UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

The Honorable Benjamin H. Grumbles, Secretary
Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, Maryland 21230

Dear Secretary Grumbles:

By letters and enclosures dated May 26, 2017 and October 20, 2017, the Maryland Department of Environmental (MDE) submitted to the U. S. Environmental Protection Agency (EPA) requesting concurrence with MDE's proposal to exclude data associated with exceptional event episodes for 8-hour ozone data influenced by the Fort McMurray wildfire on May 25 and 26, 2016, and northwestern Canada wildfires on July 21 and 22, 2016. MDE determined that the Fort McMurray and northwestern Canada wildfires caused elevated ozone concentrations at 16 and 12 monitors, respectively, throughout Maryland.

In 2016, EPA revised the Exceptional Events Rule (EER) found in §50.14 and §51.930 of 40 CFR Parts 50 and 51 of the Clean Air Act. See "Treatment of Data Influenced by Exceptional Events," 81 FR 68216 (October 3, 2016). After careful consideration of the information provided, EPA concurs on 17 monitor days, defers action on 16 monitor days, and non-concurs on 10 monitor days, based on the weight of evidence that the agency has made in the demonstrations referred to in 40 CFR 50.14(a)(2) and (b)(1). EPA's decisions are summarized in the attached table. In addition, MDE has met the schedule and procedural requirements in section 50.14(c) with respect to the same information. The basis for our concurrence is set forth in the enclosed technical support documents. My staff has entered, or shortly will enter, "concurrence flags" for these data into EPA's Air Quality System data repository.

The 2016 rule revisions 40 CFR 50.14(a)(1)(i) limit the applicability of the EER to National Ambient Air Quality Standards (NAAQS) exceedances or violations which have relevance to specific regulatory determinations by EPA. The 8-hour ozone concentrations measured at the monitors marked with "Defer" in the attached table, do not currently have regulatory significance and EPA will defer action at this time. EPA will retain MDE's demonstrations for future consideration should any of the data on which EPA is deferring action at this time become significant for a future regulatory action.

The 8-hour ozone concentrations measured at the monitors marked with "Non-concur" in the attached table, do not have current or projected future regulatory significance. Exclusion of the requested 8-hour ozone data from these monitors does not result in one or more of the following:

- 2016 or 2017 design value attainment of NAAQS
- Change in 2016 4th highest 8-hour ozone concentration

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Therefore, EPA non-concurs with MDE's request for exclusion of data from these monitors.

EPA's concurrence is a preliminary step in the regulatory process for actions that may rely on the dataset containing the event-influenced data and does not constitute final agency action. If EPA takes a regulatory action that is affected by exclusion of the ozone data for the May 25 and 26, 2016 and/or July 21 and 22, 2016 events, EPA intends to publish notice of its proposed action in the Federal Register. EPA's concurrence letter and accompanying technical support documents will be included in the record as part of the technical basis for that proposal. When EPA issues that regulatory action, it will be a final agency action subject to judicial review.

If you have any questions or wish to discuss this matter further, please have your staff contact Ms. Kyle Zieba, EPA's Maryland Liaison, at (215) 814-5420. For questions regarding this approval action, your staff may contact Ms. Alice H. Chow, Associate Director of the Office of Air Monitoring & Analysis, (215) 814-2144.

Sincerely,

Cosmo Servidio
Regional Administrator

Attachment
Enclosures

Attachment:

EPA Decision	Site Name	AQS ID	8-hour Max. (ppb)	Exceedance Date
Concur	Edgewood	240251001	79	May 25, 2016
Concur	Fair Hill	240150003	83	May 25, 2016
Concur	Furley	245100054	75	May 25, 2016
Concur	Glen Burnie	240031003	75	May 25, 2016
Concur	Millington	240290002	85	May 25, 2016
Concur	PG Eq Cntr	240338003	74	May 25, 2016
Concur	Edgewood	240251001	80	May 26, 2016
Concur	Fair Hill	240150003	76	May 26, 2016
Concur	Furley	245100054	78	May 26, 2016
Concur	Glen Burnie	240031003	76	May 26, 2016
Concur	Millington	240290002	76	May 26, 2016
Concur	Edgewood	240251001	72	July 21, 2016
Concur	Furley	245100054	74	July 21, 2016
Concur	Glen Burnie	240031003	76	July 21, 2016
Concur	Edgewood	240251001	82	July 22, 2016
Concur	Fair Hill	240150003	87	July 22, 2016
Concur	PG Eq Cntr	240338003	76	July 22, 2016
Defer	Aldino	240259001	77	May 25, 2016
Defer	Essex	240051001	78	May 25, 2016
Defer	HU-Beltsville	240330030	74	May 25, 2016
Defer	South Carroll	240130001	72	May 25, 2016
Defer	Aldino	240259001	79	May 26, 2016
Defer	Calvert	240090011	75	May 26, 2016
Defer	Essex	240053001	81	May 26, 2016
Defer	HU-Beltsville	240330030	74	May 26, 2016
Defer	South Carroll	240130001	75	May 26, 2016
Defer	Aldino	240259001	77	July 21, 2016
Defer	Essex	240053001	75	July 21, 2016
Defer	Frederick	240210037	75	July 21, 2016
Defer	Hagerstown	240430009	74	July 21, 2016
Defer	HU-Beltsville	240330030	78	July 21, 2016
Defer	Aldino	240259001	72	July 22, 2016
Defer	Essex	240053001	72	July 22, 2016
Non-concur	Beltsville CASTNET	240339991	76	May 25, 2016
Non-concur	Horn Point	240190004	71	May 25, 2016
Non-concur	Padonia	240051007	74	May 25, 2016
Non-concur	Beltsville CASTNET	240339991	72	May 26, 2016
Non-concur	Blackwater NWR CASTNET	240199991	76	May 26, 2016
Non-concur	Horn Point	240190004	77	May 26, 2016
Non-concur	Padonia	240051007	84	May 26, 2016
Non-concur	S. Maryland	240170010	73	May 26, 2016
Non-concur	Beltsville CASTNET	240339991	78	July 21, 2016
Non-concur	Padonia	240051007	73	July 21, 2016

Technical Support Document (TSD) for EPA Concurrence on O_3 Exceedances Measured at Six Maryland Monitors on May 25 and 26, 2016 as Exceptional Events

TSD Prepared December 2017

Verena Joerger

Kia Long

Office of Air Monitoring & Analysis, 3AP40

U.S. Environmental Protection Agency, Region III

1650 Arch Street

Philadelphia, Pennsylvania 19103

Alice H. Chow

Reviewed by Alice H. Chow, Associate Director

Office of Air Monitoring & Analysis (3AP40)

12/13/2017

Date Signed

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Enclosure: Technical Support Document for EPA Concurrence on O_3 Exceedances Measured at Six Maryland Monitors on May 25 and 26, 2016 as Exceptional Events

In spring of 2016, the Maryland Department of the Environment (MDE) identified that wildfires near Fort McMurray, Alberta, Canada may have caused ozone (O_3) exceedances at an O_3 monitoring site operated by MDE on May 25 and 26, 2016. The Fort McMurray wildfire began on May 1st, 2016 and quickly expanded out of control. During a period of intense fire growth, a concentrated smoke plume was lofted and transported to the central United States. The smoke contained volatile organic compounds and nitrogen oxide emissions that underwent photochemical reactions, forming O_3 that was subsequently transported to the northeastern United States.

Under the Exceptional Events Rule, air agencies can request the exclusion of event-influenced data, and EPA can agree to exclude these data, from the data set used for certain regulatory decisions. The remainder of this document summarizes the Exceptional Events Rule requirements, the event and EPA's review process.

Exceptional Events Rule Requirements

EPA promulgated the Exceptional Events Rule in 2007, pursuant to the 2005 amendment of Clean Air Act (CAA) section 319. In 2016, EPA finalized revisions to the Exceptional Events Rule. The 2007 Exceptional Events Rule and 2016 Exceptional Events Rule revisions added sections 40 CFR §50.1 (j)-(r), 50.14, and 51.930 to title 40 of the Code of Federal regulations (CFR). These sections contain definitions, criteria for EPA approval, procedural requirements, and requirements for air agency demonstrations. EPA reviews the information and analyses in the air agency's demonstration package using a weight of evidence approach and decides to concur, defer, or not concur. The demonstration must satisfy all of the Exceptional Events Rule criteria for EPA to concur with excluding the air quality data from regulatory decisions.

Under 40 CFR §50.14 (c) (3) (iv), the air agency demonstration to justify data exclusion must include:

A. "A narrative conceptual model that describes the event(s) causing the exceedance or violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s);"

B. "A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation;"

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C. "Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times" to support (B) above;

D. "A demonstration that the event was both not reasonably controllable and not reasonably preventable;" and

E. "A demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event."[1]

In addition, the air agency must meet several procedural requirements, including:

1. Submission of an Initial Notification of Potential Exceptional Event and flagging of the affected data in EPA's Air Quality System (AQS) as described in 40 CFR §50.14(c)(2)(i),

2. Completion and documentation of the public comment process described in 40 CFR §50.14(c)(3)(v), and

3. Implementation of any applicable mitigation requirements as described in 40 CFR §51.930.

For data influenced by exceptional events to be used in initial area designations, air agencies must also meet the initial notification and demonstration submission deadlines specified in Table 2 to 40 CFR §50.14. We include below a summary of the Exceptional Events Rule criteria, including those identified in 40 CFR §50.14(c)(3)(iv).

Regulatory Significance

The 2016 Exceptional Events Rule includes regulatory language that applies the provisions of CAA section 319 to a specific set of regulatory actions. As identified in 40 CFR §50.14 (a)(1)(i), these regulatory actions include initial area designations and redesignations; area classifications; attainment determinations (including clean data determinations); attainment date extensions; findings of state Implementation Plan (SIP) inadequacy leading to a SIP call; and other actions on a case-by-case basis as determined by the Administrator. Air agencies and EPA should discuss the regulatory significance of an exceptional events demonstration during the Initial Notification of Potential Exceptional Event prior to the air agency submitting a demonstration for EPA's review.

[1] A natural event is further described in 40 CFR §50.1 (k) as "an event and its resulting emissions, which may recur at the same location, in which human activity plays little or no direct causal role. For purposes of the definition of a natural event, anthropogenic sources that are reasonably controlled shall be considered to not play a direct role in causing emissions."

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Narrative Conceptual Model

The 2016 Exceptional Events Rule directs air agencies to submit, as part of the demonstration, a narrative conceptual model of the event that describes and summarizes the event in question and provides context for analyzing the required statutory and regulatory technical criteria. Air agencies may support the narrative conceptual model with summary tables or maps. For wildfire O_3 events, EPA recommends that the narrative conceptual model also discuss the interaction of emissions, meteorology, and chemistry of event and non-event O_3 formation in the area, and, under 40 CFR §50.14 (a)(1)(i), must describe the regulatory significance of the proposed data exclusion.

Clear Causal Relationship and Supporting Analyses

EPA considers a variety of evidence when evaluating whether there is a clear causal relationship between a specific event and the monitored exceedance or violation. For wildfire O_3 events, air agencies should compare the O_3 data requested for exclusion with seasonal and annual historical concentrations at the air quality monitor to establish a clear causal relationship between the event and monitored data. In addition to providing this information on the historical context for the event-influenced data, air agencies should further support the clear causal relationship criterion by demonstrating that the wildfire's emissions were transported to the monitor, that the emissions from the wildfire influenced the monitored concentrations, and, in some cases, air agencies may need to provide evidence of the contribution of the wildfire's emissions to the monitored O_3 exceedance or violation.

For wildfire O_3 events, EPA has published a guidance document that provides three different tiers of analyses that apply to the "clear causal relationship" criterion within an air agency's exceptional events demonstration. If a wildfire/O_3 event satisfies the key factors for either Tier 1 or Tier 2 clear causal analyses, then those analyses are the only analyses required to support the clear causal relationship criterion within an air agency's demonstration for that particular event. Other wildfire/O_3 events will be considered based on Tier 3 analyses.

- Tier 1: Wildfires that clearly influence monitored O_3 exceedances or violations when they occur in an area that typically experiences lower O_3 concentrations.
    - *Key Factor:* seasonality and/or distinctive level of the monitored O_3 concentration. The event-related exceedance occurs during a time of year that typically has no exceedances, or is clearly distinguishable (*e.g.*, 5-10 ppb higher) from non-event exceedances.
    - In these situations, O_3 impacts should be accompanied by clear evidence that the wildfire's emissions were transported to the location of the monitor.

- Tier 2: The wildfire event's O_3 influences are higher than non-event related concentrations, and fire emissions compared to the fire's distance from the affected monitor indicate a clear causal relationship.

- *Key Factor 1:* fire emissions and distance of fire(s) to affected monitoring site location(s). Calculated fire emissions of NO_x and reactive-VOC in tons per day (Q) divided by the distance from the fire to the monitoring site (D) should be equal to or greater than 100 tons per day/kilometers ($Q/D \geq 100$ tpd/km). The guidance document provides additional information on the calculation of Q/D.
- *Key Factor 2:* comparison of the event-related O_3 concentration with non-event related high O_3 concentrations. The exceedance due to the exceptional event:
  - Is in the 99th or higher percentile of the 5-year distribution of O_3 monitoring data, OR
  - Is one of the four highest O_3 concentrations within 1 year (among those concentrations that have not already been excluded under the Exceptional Events Rule, if any).
- In addition to the analysis required for Tier 1, the air agency should supply additional information to support the weight of evidence that emissions from the wildfire affected the monitored O_3 concentration.

- Tier 3: The wildfire does not fall into the specific scenarios (*i.e.*, does not meet the key factors) that qualify for Tier 1 or Tier 2, but the clear causal relationship criterion can still be satisfied by a weight of evidence showing.
  - In addition to the analyses required for Tier 1 and Tier 2, an air agency may further support the clear causal relationship with additional evidence that the fire emissions caused the O_3 exceedance.

Not Reasonably Controllable or Preventable

The Exceptional Events Rule requires that air agencies establish that the event be both not reasonably controllable and not reasonably preventable at the time the event occurred. This requirement applies to both natural events and events caused by human activities; however, it is presumed that wildfires on wildland will satisfy both factors of the "not reasonably controllable or preventable" element unless evidence in the record clearly demonstrates otherwise.[2]

[2] A wildfire is defined in 40 CFR §50.1(n) as "any fire started by an unplanned ignition caused by lightning; volcanoes; other acts of nature; unauthorized activity; or accidental, human-caused actions, or a prescribed fire that has developed into a wildfire. A wildfire that predominantly occurs on wildland is a natural event." Wildland is defined in 40 CFR §50.1(o) as "an area in which human activity and development are essentially non-existent, except for roads, railroads, power lines, and similar transportation facilities. Structures, if any, are widely scattered."

Natural Event or Event Caused by Human Activity that is Unlikely to Recur

According to the CAA and the Exceptional Events Rule, an exceptional event must be "an event caused by human activity that is unlikely to recur at a particular location *or* a natural event" (emphasis added). The 2016 Exceptional Events Rule includes in the definition of wildfire that "[a] wildfire that predominantly occurs on wildland is a natural event." Once an agency provides evidence that a wildfire on wildland occurred and demonstrates that there is a clear causal relationship between the measurement under consideration and the event, EPA expects minimal documentation to satisfy the "human activity that is unlikely to recur at a particular location or a natural event" element. EPA will address wildfires on other lands on a case-by-case basis.

EPA Review of Exceptional Events Demonstration

On October 20, 2016, the MDE submitted an Initial Notification of Potential Exceptional Event for 2 exceedances of the 2008 8-hour O_3 standard that occurred at Fair Hill (240150003) in Cecil County on May 25 and 26, 2016. On May 31st, 2016, MDE submitted an exceptional events demonstration for 16 exceedances of the 2008 8-hour O_3 standard at the following monitors:

- Aldino (AQS: 240259001) – May 25 and 26, 2016
- Beltsville CASTNET (AQS: 240339991) – May 25, 2016
- Blackwater NWR CASTNET (AQS: 240199991) – May 26, 2016
- Edgewood (AQS: 240251001) – May 25 and 26, 2016
- Essex (AQS: 240053001) – May 25 and 26, 2016
- Fair Hill (AQS: 240150003) – May 25 and 26, 2016
- Furley (AQS: 245100054) – May 26, 2016
- Glen Burnie (AQS: 240031003) – May 26, 2016
- Horn Point (AQS: 240190004) – May 26, 2016
- Millington (AQS: 240290002) – May 25 and 26, 2016
- Padonia (AQS: 240051007) – May 26, 2016

and 12 exceedances of the 2015 8-hour O_3 standard that occurred at the following monitors:

- Beltsville CASTNET (AQS: 240339991) – May 26, 2016
- Calvert (AQS: 240090011) – May 26, 2016
- Furley (AQS: 245100054) – May 25, 2016
- Glen Burnie (AQS: 240031003) – May 25, 2016
- Horn Point (AQS: 240190004) – May 25, 2016
- HU-Beltsville (AQS: 240330030) – May 25 and 26, 2016
- Padonia (AQS: 240051007) – May 25, 2016
- PG Eq Cntr (AQS: 240338003) – May 25, 2016

- South Carroll (AQS: 240130001) – May 25 and 26, 2016
- S. Maryland (AQS: 240170010) – May 26, 2016

Regulatory Significance

EPA reviewed MDE's Initial Notification of Potential Exceptional Event and determined that the exclusion of 8-hour O_3 measurements from the Fair Hill monitor on May 25 and 26, 2016 had regulatory significance for the 2008 8-hour O_3 standard, and worked with MDE to identify any other relevant exceedances and monitoring sites affected. In consultation with EPA, MDE identified additional monitors where exclusion of the exceptional event data had regulatory significance for the 2008 and 2015 O_3 standards, and these monitors were added to MDE's request. Ultimately, monitor days without immediate or possible regulatory significance were also requested by MDE in their final demonstration and were either deferred or non-concurred by EPA. Table 1 summarizes the exceedances and EPA's decisions.

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Table 1. EPA 8-hour O_3 Exceedance Summary

Exceedance Date	Site Name	AQS ID	8-hour Max. (ppb)	NAAQS Standard Affected	EPA Decision
May 25, 2016	Edgewood	240251001	79	2008	Concur
May 25, 2016	Fair Hill	240150003	83	2008	Concur
May 25, 2016	Furley	245100054	75	2015	Concur
May 25, 2016	Glen Burnie	240031003	75	2015	Concur
May 25, 2016	Millington	240290002	85	2008	Concur
May 25, 2016	PG Eq Cntr	240338003	74	2015	Concur
May 26, 2016	Edgewood	240251001	80	2008	Concur
May 26, 2016	Fair Hill	240150003	76	2008	Concur
May 26, 2016	Furley	245100054	78	2008	Concur
May 26, 2016	Glen Burnie	240031003	76	2008	Concur
May 26, 2016	Millington	240290002	76	2008	Concur
May 25, 2016	Aldino	240259001	77	TBD	Defer
May 25, 2016	Essex	240051001	78	TBD	Defer
May 25, 2016	HU-Beltsville	240330030	74	TBD	Defer
May 25, 2016	South Carroll	240130001	72	TBD	Defer
May 26, 2016	Aldino	240259001	79	TBD	Defer
May 26, 2016	Calvert	240090011	75	TBD	Defer
May 26, 2016	Essex	240053001	81	TBD	Defer
May 26, 2016	HU-Beltsville	240330030	74	TBD	Defer
May 26, 2016	South Carroll	240130001	75	TBD	Defer
May 25, 2016	Beltsville CASTNET	240339991	76	NA	Non-concur
May 25, 2016	Horn Point	240190004	71	NA	Non-concur
May 25, 2016	Padonia	240051007	74	NA	Non-concur
May 26, 2016	Beltsville CASTNET	240339991	72	NA	Non-concur
May 26, 2016	Blackwater NWR CASTNET	240199991	76	NA	Non-concur
May 26, 2016	Horn Point	240190004	77	NA	Non-concur
May 26, 2016	Padonia	240051007	84	NA	Non-concur
May 26, 2016	S. Maryland	240170010	73	NA	Non-concur

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Narrative Conceptual Model

MDE's demonstration provided a narrative conceptual model to describe how emissions from Fort McMurray, Alberta, Canada caused O_3 exceedances at the affected monitoring stations. The conceptual model included a general overview of typical O_3 formation in Maryland, a literature review of studies that examine the role of wildfires on downwind O_3, and the meteorology, O_3 and NO_x concentrations and satellite smoke observations for the days leading up to, during, and after the exceptional event dates.

In the demonstration, MDE explained that under typical airmass composition, O_3 formation in Maryland occurs "due to the photolization of volatile organic compounds (VOCs) and a combination of regional and locally sourced anthropogenic NO_x in the presence of sunlight." While Maryland has urban pollution plumes, MDE's demonstration explained that "these emissions alone regularly fall short of producing ozone capable of [maximum daily 8-hour average ozone] concentrations above 70 ppb".

The Fort McMurray wildfire was fast growing and by May 19, 2016 was estimated to have burned over 500,000 hectares. Low pressure in the western United States helped to build high pressure over the Midwest, transporting the smoke from the fire (containing O_3 precursors) southward into the northern plains and Midwestern United States and down to the surface beginning May 20-21, where the airmass photochemically aged. By May 24, the modified airmass arrived in Maryland and elevated O_3 was observed across the state. The MDE demonstration noted that wildfires can affect air quality in faraway places, citing that "Canadian wildfires have increased ozone concentrations in Houston, TX and as far away as Europe".

Table 2. Documentation of Narrative Conceptual Model

Exceedance Date	Demonstration Citation	Quality of Evidence	Criterion Met?
May 25, 2016	Section 2: p 16-46	Sufficient	Yes
May 26, 2016	Section 2: p 16-46	Sufficient	Yes

Clear Causal Relationship and Supporting Analyses

MDE's demonstration included multiple analyses to demonstrate a clear causal relationship between the Fort McMurray fire and the monitored exceedances. A selection of these analyses is listed and further discussed below.

Trajectory Analysis

MDE included 120-hour forward and backward trajectories between May 20th and 25th, 2016 using the National Oceanic and Atmospheric Administration's Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model. The forward trajectories (originating near the Fort

McMurray wildfire) generally indicated transport to the Midwest. The backward trajectories (originating in northeast Maryland) clearly indicated transport from the Midwest, which was consistent with MDE's conceptual model.

Satellite Imagery of Plume with Evidence of Plume Impacting Ground

Satellite retrievals of carbon monoxide (CO) over North America strengthened MDE's conceptual model of transport of Fort McMurray fire emissions to Maryland. CO can be used as a wildfire smoke indicator and is a precursor for O_3. MDE presented a series of satellite retrievals from May 18 to 26, 2016 that show a plume of CO located near the Fort McMurray wildfire travelling south and eastward into the Midwest and eventually to Maryland. The plume of CO over Maryland occurred in the same time period as elevated ground-level measurements of CO were observed at several MDE monitors, indicating that the plume impacted the ground around the same time as it was detected by satellite.

Q/d Analysis

While required for Tier 2 & 3 demonstrations, MDE felt that, "the 100 [tpd/km] value is not representative for long-range east-coast smoke events". Thus MDE not only provided a standard Q/d estimate, but also four, other estimates based on various scenarios. The standard Q/d estimated by MDE was 4.1 tpd/km – much lower than the required 100 tpd/km. Of the various scenarios presented by MDE, the only one to reach 100 tpd/km or greater was one assuming maximum fuel loading, one day of burning, with the plume impacting Minneapolis, Minnesota instead of Maryland. While the results of this analysis did not satisfy the Q/d value requirements, MDE's inclusion of additional analyses in this demonstration are adequate in fulfilling this requirement.

Comparison of Event O_3 Concentrations with Non-event

Compared to the past five years (2012-2016), several of the observed exceedances (at the requested monitors on May 25 and 26, 2016) were considered unusually high. Of the 16 monitors for which MDE requested data exclusion, three of those monitors on May 25, 2016, and five on May 26, 2016 observed 8-hour O_3 concentrations that were above the 99th percentile for 2012-2016 8-hour O_3 data. The Millington and Furley monitors met or surpassed the 99th percentile on May 25, and the Furley monitor on May 26. When examining 2012-2016 8-hour O_3 data for May only, the number of monitors greater than the 99th percentile increases to nine and twelve for May 25, 2016 and May 26, 2016, respectively. The Fair Hill, Furley, Edgewood, Millington, and PG Eq Cntr monitors were five of the nine monitors that surpassed the 99th percentile for May-only 8-hour O_3 on May 25, 2016, and the Edgewood, Furley, Glen Burnie, and Millington monitors were four of the 12 monitors that surpassed the 99th percentile for May-only 8-hour O_3 on May 26, 2016.

Evidence of Changes in Spatial/Temporal O_3 and/or NO_x Patterns

Figure 18 of MDE's demonstration illustrated maximum daily 8-hour average O_3 concentrations measured by O_3 monitors across the eastern United States during May 18-28, 2016. O_3 concentrations between 50 and 65 ppb were observed in Canada and the Midwest on May 18 and 19. On later dates, this area of elevated O_3 concentrations, which was spatially associated with the wildfire smoke plume, moved south and intensified before moving east and further intensifying. May 25 and 26, 2016 had the highest O_3 concentrations in Maryland of this time period. On May 18, 2016, O_3 concentrations were well below the NAAQS at < 40 ppb in most of Maryland, but by May 25th, they were between 60 and 85 ppb and either approaching or exceeding the 2015 and 2008 O_3 NAAQS.

Additionally, MDE included time series of NO_x and total reactive nitrogen (NO_y) for May 2012-2016. While MDE did not indicate if the NO_x and NO_y concentrations are significantly higher during the exceptional event, NO_x appeared much higher than many of the other observations at one of MDE's monitors, and one monitor during the exceptional event, NO_y also appeared elevated relative to the rest of the 2012-2016 May data.

Concentrations of Supporting Ground-level Measurements

In addition to the elevated CO concentrations discussed previously, MDE included evidence of wildfire-related, elevated 24-hour $PM_{2.5}$ observations. MDE explained that "The entire MDE network showed a correlated increase in $PM_{2.5}$ 24-hour averages from May 24-29 which aligned with the onset of the smoke plume in Maryland. No other period of the month exhibited such a coherent increase across the entire Maryland network".

Similar Day Analysis

MDE identified three days in the time period of May-only 2012-2016 with similar meteorology that could be compared to the exceptional event days. None of the similar days were associated with O_3 concentrations near as high as those observed throughout Maryland on May 25, 2016. MDE explains that "spatially none of the [similar] days are comparable to the 2016 event either. More than half of the state was under code orange conditions in 2016 when in the [similar] 2013 case only four monitors were above 70 ppb, in 2014, none, and in 2015 only two".

Photochemical Model

The Community Multi-Scale Air Quality (CMAQ) O_3 model can predict quantitatively and spatially O_3 concentrations. In 2016 when MDE ran CMAQ in support of their exceptional event demonstration, the model did not include 2016 wildfire emissions in the O_3 chemical creation mechanism. Therefore, the model results could be compared to the observed O_3 concentrations. If CMAQ significantly underpredicts daily maximum 8-hour O_3, it is indicative that there were O_3 sources that were not accounted for. Therefore, MDE writes, "the NOAA

operational CMAQ model represented a prediction of ozone in the absence of smoke under normal conditions".

Similar to the plume of CO discussed above, MDE's demonstration included figures showing an area of underpredicted maximum daily 8-hour O_3 in the Midwest around May 18-24, 2016. By May 25, the area of underprediction had spread east, and by May 26, 2016 the entire state of Maryland was included in the area of underprediction. The areas of underprediction ranged from 5 to 20 ppb below observed concentrations as the plume moved over the Mid-West and into Maryland. The underprediction of O_3 by CMAQ (suggesting unexpected O_3 source(s)) was underscored in MDE's demonstration because, as MDE writes, "it tends to slightly over-forecast ozone concentrations".

Conclusions

MDE stated that the evidence presented demonstrates "that the Fort McMurray wildfire affected air quality in such a way that there exists a clear causal relationship between the event (Fort McMurray fire) and the monitored ozone exceedances in Maryland on May 25 and 26, 2016 and thus satisfies the clear causal relationship criterion for recognition as an exceptional event".

The analyses included in the demonstration, specifically, the similar day analysis and comparison of modeled (without fire emissions) with observed O_3 concentrations, sufficiently demonstrated a clear causal relationship between the emissions generated by the Fort McMurray wildfire and the exceedances measured at the Fair Hill, Furley, Glen Burnie, PG Eq Cntr, Edgewood, and Millington monitors.

Table 3. Documentation of Clear Causal Relationship and the Supporting Analyses

Exceedance Date	Demonstration Citation	Quality of Evidence	Criterion Met?
May 25, 2016	Section 3: p 47-99	Sufficient	Yes
May 26, 2016	Section 3: p 47-99	Sufficient	Yes

Not Reasonably Controllable or Preventable

The Exceptional Events Rule presumes that wildfire events on wildland are not reasonably controllable or preventable (40 CFR §50.14(b)(4)). MDE's demonstration provided evidence that the wildfire event meets definition of wildfire. Specifically, MDE states that "[these fires] were outside the United States, and were therefore neither reasonably controllable or preventable by the state of Maryland. No policy that Maryland enacted could have prevented the fire or smoke which it caused, to enter the United States or Maryland. MDE was not aware of any evidence clearly demonstrating that prevention or control efforts beyond those actually made

would have been reasonable." Therefore, the documentation provided sufficiently demonstrates that the event was not reasonably controllable and not reasonably preventable.

Table 4. Documentation of not Reasonably Controllable or Preventable

Exceedance Date	Demonstration Citation	Quality of Evidence	Criterion Met?
May 25, 2016	Section 5: p 100	Sufficient	Yes
May 26, 2016	Section 5: p 100	Sufficient	Yes

Natural Event or Event Caused by Human Activity that is Unlikely to Recur

The definition of "wildfire" at 40 CFR §50.1(n) states, "A wildfire that predominantly occurs on wildland is a natural event." MDE's demonstration includes documentation that the event meets the definition of a wildfire and occurred predominantly on wildland. MDE has therefore shown that the event was a natural event.

Table 5. Documentation of Natural Event

Exceedance Date	Demonstration Citation	Quality of Evidence	Criterion Met?
May 25, 2016	Section 4: p 100	Sufficient	Yes
May 26, 2016	Section 4: p 100	Sufficient	Yes

Schedule and Procedural Requirements

In addition to technical demonstration requirements, 40 CFR §50.14(c) and 40 CFR §51.930 specify schedule and procedural requirements an air agency must follow to request data exclusion. Table 6 outlines EPA's evaluation of these requirements.

Table 6: Schedules and Procedural Criteria

Criterion	Reference	Demonstration Citation	Criterion Met?
Did the agency provide prompt public notification of the event?	40 CFR §50.14 (c)(1)(i)	Section 6: p 100	Yes
Did the agency submit an Initial Notification of Potential Exceptional Event and flag the affected data	40 CFR §50.14 (c)(2)(i)	NA	Yes

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in EPA's Air Quality System (AQS)			
Did the initial notification and demonstration submittals meet the deadlines for data influenced by exceptional events for use in initial area designations, if applicable? Or the deadlines established by EPA during the Initial Notification of Potential Exceptional Events process, if applicable?	40 CFR §50.14 Table 2 40 CFR §50.14(c)(2)(i)(B)	May 31, 2017	Yes
Was the public comment process followed and documented? • Did the agency document that the comment period was open for a minimum of 30 days? • Did the agency submit to EPA any public comments received? • Did the state address comments disputing or contradicting factual evidence provided in the demonstration?	40 CFR §50.14 (c)(3)(v)	Section 6: p 100	Yes

Has the agency met requirements regarding submission of a mitigation plan, if applicable?	40 CFR §50.1930(b)	NA	NA

Conclusion

EPA has reviewed the documentation provided by MDE to support claims that smoke from wildfires in Fort McMurray, Alberta, Canada caused exceedances of the 2008 8-hour O_3 standard at the Fair Hill, Glen Burnie, PG Eq Cntr, Edgewood, Furley, and Millington monitoring sites on May 25, 2016 and at the Fair Hill, Glen Burnie, Edgewood, Furley, and Millington monitoring sites on May 26, 2016. EPA has determined that the flagged exceedances at these monitoring sites on May 25 and 26 satisfy the exceptional event criteria: the event was a natural event, which affected air quality in such a way that there exists a clear causal relationship between the event and the monitored exceedance, and was not reasonably controllable or preventable. EPA has also determined that MDE has satisfied the procedural requirements for data exclusion.

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Technical Support Document (TSD) for EPA Concurrence on O_3 Exceedances Measured at Five Maryland Monitors on July 21 and 22, 2016 as Exceptional Events

TSD Prepared December 2017

Verena Joerger

Kia Long

Office of Air Monitoring & Analysis, 3AP40

U.S. Environmental Protection Agency, Region III

1650 Arch Street

Philadelphia, Pennsylvania 19103

Alice H. Chow

Reviewed by Alice H. Chow, Associate Director

Office of Air Monitoring & Analysis (3AP40)

12/12/2017

Date Signed

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Enclosure: Technical Support Document for EPA Concurrence on O_3 Exceedances Measured at Five Maryland Monitors on July 21 and 22, 2016 as Exceptional Events

In summer of 2016, the Maryland Department of the Environment (MDE) identified that wildfires in northwestern Canada may have caused ozone (O_3) exceedances at 12 monitoring sites operated by MDE on July 21 and 22, 2016. The aggregate of wildfires in and around the Northwest Territories of Canada produced a smoke plume containing O_3 precursors that was transported eastward and south and subsequently subsided over the Mid-Atlantic United States.

Under the Exceptional Events Rule, air agencies can request the exclusion of event-influenced data, and EPA can agree to exclude these data, from the data set used for certain regulatory decisions. The remainder of this document summarizes the Exceptional Events Rule requirements, the event and EPA's review process.

Exceptional Events Rule Requirements

EPA promulgated the Exceptional Events Rule in 2007, pursuant to the 2005 amendment of Clean Air Act (CAA) section 319. In 2016, EPA finalized revisions to the Exceptional Events Rule. The 2007 Exceptional Events Rule and 2016 Exceptional Events Rule revisions added sections 40 CFR §50.1 (j)-(r), 50.14, and 51.930 to title 40 of the Code of Federal regulations (CFR). These sections contain definitions, criteria for EPA approval, procedural requirements, and requirements for air agency demonstrations. EPA reviews the information and analyses in the air agency's demonstration package using a weight of evidence approach and decides to concur, defer, or not concur. The demonstration must satisfy all of the Exceptional Events Rule criteria for EPA to concur with excluding the air quality data from regulatory decisions.

Under 40 CFR §50.14 (c) (3) (iv), the air agency demonstration to justify data exclusion must include:

A. "A narrative conceptual model that describes the event(s) causing the exceedance or violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s);"

B. "A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation;"

C. "Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times" to support (B) above;

D. "A demonstration that the event was both not reasonably controllable and not reasonably preventable;" and

E. "A demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event."[1]

In addition, the air agency must meet several procedural requirements, including:

1. Submission of an Initial Notification of Potential Exceptional Event and flagging of the affected data in EPA's Air Quality System (AQS) as described in 40 CFR §50.14(c)(2)(i),

2. Completion and documentation of the public comment process described in 40 CFR §50.14(c)(3)(v), and

3. Implementation of any applicable mitigation requirements as described in 40 CFR §51.930.

For data influenced by exceptional events to be used in initial area designations, air agencies must also meet the initial notification and demonstration submission deadlines specified in Table 2 to 40 CFR §50.14. We include below a summary of the Exceptional Events Rule criteria, including those identified in 40 CFR §50.14(c)(3)(iv).

Regulatory Significance

The 2016 Exceptional Events Rule includes regulatory language that applies the provisions of CAA section 319 to a specific set of regulatory actions. As identified in 40 CFR §50.14 (a)(1)(i), these regulatory actions include initial area designations and redesignations; area classifications; attainment determinations (including clean data determinations); attainment date extensions; findings of state Implementation Plan (SIP) inadequacy leading to a SIP call; and other actions on a case-by-case basis as determined by the Administrator. Air agencies and EPA should discuss the regulatory significance of an exceptional events demonstration during the Initial Notification of Potential Exceptional Event prior to the air agency submitting a demonstration for EPA's review.

[1] A natural event is further described in 40 CFR §50.1 (k) as "an event and its resulting emissions, which may recur at the same location, in which human activity plays little or no direct causal role. For purposes of the definition of a natural event, anthropogenic sources that are reasonably controlled shall be considered to not play a direct role in causing emissions."

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Narrative Conceptual Model

The 2016 Exceptional Events Rule directs air agencies to submit, as part of the demonstration, a narrative conceptual model of the event that describes and summarizes the event in question and provides context for analyzing the required statutory and regulatory technical criteria. Air agencies may support the narrative conceptual model with summary tables or maps. For wildfire O_3 events, EPA recommends that the narrative conceptual model also discuss the interaction of emissions, meteorology, and chemistry of event and non-event O_3 formation in the area, and, under 40 CFR §50.14 (a)(1)(i), must describe the regulatory significance of the proposed data exclusion.

Clear Causal Relationship and Supporting Analyses

EPA considers a variety of evidence when evaluating whether there is a clear causal relationship between a specific event and the monitored exceedance or violation. For wildfire O_3 events, air agencies should compare the O_3 data requested for exclusion with seasonal and annual historical concentrations at the air quality monitor to establish a clear causal relationship between the event and monitored data. In addition to providing this information on the historical context for the event-influenced data, air agencies should further support the clear causal relationship criterion by demonstrating that the wildfire's emissions were transported to the monitor, that the emissions from the wildfire influenced the monitored concentrations, and, in some cases, air agencies may need to provide evidence of the contribution of the wildfire's emissions to the monitored O_3 exceedance or violation.

For wildfire O_3 events, EPA has published a guidance document that provides three different tiers of analyses that apply to the "clear causal relationship" criterion within an air agency's exceptional events demonstration. If a wildfire/O_3 event satisfies the key factors for either Tier 1 or Tier 2 clear causal analyses, then those analyses are the only analyses required to support the clear causal relationship criterion within an air agency's demonstration for that particular event. Other wildfire/O_3 events will be considered based on Tier 3 analyses.

- Tier 1: Wildfires that clearly influence monitored O_3 exceedances or violations when they occur in an area that typically experiences lower O_3 concentrations.
    - *Key Factor:* seasonality and/or distinctive level of the monitored O_3 concentration. The event-related exceedance occurs during a time of year that typically has no exceedances, or is clearly distinguishable (*e.g.*, 5-10 ppb higher) from non-event exceedances.
    - In these situations, O_3 impacts should be accompanied by clear evidence that the wildfire's emissions were transported to the location of the monitor.

- Tier 2: The wildfire event's O_3 influences are higher than non-event related concentrations, and fire emissions compared to the fire's distance from the affected monitor indicate a clear causal relationship.

- *Key Factor 1:* fire emissions and distance of fire(s) to affected monitoring site location(s). Calculated fire emissions of NO_x and reactive-VOC in tons per day (Q) divided by the distance from the fire to the monitoring site (D) should be equal to or greater than 100 tons per day/kilometers ($Q/D \geq 100$ tpd/km). The guidance document provides additional information on the calculation of Q/D.
- *Key Factor 2:* comparison of the event-related O_3 concentration with non-event related high O_3 concentrations. The exceedance due to the exceptional event:
  - Is in the 99th or higher percentile of the 5-year distribution of O_3 monitoring data, OR
  - Is one of the four highest O_3 concentrations within 1 year (among those concentrations that have not already been excluded under the Exceptional Events Rule, if any).
- In addition to the analysis required for Tier 1, the air agency should supply additional information to support the weight of evidence that emissions from the wildfire affected the monitored O_3 concentration.

- Tier 3: The wildfire does not fall into the specific scenarios (*i.e.,* does not meet the key factors) that qualify for Tier 1 or Tier 2, but the clear causal relationship criterion can still be satisfied by a weight of evidence showing.
  - In addition to the analyses required for Tier 1 and Tier 2, an air agency may further support the clear causal relationship with additional evidence that the fire emissions caused the O_3 exceedance.

Not Reasonably Controllable or Preventable

The Exceptional Events Rule requires that air agencies establish that the event be both not reasonably controllable and not reasonably preventable at the time the event occurred. This requirement applies to both natural events and events caused by human activities; however, it is presumed that wildfires on wildland will satisfy both factors of the "not reasonably controllable or preventable" element unless evidence in the record clearly demonstrates otherwise.[2]

[2] A wildfire is defined in 40 CFR §50.1(n) as "any fire started by an unplanned ignition caused by lightning; volcanoes; other acts of nature; unauthorized activity; or accidental, human-caused actions, or a prescribed fire that has developed into a wildfire. A wildfire that predominantly occurs on wildland is a natural event." Wildland is defined in 40 CFR §50.1(o) as "an area in which human activity and development are essentially non-existent, except for roads, railroads, power lines, and similar transportation facilities. Structures, if any, are widely scattered."

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Natural Event or Event Caused by Human Activity that is Unlikely to Recur

According to the CAA and the Exceptional Events Rule, an exceptional event must be "an event caused by human activity that is unlikely to recur at a particular location *or* a natural event" (emphasis added). The 2016 Exceptional Events Rule includes in the definition of wildfire that "[a] wildfire that predominantly occurs on wildland is a natural event." Once an agency provides evidence that a wildfire on wildland occurred and demonstrates that there is a clear causal relationship between the measurement under consideration and the event, EPA expects minimal documentation to satisfy the "human activity that is unlikely to recur at a particular location or a natural event" element. EPA will address wildfires on other lands on a case-by-case basis.

EPA Review of Exceptional Event Demonstration

On February 1, 2017, MDE submitted an Initial Notification of Potential Exceptional Event for 7 exceedances of the 2008 8-hour O_3 standard that occurred at the following monitors:

- Aldino (AQS: 240259001) – July 21, 2016
- Beltsville CASTNET (AQS: 240339991) – July 21, 2016
- Fair Hill (AQS: 240150003) – July 22, 2016
- Glen Burnie (AQS: 240031003) – July 21, 2016
- HU-Beltsville (AQS: 240330030) – July 21, 2016
- PG Eq Cntr (AQS: 240338003) – July 22, 2016
- Edgewood (AQS: 240251001) – July 22, 2016

and 8 exceedances of the 2015 8-hour O_3 standard at the following monitors:

- Aldino (AQS: 240259001) – July 22, 2016
- Edgewood (AQS: 240251001) – July 21, 2016
- Essex (AQS: 240053001) – July 21 and 22, 2016
- Frederick (AQS: 240210037) – July 21, 2016
- Furley (AQS: 245100054) – July 21, 2016
- Hagerstown (AQS: 240430009) – July 21, 2016
- Padonia (AQS: 240051007) – July 21, 2016

Regulatory Significance

EPA reviewed MDE's Initial Notification of Potential Exceptional Event and determined that the exclusion of 8-hour O_3 measurements from some of the monitors included had regulatory significance for the 2008 and 2015 8-hour O_3 standard. EPA worked with MDE to identify any other relevant exceedances and monitors that may have been impacted by the event and affected regulatory determinations. Ultimately, monitor days without immediate or possible regulatory significance were also requested by MDE in their final demonstration and were

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either deferred or non-concurred by EPA. Table 1 summarizes the exceedances and EPA's decisions.

Table 1. EPA 8-hour O_3 Exceedance Summary

Exceedance Date	Site Name	AQS ID	8-hour Max. (ppb)	NAAQS Standard Affected	EPA Decision
July 21, 2016	Edgewood	240251001	72	2015	Concur
July 21, 2016	Furley	245100054	74	2015	Concur
July 21, 2016	Glen Burnie	240031003	76	2015	Concur
July 22, 2016	Edgewood	240251001	82	2008	Concur
July 22, 2016	Fair Hill	240150003	87	2008	Concur
July 22, 2016	PG Eq Cntr	240338003	76	2008	Concur
July 21, 2016	Aldino	240259001	77	TBD	Defer
July 21, 2016	Essex	240053001	75	TBD	Defer
July 21, 2016	Frederick	240210037	75	TBD	Defer
July 21, 2016	Hagerstown	240430009	74	TBD	Defer
July 21, 2016	HU-Beltsville	240330030	78	TBD	Defer
July 22, 2016	Aldino	240259001	72	TBD	Defer
July 22, 2016	Essex	240053001	72	TBD	Defer
July 21, 2016	Beltsville CASTNET	240339991	78	NA	Non-concur
July 21, 2016	Padonia	240051007	73	NA	Non-concur

Narrative Conceptual Model

MDE's demonstration provided a narrative conceptual model to describe how emissions from northwestern Canada caused O_3 exceedances at the affected monitoring stations. The conceptual model included a general overview of typical O_3 formation in Maryland, a literature review of studies that examine the role of wildfires on downwind O_3, and the meteorology, O_3, and NO_x concentrations and satellite smoke observations for the days leading up to, during, and after the exceptional event dates.

In the demonstration, MDE explained that under typical airmass composition, O_3 formation in Maryland occurs "due to the photolization of volatile organic compounds (VOCs) and a combination of regional and locally sourced anthropogenic NO_x in the presence of sunlight." While Maryland has urban pollution plumes, MDE's demonstration explained that "these emissions alone regularly fall short of producing ozone capable of [maximum daily 8-hour average ozone] concentrations above 70 ppb".

In 2016, A dry spring promoted fire prone conditions throughout northwestern Canada. During the week of July 13-20, 2016, 205 fires started in northwestern Canada and burned 109,724

hectares. An area of low pressure over northwestern Canada, created northwesterly winds that transported O_3 precursors southeast. A weak cold front then pushed through Maryland and behind it, an area of high pressure moved in over the Mid-Atlantic, causing the O_3 precursors to subside to the surface. The next day (July 21, 2016), the photochemically aged airmass was at the surface over Maryland and elevated O_3 was observed across Maryland. Long-range forest fire effects on O_3 concentrations are not unheard of, and MDE cited several similar studies where, "Canadian wildfires have increased ozone concentrations in Houston, TX and as far away as Europe".

Table 2. Documentation of Narrative Conceptual Model

Exceedance Date	Demonstration Citation	Quality of Evidence	Criterion Met?
July 21, 2016	Section 2: p 15-49	Sufficient	Yes
July 22, 2016	Section 2: p 15-49	Sufficient	Yes

Clear Causal Relationship and Supporting Analyses

MDE's demonstration included multiple analyses to demonstrate a clear causal relationship between the northwestern Canadian fires and the monitored exceedances. A selection of these analyses is listed and further discussed below.

Trajectory Analysis

MDE included 72-hour forward and backward trajectories between July 17th and 20th, 2016 using the National Oceanic and Atmospheric Administration's Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model. The forward trajectories originating around the location of the smoke plume generally showed transport south and east toward the northeast United States. The backward trajectories beginning in central Maryland, indicated transport from the northwest. These trajectories were consistent with the conceptual model presented earlier in the demonstration.

Satellite Imagery of Plume with Evidence of Plume Impacting Ground

Satellite retrievals of total column carbon monoxide (CO) over North America from July 18th to 21st, 2016 showed a plume of CO over northwestern Canada on July 18 that initially traveled southeast and reached Maryland by July 20th. In this analysis, total column CO was used as a wildfire smoke indicator, and the track of the plume corresponded well with the proposed track of O_3 precursors in the conceptual model. At the surface, several CO monitors measured elevated CO concentrations, including one site (Horn Point) that measured the highest CO concentrations for the month of July on July 20th. The timing of the peaks in surface CO monitor concentrations was consistent with the timing of the CO plume entering the Mid-Atlantic, as detected from satellite retrievals.

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Q/d Analysis

While required for Tier 2 & 3 demonstrations, MDE felt that, "the [required] 100 [tpd/km] value is not representative for long-range east-coast smoke events". However, MDE included the required Q/d analysis which yielded an estimate of 1.8 tpd/km from the central point of the fires in northwestern Canada to Fair Hill, Maryland. The Q/d estimate was much lower than the required 100 tpd/km. While the results of this analysis did not satisfy the Q/d value requirements, MDE's additional analyses included in this demonstration were able to satisfy the requirement of a clear causal relationship between the wildfires and O_3 exceedances in Maryland.

Comparison of Event O_3 Concentrations with Non-event

Compared to the past five years (2012-2016), several of the observed exceedances (at the requested monitors on May 25 and 26, 2016) were considered unusually high. Of the 12 monitors for which MDE requested data exclusion, three of those monitors on July 21, 2016, and two on July 22, 2016 observed 8-hour O_3 concentrations that were above the 99th percentile for 2012-2016. The Fair Hill and Edgewood monitors were the two that surpassed the 99th percentile 8-hour O_3 on July 22, 2016. If the year of 2012 was excluded, The Furley monitor met or surpassed the 99th percentile on July 21, 2016, and the Edgewood, Fair Hill, and PG Eq Cntr monitor surpassed the 99th percentile 8-hour O_3 on July 22, 2016.

Evidence of Changes in Spatial/Temporal O_3 and/or NO_x Patterns

Figures included in MDE's demonstration showed Hazard Mapping System (HMS) analyzed smoke moving southeast in the event time frame and accompanying pockets of elevated O_3 (albeit lower concentrations than those recorded on July 21st and 22nd in Maryland). On July 18th and 19th, 2016, maximum 8-hour O_3 concentrations in Maryland were between 40 and 60 ppb. On July 20, smoke from the northwestern Canadian wildfires arrived in Maryland and on July 19th and 20th, maximum 8-hour O_3 concentrations ranged from 65-85 ppb.

NO_x concentrations recorded during the event time frame were the highest observed in the month of July, 2016. MDE plotted the ratio of maximum 8-hour average ozone concentration to total NO_x output from Pennsylvania and Maryland. O_3 to NO_x ratios during the event were the 24th and 13th highest ratios in July since 2010. Because MDE used only local NO_x emissions for the ratio, "The higher than typical ratio suggested ozone production was beyond classic event production and was likely aided by other constituents".

Concentrations of Supporting Ground-Level Measurements

In addition to the elevated CO concentrations discussed above, MDE included analyses of fine particles ($PM_{2.5}$), total non-methane organic compounds (TNMOC), and O_3 to NO_x ratios. Like the observed CO concentrations, the other ground-level measurements were slightly higher than non-event concentrations. The statewide 6-hour average $PM_{2.5}$ concentration peaked at 15 $\mu g/m^3$ during the event period, which was the highest measurement of the month. TNMOC

also peaked during the event period, with the 24-hour moving average of TNMOC in July being the highest during the event period.

Photochemical Model

The Community Multi-Scale Air Quality (CMAQ) O_3 model can predict quantitatively and spatially O_3 concentrations. For this demonstration, MDE ran CMAQ without including 2016 wildfire emissions in the O_3 chemical creation mechanism. Therefore, the model results can be compared to the observed O_3 concentrations, and if CMAQ underpredicts daily maximum 8-hour O_3, it is indicative of O_3 sources not accounted for by CMAQ.

Similar to the plume of CO discussed above, MDE's demonstration included figures showing an area of underpredicted maximum daily 8-hour O_3 in Ohio on July 19, 2016. The area of underprediction moved east into Maryland on July 20th, and expanded further east on July 21. By July 22nd, the area of underprediction over Maryland was much smaller. The areas of underprediction ranged from 5 to 15 ppb as the plume moved from Ohio to Maryland. The underprediction of O_3 by CMAQ (suggesting unexpected O_3 source(s)) is underscored in MDE's demonstration by how, as MDE wrote, "it tends to slightly over-forecast ozone concentrations".

Conclusions

MDE stated that the evidence presented demonstrates, "that the wildfire events affected air quality in such a way that there exists a clear causal relationship between the specific event (fires in northwestern Canada) and the monitored ozone exceedance on July 21 and 22, 2016 and thus satisfies the clear causal relationship criterion for recognition as an exceptional event".

The analyses included in the demonstration, specifically the spatial changes in O_3 analysis and comparison of modeled (without fire emissions) with observed O_3 concentrations, sufficiently demonstrated a clear causal relationship between the emissions generated the northwestern Canadian wildfires and the exceedance measured at the affected monitors.

Table 3. Documentation of Clear Causal Relationship and the Supporting Analyses

Exceedance Date	Demonstration Citation	Quality of Evidence	Criterion Met?
July 21, 2016	Section 3: p 48-88	Sufficient	Yes
July 22, 2016	Section 3: p 48-88	Sufficient	Yes

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Not Reasonably Controllable or Preventable

The Exceptional Events Rule presumes that wildfire events on wildland are not reasonably controllable or preventable (40 CFR §50.14(b)(4)). MDE's demonstration provided evidence that the wildfire event meets the definition of a wildfire. Specifically, MDE stated that the wildfires relevant to this event, "were likely due to lightning, were outside of the United States, and were therefore neither reasonably controllable or preventable by the state of Maryland. No policy that Maryland enacted could have prevented the fire or the smoke which it caused, to enter the United States or Maryland. MDE was not aware of any evidence clearly demonstrating that prevention or control efforts beyond those actually made would have been reasonable. Therefore, emissions from these wildfires were not reasonably controllable or preventable and meet the criterion for treatment as an exceptional event".

Table 4. Documentation of not Reasonably Controllable or Preventable

Exceedance Date	Demonstration Citation	Quality of Evidence	Criterion Met?
July 21, 2016	Section 5: p 88	Sufficient	Yes
July 22, 2016	Section 5: p 88	Sufficient	Yes

Natural Event or Event Caused by Human Activity that is Unlikely to Recur

The definition of "wildfire" at 40 CFR §50.1(n) states, "A wildfire that predominantly occurs on wildland is a natural event". MDE's demonstration includes documentation that the event meets the definition of a wildfire and occurred predominantly on wildland. "The fires across the Northwest Territories and west-central areas of Canada qualify as a natural event because lightning activity was suspected as the cause...Wildfire emissions affecting ozone concentrations in Maryland were generated predominantly from sparsely populated forested areas, meeting the definition of wildland". MDE has therefore shown that the event was a natural event.

Table 5. Documentation of Natural Event

Exceedance Date	Demonstration Citation	Quality of Evidence	Criterion Met?
July 21, 2016	Section 4: p 88	Sufficient	Yes
July 22, 2016	Section 4: p 88	Sufficient	Yes

Schedule and Procedural Requirements

In addition to technical demonstration requirements, 40 CFR §50.14(c) and 40 CFR §51.930 specify schedule and procedural requirements an air agency must follow to request data exclusion. Table 6 outlines EPA's evaluation of these requirements.

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Table 6. Schedules and Procedural Criteria

Criterion	Reference	Demonstration Citation	Criterion Met?
Did the agency provide prompt public notification of the event?	40 CFR §50.14 (c)(1)(i)	Section 6: p 88	Yes
Did the agency submit an Initial Notification of Potential Exceptional Event and flag the affected data in EPA's Air Quality System (AQS)	40 CFR §50.14 (c)(2)(i)	NA	Yes
Did the initial notification and demonstration submittals meet the deadlines for data influenced by exceptional events for use in initial area designations, if applicable? Or the deadlines established by EPA during the Initial Notification of Potential Exceptional Events process, if applicable?	40 CFR §50.14 Table 2 40 CFR §50.14(c)(2)(i)(B)	May 31, 2017	Yes
Was the public comment process followed and documented? • Did the agency document that the comment period was open for a minimum of 30 days? • Did the agency submit to EPA	40 CFR §50.14 (c)(3)(v)	Section 6: p 88	Yes

any public comments received? • Did the state address comments disputing or contradicting factual evidence provided in the demonstration?			
Has the agency met requirements regarding submission of a mitigation plan, if applicable?	40 CFR §50.1930(b)	NA	NA

Conclusion

EPA has reviewed the documentation provided by MDE to support claims that smoke from wildfires in northwestern Canada caused exceedances of the 2008 8-hour O_3 standard at the Glen Burnie monitoring site on July 21, 2016, the 2015 8-hour O_3 standard at the Furley and Edgewood monitoring sites on July 21, 2016, and the 2008 8-hour O_3 standard at the Fair Hill and PG Eq Cntr monitoring sites on July 22nd, 2016. EPA has determined that the flagged exceedances at these monitoring sites satisfy the exceptional event criteria: the event was a natural event, which affected air quality in such a way that there exists a clear causal relationship between the event and the monitored exceedance, and was not reasonably controllable or preventable. EPA has also determined that MDE has satisfied the procedural requirements for data exclusion.

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