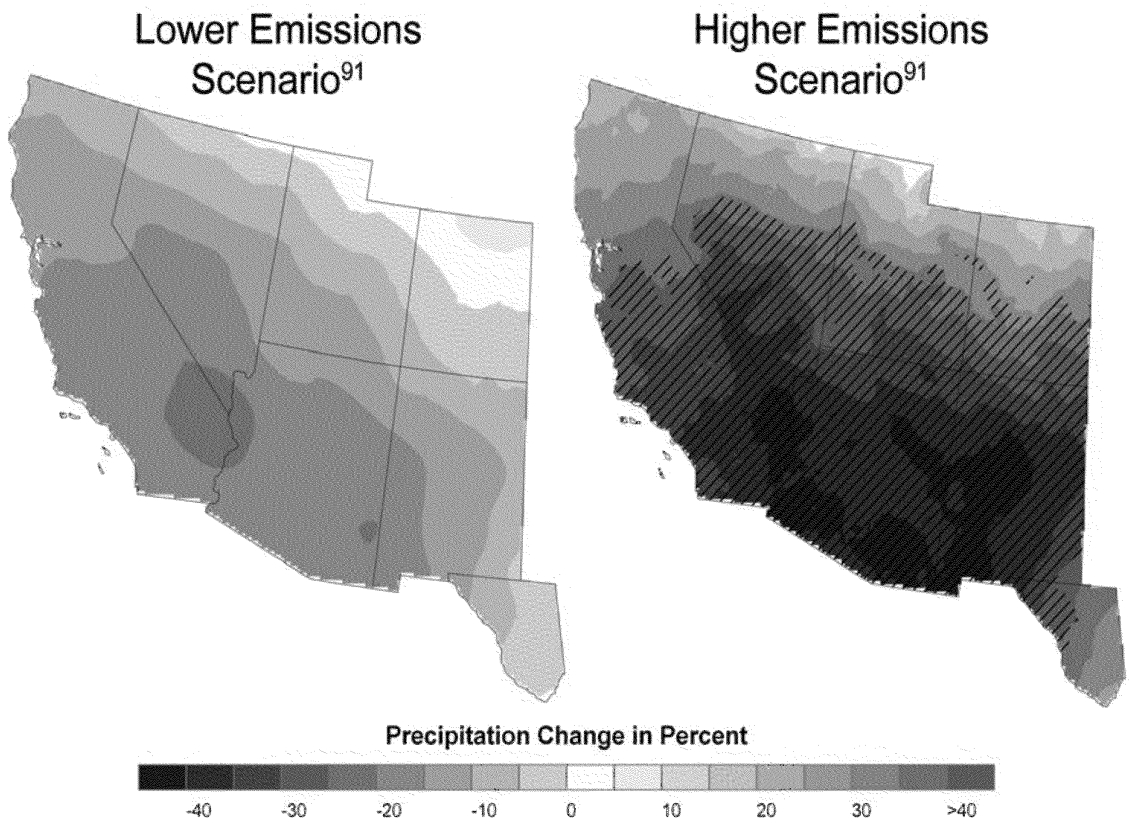
Figure 15.4: Projected Change in Spring Precipitation (2080-2099) in the Southwest



Source: Karl et al. (2009). Percentage change in March-April-May precipitation for 2080-2099 compared to 1961-1979 in the Southwest. Confidence in the projected changes is highest in the hatched areas.

Despite a greater likelihood of drier overall conditions in the Southwest, precipitation patterns are expected to fluctuate between extremely dry and extremely wet winters. If there is rainfall, it is more likely to occur in heavy downpours and may trigger rain-on-snow events (i.e., rapid snowmelt associated with heavy rainfall). The projected future increase in the amount of precipitation falling as rain rather than snow in lower mountain elevations also contributes to the likelihood of flooding.

Forestry and Ecosystems

In recent years, rising temperatures and related reductions in spring snowpack and soil moisture have led to record wildfires (Karl et al., 2009). Overall total area burned by wildfire is projected to increase, although the likelihood of impacts at any given location will depend on local conditions. Some forest types, such as piñon pine-juniper woodlands in the Four Corners region of the Southwest, have experienced substantial die-off due to the severity of current drought conditions and are at greater risk of wildfire. Grasslands are also projected to expand in some areas of the Southwest as a result of increasing temperatures and shifting precipitation patterns, which will likely increase fire risk.

Climate-sensitive ecosystems such as high-elevation alpine forests and tundra are expected to decline under future temperature and precipitation changes. In California, studies project that high-elevation forests will be reduced by 60 to 90% by the end of the century under higher emissions scenarios. Climate change is also expected to threaten the future viability of globally significant biodiversity "hotspots" of

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the Southwest such as the Madrean pine-oak woodlands, which presently exist only in isolated mountaintop patches in southern Arizona, New Mexico, and West Texas. This unique ecosystem contains numerous endemic plant and animal species as well as the greatest diversity of pine species in the world.

In response to projected changes in temperature, precipitation, and drought patterns in the Southwest, some native species are expected to experience substantial range reductions and competition from non-native and invasive species. Studies cited in Karl et al. (2009) project that two-thirds of the more than 5,500 native plant species in California will decline up to 80% by the end of the century under higher emissions scenarios. The Sonoran Desert is already being invaded by red brome and buffle grasses native to Africa and may be threatened with future loss of its iconic species, the saguaro cactus. Some species may be able to shift their ranges northward and upward in elevation to cooler climates but will be challenged by the mountainous topography and human-caused fragmentation of the landscape.

Regional Infrastructure, Economy, and Health

Increased risk of wildfire and flooding expected under future climate change threatens infrastructure and the region's rapidly expanding cities. In addition, projected temperature increases in a region that already experiences very high summer temperatures and poor air quality will significantly stress human health, electricity, and water supply. This will be particularly evident in major cities such as Phoenix, Albuquerque, and Las Vegas, and many California cities with substantial urban heat island effects. More intense, longer-lasting heat wave events are projected to occur over this century, which may increase risks of electricity brownouts and blackouts as demands for air conditioning increase. Hydroelectric systems will also be affected by changes in the timing and amount of river flows, particularly in areas with limited storage capacity.

Much of the region's agriculture may be negatively impacted by future warming, particularly specialty crops in California such as apricots, almonds, artichokes, figs, kiwis, olives, and walnuts. These crops require a minimum number of hours at a certain winter temperature threshold to become dormant and set fruit for the following year. Tourism and outdoor recreation, also important to the region's economy, will be affected by increasing temperatures and changing precipitation patterns. The winter recreation and associated businesses such as downhill and cross-country skiing, snowshoeing, and snowmobiling will likely be affected by a decline in snowpack. Under a high emissions scenario 40% to almost 90% decreases in end-of-season snowpack have been projected in counties with major ski resorts from New Mexico to California. The recreational experience of hikers, bikers, birders, boaters, and others may be affected by reductions in river flow and lake/reservoir levels and changes to the region's iconic ecosystems and landscapes.

15(f) Northwest

Studies cited by Karl et al. (2009) indicate that average annual temperature in the Northwest rose about 1.5°F (0.83□C) over the past century, with some areas experiencing increases up to 4°F (2□C). By the end of the century, regional temperature is projected to increase another 3°F to 10°F (2 to 5.6□C) under lower and higher emissions scenarios, respectively. Precipitation is expected to increase in the winter and decrease in the summer, though these projections are less certain than those for temperature.

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Water and Coastal Resources

The majority of the Northwest is highly dependent on water stored in spring snowpack to maintain streamflow throughout the summer (measured as April 1 snow water equivalent). April 1 snowpack has already declined substantially throughout the region and is projected to decline up to 40% in the Cascades by the 2040s. Warming temperatures will cause more precipitation to fall as rain rather than snow and contribute to earlier snowmelt and major changes in the timing of runoff. Over the past 50 years, the peak spring runoff has occurred up to 25 to 30 days earlier and this trend is projected to continue, with runoff shifting 20 to 40 days earlier within this century. Streamflow is projected to increase in winter and early spring but decrease in late spring, summer, and fall. Given these changes, some sensitive watersheds may experience both increased flood risk in winter and increased drought risk in summer.

Sea level rise will likely contribute to increased coastal erosion and loss of beaches in the Northwest. Some climate models have projected changes in atmospheric pressure patterns that suggest a more southwesterly direction of future winter winds. This change, combined with higher sea levels, would accelerate coastal erosion all along the Pacific Coast. Risk of landslides on coastal bluffs may increase due to the projected heavier winter rainfall that saturates soils and causes them to become unstable.

Forestry and Ecosystems

In recent decades, the risk of forest fires has risen as the region has experienced higher summer temperatures, earlier spring snowmelt, and increased summer moisture deficits; this trend is expected to continue under future climate change. In the short term, the growth of high elevation forests on the west side of the Cascade Mountains is expected to increase; however, projected soil moisture deficits will likely decrease tree growth and limit forest productivity over the long term, with low elevation forests experiencing these changes first. The extent and species composition of Northwest forests are also expected to change in response to climate change. The frequency and intensity of mountain pine beetle and other insect attacks is likely to rise, which may further increase fire risk as the number of standing dead trees increases. Local populations of plants and animals may become extirpated if species are unable or if environmental changes outpace their ability to shift their ranges to more favorable habitat. For example, already threatened or endangered species like wild Pacific salmon will be further impacted by earlier peak streamflows, lower summer streamflows, warmer water temperatures, and changes in the ocean environment. Studies cited by Karl et al. (2009) indicate that about one-third of the current habitat for the Northwest's salmon and other cold-water fish will no longer be suitable for them by the end of this century when temperature surpasses key thresholds.

Regional Infrastructure and Economy

The Northwest's network of dams and reservoirs are operated for a complex set of competing uses—including flood protection, hydropower, municipal and industrial uses, agricultural irrigation, navigation, and ecosystem protection—and is not designed to accommodate projected precipitation and streamflow changes. For example, reservoirs might have to release (rather than store) large amounts of runoff during the winter and early spring to fulfill flood protection objectives, leaving the region without a reliable water supply for hydroelectric power production in summer and early fall when temperatures reach their peak and electricity demand for air conditioning and refrigeration is greatest. Conflicts and the need for trade-offs between all of these water uses are expected to increase.

Much of the region's agriculture, especially production of tree fruit such as apples, is likely to be negatively impacted by future warming and precipitation changes. Impacts may include a decline water supply for irrigation, an increase in insect pests and disease, and increased competition from weeds. The

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projected decline in forest productivity and limited tree growth may affect the Northwest's timber industry.

15(g) Alaska

Over the past 50 years, Alaska's annual average temperature has increased by 3.4°F (1.9□C) and winters have warmed by 6.3°F (3.5□C), which is more than twice the rate of the rest of the United States These observed changes are consistent with climate model projections of temperature increases in Alaska of 4 to 7°F (2 to 4□C) by mid-century. Climate models also project precipitation increases; however, higher air temperatures coupled with increased evaporation are expected to result in reduced soil moisture and drier overall conditions.

Forestry and Ecosystems

Alaska's higher average annual temperatures are already contributing to earlier spring snowmelt, reduced sea ice, widespread glacier retreat, and permafrost thawing. Across southern Alaska, increased rates of evaporation and permafrost thawing have reduced areas covered by surface waters, particularly closed-basin lakes (i.e., lakes without stream inputs and outputs). Drought stress has substantially reduced the rate of growth in white spruce forests in interior Alaska, and continued warming could lead to widespread tree mortality. Alaska's tree line is shifting northward into tundra, impacting wildlife such as migratory birds and caribou that depend on open tundra habitat.

Warmer, drier conditions have also led to an increased incidence of forest insect pest outbreaks and wildfire. The largest outbreak of spruce beetles in the world occurred in south-central Alaska during the 1990s, worsened by a multi-year drought that left trees too stressed to withstand the infestation. Outbreaks of spruce budworm are also expected to increase as summers become warmer and drier; prior to 1990, interior Alaskan winters were too severe for this species to reproduce. Pest infestations can create large, dense areas of dead trees, which are highly flammable and increase the likelihood of wildfire. The area burned by wildfire in Alaska and northwest Canada tripled between the 1960s and the 1990s. Under future climate conditions, the average area burned per year in Alaska is projected to double by mid-century. By the end of this century, area burned by fire could triple or quadruple under moderate or higher GHG emissions scenarios.

Regional Infrastructure and Economy

Throughout Alaska, warming air temperatures have increased permafrost temperatures to the point of thawing, putting roads, runways, water and sewer systems, and other infrastructure at risk from land subsidence. Forest ecosystems are also threatened as thawing permafrost undermines tree root systems. Agriculture may benefit from longer summers and growing seasons associated with warming temperatures. However, crop production may also be negatively affected due to an increased likelihood of summer drought and decreased soil moisture.

Over this century, increased sea surface temperatures and reduced sea ice cover are likely to lead to northward shifts in the Pacific storm track, an increased frequency and/or intensity of storms, and increased impacts on Alaska's coasts. High-wind events have already become more frequent along the western and northern coasts and the rate of erosion along Alaska's northeastern coastline has doubled over the past 50 years. Coastal areas are increasingly vulnerable to wind and wave damage due to the loss of their protective sea ice buffer, increasing storm activity, and thawing coastal permafrost. These impacts are especially significant given that Alaska has more coastline than all other U.S. states combined.

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Potential benefits of reduced sea ice include increased economic opportunities such as shipping and resource extraction. Potential negative effects include increased coastal erosion and flooding associated with coastal storms. Rising air and water temperatures and reduced sea ice will also affect the timing and location of plankton blooms, which may displace marine species dependent on plankton such as pollock and other commercial fish stocks, seabirds, seals, and walruses. Species ranges are shifting northward in search of colder waters and food sources; one study found that between 1982 and 2006, the center of the range for the examined species moved 19 miles (31 km) north. The commercial fishing industry may be affected by rising costs as the most productive commercial fisheries move further away from existing fishing ports and processing infrastructure, requiring either relocation or increased transportation time and fuel expense.

Native Alaskans

Climate change threatens the livelihoods and communities of the indigenous peoples of Alaska, whose cultural identities often depend on traditional ways of collecting and sharing food. Reduced sea ice is already affecting the availability and accessibility of seal, walrus, and fish populations that are traditional food sources for Native Alaskans. Caribou, another traditional food source, are likely to be affected by future warming since their migration patterns depend on being able to cross frozen rivers and wetlands. In addition, over 100 Native Alaskan villages on the coast and in low-lying areas along rivers are at risk of increased flooding and erosion due to warming.

15(h) Islands

Impacts from a changing climate pose challenges to the U.S.-affiliated islands of the Caribbean and Pacific. In the Caribbean, this includes Puerto Rico and the U.S. Virgin Islands. In the Pacific, this includes the Hawaiian Islands, American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, the Federated States of Micronesia, the Republic of the Marshall Islands, and the Republic of Palau. According to studies cited by Karl et al. (2009), the Caribbean and Pacific islands have experienced rising air temperatures over the last century, with even larger increases (up to 6 or 7°F [3 or 4°C]) under higher emissions scenarios) projected for the future (Figure 15.5). Ocean surface temperatures in both the Pacific and Caribbean are also expected to increase. Average annual precipitation is projected to decrease in the Caribbean, while the Pacific Islands are expected to experience an increased frequency of heavy downpours and increased rainfall in summer rather than the normal winter rainy season (although projections are less certain).

Small islands are considered among the most vulnerable to climate change; however, the degree to which climate change will affect each island depends upon a variety of factors, including the island's geology, area, height above sea level, extent of reef formation, and the size of its freshwater aquifer. Although the exact nature and magnitude of climate change impacts will be unique for each island, the following discussion highlights general types of impacts the U.S.-affiliated islands are expected to experience under a changing climate.

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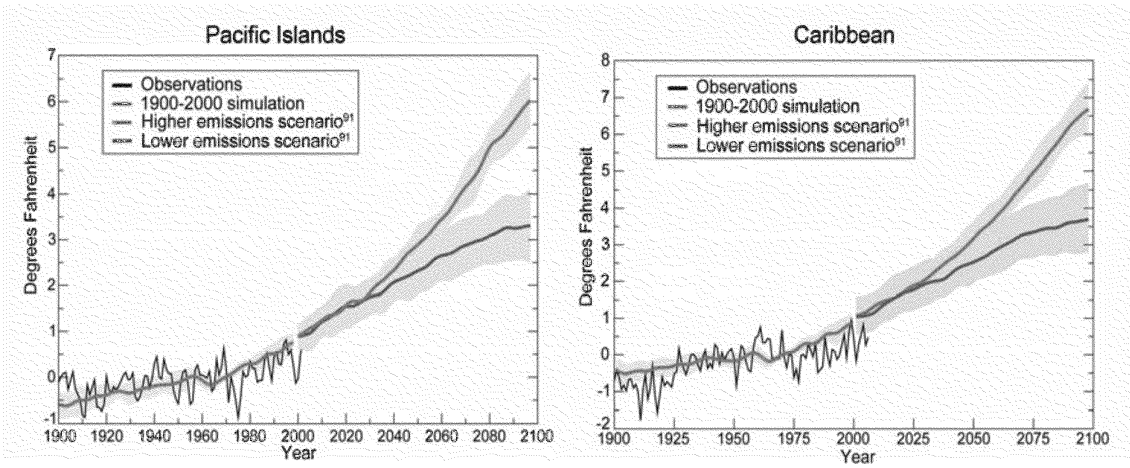
Figure 15.5: Pacific and Caribbean Island Air Temperature Change



Source: Karl et al. (2009). Observed and projected air temperature changes, 1900 to 2100, relative to 1960 to 1979. The shaded areas show the likely ranges, while the lines show the central projections from a set of climate models.

Water Resources

The majority of islands in the Pacific and the Caribbean have limited sources of the freshwater needed to support unique ecosystems, public health, agriculture, and tourism. These limited water resources are already strained in some areas by a rapidly rising population. Because rainfall and tropical storms serve to replenish ground water supplies, the significant decreases in precipitation projected for the Caribbean and changes in tropical storm patterns will likely reduce the availability of freshwater. In the Pacific Islands, potential positive impacts of projected increases in rainfall during the summer months include an increased seasonal water supply. Potential negative impacts include increased flooding, which would increase the risk of water contamination from agricultural or sewage pollution. Sea level rise and increased frequency of flooding from higher storm tides may also increase risk of contamination of the freshwater supply by saltwater.

Island Coastal and Marine Ecosystems

Sea level rise will likely contribute to increased erosion and permanent loss of shorelines and coastal land, particularly in low-lying island areas. "Extreme" sea level days (with a daily average of more than 6 inches (15 cm) above the long-term average) and their associated impacts may also result from a combination of gradual sea level rise, seasonal heating, and high tides. Flooding is expected to become more frequent due to higher storm tides. Certain plant and animal species, many of which are endemic to specific islands and exist nowhere else in the world, may experience habitat loss as a result of these impacts, potentially threatening the survival of many already vulnerable species. Sea level rise, increasing storm damage, warmer water temperatures, and ocean acidification due to a rising carbon dioxide concentration will likely contribute to a decline in important island ecosystems such as mangroves and coral reefs. Even small increases in water temperature can cause coral bleaching, which damages and kills corals. If carbon dioxide concentrations continue to rise at their current rate, the Florida Keys, Puerto Rico, Hawaii, and the Pacific Islands are projected to lose their coral reef ecosystems as a result of these stresses.

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Island Infrastructure and Economy

Hurricanes, typhoons, and other storm events, with their intense precipitation and storm surge, already cause major impacts to Pacific and Caribbean island communities each year. As the climate continues to warm, peak wind intensities and precipitation from future tropical cyclones are likely to increase. This in addition to sea level rise is expected to cause higher storm surge levels and flooding that could potentially impact critical infrastructure such as communications, port facilities and harbors, roads, airports, and bridges. Many islands already have weak water distribution systems and old infrastructure, which would be severely strained by extreme events. Long-term infrastructure damage would affect communities' ability to recover between events and increase costs associated with disaster risk management, health care, education, management of freshwater resources, and food production.

The tourism and fisheries industries, critical to most island economies, would be impacted by climate changes affecting freshwater supplies, infrastructure, and coastal and marine ecosystems, particularly coral reefs. In the Caribbean, coral reefs provide between $3.1 billion and $4.6 billion of annual net benefits from fisheries, tourism, and shoreline protection services. The loss of income from degraded reefs is conservatively estimated at several hundred million dollars annually by 2015.

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Part V

Observed and Projected Human Health and Welfare Effects From Climate Change in Other World Regions

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Section 16

Impacts in Other World Regions

The primary focus of this document is on the observed and potential future impacts associated with elevated GHG concentrations and associated climate change within the United States. However, EPA has considered the global nature of climate change in at least two ways for purposes of this document.

First, GHGs, once emitted, remain in the atmosphere for decades to centuries, and thus become, for all practical purposes, uniformly mixed in the atmosphere, meaning that U.S. emissions have climatic effects not only in the United States but in all parts of the world. Likewise, GHG emissions from other countries can influence the climate of the United States, and therefore affect human health, society, and the natural environment within the United States. All observed and potential future climate change impacts within the United States reviewed in this document consider climate change driven by *global* anthropogenic GHG emissions.

Second, despite widely discussed metrics such as global average temperature, climate change will manifest itself very differently in different parts of the world, where regional changes in temperatures and precipitation patterns, for example, can deviate significantly from changes in the global average. This regional variation in climate change, coupled with the fact that countries are in very different positions with respect to their vulnerability and adaptive capacity, means that the impacts of climate change will be experienced very differently in different parts of the world. In general, the relatively poor nations may experience the most severe impacts, due to their heavier reliance on climate-sensitive sectors such as agriculture and tourism, and due to their lack of resources for increasing resilience and adaptive capacity to climate change (see Parry et al., 2007). In addition to the fact that U.S. GHG emissions contribute to these impacts (see Section 2 for a comparison of U.S. total and transportation emissions to other countries' emissions), climate change impacts in certain regions of the world will have political, social, economic, and environmental ramifications for the United States. Climate change has the potential to alter trade relationships and may exacerbate problems that raise humanitarian and national security issues for the United States (Karl et al., 2009).

16(a) National Security Concerns

A number of analyses and publications inside and outside the government have focused on the potential U.S. national security implications of climate change.[85] For the most part, this body of work has been developed by organizations such as the Center for Naval Analyses (CNA) Corporation and National Intelligence Council rather than teams of scientists. These organizations have leveraged their national security expertise to synthesize the potential security implications of various climate impacts. The recent USGCRP scientific assessment (Karl et al., 2009) has also recognized this issue, stating:

> In an increasingly interdependent world, U.S. vulnerability to climate change is linked to the fates of other nations. For examples, conflicts or mass migrations of people resulting from food scarcity and other resource limits, health impacts, or environmental stresses in other parts of the world could threaten U.S. national security … Meeting the challenge of improving conditions for the world's poor has economic implications for the United States, as does intervention and resolution of intra- and intergroup conflicts. Where climate change exacerbates such challenges,

[85] As the discussion on the national security risks of climate change is limited in the assessment literature, this section relies upon the following sources: U.S. government-published or -funded analyses — including the 2009 assessment report *Global Climate Change Impacts in the United States* — and a report by the Center for Naval Analyses (CNA) Corporation. These sources typically rely on the assessment literature for their underlying science.

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for example by limiting access to scarce resources or increasing incidence of damaging weather events, consequences are likely for the U.S. economy and security."

A public report prepared for the Department of Defense (Schwartz and Randall, 2003) examined what the effects on U.S. national security might be from an abrupt climate change scenario.[86] Based on their interviews with leading climate scientists and their independent research, the authors conclude that the resultant climatic conditions could lead to resource constraints and potentially destabilize the global geo-political environment, with resultant national security concerns for the United States.

ACIA (2004) raised security issues, stating that as Arctic sea ice declines, historically closed sea passages will open, thus raising questions regarding sovereignty over shipping routes and ocean resources. In IPCC (Anisimov, 2007), a study shows projections suggesting that by 2050, the Northern Sea Route will have 125 days per year with less than 75% sea ice cover, which represents favorable conditions for navigation by ice-strengthened cargo ships. This may have implications for trade and tourism as well.

CNA Corporation, a nonprofit national security analysis institution, issued a report entitled *National Security and the Threat of Climate Change* (2007), in which a dozen retired generals and admirals prepared an assessment of the threats of climate change to national security, based on briefings from the U.S. intelligence community, climate scientists, and business and state leaders. Among their conclusions was that climate change acts as a "threat multiplier" for instability in some of the most volatile regions of the world. "Projected climate change will seriously exacerbate already marginal living standards in many Asian, African, and Middle Eastern nations, causing widespread political instability and the likelihood of failed states," said the authors. Regarding the potential impact of climate change on military systems, infrastructure and operations, the report stated that climate change will stress the U.S. military by affecting weapons systems and platforms, bases, and military operations. A U.S. Navy (2001) study was cited which states that an ice-free Arctic will require an increased scope for naval operations. Given these concerns, one of the recommendations of the CNA (2007) report was for the Department of Defense to conduct an assessment of the impact on U.S. military installations worldwide of rising sea levels, extreme weather events, and other possible climate change impacts over the next 30 to 40 years.

The U.S. Congress has recognized there are potential national security concerns due to climate change and requested that the defense and intelligence communities examine these linkages. H.R. 4986, passed in January 2008, requires the Department of Defense to consider the effect of climate change on its facilities, capabilities, and missions. Specific directives in the bill include that future national security strategies and national defense strategies must include guidance for military planners to assess the risks of projected climate change on current and future armed forces missions, as well as update defense plans based on these assessments (H.R. 4986, 2008).

In June 2008 testimony before the House, Dr. Thomas Fingar, Deputy Director of National Intelligence for Analysis, laid out a national intelligence statement on the U.S. national security implications from climate change projected out to 2030. Using a broad definition for national security,[87] the assessment found that:

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[86] The abrupt climate change used for the study was the unlikely, but plausible, collapse of the thermohaline circulation in the Atlantic, modeled after an event that occurred 8,200 years ago.

[87] This definition of national security considered if the effects would directly impact the U.S. homeland, a U.S. economic partner, or a U.S. ally. Additionally, the potential for humanitarian disaster was focused on as well as if an effect would result in degrading or enhancing an element of national power. For more information, see Fingar, 2008.

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> "[G]lobal climate change will have wide-ranging implications for U.S. national security interests over the next 20 years…We judge that the most significant impact for the United States will be indirect and result from climate-driven effects on many other countries and their potential to seriously affect U.S. national security interests. We assess that climate change alone is unlikely to trigger state failure in any state out to 2030, but the impacts will worsen existing problems—such as poverty, social tensions, environmental degradation, ineffectual leadership, and weak political institutions. Climate change could threaten domestic stability in some states, potentially contributing to intra- or, less likely, interstate conflict, particularly over access to increasingly scarce water resources." (Fingar, 2008)

Building on that work, the National Intelligence Council in November 2008, in its publication *Global Trends 2025: A Transformed World*, discussed climate change impacts prominently. The report posed a scenario named "October Surprise," which discussed the economic and sociopolitical ramifications of an extreme flooding event linked to global climate change in New York City in 2020 (NIC, 2008).

16(b) Overview of International Impacts

The IPCC Working Group II volume of the *Fourth Assessment Report* reviews the potential impacts in different regions of the world. The IPCC (Parry et al., 2007) identifies as the most vulnerable regions:

- The Arctic, because of high rates of projected warming on natural systems.
- Africa, especially the sub-Saharan region, because of current low adaptive capacity as well as climate change.
- Small islands, due to high exposure of population and infrastructure to risk of sea level rise and increased storm surge.
- Asian mega deltas, such as the Ganges-Brahmaputra and the Zhujiang, due to large populations and high exposure to sea level rise, storm surge and river flooding.

Table 16.1 summarizes the vulnerabilities and projected impacts for different regions of the world, as identified by the IPCC (2007b); the paragraphs that follow provide some additional detail for key sectoral impacts that have received attention by the research community.

On a global basis, according to IPCC, "projected climate change-related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity," through several factors including "the increased frequency of cardio-respiratory diseases due to higher concentrations of ground level ozone related to climate change (IPCC, 2007b)." More specifically, "cities that currently experience heat waves are expected to be further challenged by an increased number, intensity and duration of heat waves during the course of the century, with potential for adverse health impacts."

Mosquito-borne diseases which are sensitive to climate change, such as dengue and malaria are of great importance globally. Studies cited in Confalonieri et al. (2007) have reported associations between spatial, temporal, or spatiotemporal patterns of dengue and climate, although these are not entirely consistent. Similarly, the spatial distribution, intensity of transmission, and seasonality of malaria is observed to be influenced by climate in sub-Saharan Africa (Confalonieri et al., 2007). In other world regions (e.g., South America, continental regions of the Russian Federation), there is no clear evidence that malaria has been affected by climate change (Confalonieri et al., 2007). Changes in reporting, surveillance, disease control measures, population, land use, and other factors must to be taken into account when attempting to attribute changes in human diseases to climate change (Confalonieri et al., 2007).

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Food production is expected to be much more vulnerable to climate change in poorer regions of the world compared to food production in the United States and other high, northern latitude regions. The IPCC (2007b) stated with medium confidence[88] that, at lower latitudes, especially seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (~2 to 3.5°F [1 to 2°C]), which would increase risk of hunger. Furthermore, increases in the frequency of droughts and floods are projected to affect local production negatively, especially in subsistence sectors at low latitudes. Drought conditions, flooding, and pest outbreaks are some of the current stressors to food security that may be influenced by future climate change. Sub-Saharan Africa is currently highly vulnerable to food insecurity (Easterling et al., 2007). A study cited by Easterling et al. (2007) projected increases in carbon storage on croplands globally under climate change up to 2100 but found that ozone damage to crops could significantly offset these gains.

Regarding global forest production, the IPCC (Easterling et al., 2007) concluded that forestry production is estimated to change modestly with climate change in the short- and medium-term (medium confidence). The projected change in global forest products output ranges from a modest increase to a slight decrease, with significant variations regionally. There is projected to be a production shift from low latitude regions in the short-term, to high latitude regions in the long-term. Projected changes in the frequency and severity of extreme climate events have significant consequences for forestry production in addition to impacts of projected mean climate (high confidence) (Easterling et al., 2007). Climate variability and change also modify the risks of fires, and pest and pathogen outbreaks, with negative consequences for forestry (high confidence) (Easterling et al., 2007).

The IPCC made the following conclusions when considering how climate change may affect water resources across all world regions:

- The impacts of climate change on freshwater systems and their management are mainly due to the observed and projected increases in temperature, sea level, and precipitation variability (very high confidence) (Kundzewicz et al., 2007).
- All regions show an overall net negative impact of climate change on water resources and freshwater ecosystems (high confidence). Areas in which runoff is projected to decline are likely to face a reduction in the value of the services provided by water resources (very high confidence). The beneficial impacts of increased annual runoff in other areas will be tempered by negative effects due to increased precipitation variability and seasonal runoff shifts on water supply, water quality, and flood risk (high confidence) (Kundzewicz et al., 2007).
- Climate change affects the function and operation of existing water infrastructure as well as water management practices. Adverse effects of climate change on freshwater systems aggravate the impacts of other stresses, such as population growth, changing economic activity, land-use change, and urbanization. Globally, water demand will grow in the coming decades, primarily due to population growth and increased affluence; regionally, large changes in irrigation water demand as a result of climate changes are likely. Current water management practices are very likely to be inadequate to reduce negative impacts of climate change on water supply reliability, flood risk, health, energy, and aquatic ecosystems (very high confidence) (Kundzewicz et al., 2007).

[88] According to IPCC terminology, "medium confidence" conveys a 5 out of 10 chance of being correct. See Box 1.2 for a full description of IPCC's uncertainty terms.

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- In polar regions, components of the terrestrial cryosphere and hydrology are increasingly being affected by climate change. Changes to cryospheric processes[89] are also modifying seasonal runoff (very high confidence) (Anisimov et al., 2007).

The IPCC (Nicholls et al., 2007) identified that coasts are experiencing the adverse consequences of hazards related to climate and sea level (very high confidence). They are highly vulnerable to extreme events, such as storms which impose substantial costs on coastal societies. Through the 20th century, global rise of sea level contributed to increased coastal inundation, erosion, and ecosystem losses but with considerable local and regional variation due to other factors (Nicholls et al., 2007). Many large cities are located in areas that are vulnerable to sea level rise and flooding. In most of these cities, the poor often live in areas that are susceptible to extreme events and face constraints on their ability to adapt (Karl et al., 2009).

The IPCC (Fischlin et al., 2007) recently made the following conclusions when considering how climate change may affect ecosystems across all world regions:

- During the course of this century, the resilience of many ecosystems is likely to be exceeded by an unprecedented combination of changes in climate and in other global change drivers (especially land use, pollution, and overexploitation), if GHG emissions and other changes continue at or above current rates (high confidence). The elevated CO_2 levels and associated climatic changes will alter ecosystem structure, reduce biodiversity, perturb functioning of most ecosystems, and compromise the services they currently provide (high confidence). Present and future land-use change and associated landscape fragmentation are very likely to impede species' migrations and geographic range shifts in response to changes in climate (very high confidence).
- Ecosystems and species are very likely to show a wide range of vulnerabilities to climate change, depending on the extent to which climate change alters conditions that could cross critical, ecosystem-specific thresholds (very high confidence). The most vulnerable ecosystems include coral reefs, the sea ice biome and other high latitude ecosystems (e.g., boreal forests), mountain ecosystems, and Mediterranean-climate ecosystems[90] (high confidence). Least vulnerable ecosystems include savannas and species–poor deserts, but this assessment is especially subject to uncertainty relating to the CO_2 fertilization effect and disturbance regimes such as fire (low confidence).

While there is currently a lack of information about how potential impacts due to climate change may influence trade and migration patterns, there is considerable evidence that they will be affected. The USGCRP (Karl et al., 2009) concluded that the number of people wanting to immigrate to the United States will increase as conditions worsen elsewhere, and that climate change has the potential to alter trade relationships by changing the comparative trade advantages of regions or nations. Shifts in both trade and migration can have multiple causes and the direct cause of potential increased migration, such as extreme climatic events, will be difficult to separate from other forces that drive people to migrate (Karl et al., 2009).

[89] Cryospheric processes are defined to include the annual freezing and melting of snow cover, ice sheets, lake and river ice, permafrost, and sea ice.
[90] Mediterranean climate ecosystems feature subtropical climate with dry summers. Despite the name, these ecosystems exist in the United States along the coasts of central and southern California.

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Table 16.1: Examples of Key Regional Impacts as Identified by IPCC (2007b)*	
Africa	New studies confirm that Africa is one of the most vulnerable continents to climate variability and change because of multiple stresses and low adaptive capacity. Some adaptation to current climate variability is taking place; however, this may be insufficient for future changes in climate. By 2020, between 75 million and 250 million people are projected to be exposed to increased water stress due to climate change. If coupled with increased demand, this will adversely affect livelihoods and exacerbate water-related problems. Agricultural production, including access to food, in many countries and regions is projected to be severely compromised by climate variability and change. The area suitable for agriculture, the length of growing seasons, and yield potential, particularly along the margins of semi-arid and arid areas, are expected to decrease. This would further adversely affect food security and exacerbate malnutrition in the continent. In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020.
Asia	Glacier melt in the Himalayas is projected to increase flooding and rock avalanches from destabilized slopes and to affect water resources within the next two to three decades. This will be followed by decreased river flows as the glaciers recede. Freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease due to climate change, which, along with population growth and increasing demand arising from higher standards of living, could adversely affect more than a billion people by the 2050s. Coastal areas, especially heavilypopulated mega delta regions in South, East, and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some mega deltas, flooding from the rivers. It is projected that crop yields could increase up to 20% in East and South-East Asia, while they could decrease up to 30% in Central and South Asia by the mid-21st century. The risk of hunger is projected to remain very high in several developing countries. Endemic morbidity and mortality due to diarrhea disease primarily associated with floods and droughts is expected to rise in East, South, and South-East Asia due to projected changes in the hydrological cycle associated with global warming. Increases in coastal water temperature would exacerbate the abundance and/or toxicity of cholera in South Asia.
Latin America	By mid-century, increases in temperature and associated decreases in soil water are projected to lead to gradual replacement of tropical forest by savanna in eastern Amazonia. Semi-arid vegetation will tend to be replaced by arid-land vegetation. There is a risk of significant biodiversity loss through species extinction in many areas of tropical Latin America. In drier areas, climate change is expected to lead to salinization and desertification of agricultural land. Productivity of some important crops is projected to decrease and livestock productivity to decline, with adverse consequences for food security. In temperate zones, soybean yields are projected to increase. Sea level rise is projected to cause increased risk of flooding in low-lying areas. Increases in sea surface temperature due to climate change are projected to have adverse effects on Mesoamerican coral reefs and cause shifts in the location of Southeast Pacific fish stocks. Changes in precipitation patterns and the disappearance of glaciers are projected to significantly affect water availability for human consumption, agriculture, and energy generation.

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Polar Regions	For human communities in the Arctic, impacts, particularly those resulting from changing snow and ice conditions, are projected to be mixed. Detrimental impacts would include those on infrastructure and traditional indigenous ways of life. Beneficial impacts would include reduced heating costs and more navigable northern sea routes.
Small Islands	Small islands, whether located in the tropics or at higher latitudes, have characteristics that make them especially vulnerable to the effects of climate change, sea level rise, and extreme events. Deterioration in coastal conditions (e.g., through erosion of beaches and coral bleaching) is expected to affect local resources (e.g., fisheries) and reduce the value of these destinations for tourism. Sea level rise is expected to exacerbate inundation, storm surge, erosion, and other coastal hazards, thus threatening vital infrastructure, settlements, and facilities that support the livelihood of island communities. By mid-century climate change is projected to reduce water resources in many small islands, (e.g., in the Caribbean and Pacific), to the point where they become insufficient to meet demand during low-rainfall periods.
* With the exception of some very high-confidence statements for small islands, all other IPCC conclusions within this box are of either high or medium confidence.	

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Appendix A: Brief Overview of Adaptation

Adaptation to climate change is the adjustment in the behavior or nature of a system to the effects of climate change. In the process of developing information to support the Administrator's decision regarding whether elevated combined greenhouse gas (GHG) concentrations endanger public health or welfare, various questions were raised about the relevance of adaptation. As noted in the Introduction, this document does not focus on adaptation because it (like GHG mitigation) is essentially a response to any known and/or perceived risks due to climate change. Although adaptation was not considered explicitly in the document, it does note where the underlying references already take into account certain assumptions about adaptation. This appendix provides a brief overview of the state of knowledge pertaining to adaptation.

What is Adaptation?

As defined in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (2007):

> Adaptation to climate change takes place through adjustments to reduce vulnerability or enhance resilience in response to observed or expected changes in climate and associated extreme weather events. Adaptation occurs in physical, ecological and human systems. It involves changes in social and environmental processes, perceptions of climate risk, practices and functions to reduce potential damages or to realize new opportunities.

Adaptations vary according to the system in which they occur; who undertakes them, the climatic stimuli that prompts them: and their timing, functions, forms, and effects. Adaptation can be of two broad types:

- Reactive or autonomous adaptation is the process by which species and ecosystems respond to changed conditions. An example is the northward migration of a species in response to increasing temperature.

- Anticipatory adaptation is planned and implemented before impacts of climate change are observed. An example is the construction of dikes in response to (and to prepare for) expected sea level rise.

Summary of the Scientific Literature on Adaptation

1. ***There is experience with adapting to weather, climate variability, and the current and projected impacts of climate change.***

    - There is a long record of practices to adapt to the impacts of weather, as well as natural climate variability. These practices include proactive steps like water storage and crop and livelihood diversification, as well as reactive or ex-post steps like emergency response, disaster recovery and migration.[91]

    - The IPCC (2007) states–with very high confidence[92]–that "Adaptation to climate change is already taking place, but on a limited basis."[93]

[91] Adger et al. (2007), p. 720

[92] A set of terms to describe uncertainties in current knowledge was used throughout IPCC's Fourth Assessment Report. On the basis of a comprehensive reading of the literature and their expert judgment, IPCC authors assigned a confidence level to major statements on the basis of their assessment of current knowledge, as follows:

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- A wide array of adaptation options is available, ranging from purely technological (e.g., sea walls), through behavioral changes (e.g., altered food and recreational choices), to managerial (e.g., altered farm practices), and to policy (e.g., planning regulations).[94]

- Some programs have developed strategic plans for responding to climate change. An example is EPA's *National Water Program Strategy: Response to Climate Change* (U.S. EPA, 2008).

2. ***Although adaptation options are known, available, and used in some places, there are significant barriers to their adoption.***

   - The IPCC states with very high confidence that "there are substantial limits and barriers to adaptation." These include formidable environmental, economic, informational, social, attitudinal, and behavioral barriers to the implementation of adaptation that are not fully understood.[95] The IPCC also states that there are significant knowledge gaps for adaptation, as well as impediments to flows of knowledge and information relevant to adaptation decisions.[96]

3. ***Current scientific information does not provide sufficient information to assess how effective current and future adaptation options will be at reducing vulnerability to the impacts of climate change. The fact that a country has a high capacity to adapt to climate change does not mean that its actions will be effective at reducing vulnerability.***

   - While many technologies and adaptation strategies are known and developed in some countries, the available scientific literature does not indicate how effective various options are at fully reducing risks, particularly at higher levels of warming and related impacts, and for vulnerable groups.[97]

   - High adaptive capacity does not necessarily translate into actions that reduce vulnerability. For example, despite a high capacity to adapt to heat stress through relatively inexpensive adaptations, residents in urban areas in some parts of the world, including European cities, continue to experience high levels of mortality.[98] To minimize the risks of heat stress domestically, EPA (2006) has worked collaboratively with other government agencies to provide guidance to municipalities on steps they can take to reduce heat-related morbidity and mortality.[99]

Very high confidence	At least 9 out of 10 chance of being correct
High confidence	About 8 out of 10 chance
Medium confidence	About 5 out of 10 chance
Low confidence	About 2 out of 10 chance
Very low confidence	Less than a 1 out of 10 chance

[93] Adger et al. (2007), p. 720
[94] ibid
[95] ibid
[96] Adger et al. (2007), p. 719
[97] ibid
[98] ibid
[99] Excessive Heat Events Guidebook (2006)

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- Further research is needed to monitor progress on adaptation and to assess the direct as well as ancillary effects of adaptation measures.[100]

4. ***For any country–even one with high adaptive capacitySit is particularly difficult to reduce vulnerability for all segments of the population. The most vulnerable and difficult to reach populations are the elderly, children, and the poor.***

   - The IPCC states with very high confidence that "adaptive capacity is uneven across and within societies." There are individuals and groups within all societies that have insufficient capacity to adapt to climate change.[101]

5. ***More adaptation will be required to reduce vulnerability to climate change.*** [102] ***Additional adaptation can potentially reduce, but is never expected to completely eliminate, vulnerability to current and future climate change.***

   - According to the IPCC, "adaptation alone is not expected to cope with all the projected effects of climate change, and especially not over the long term as most impacts increase in magnitude." [103]

6. ***A portfolio of adaptation and mitigation measures can diminish the risks associated with climate change.***

   - Even the most stringent mitigation efforts cannot avoid further impacts of climate change in the next few decades, which makes adaptation essential, particularly in addressing near-term impacts. Unmitigated climate change would, in the long term, be likely to exceed the capacity of natural, managed, and human systems to adapt.[104]

[100] Adger et al. (2007) p. 737
[101] Adger et al. (2007), p. 719
[102] Adger et al. (2007), p. 719
[103] IPCC (2007), p. 19
[104] IPCC (2007), p. 20

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Appendix B: Greenhouse Gas Emissions From Section 202(a) Source Categories

This Appendix provides greenhouse gas (GHG) emission information from Clean Air Act Section 202(a) source categories. It includes an overview of the respective source categories with a description of how the emission data from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* map to these source categories. Then, relevant emission data are presented and comparisons are made between U.S. GHG emissions from Section 202(a) source categories and domestic and global emission data. To inform the Administrator's assessment, the following types of comparisons for both the collective and individual emissions of GHGs from Section 202(a) source categories are provided:

- As a share of total global aggregate emissions of the well-mixed GHGs
- As a share of total U.S. aggregate emissions of the six GHGs
- As a share of the total global transportation emissions of the six GHGs

In addition, for each individual GHG, the following comparisons were also calculated:

- As a share of total U.S. Section 202(a) GHG emissions
- As a share of U.S. emissions of that individual GHG, including comparisons to the magnitude of emissions of that GHG from non-transport related source categories
- As a share of global emissions of that individual GHG
- As a share of global transport GHG emissions
- As a share of all global GHG emissions

(A) Overview of Section 202(a) Source Categories

To inform the Administrator's cause or contribute finding, EPA analyzed historical GHG emission data for motor vehicles and motor vehicle engines in the United States from 1990 to 2007 (the most recent year for which official EPA estimates are available). The motor vehicles and motor vehicle engines addressed include:

- Passenger cars
- Light-duty trucks
- Motorcycles
- Buses
- Medium/heavy-duty trucks

The source of the emissions data is the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007 (U.S. EPA, 2009).* The *U.S. Inventory* is organized around the source classification scheme put forth by the Intergovernmental Panel on Climate Change, in which emissions from motor vehicles and motor vehicle engines are reported within two different sectors: Energy and Industrial Processes. Table B.1 describes the correspondence between Section 202(a) GHG emission source categories and IPCC source categories:

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Table B.1:Source Categories Included Under Section 202(a)

Section 202(a) Source Category	IPCC Sector	IPCC Source Category	Greenhouse Gases
Passenger Cars	Energy	1A3b (i) Cars	CO_2, CH_4, N_2O
Light-Duty Trucks	Energy	1A3b (ii) Light-duty trucks	CO_2, CH_4, N_2O
Motorcycles	Energy	1A3b (iv) Motorcycles	CO_2, CH_4, N_2O
Buses	Energy	1A3b (iii) Heavy-duty trucks and buses	CO_2, CH_4, N_2O
Medium/Heavy-Duty Trucks	Energy	1A3b (iii) Heavy-duty trucks and buses	CO_2, CH_4, N_2O
Cooling (from section 202(a) sources)	Industrial Processes	2F1 Refrigeration and Air Conditioning Equipment	Hydrofluorocarbons (HFCs)

GHG emissions from aviation, pipelines, railways, and marine transport are included in the IPCC Energy Sector under 1A3 but are not included within Section 202(a).

(B) GHG Emissions from Section 202(a) Source Categories

(1) Total, combined GHG emissions from Section 202(a) source categories

Table B.2 presents historical emissions of all GHGs (CO_2, CH_4, N_2O, and HFCs) from Section 202(a) source categories from 1990-2007 in carbon dioxide equivalent units ($TgCO_2e$).[105] Passenger cars (38.7. percent), light-duty trucks (32.4 percent), and medium/heavy-duty trucks (24.8 percent) emitted the largest shares of GHG emissions in 2007, followed by cooling (from section 202(a) sources) (3.2 percent), buses (0.7 percent), and motorcycles (0.1 percent). From 1990 to 2007, GHG emissions from Section 202(a) source categories grew by 33.9 %due in part to increased demand for travel and the stagnation of fuel efficiency across the U.S. vehicle fleet. Since the 1970s, the number of highway vehicles registered in the United States has increased faster than the overall population, according to the Federal Highway Administration (FHWA).[106] Likewise, the number of miles driven (up 41.3% from 1990 to 2007) and the gallons of gasoline consumed each year in the United States have increased steadily since the 1980s, according to the FHWA and Energy Information

[105] A Tg is one teragram, or one million metric tons.
[106] FHWA (1996 through 2008) Highway Statistics. Federal Highway Administration, U.S. Department of Transportation, Washington, DC. Report FHWA-PL-96-023-annual. Available online at <http://www.fhwa.dot.gov/policy/ohpi/hss/hsspubs.htm>.

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Administration, respectively.[107] These increases in motor vehicle use are the result of a confluence of factors, including population growth, economic growth, urban sprawl, low fuel prices, and increasing popularity of sport utility vehicles and other light-duty trucks that tend to have lower fuel efficiency.

[107] DOE (1993 through 2008) Transportation Energy Data Book. Office of Transportation Technologies, Center for Transportation Analysis, Energy Division, Oak Ridge National Laboratory. ORNL-5198.

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Table B.2: Total Greenhouse Gas Emissions by Section 202(a) Source Category (Tg CO_2e)

Section 202(a) Sources	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Passenger Cars	656.9	633.9	670.3	673.1	686.5	664.4	660.7	677.3	651.1	639.6
Light-Duty Trucks	336.2	428.6	489.7	492.9	502.9	536.5	557.3	517.1	528.8	533.8
Motorcycles	1.8	1.8	1.9	1.7	1.7	1.7	1.8	1.7	1.9	2.1
Buses	8.3	9.0	10.9	10.0	9.7	10.5	14.7	11.8	12.1	12.1
Medium/Heavy-Duty Trucks	228.8	272.4	342.7	341.8	355.9	352.3	365.0	392.9	402.3	408.6
Cooling (from section 202(a) sources)	0.0	16.2	43.0	46.7	49.9	52.4	55.1	56.5	55.9	53.2
Total	1231.9	1362.1	1558.5	1566.3	1606.6	1617.7	1654.6	1657.3	1652.1	1649.3

Between 1990 and 2007, GHG emissions from passenger cars decreased 2.6%, though there was some growth in GHG emissions from 2000 to 2002, and again from 2004 to 2005. Emissions from light-duty trucks increased 58.8% from 1990 to2007, largely due to the increased use of sport-utility vehicles and other light-duty trucks. Meanwhile, GHG emissions from heavy-duty trucks increased 78.6%, reflecting the increased volume of total freight movement and an increasing share transported by trucks. In 1990, there were no hydrofluorocarbons (HFCs) used in vehicle cooling systems. HFCs were gradually introduced into motor vehicle air conditioning and refrigerating systems during the 1990s as chlorofluorocarbons (CFCs), and hydrochlorofluorocarbons (HCFCs) started to phase out of production as required under the Montreal Protocol and Title VI of the Clean Air Act.

Table B.3 presents GHG emissions from Section 202(a) source categories alongside total U.S. emissions. The table also presents emissions from the electricity generation and industrial sectors for comparison. In 1990, Section 202(a) source categories emitted 20.2% of total U.S. emissions, behind the electricity generation sector (30.5%) and the industrial sector (24.5%). By 2007, Section 202(a) source categories collectively were the second largest sector with 23.1% of total U.S. emissions, due both to growth in vehicle emissions and a decline in emissions from industry.

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Table B.3: Sectoral Comparison to Total U.S. Greenhouse Gas Emissions (Tg CO_2e)

U.S. Emissions	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Section 202(a) GHG emissions	1231.9	1362.1	1558.5	1566.3	1606.6	1617.7	1654.6	1657.3	1652.1	1649.3
Share of U.S. (%)	20.2%	21.1%	22.2%	22.7%	23.1%	23.2%	23.4%	23.3%	23.4%	23.1%
Electricity sector emissions	1859.1	1989.0	2329.3	2292.1	2301.1	2329.6	2362.0	2429.4	2375.5	2445.1
Share of U.S. (%)	30.5	30.8	33.2	33.2	33.1	33.4	33.4	34.2	33.7	34.2
Industrial sector emissions	1496.0	1524.5	1467.5	1415.0	1418.4	1394.7	1408.7	1364.9	1388.4	1386.3
Share of U.S. (%)	24.5	23.6	20.9	20.5	20.4	20.0	19.9	19.2	19.7	19.4
Total U.S. GHG emissions	6098.7	6463.3	7008.2	6896.3	6942.3	6981.1	7064.9	7108.6	7051.1	7150.1

Table B.4 compares total GHG emissions from Section 202(a) source categories to all U.S. GHG emissions, global GHG emissions from the transport sector (as defined by IPCC), and total global GHG emissions from all source categories, for 2005.[108] Section 202(a) GHG emissions are a significantly larger share of global transport GHG emissions (28.0%) than the corresponding share of all U.S. GHG emissions to the global total (18.4%), reflecting the relative size of the transport sector in the United States compared to the global average. Section 202(a) GHG emissions were 4.3% of total global emissions in 2005. The global transport sector was 15.3% of all global emissions in 2005.

[108] The year 2005 is the most recent year for which comprehensive greenhouse gas emissions data are available for all gases, all countries, and all sources. Global estimates are 'gross' emissions estimates and do not include removals of greenhouse gas emissions from the atmosphere by terrestrial sinks (i.e., forests and other biomass). Global data come from the World Resources Institute's Climate Analysis Indicators Tool, which contains national data submitted by Parties to the UNFCCC, and other independent and peer-reviewed datasets (e.g., International Energy Agency).

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Table B.4: Comparison to Global Greenhouse Gas Emissions (Tg CO_2e)

	2005	Sec 202(a) Share
All U.S. GHG emissions	7,109	23.3%
Global transport GHG emissions	5,925	28.0%
All global GHG emissions	38,726	4.3%

(2) Individual GHG emissions from Section 202(a) source categories

Table B.5 presents total GHG emissions from Section 202(a) source categories by gas, in CO_2 equivalent units. In 2007, CO_2 made up the largest share of emissions (95.1%), followed by HFCs (3.2%), N_2O (1.6%) and CH_4 (0.1%). Since 1990, the share of HFCs has increased (from zero in 1990), whereas the share of the other gases has correspondingly decreased. Methane and N_2O emissions have decreased in absolute terms since 1990.

Table B.5: Greenhouse Gas Emissions From Section 202(a) Source Categories by Gas (Tg CO_2e)

Section 202(a) Sources		1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CO_2		1187.3	1291.9	1463.8	1470.5	1512.0	1524.2	1561.4	1566.2	1564.9	1568.5
	Share of Sec 202 GHGs	96%	95%	94%	94%	94%	94%	94%	95%	95%	95%
CH_4		4.2	3.8	2.9	2.8	2.4	2.2	2.1	1.9	1.8	1.7
	Share of Sec 202 GHGs	0.34%	0.28%	0.18%	0.18%	0.15%	0.14%	0.13%	0.12%	0.11%	0.10%
N_2O		40.4	50.1	48.8	46.4	42.3	38.9	36.1	32.7	29.5	26.0
	Share of Sec 202 GHGs	3.3%	3.7%	3.1%	3.0%	2.6%	2.4%	2.2%	2.0%	1.8%	1.6%
HFCs		0.0	16.2	43.0	46.7	49.9	52.4	55.1	56.5	55.9	53.2
	Share of Sec 202 GHGs	0.0%	1.2%	2.8%	3.0%	3.1%	3.2%	3.3%	3.4%	3.4%	3.2%
Total GHGs		1231.9	1362.1	1558.5	1566.3	1606.6	1617.7	1654.6	1657.3	1652.1	1649.3

(a) Carbon dioxide emissions from Section 202(a) source categories

Carbon dioxide is emitted from motor vehicles and motor vehicle engines during the fossil fuel combustion process. During combustion, the carbon (C) stored in the fuels is oxidized and emitted as CO_2 and smaller amounts of other carbon compounds, including CH_4, carbon monoxide (CO), and non-methane volatile organic compounds (NMVOCs). These other C-containing non-CO_2 gases are emitted as by-products of incomplete fuel combustion, but are, for the most part, eventually oxidized to CO_2 in the atmosphere.

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As the dominant GHG emitted from motor vehicles and motor vehicle engines (95.1% of total emissions in 2007), CO_2 emission trends in Table B.6 mirror those of the GHG emission total. Carbon dioxide emissions grew by 32.1% between 1990 and 2007. Most of this growth occurred as a result of increased CO_2 emissions from light-duty trucks (62.8%) and medium/heavy-duty trucks (78.8%). Emissions from passenger cars did not grow over the same time period.

Table B.6: CO_2 Emissions by Section 202(a) Source Category (Tg CO_2)

Sec. 202 Source Categories	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Passenger Cars	628.8	604.9	643.5	647.9	662.6	642.1	640.0	658.4	634.4	625.0
Light-Duty Trucks	320.7	405.0	466.2	470.5	483.5	519.1	541.2	502.8	515.5	522.0
Motorcycles	1.7	1.8	1.8	1.7	1.7	1.6	1.7	1.6	1.9	2.0
Buses	8.3	9.0	10.9	10.0	9.6	10.5	14.7	11.8	12.1	12.0
Medium/Heavy-Duty Trucks	227.8	271.2	341.3	340.4	354.5	350.8	363.7	391.6	401.1	407.4
Cooling (from section 202(a) sources)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	1187.3	1291.9	1463.8	1470.5	1512.0	1524.2	1561.4	1566.2	1564.9	1568.5

Table B.7 presents CO_2 emissions from Section 202(a) source categories alongside total U.S. CO_2 emissions. The table also presents emissions from the electricity generation and industrial sectors for comparison. In 1990, Section 202(a) source categories emitted 23.4% of total U.S. CO_2 emissions, behind the electricity generation sector (36.0%), and ahead of the industrial sector (22.3%). By 2007, emissions from Section 202(a) source categories increased to 25.7% of total U.S. CO_2 emissions.

Table B.7: Sectoral Comparison to Total U.S. CO_2 Emissions (Tg CO_2)

U.S. CO_2 Emissions	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Section 202 CO_2 emissions	1187.3	1291.9	1463.8	1470.5	1512.0	1524.2	1561.4	1566.2	1564.9	1568.5
Share of U.S. CO_2 (%)	23.4%	23.9%	24.6%	25.1%	25.6%	25.6%	25.8%	25.7%	26.0%	25.7%
Electricity Sector CO_2	1829.7	1964.2	2311.7	2274.6	2284.0	2313.6	2345.0	2412.0	2358.3	2429.4
Share of U.S. CO_2 (%)	36.0	36.3	38.8	38.8	38.7	38.8	38.8	39.6	39.2	39.8
Industrial Sector CO_2	1132.6	1176.5	1148.6	1119.7	1122.5	1111.6	1130.4	1100.3	1126.0	1115.7
Share of U.S. CO_2 (%)	22.3	21.8	19.3	19.1	19.0	18.6	18.7	18.1	18.7	18.3
Total U.S. CO_2 emissions	5076.7	5407.9	5955.2	5860.0	5908.2	5963.2	6048.1	6090.8	6014.9	6103.4

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Table B.8 compares total CO_2 emissions from Section 202(a) source categories to total U.S. emissions, global GHG emissions from the transport sector (as defined by IPCC), and total global GHG emissions from all source categories, for 2005. Section 202(a) CO_2 emissions are a significantly larger share of global transport GHG emissions (26.4%) than the corresponding share of all U.S. CO_2 emissions to the global total (22.0%), reflecting the relative size of the transport sector in the U.S. compared to the global average. Section 202(a) CO_2 emissions were 4.0% of total global GHG emissions in 2005.

Table B.8: Comparison to U.S. and Global Greenhouse Gas Emissions (Tg CO_2e)

Global Emissions	2005	Sec 202(a) CO_2 Share
All U.S. GHG emissions	7,109	22.0%
All global CO_2 emissions	27,526	5.7%
Global transport GHG emissions	5,925	26.4%
All global GHG emissions	38,726	4.0%

(b) Methane emissions from Section 202(a) source categories

Methane emissions from motor vehicles are a function of the CH_4 and hydrocarbon content of the motor fuel, the amount of hydrocarbons passing uncombusted through the engine, and any post-combustion control of hydrocarbon emissions (such as catalytic converters).

Table B.9 shows the trend in CH_4 emissions from Section 202(a) source categories since 1990, presented in carbon dioxide equivalents. The combustion of gasoline in passenger cars and light-duty trucks was responsible for the majority (91.2%) of the CH_4 emitted from Section 202(a) source categories. From 1990 to 2007, CH_4 emissions decreased by 61%.

Table B.9: CH_4 Emissions by Section 202(a) Source Category (Tg CO_2e)

202(a) Sources	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Passenger Cars	2.6	2.1	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9
Light-Duty Trucks	1.4	1.4	1.1	1.1	0.9	0.8	0.7	0.7	0.7	0.6
Motorcycles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Buses	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Medium/Heavy-Duty Trucks	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cooling (from section 202(a) sources)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A`	N/A
Total	4.2	3.8	2.9	2.8	2.4	2.2	2.1	1.9	1.8	1.7

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Table B.10 presents CH_4 emissions from Section 202(a) source categories alongside total U.S. CH_4 emissions. The table also presents CH_4 emissions from landfills and natural gas systems for comparison. In 2007, Section 202(a) source categories emitted 0.3% of total U.S. CH_4 emissions; landfills (22.7%) and natural gas systems (17.9.%) represented a significantly larger share. Overall, total U.S. CH_4 emissions decreased by 5.1% (31.3 $TgCO_2e$) from 1990 to 2007, in part due to efforts to reduce emissions at individual sources such as landfills and coal mines.

Table B.10: Sectoral Comparison to Total U.S. CH_4 Emissions (Tg CO_2e)

U.S. CH_4 Emissions	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Section 202(a) CH_4 emissions	4.2	3.8	2.9	2.8	2.4	2.2	2.1	1.9	1.8	1.7
Share of U.S. CH_4 (%)	0.69	0.62	0.48	0.48	0.42	0.39	0.37	0.34	0.31	0.28
Landfill CH_4 emissions	149.2	144.3	122.3	119.5	121.9	128.3	126.2	127.8	130.4	132.9
Share of U.S. CH_4 (%)	24.2	23.4	20.7	20.7	21.0	22.2	22.4	22.8	22.4	22.7
Natural Gas CH_4 emissions	129.6	132.6	130.8	129.5	129.0	127.2	118.0	106.3	104.8	104.7
Share of U.S. CH_4 (%)	21.0	21.5	22.1	22.4	22.2	22.0	21.0	18.9	18.0	17.9
Total U.S. CH_4 emissions	616.6	615.8	591.1	577.1	580.9	578.7	562.7	561.7	582.0	585.3

Table B.11 compares total CH_4 emissions from Section 202(a) source categories to U.S. GHG emissions, global GHG emissions from the transport sector (as defined by IPCC), and total global GHG emissions from all source categories, for 2005. Section 202(a) CH_4 emissions are a significantly smaller share of U.S., global transport, and global emissions in comparison to Section 202(a) CO_2 emissions.

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Table B.11: Comparison to US and global greenhouse gas emissions (Tg CO_2e)

Global Emissions	2005	Sec 202(a) CH_4 Share
All U.S. GHG emissions	7,109	0.03%
All global CH_4 emissions	6,408	0.03%
Global transport GHG emissions	5,925	0.03%
All global GHG emissions	38,726	0.005%

(c) Nitrous oxide emissions from Section 202(a) source categories

Nitrous oxide (N_2O) is a product of the reaction that occurs between nitrogen and oxygen during fuel combustion. N_2O emissions from motor vehicles and motor vehicle engines are closely related to fuel characteristics, air-fuel mixes, combustion temperatures, and the use of pollution control equipment. For example, some types of catalytic converters installed to reduce motor vehicle NO_X, CO, and hydrocarbon emissions can promote the formation of N_2O.

Table B.12 shows the trend in N_2O emissions from Section 202(a) source categories since 1990, presented in carbon dioxide equivalents. Section 202(a) emissions of N_2O decreased by 35.55% from 1990 to 2007. Earlier generation control technologies initially resulted in higher N_2O emissions, causing a 24.2% increase in N_2O emissions from motor vehicles between 1990 and 1995. Improvements in later-generation emission control technologies have reduced N_2O output, resulting in a 48.1% decrease in N_2O emissions from 1995 to 2007. Overall, Section 202(a) N_2O emissions were predominantly from gasoline-fueled passenger cars (52.8 %) and light-duty trucks (42.8%) in 2007.

Table B.12: N_2O Emissions by Section 202(a) Source Category (Tg CO_2e)

202(a) Sources	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Passenger Cars	25.4	26.9	25.2	23.8	22.5	21.0	19.5	17.8	15.7	13.7
Light-Duty Trucks	14.1	22.1	22.4	21.3	18.5	16.6	15.3	13.7	12.6	11.1
Motorcycles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Buses	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Medium/Heavy-Duty Trucks	0.8	1.0	1.2	1.2	1.3	1.3	1.2	1.2	1.1	1.1
Cooling (from section 202(a) sources)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	40.4	50.1	48.8	46.4	42.3	38.9	36.1	32.7	29.5	26.0

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Table B.13 presents N_2O emissions from Section 202(a) source categories alongside total U.S. N_2O emissions. The table also presents N_2O emissions from agricultural soil management and nitric acid production for comparison. In 2007, Section 202(a) source categories emitted 8.3% of total United States N_2O emissions, making it the second largest source category. By far the largest source category in the United States is agricultural soil management, representing 66.7% of total N_2O emissions in 2007. The third largest source in 2007 was nitric acid production (7.0%).

Table B.13: Sectoral Comparison to Total U.S. N_2O Emissions (Tg CO_2e)

U.S. N_2O Emissions	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Section 202(a) N_2O emissions	40.4	50.1	48.8	46.4	42.3	38.9	36.1	32.7	29.5	26.0
Share of U.S. N_2O (%)	12.8	15.0	14.8	13.8	13.1	12.5	11.4	10.3	9.4	8.3
Agricultural Soil N_2O emissions	200.3	202.3	204.5	220.4	207.6	202.8	211.2	210.6	208.4	207.9
Share of U.S. N_2O (%)	63.6	60.6	62.1	65.5	64.5	64.9	66.4	66.7	66.8	66.7
Nitric Acid N_2O emissions	20.0	22.3	21.9	17.8	19.3	18.1	18.0	18.6	18.2	21.7
Share of U.S. N_2O (%)	6.3	6.7	6.7	5.3	6.0	5.8	5.6	5.9	5.8	7.0
Total U.S. N_2O emissions	315.0	334.1	329.2	336.5	322.0	312.5	317.8	315.9	312.1	311.9

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Table B.14 compares total N_2O emissions from Section 202(a) source categories to U.S. GHG emissions, global GHG emissions from the transport sector (as defined by IPCC), total global N_2O emissions, and total global GHG emissions from all source categories, for 2005. Section 202(a) N_2O emissions are just under 0.55% of global transport emissions and 0.08% of all global GHG emissions.

Table B.14: Comparison to U.S. and Global Greenhouse Gas Emissions (Tg CO_2e)

	2005	Sec 202(a) N_2O Share
All U.S. GHG emissions	7,109	0.46%
All global N_2O emissions	3,286	0.99%
Global transport GHG emissions	5,925	0.55%
All global GHG emissions	38,726	0.08%

(d) HFC emissions from Section 202(a) source categories

HFCs (a term that encompasses a group of 11 related compounds) are progressively replacing CFCs and HCFCs in Section 202(a) cooling and refrigeration systems as they are being phased out under the Montreal Protocol and Title VI of the Clean Air Act.[109] For example, HFC-134a has become a replacement for CFC-12 in mobile air conditioning systems. A number of HFC blends, containing multiple compounds, have also been introduced. The emission pathway can be complex, with HFCs being emitted to the atmosphere during the charging, operation, and decommissioning/disposal of cooling and refrigeration system.

Table B.15 shows the trend in HFC emissions from Section 202(a) source categories since 1990, presented in carbon dioxide equivalents. As opposed to the GHGs discussed above, estimates of HFC emissions are presented here as the sum of HFC emissions from all vehicle modes that qualify as section 202(a) source categories. This was done because the *U.S. Inventory* does not disaggregate HFC emission data into vehicle types in exactly the same way as it does for other GHGs. The vehicle modes that are included in the HFC emission estimates are passenger cars, light-duty trucks and buses. Additionally, while HFC emissions associated with comfort cooling for passengers in medium and heavy duty trucks are considered a section 202(a) source, these emissions are not included here because they are not estimated for the *U.S. Inventory* due to insufficient data. As such, the numbers presented here are likely a slight underestimate of total section 202(a) HFC emissions. HFCs were not used in motor vehicles in 1990, but by 2007 emissions had increased to 53.2 Tg CO_2e. From 1995 to 2007, HFC emissions from Section 202(a) source categories increased by 227%.

[109] 2006 IPCC Guidelines, Volume 3, Chapter 7. Page 43 (IPCC, 2006a).

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Table B.15: HFC Emissions by Section 202(a) Source Category (Tg CO_2e)

202(a) HFC Sources	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Cooling (from section 202(a) sources)	0.0	16.2	43.0	46.7	49.9	52.4	55.1	56.5	55.9	53.2

Table B.16 presents HFC emissions from Section 202(a) source categories alongside total U.S. HFC emissions. The table also presents HFC emissions from HCFC-22 production and all other end-use applications of substitutes for ozone-depleting substances (ODS substitutes) for comparison. In 2007, Section 202(a) source categories emitted 42.4% of total U.S. HFC emissions, making it the largest source category. Other applications of ODS substitutes (including foam blowing, fire protection, aerosol propellants, solvents, and other applications) accounted for 44.1%. HCFC-22 chemical production results in byproduct releases of HFC-23, which accounted for 98.6% of HFC emissions in 1990, but declined by 2007 and now represents 13.5%.

Table B.16: Sectoral Comparison to Total U.S. HFC Emissions (Tg CO_2e)

U.S. HFC Emissions	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Section 202(a) HFC emissions	0.0	16.2	43.0	46.7	49.9	52.4	55.1	56.5	55.9	53.2
Share of U.S. HFC (%)	*0*	*26*	*43*	*48*	*48*	*52*	*49*	*49*	*46.9*	*42.4*
HCFC-22 Production	36.4	33.0	28.6	19.7	21.1	12.3	17.2	15.8	13.8	17.0
Share of U.S. HFC (%)	98.6	53.4	28.6	20.4	20.2	12.1	15.3	13.6	11.6	13.5
Other ODS Substitutes	0.5	12.6	28.5	30.4	33.3	36.7	40.1	43.8	49.4	55.4
Share of U.S. HFC (%)	*1.4*	*20.4*	*28.5*	*31.4*	*31.9*	*36.2*	*35.7*	*37.7*	*41.5*	*44.1*
Total U.S. HFC emissions	36.9	61.8	100.1	96.9	104.3	101.4	112.4	116.1	119.1	125.5

Table B.17 compares total HFC emissions from Section 202(a) source categories to U.S. GHG emissions, global GHG emissions from the transport sector (as defined by IPCC), total global HFC emissions, and total global GHG emissions from all source categories, for 2005. Section 202(a) HFC emissions are 0.95% of global transport emissions and 0.15% of all global GHG emissions, but actually make up 14.8% of global HFC emissions.

Table B.17: Comparison to U.S. and Global Greenhouse Gas Emissions (Tg CO_2e)

	2005	Sec 202(a) HFC Share
All U.S. GHG emissions	7,109	0.79%
All global HFC emissions	381	14.8%
Global transport GHG emissions	5,925	0.95%
All global GHG emissions	38,726	0.15%

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(e) PFC and SF_6 emissions

Perfluorocarbons (PFCs) are not emitted from motor vehicles or motor vehicle engines in the United States. The main sources of PFC emissions in the United States are aluminum smelting and semiconductor manufacturing.

Similarly, sulfur hexafluoride (SF_6) is not emitted from motor vehicles or motor vehicle engines in the United States, although use of SF_6 for tire inflation has been reported in other countries.[110] The main sources of SF_6 emissions in the United States are electrical transmission and distribution systems and primary magnesium smelting.

[110] 2006 IPCC Guidelines, Volume 3, Chapter 8 (IPCC, 2006b).

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Appendix C: Direct Effects of Ambient GHG Concentrations on Human Health

Greenhouse gases (GHG), at both current and projected atmospheric concentrations, are not expected to pose exposure risks on human respiratory systems (i.e., breathing/inhalation). The literature supporting this conclusion is described below.

Carbon dioxide (CO_2)

The direct effects of high CO_2 concentrations on human health were assessed in the EPA (2000a) report, *Carbon Dioxide as a Fire Suppressant: Examining the Risks*, and have also been reviewed by the IPCC (2005) *Special Report on Carbon Dioxide Capture and Storage*. At concentrations above about 2%, CO_2 has a strong effect on respiratory physiology, and at concentrations above 7 to 10%, it can cause unconsciousness and death (IPCC, 2005). Exposure studies have not revealed any adverse health effect of chronic exposure to concentrations below 1%. At concentrations greater than 17%, loss of controlled and purposeful activity, unconsciousness, convulsions, coma, and death occur within one minute of initial inhalation of CO_2 (OSHA, 1989; CCOHS, 1990; Dalgaard et al., 1972; CATAMA, 1953; Lambertsen, 1971). But CO_2 is a physiologically active gas and is a normal component of blood gases (U.S. EPA, 2000b). Acute CO_2 exposure of up to 1% and 1.5% by volume is tolerated quite comfortably (U.S. EPA, 2000b).

The ambient concentration of CO_2 in the atmosphere is presently about 0.039% by volume (or 386 ppm). Projected increases in CO_2 concentrations from anthropogenic emissions range from 41 to 158% above 2005 levels (of about 380 ppm) or 535 to 983 ppm by 2100 (Meehl et al., 2007) (see Section 5). Such increases would result in atmospheric CO_2 concentrations of 0.054 to 0.098% by volume in 2100, which is well below published thresholds for adverse health effects.

Methane (CH_4)

CH_4 is flammable or explosive at concentrations of 5 to 15% by volume (50,000 to 150,000 ppm) of air (NIOSH, 1994; NRC, 2000). At high enough concentrations, CH_4 is also a simple asphyxiant, capable of displacing enough oxygen to cause death by suffocation. Threshold limit values are not specified because the limiting factor is the available oxygen (NRC, 2000). Atmospheres with oxygen concentrations below 19.5% can have adverse physiological effects, and atmospheres with less than 16% oxygen can become life threatening (MSHA, 2007). Methane displaces oxygen to 18% in air when present at 14% (140,000 ppm).

When oxygen is readily available, CH_4 has little toxic effect (NRC, 2000). In assessing emergency exposure limits for CH_4, the NRC (2000) determined that an exposure limit that presents an explosion hazard cannot be recommended, even if it is well below a concentration that would produce toxicity. As such, it recommended an exposure limit of 5,000 ppm for methane (NRC, 2000). The National Institute for Occupational Health Safety (NIOSH, 1994) established a threshold limit value (TLV) for methane at 1,000 ppm.

The current atmospheric concentration of CH_4 is 1.78 ppm. The projected CH_4 concentration in 2100 ranges from 1.46 to 3.39 ppm by 2100, well below any recommended exposure limits (Meehl et al., 2007).

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Nitrous Oxide (N_2O)

N_2O is an asphyxiant at high concentrations. At lower concentrations, exposure causes central nervous system, cardiovascular, hepatic (pertaining to the liver), hematopoietic (pertaining to the formation of blood or blood cells), and reproductive effects in humans (Hathaway et al., 1991). At a concentration of 50 to 67% (500,000 to 670,000 ppm) N_2O is used to induce anesthesia in humans (Rom, 1992).

NIOSH has established a recommended exposure limit (REL) for N_2O of 25 ppm as a time-weighted average (TWA) for the duration of the exposure (NIOSH, 1992). The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned N_2O a TLV of 50 ppm as a TWA for a normal 8-hour workday and a 40-hour workweek (ACGIH, 1994).

The NIOSH limit is based on the risk of reproductive system effects and decreases in audiovisual performance (NIOSH, 1992). The ACGIH limit is based on the risk of reproductive, hematological (related to the study of the nature, function, and diseases of the blood and of blood-forming organs), and nervous system effects (ACGIH, 1994).

The current atmospheric concentration of N_2O is 0.32 ppm. The projected N_2O concentration in 2100 ranges from 0.36 to 0.46 ppm,, well below any exposure limits (Meehl et al., 2007).

Fluorinated Gases (HFCs, PFCs, SF_6)

Most fluorinated gases emitted from anthropogenic activities are released in very small quantities relative to established thresholds for adverse health outcomes from exposure. The health effects of exposure to one illustrative HFC gas, one illustrative HCFC gas, and sulfur hexafluoride (SF_6) are given in the context of their current atmospheric concentration. Chlorofluorocarbons are not included in this discussion given their phaseout under the Montreal Protocol.

The NRC (1996) recommended a 1-hour emergency exposure guidance level (EEGL) of 4,000 ppm for HFC-134a. This recommendation was based on a no-observed-adverse-effect level of 40,000 ppm in cardiac-sensitization tests of male beagles (NRC, 1996). It recommended 24-hour EEGL of 1,000 ppm based on the fetotoxicity effects (slight retardation of skeletal ossification) observed in rats exposed to HFC-134a. Finally, it recommended a 90-day Continuous Exposure Guidance Level (CEGL) of 900 ppm based on a two-year chronic toxicity study conducted in male rats exposed to HFC-134a at different concentrations for six hours/day, five days/week. The atmospheric concentration of HFC 134a in 2003 was in the range of 26 to 31 parts per trillion according to IPCC/TEAP (2005), many orders of magnitude below EEGLs.

For HCFC-123, the end points of pharmacological or adverse effects considered for establishing an EEGL are cardiac sensitization, anesthesia or CNS-related effects, malignant hyperthermia, and hepatotoxicity. According to the NRC (1996), the concentration required to produce cardiac sensitization in 50% of the animals for HCFC-123 was determined in dog studies to be 1.9% (19,000 ppm) for a 5-minute exposure. The NRC recommended that 1,900 ppm (19,000 ppm divided by an uncertainty factor of 10 for interspecies variability) should be considered the human no-observed-effect level for a 1-minute exposure to HCFC-123 on the basis of the dog cardiac-sensitization model. The concentration of HCFC-123 in 1996 was 0.03 parts per trillion according to IPCC/TEAP (2005), many orders of magnitude below the established effect level.

SF_6 is a relatively nontoxic gas but an asphyxiant at high concentrations. The NIOSH) recommended exposure limit is 1,000 ppm (NIOSH, 1997). The SF_6 concentration in 2003 was about 5 parts per trillion according to IPCC/TEAP (2005), many orders of magnitude below the exposure limit.

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Subject: endangerment finding

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