Comments of Sierra Club on EPA's Intended Ozone Nonattainment Areas for Michigan
Submitted via Regulations.gov, February 5, 2018
Docket ID No. EPA–HQ–OAR–2017–0548

Sierra Club submits these comments on behalf of its more than 3 million members and supporters. More than 23,700 Sierra Club members live in Michigan, including thousands who live in the Western Michigan area impacted by the ozone pollution discussed below. Sierra Club is the nation's oldest and largest grassroots organizations and has advocated for public health and the environment in Michigan for many decades.

I. The Weight of Evidence Requires EPA to Include Ottawa County in Michigan's Nonattainment Areas.

The weight of evidence requires EPA to designate Ottawa County nonattainment. EPA's failure to even consider Ottawa County for nonattainment runs counter to its own statement that the agency "*must* designate an area nonattainment if it has an air quality monitor that is violating the standard or *if it has sources of emissions that are contributing to a violation of the NAAQS in a nearby area*."[1]

Ottawa County emissions of ozone precursors rank seventh among all Michigan counties, and are higher than any of the Western Michigan counties EPA intends to designate as nonattainment. The prevailing winds blow from Ottawa County north to Muskegon County. HYSPLIT analyses also suggests that pollution from Ottawa County impacts the violating monitor in Muskegon County, as well as the violating monitor on its southern border with Allegan County, though EPA ignores these results. The attached air dispersion modeling conducted by Sonoma Technology confirms what one would suspect based on emissions levels and the prevailing wind patterns: the largest source of NOx in this area – the JH Campbell Generating Complex in Ottawa County – contributes very significantly to Western Michigan counties' ozone nonattainment.

EPA points to pollution transported from areas across Lake Michigan as the primary contributor to violations at the Western Michigan monitors. While it may be the case that pollution from other states also contributes to nonattainment, this does not allow EPA to ignore JH Campbell's large in-state contribution when designating nonattainment areas. To the contrary, EPA "must" designate Ottawa County nonattainment because it "has sources of emissions that are contributing to a violation of the NAAQS in a nearby area."[2]

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[1] EPA, Michigan Allegan County, Berrien County, Muskegon County and Detroit Nonattainment Areas Intended Area Designations for the 2015 Ozone National Ambient Air Quality Standards Technical Support Document, https://www.epa.gov/sites/production/files/2017-12/documents/mi_120d_tsd_final.pdf (hereinafter "Michigan TSD") at 1 (emphasis added); *see also* 42 U.S.C. § 7407(d)(1)(A)(i).

[2] There can be no dispute that Ottawa County is "nearby" Muskegon, as EPA has interpreted that term in the past. Ottawa is in a neighboring county and within the same CSA. *See, e.g.*, *Ohio v. Ruckelshaus*, 776 F.2d 1333, 1338 (6th Cir. 1985) (EPA is permitted to designate nonattainment areas by "boundaries which include important sources of pollution that contribute to the pollution levels of the area.").

A. Emissions of Ozone Precursors in Ottawa County

Because the "sources and levels of ozone-precursor pollutants are important factors in the initial are designations process,"[3] EPA provides the 2014 National Emissions Inventory data for NOx and VOCs by county on its ozone designations page.[4] With a total of 22,558 total tons of NOx and VOCs, Ottawa County ranks as second highest in the Grand Rapids – Muskegon – Holland Combined Statistical Area (CSA) for ozone precursors following neighboring Kent County, which includes the City of Grand Rapids.[5] It ranks much higher than the other Western Michigan counties that EPA intends to designate nonattainment. Allegan County's 2014 emissions of NOx and VOCs were less than half of Ottawa County's while Muskegon's were just over half of Ottawa's. Further, the collective 33,000 tons of NOx from Ottawa and Kent Counties that EPA references in its Michigan TSD is far larger than from most of the counties across the Lake in Wisconsin, Illinois and Indiana that Michigan blames for Muskegon's nonattainment.[6] This is in large part due to the contribution of the JH Campbell plant, which alone contributed 4,732 tons of NOx and 143 tons of VOCs in 2014. Michigan acknowledges "the majority of the NOx and VOC emissions in this MSA are . . . contained within these two counties."[7] This factor weighs heavily towards a nonattainment designation.

B. Air Transport Patterns

The region's air transport patterns also support including Ottawa County as a nonattainment area. The data Michigan provided to EPA include a wind rose for the Muskegon monitor at Figure 7. It is clear that the greatest likelihood of prevailing winds is from due south, where Ottawa County and the JH Campbell plant are located. Michigan states without support that "[l]ocal emissions do not appear to contribute to ozone concentrations in the area" and claims the HYSPLIT outputs show "no influence on the [Western Michigan] nonattaining monitors from [Ottawa and Kent] counties."[8] Upon inspection however, the HYSPLIT outputs from both Michigan and EPA do show back trajectories to Ottawa County from the Muskegon monitor.[9]

EPA fails to acknowledge these results, and instead focuses on Lake Michigan-specific ozone studies which "provide evidence that lake breeze meteorology plays a role in ozone production and transport to western Michigan counties."[10] EPA concludes that "the violating monitors are

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[3] Mem. from Janet McCabe to Regional Administrators, Area Designations for the 2015 Ozone National Ambient Air Quality Standards (Feb. 25, 2016), Attach. 3, at 5.
[4] EPA, Ozone Designations Guidance and Data, https://www.epa.gov/ozone-designations/ozone-designations-guidance-and-data
[5] The Grand Rapids – Muskegon – Holland Combined Statistical Area includes eight counties: Barry, Kent, Montcalm, Ottawa, Muskegon, Allegan, Ionia, and Mecosta.
[6] Michigan Department of Environmental Quality, Recommended Area Designations in Michigan for the 2015 Ozone National Ambient Air Quality Standard (Sept. 30, 2016), https://www.epa.gov/sites/production/files/2016-11/documents/mi-rec.pdf (hereinafter "Michigan Recommendations") at 10, Table 4.
[7] Michigan Recommendations at 42-43.
[8] *Id.* at 8, 43.
[9] *Id.* at 14, Figure 6; Michigan TSD at 30, Figure 12.
[10] Michigan TSD at 22.

mainly affected by emissions coming from the west and southwest over Lake Michigan."[11] Even if EPA is correct to conclude that there are impacts from cross-lake sources, this would not release EPA from its obligation to designate in-state areas nonattainment if those areas also are contributing to NAAQs violations.

In explaining its overall approach to the analysis, EPA states that "[a]t shoreline locations, the contribution of ozone-forming emissions from the sources in Michigan is negligible."[12] EPA relies solely on its 2009 Western Michigan Ozone study for this claim. EPA does not define "shoreline location," and does not make public the relied upon study to allow scrutiny of this claim. It is unclear whether the Muskegon monitor, which is nearly three miles inland, should be considered "shoreline" or whether it was specifically considered in the study. Thus, this is not sufficient evidence for EPA to discount the impact of Ottawa County very high levels of ozone precursors on Muskegon's nonattainment. Moreover, the robust and detailed modeling performed by Sonoma Technology, and discussed below, compellingly contradicts this finding. EPA's final nonattainment area analysis must consider this additional information.

C. Sonoma Technology Modeling

Ozone source apportionment modeling conducted by Sonoma Technology demonstrates significant impacts from the J.H. Campbell plant in Ottawa County at the nearby monitors in Muskegon County to the north and Allegan and Berrien Counties to the south, further supporting a nonattainment designation for Ottawa County.

1. Modeling Methods

In order to evaluate the ozone impacts of a number of large individual sources and groups of sources of ozone precursors, the Sierra Club retained Sonoma Technology, Inc. (Sonoma) to conduct air dispersion modeling using the Comprehensive Air Quality Model with extensions (CAMx). Sonoma used EPA's 2011 modeling platform, including acquiring 2011 emissions data from EPA, 2011 outputs from the Weather Research and Forecasting (WRF) meteorological model, and 2011 GEOS-Chem results to prepare initial conditions and boundary condition inputs. Emissions processing was conducted using the Sparse Matrix Kernel Emissions Modeling System (SMOKE). The source apportionment modeling was conducted for the 2011 ozone season (May to September) for a domain covering the continental United States at 12-km spatial resolution (Figure below), and results were compiled into a series of databases.

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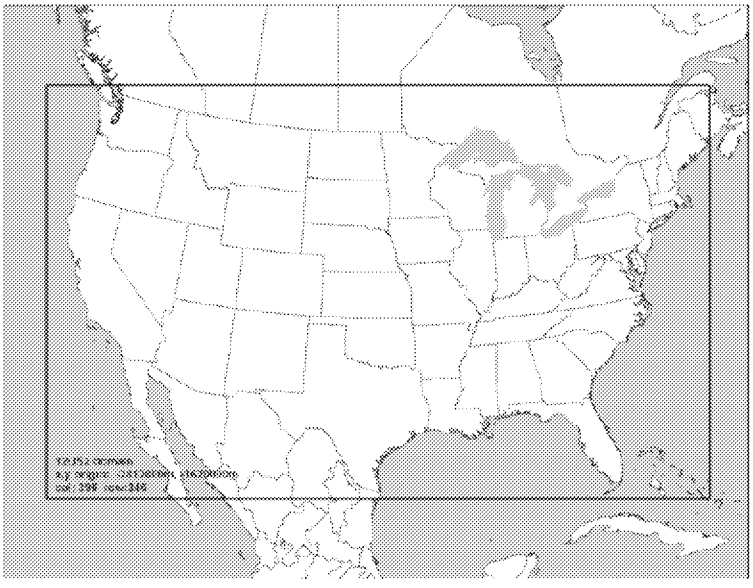
[11] *Id.*
[12] *Id.* at 5.

Figure 1: Modeling domain for the source apportionment model simulations



Source: U.S. Environmental Protection Agency (2015)

Detailed modeling methods are provided as Appendix A to these comments and complete modeling files are being delivered to the Agency on two hard drives concurrently with the electronic filing of these comments.[13]

2. Modeling Results

Sonoma's CAMx OSAT modeling demonstrates significant impacts from the J.H. Campbell facility at monitors in all three of the nearby nonattaining counties. Modeled 8-hour ozone impacts from the J.H. Campbell plant exceeded 1 percent of the 2015 primary ozone National Ambient Air Quality Standard (i.e., 0.7 parts per billion (ppb)) on forty-three distinct days during the 2011 ozone season at monitors in Muskegon, Allegan and/or Berrien Counties. Specifically, 8-hour ozone impacts from J.H. Campbell exceeded 0.7 ppb:

- On 21 days during the 2011 ozone season at the monitor in Muskegon County, with a maximum contribution of 4.66 ppb at that monitor on July 9, 2011.

- On 19 days during the 2011 ozone season at the monitor in Berrien County, with a maximum contribution of 4.33 ppb at that monitor on July 19, 2011.

- On 22 days during the 2011 ozone season at the monitor in Allegan County, with a maximum contribution of 3.79 ppb at that monitor on August 8, 2011.

[13] *See* E-mail from Josh Berman, Sierra Club to Denise Scott, EPA, dated Feb. 5, 2018, 9:44AM ET.

A spreadsheet identifying all of the monitor-days during the 2011 ozone season on which maximum 8-hour contributions from the J.H. Campbell plant exceeded 1 percent of the 2015 ozone NAAQS is attached as Exhibit 1.

3. Accounting for Changes in Emissions Profile from J.H. Campbell

Although J.H. Campbell has improved is control of NOx emissions at two of its three units since 2011, a comparison of daily emissions during the modeled 2011 ozone season and the (most recent) 2017 ozone seasons using data from EPA's Air Markets Program Database (https://ampd.epa.gov/ampd/) demonstrates that the facility will continue to contribute significantly to monitored ozone levels in Muskegon, Allegan, and Berrien Counties.

The CAMx modeling showed that J.H. Campbell can contribute ozone at levels exceeding 1 percent of the 2015 ozone NAAQS based on daily emissions as low as 16.25 tons in Allegan and Berrien Counties and 17.62 tons in Muskegon County, daily tonnage levels that the facility has continued to exceed at times during 2017 despite the improved controls. Specifically, the CAMx OSAT modeling showed a 1.29 ppb impact in Berrien County and a 0.82 ppb impact in Allegan County on June 13, 2011 when emissions from the J.H. Campbell plant were 16.25 tons, a level the facility exceeded four times during the 2017 ozone season. In addition, the CAMx OSAT modeling showed a 1.07 ppb impact in Muskegon County on May 29, 2011 when emissions from the J.H. Campbell plant were 17.62 tons, a level the facility met or exceeded two times during the 2017 ozone season.

Importantly, the J.H. Campbell facility accounts for only a fraction of the total emissions of ozone precursors in Ottawa County. In 2014, the most recent year for which EPA has made available data from its National Emissions Inventory, J.H. Campbell accounted for only 37.9 percent of the NOx emissions in Ottawa County.[14] Were the additional sources of NOx in Ottawa County to be tagged in the modeling in conjunction with J.H. Campbell, the modeled impacts in Muskegon, Allegan and Berrien Counties would increase, likely substantially. The modeling strongly supports designation of Ottawa County as an area that "contributes to ambient air quality in a nearby area that does not meet" the NAAQS. 42 U.S.C. § 7407(d)(1)(A)(i). Moreover, the Sonoma CAMx modeling is the only analysis in EPA's record that specifically considers an Ottawa County source's impact on the nonattaining monitors in Berrien, Allegan and Muskegon Counties and must be given substantial weight in EPA's analysis.

[14] 2014 NOx emissions from J.H. Campbell were 4,732 tons according to EPA's Air Market's Program Database. Ottawa County NOx emissions were 12,482 tons according to EPA's 2014 National Emission Inventory dataset of county level emissions without biogenics. Available at: https://www.epa.gov/ozone-designations/ozone-designations-guidance-and-data.

D. Additional Evidence Weighing in Favor of Designating Ottawa County Nonattainment.

Ottawa County's traffic, vehicle miles traveled (VMT), population density and population growth also weigh towards nonattainment. As shown in Figure 11 of the Michigan TSD, Ottawa County is home to several major transportation arteries and has a high level of VMT. It is one of the few area counties with population growth (Figure 10), and, along with Kent County "contain[s] the majority of the population within this MSA."[15]

In conclusion, with all five factors strongly pointing towards nonattainment – and particularly in light of the new evidence presented in the Sonoma Technology modeling – EPA should designate Ottawa County as a nonattainment area. EPA's out of hand rejection of in-state impacts on air quality in Muskegon and other Western Michigan nonattainment is unsupported and in error.

Respectfully submitted,

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Attachments:
Appendix A – Sonoma Technology Modeling Methods
Exhibit 1 – Sonoma Technology Modeling Results
(By overnight mail) Sonoma Technology Modeling Files

[15]Michigan Recommendations at 42.

Appendix A

Sonoma Technology Modeling Methods

Photochemical Grid Model and Source Apportionment

To quantify the ozone impacts due to precursor emissions from individual power plants and other source groups, Sonoma Technology Inc. (STI) performed CAMx OSAT source apportionment model simulations for the 2011 ozone season (May to September). The modeling domain and configurations used were based on those developed by EPA in recent ozone transport assessments using CAMx OSAT,[16] and included the use of the carbon-bond 6 revision 2 gas phase chemistry mechanism.

The Comprehensive Air Quality Model with Extensions (CAMx version 6.1)[17] is a publically available, peer-reviewed, state-of-the-science three-dimensional grid-based (Eulerian) photochemical air quality model designed to simulate the emission, transport, diffusion, chemical transformation, and removal of gaseous and particle pollutants in the atmosphere over spatial scales ranging from continental to urban. CAMx was designed to approach air quality as a whole by including capabilities for modeling multiple air quality issues, including tropospheric ozone, fine particles, visibility degradation, acid deposition, air toxics, and mercury. The ability of photochemical grid models such as CAMx to treat a large number of sources and their chemical interactions makes them well suited for assessing the impacts of natural and anthropogenic emissions sources on air quality. CAMx is widely used to support regulatory air quality assessments and air quality management policy decisions in the United States. In recent years, the EPA has used CAMx to support the NAAQS designation process[18] and evaluate interstate pollutant transport.[19]

CAMx also includes Ozone Source Apportionment Technology (OSAT), which can be used to estimate the contributions of individual sources, groups of sources, or source regions to ozone concentrations at a given receptor location.[20] Source apportionment modeling is useful for

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[16] U.S. Environmental Protection Agency (2014) Regulatory impact analysis of the proposed revisions to thenational ambient air quality standards for ground-level ozone. Prepared by the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, EPA-452/P-14-006, November. Available at http://www.epa.gov/ttnecas1/regdata/RIAs/20141125ria.pdf.

[17] ENVIRON International Corporation (2014) User's guide: Comprehensive Air Quality Model with extensions (CAMx) version 6.1. April. Available at http://www.camx.com/files/camxusersguide_v6-10.pdf.

[18] U.S. Environmental Protection Agency (2014) Regulatory impact analysis of the proposed revisions to thenational ambient air quality standards for ground-level ozone. Prepared by the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, EPA-452/P-14-006, November. Available at http://www.epa.gov/ttnecas1/regdata/RIAs/20141125ria.pdf.

[19] U.S. Environmental Protection Agency (2005) Technical support document for the final clean air interstate rule: air quality modeling. Technical support document prepared by the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, March.

[20] Yarwood G.Y., Stoeckenius T.E., Wilson G., Morris R.E., and Yocke M.A. (1996) Development of a methodology to assess geographic and temporal ozone control strategies for the South Coast Air Basin. Report prepared by ENVIRON International Corporation, Novato, CA, December.

understanding model performance, designing emission control strategies, and performing culpability assessments to identify emission sources that contribute significantly to pollution.[21] The key precursor species for ozone production are volatile organic compounds (VOC) and oxides of nitrogen (NOx). OSAT uses reactive tracers to track the fate of these precursor emissions and the ozone formation resulting from them within a CAMx simulation. The ozone and precursors are tracked and apportioned by OSAT without perturbing the host model chemistry; therefore the OSAT results are fully consistent with the host model results for total concentrations. OSAT can efficiently estimate source contributions from multiple emission sources within a single model simulation. Importantly, while source apportionment modeling can be used to estimate source contributions to ozone concentrations for a given set of emission inputs, sensitivity modeling approaches such as brute-force modeling4 or the direct decoupled method (DDM)[22] are needed to quantify the effect of a given emission control scenario (e.g., 90% NOx reduction at power plants) on ozone concentrations.

In this work, the Anthropogenic Precursor Culpability Assessment (APCA) extension of OSAT was used. APCA is based on OSAT, but calculates source contributions a little differently to recognize the fact that biogenic (or non-anthropogenic) emissions are not controllable. For example, when ozone is formed by reactions between biogenic VOC and anthropogenic NOx, APCA apportions the ozone contribution entirely to the anthropogenic source. APCA only apportions ozone contributions to biogenic sources when both the VOC and NOx precursors are from biogenic sources. APCA is useful for determining which source controls might have the greatest effect at reducing ozone concentrations.

2011 EPA Modeling Platform

The CAMx OSAT simulations were based on EPA's 2011 modeling platform. A modeling platform consists of a structured system of connected data and models that provide a consistent and transparent basis for assessing the air quality impact of anticipated changes in emissions. EPA develops and evaluates a new modeling platform each time the National Emissions Inventory (NEI) is updated (every three years). EPA has used the 2011 modeling platform to support development of revised ozone NAAQS (U.S. Environmental Protection Agency, 2014a)and to quantify future-year interstate contributions to ozone concentrations to help states address their obligations under the "Good Neighbor" provision of the Clean Air Act for the 2008 ozone NAAQS.[23]

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[21] ENVIRON International Corporation (2010) User's guide: Comprehensive Air Quality Model with extensions (CAMx) Version 5.30. December. Available at http://www.camx.com/files/CAMxUsersGuide_v5.30.pdf.

[22] DDM provides sensitivity coefficients that relate emissions changes to model outcomes. These sensitivity coefficients can be used to evaluate how pollutant concentrations would respond to a range of changes in emissions from a source or group of sources.

[23] U.S. Environmental Protection Agency (2015) Air quality modeling technical support document for the 2008 ozone NAAQS transport assessment. Technical support document prepared by the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January. Available at http://www.epa.gov/airtransport/O3TransportAQModelingTSD.pdf.

The CAMx OSAT simulations relied on EPA's 2011v6.1 modeling platform, which was based on the 2011 NEI, Version 1 (2011NEIv1). The NEI is compiled by EPA on a triennial basis, primarily from data submitted by state, local, and tribal air agencies, and the 2011 NEI includes emissions from five source sectors: point sources, nonpoint (or area) sources, onroad mobile sources, nonroad mobile sources, and fire events.

For air quality modeling purposes, the 2011 NEI data was augmented by EPA to include biogenic emissions and data from Canadian and Mexican emissions inventories. In addition, the annualized point source data for electrical generating units (EGUs) in the 2011 NEI were replaced with hourly 2011 continuous emissions monitoring (CEMS) data for SO2and NOx. Annual emissions for pollutants were converted to an hourly basis using CEMS input data.[24]

Source Apportionment Tagging

After obtaining the 2011 modeling platform from EPA, STI worked with the Sierra Club and state air agencies in Connecticut and Delaware to identify sources and source groups to be tagged for ozone attribution analysis. Tagged sources fell into one of the following general categories:

- Individual coal-fired power plants (in some cases, specific coal-fired EGUs within a single facility were tagged separately);
- Groups of coal-fired power plants within a state or sub-state region (e.g., downstate New York);
- Groups of other (non-EGU) point sources within a state or sub-state region; and
- Non-point source sectors (e.g., biogenic sources and onroad mobile sources) within a state, sub-state, or multi-state region (e.g., states in the Southeast States Air Resources Managers [SESARM] consortium).

A total of 52 EGUs were individually tagged, while several dozen additional EGUs were tagged within 61 state and sub-state regions. Point sources that were tagged individually were not included in any of the state-or sub-state-level tag groups. In addition, each non-point source sector was tagged within 15 state, sub-state, or multi-state regions. Because of the large number of tags modeled, the processing was divided in to three separate CAMx OSAT simulations. J.H. Campbell is represented by source tag I41 in Simulation 1.

[24] U.S. Environmental Protection Agency (2011) Preparation of emissions inventories for the version 6.1, 2011 emissions modeling platform. Technical support document prepared by the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, November. Available at http://www.epa.gov/ttn/chief/emch/2011v6/2011v6.1_2018_2025_base_EmisMod_TSD_nov2014_v6.pdf

Meteorology

Meteorological inputs for the CAMx-OSAT simulations were developed by EPA for the 2011 modeling platform using version 3.4 of the Weather Research and Forecasting (WRF) numerical weather prediction model.[25] The meteorological outputs from WRF include hourly varying winds, temperature, moisture, vertical diffusion rates, clouds, and rainfall rates. Additional details about this WRF simulation and its performance evaluation can be found in U.S. Environmental Protection Agency's Meteorological model performance for annual 2011 WRF v3.4 simulation.[26]

Initial and Boundary Conditions

Initial and lateral boundary conditions were developed from three-dimensional global atmospheric chemistry simulations with GEOS-Chem standard version 8-03-02 with 8-02-01 chemistry (http://geos-chem.org) provided with the EPA 2011 platform. The GEOS-Chem predictions were translated into CAMx-ready initial and boundary conditions using code and procedures developed by Henderson et al.,[27] and modifications provided to STI by the Lake Michigan Air Directors Consortium (LADCO) to accommodate carbon-bond 6 chemistry species. OSAT tracks ozone transported through the boundaries, as well as ozone formation resulting from precursor emissions transported through the boundaries.

Post-Processing

The raw result from a CAMx OSAT simulation is hourly ozone contributions from each source tag at each grid cell in the modeling domain for the 2011 ozone season. These hourly contributions were extracted and post-processed for several hundred receptor sites, listed in the electronic attachment provided with this memorandum. The receptors correspond to quality monitoring sites across the eastern half of the United States, and include sites of specific interest to northeastern states, as well as monitors with current ozone design values exceeding 65 ppb. At each receptor and for each day, the 8-hr average ozone contribution was calculated for all source tags using the averaging period corresponding to the period of highest modeled 8-hr average concentration at the receptor location. Although this analysis approach may not capture the largest ozone contributions modeled during the day, it does reflect contributions during time periods when ozone concentrations are highest. This analysis approach also ensures that ozone contributions from all source tags6 sum to total modeled 8-hr ozone concentration each day. The post-processed OSAT results were compiled into Microsoft Access databases.

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[25] Skamarock W.C., Klemp J.B., Dudhia J., Gill D.O., Barker D.M., Duda M.G., Huang X.-Y., Wang W., and Powers J.G. (2008) A description of the Advanced Research WRF Version 3. NCAR Technical Note NCAR/TH-475+STR, June.

[26] U.S. Environmental Protection Agency, Meteorological model performance for annual 2011 WRF v3.4 simulation. Technical support document prepared by the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, November. Available at http://www.epa.gov/ttn/scram/reports/MET_TSD_2011_final_11-26-14.pdf.

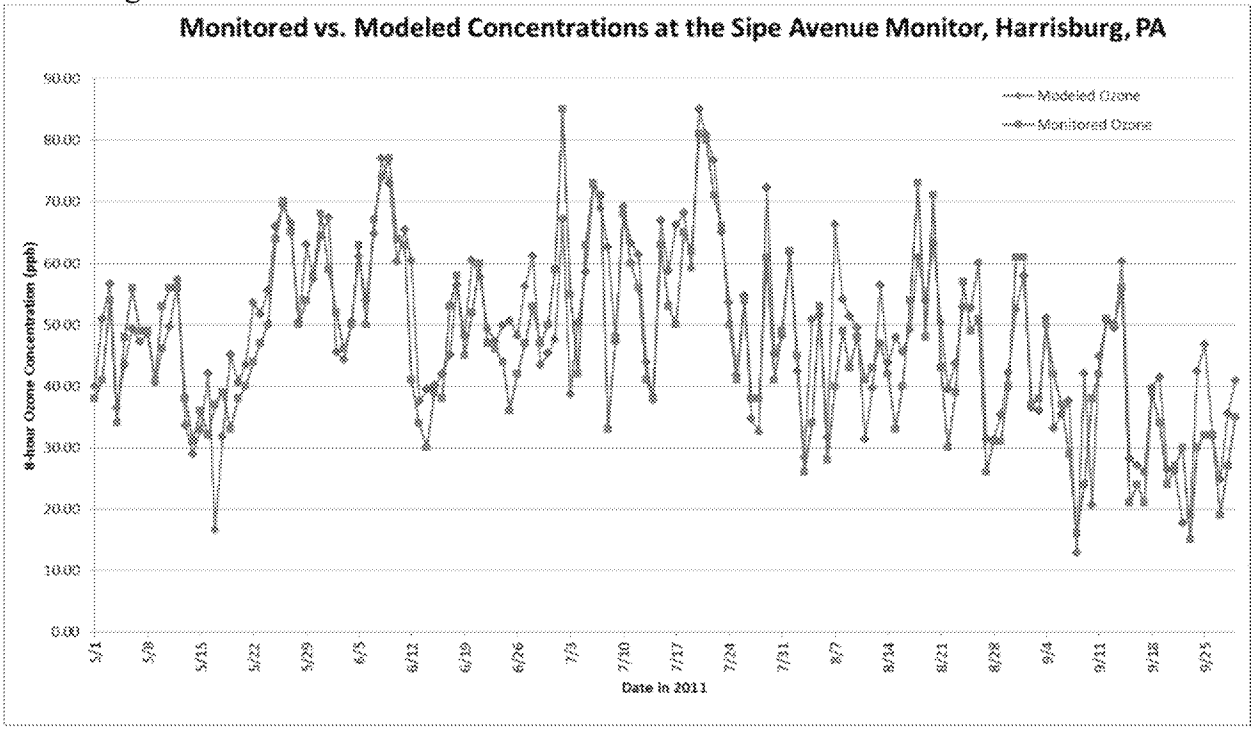
[27] Henderson B.H., Akhtar F., Pye H.O.T., Napelenok S.L., and Hutzell W.T. (2014) A database and tool for boundary conditions for regional air quality modeling: description and evaluations. *Geosci. Model Dev.*, 7, 339-360.

Model Performance Evaluation

EPA evaluated its 2011 modeling platform using statistical assessments of model predictions versus observations paired in time and space. Overall, the model performance statistics for ozone were within or close to the ranges found in other peer-reviewed applications[28] and were found to be suitable for use in a regulatory context.[29]

As an example of how the 2011 modeling platform was performing in southeast Pennsylvania, Figure 2 shows a time-series comparison between modeled and monitored peak 8-hr ozone concentrations at the Sipe Avenue monitor in Harrisburg. The modeled ozone concentrations will not typically show perfect agreement with observed concentrations. For the Sipe Avenue monitor,the model performs well and captures observed ozone trends throughout the 2011 ozone season quite well, but tends to under-predict ozone concentrations when monitored concentrations are highest.

Figure 2. Monitored vs. modeled 8-hr ozone concentrations at the Sipe Avenue monitor near Harrisburg.



[28] Simon H., Baker K.R., and Phillips S. (2012) Compilation and interpretation of photochemical model performance statistics published between 2006 and 2012. *Atmos. Environ.*, 61, 124-139, doi: 10.1016/j.atmosenv.2012.07.012. Available at http://www.sciencedirect.com/science/article/pii/S135223101200684X.

[29] U.S. Environmental Protection Agency (2014), Regulatory impact analysis of the proposed revisions to thenational ambient air quality standards for ground-level ozone. Prepared by the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, EPA-452/P-14-006, November. Available at http://www.epa.gov/ttnecas1/regdata/RIAs/20141125ria.pdf .