GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

Canadian Wildfire Exceptional Event Demonstration for Exceedances of the 2024 Annual $PM_{2.5}$ NAAQS at Columbus, GA in 2023

Prepared by:
Air Protection Branch
Environmental Protection Division

February 7, 2025

TABLE OF CONTENTS

1. INTRODUCTION **1**
2. NARRATIVE CONCEPTUAL MODEL **2**
3. PUBLIC NOTIFICATION **3**
4. CLEAR CAUSAL RELATIONSHIP AND SUPPORTING ANALYSES **5**
5. NOT REASONABLY CONTROLLABLE OR PREVENTABLE **8**
6. HUMAN ACTIVITY UNLIKELY TO RECUR AT A PARTICULAR LOCATION OR NATURAL EVENT **8**
7. PUBLIC COMMENT PERIOD **8**
APPENDIX A: ACTIVE WILDFIRES IN CANADA **8**
APPENDIX B: HMS SMOKE AND ACTIVE FIRES **10**
APPENDIX C: HYPLSIT BACK-TRAJECTORY MAPS **12**
APPENDIX D: $PM_{2.5}$ SURFACE CONCENTRATIONS IN THE SOUTHEAST **14**
APPENDIX E: HOURLY $PM_{2.5}$ TIME SERIES **16**
APPENDIX F: UPPER AIR MAPS **17**
APPENDIX G: PUBLIC COMMENTS **22**
APPENDIX H: RESPONSES TO PUBLIC COMMENTS **22**

1. Introduction

The current annual and 24-hour $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS) are 9.0 $\mu g/m^3$ and 35 $\mu g/m^3$, respectively. Federal Reference Method (FRM) monitors collect $PM_{2.5}$ samples for 24 hours on filters while Federal Equivalent Method (FEM) monitors measure hourly $PM_{2.5}$ concentrations continuously. An exceedance of the 2024 annual $PM_{2.5}$ NAAQS occurs when the measured 24-hour $PM_{2.5}$ concentration is greater than 9.0 $\mu g/m^3$.

From 2019 through July 2020, $PM_{2.5}$ data was collected at the Columbus-Cusseta site (13-215-0011) with an FRM monitor on a one in three-day schedule. This location was shut down at the end of July 2020, and then a new site was established in March 2021 at the Columbus-Baker site (13-215-0012). The data from these two locations in Columbus (Cusseta and Baker) is linked in AQS for attainment purposes. At the Columbus-Baker location, one FRM monitor began collecting data in March 2021 on a one in three-day sampling schedule. From 2021 through 2023, one FRM monitor operated at the Columbus-Baker site. In addition, an FEM monitor started collecting data in June 2023, with a NAAQS exclusion on the data. The Columbus, GA-AL MSA is in attainment of the 2012 $PM_{2.5}$ NAAQS.

This exceptional event demonstration shows that the Columbus-Baker air monitoring site located in Columbus (Muscogee County) in the state of Georgia (AQS ID: 13-215-0012) reported exceedances of the 2024 annual $PM_{2.5}$ NAAQS on nine different days from 2021-2023 that qualify for exceptional event demonstrations (Table 1), two of which were due to Canadian wildfires. These exceedances resulted from the transport of wildfire smoke that originated in Canada; therefore, they qualify for removal under the Exceptional Events Rule (EER). Design values (DVs) of the Columbus-Baker monitor with and without U.S. Environmental Protection Agency (EPA) concurrence are shown in Table 2. DVs are calculated using 24-hour $PM_{2.5}$ measurements from 2021-2023. For each year, these measurements are first averaged into quarterly values, then to a yearly value. The average of these yearly values is reported as the DV. Inclusion of these events produces a DV of 10.0 $\mu g/m^3$, which is above the new 2024 $PM_{2.5}$ annual NAAQS; however, exclusion reduces the DV to 9.0 $\mu g/m^3$.

On December 20, 2024, the Georgia Environmental Protection Division (EPD) submitted an Initial Notification for these events to the EPA. The request indicated that two events identified in Table 1 were impacted by smoke from wildfires and requested review of the events under the case-by-case provision at 40 CFR 50.14(a)(1)(i)(F). This demonstration will focus on the two Canadian wildfire events, while a separate demonstration will focus on the seven prescribed fire events. The Georgia EPD formally requests that the EPA concur with the exclusion of these wildfire events.

Table 1. Exceedances of the 2024 annual $PM_{2.5}$ NAAQS observed by monitors stationed in Columbus, GA at the Columbus-Baker site in 2021-2023 that qualify for removal under the Exceptional Events Rule.

#	Date	24-hour $PM_{2.5}$ ($\mu g/m^3$)	Tier	Cause of Exceedance
1	03/08/21	60.7	1	Prescribed fires
2	03/14/21	35.1	1	Prescribed fires
3	02/10/22	32.0	1	Prescribed fires
4	03/03/22	55.1	1	Prescribed fires
5	02/08/23	21.0	2	Prescribed fires
6	03/01/23	21.1	2	Prescribed fires
7	03/07/23	25.0	2	Prescribed fires
8	06/29/23	20.8	2	Canadian Wildfires
9	07/17/23	25.3	2	Canadian Wildfires

Table 2. Design values (DV) for monitors at the Columbus-Baker site for the 2024 annual $PM_{2.5}$ NAAQS.

Monitor Site (AQS ID)	2021-2023 DV without EPA Concurrence ($\mu g/m^3$)	2021-2023 DV with EPA Concurrence ($\mu g/m^3$)
Columbus-Baker (13-215-0012)	10.0	9.0

The EPA has outlined requirements for demonstrations of wildfire events in the 2016 document *Guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events that May Influence Ozone Concentrations* and, pertinent to this demonstration, the 2024 supplementary document *$PM_{2.5}$ Wildland Fire Exceptional Events Tiering Document*. This demonstration will describe how the proposed wildfire events meet the requirements of the EER as described in regulation and the guidance documents, as applicable.

2. Narrative Conceptual Model

The EER requires that demonstrations include a narrative conceptual model describing the event. This section describes the 2023 wildfires that affected public health and impacted air quality monitors in Columbus, GA. Estimates from the National Oceanic and Atmospheric Administration (NOAA) Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT) model are used to describe the transportation of wildfire smoke to the area and around the state which ultimately led to enhancements of $PM_{2.5}$ concentrations that exceeded the NAAQS level.

Canadian wildfires during the 2023 wildfire season were well documented and impacted much of the geography of the United States. This season started ahead of the typical Canadian wildfire season, lasting from mid-April to late October (seasons are usually from May – September)[1]. Temperatures and land aridity across Canada were unusually high and resulted in the burning of a record-breaking amount of land area (≥156,000 km^2)[2]. The land area burned during this season

[1] https://doi.org/10.1038/s41467-024-51154-7
[2] https://doi.org/10.1007/s00376-023-3241-0

far exceeded the average[3] of 21,000 km^2, with the most active burns situated in the eastern province of Quebec in June and July.

Figures in Appendix A are provided to show active Canadian wildfires on the days of the exceedances and for three days beforehand via the Natural Resources Canada Interactive Map[4]. For Figures A1 and A2, when the exceedance was recorded by the relevant monitor, Canadian wildfires were on-going across the country, the majority of which had each consumed >1,000 hectares. These fires were similarly as intense up to three days prior to the recorded exceptional events.

Shown in Section 4, these wildfires resulted in the United States being blanketed in smoke and impacted $PM_{2.5}$ surface level concentrations across the country. Pertinent to this demonstration, concentrations were impacted across the southeast of the country, often simultaneously and in conjunction with the arrival of air masses either from Canada or circulated from smoke-laden areas within the United States. Air mass back-trajectories from NOAA's HYSPLIT model indicate that the plumes responsible for the summertime events were emitted either from fires in Quebec or from the western provinces (British Columbia, Alberta, and Saskatchewan), and transported across the Midwest of the United States.

This conceptual model describes how emissions from wildfires in Canada and environmental conditions contributed to the wildfire events dated in Table 1. Smoke emissions enhanced $PM_{2.5}$ concentrations observed by the monitor as they were transported to the Columbus-Baker site and caused an exceedance of the annual $PM_{2.5}$ NAAQS. The Georgia EPD requests the EPA's concurrence on June 29 and July 17, 2023, for exclusion from regulatory decision making, specifically state attainment determinations.

3. Public Notification

As described in 40 CFR 51.930(a), states requesting to exclude data due to exceptional events must take appropriate and reasonable actions to protect public health from exceedances or violations of the NAAQS. These include providing for, at a minimum, prompt public notification whenever concentrations are expected to exceed a NAAQS, public education on actions individuals may take to reduce exposures to unhealthy air quality during events, and implementation of appropriate measures to protect public health from event-caused exceedances or violations of the NAAQS.

With respect to public notification and public education, the Georgia Forestry Commission (GFC) has a public website[5] with an interactive wildfire and burn permit map that contains the current Air Quality Index at all monitors in Georgia with the option to add the following layers: (1) burn restrictions, (2) daily burn permits, (3) $PM_{2.5}$, (4) NOAA Hazard Mapping System (HMS) smoke plumes, (5) wind vectors, and (6) smoke forecast. The public can zoom in to see if smoke may impact their location. The Georgia EPD website[6] has a link to the GFC interactive burn permit map. Also, the Georgia EPD website has a link to EPA's AirNow Fire and Smoke

[3] https://cwfis.cfs.nrcan.gc.ca/ha/nfdb
[4] https://cwfis.cfs.nrcan.gc.ca/interactive-map
[5] https://georgiafc.firesponse.com/public/
[6] https://epd.georgia.gov/air-protection-branch/open-burning-rules-georgia

Map[7], EPA's AirNow When Smoke is in the Air[8], EPA's AirNow Prepare for Fire Season[9], and the EPA's Smoke-Ready Toolbox for Wildfires[10]. These websites identify several protective measures that individuals should take to reduce smoke exposure as needed, including limiting outdoor activities, avoiding strenuous outdoor activity and remaining indoors, and considering temporarily relocating or closing all doors and windows during smoke events. In addition, the Georgia EPD Ambient Air Monitoring Program website[11] provides near real-time ambient air concentrations of multiple criteria pollutants (O_3, $PM_{2.5}$, SO_2, NO_2, and CO) across the state.

Outside Georgia EPD and GFC, there was additional notification provided by various news outlets to the public about the potential for elevated air quality impacts from Canadian Wildfires. Some examples include:

- https://www.wsbtv.com/news/local/atlanta/expect-flight-delays-into-atlanta-thanks-canada-wildfire-smoke/RX2WTAWHTBGEVGQAMWFRLYCEJU/ (North Georgia/Metro Atlanta, 6/7/2023)
- https://www.13wmaz.com/article/weather/smoke-from-wildfire-to-central-georgia/93-87f7b552-98fd-4b86-8f99-94140c76d38d (Macon/Central Georgia, 6/7/2023)
- https://www.youtube.com/watch?v=sZkxex_jpQw (Central Georgia, 6/7/2023)
- https://www.wsbradio.com/weather/wildfire-smoke-drifting-south-canada-into-north-georgia/OKNENTCA6JGGJPYQ76VCO6LF5Q/ (Metro Atlanta/Birmingham, Alabama, 6/7/2023)
- https://www.gpb.org/news/the-picture-show/2023/06/07/photos-extreme-canadian-wildfire-smoke-shrouds-parts-of-us (North and South Carolina, 6/7/2023)
- https://www.atlantanewsfirst.com/2023/06/08/air-quality-georgia-will-smoke-wildfires-reach-us/ (Greater Metro Atlanta, 6/8/2023)
- https://patch.com/georgia/atlanta/code-orange-alert-what-know-air-quality-ga (Atlanta, 6/8/2023)
- https://www.walb.com/2023/06/08/canadian-wildfire-smoke-arrives-south-ga-effects-are-minimal/ (Albany/South Georgia, 6/8/2023)
- https://abcnews.go.com/US/canadian-wildfire-dangers-prompt-proactive-mitigation-government-experts/story?id=100478859 (Predicts plume will migrate to Georgia, 7/1/2023)
- https://www.11alive.com/article/weather/stormtracker/wildfire-smoke-north-georgia/85-b4670fee-4608-4f99-9904-bbdbcf924375 (North Georgia, 7/17/2023)
- https://foxchattanooga.com/weather/stormtrack-9-blog/canadian-wildfire-smoke-impacts-tennessee-georgia-air-quality-once-again (Chattanooga, 7/17/2023)
- https://www.nytimes.com/2023/07/18/us/smoke-wildfires-nc-georgia.html (Georgia, 7/18/2023)
- https://www.fox5atlanta.com/news/code-orange-alert-metro-atlanta-canadian-wildfire-smoke (Georgia, 7/18/2023)

[7] https://fire.airnow.gov/
[8] https://www.airnow.gov/wildfires/when-smoke-is-in-the-air/
[9] https://www.airnow.gov/sites/default/files/2020-10/prepare-for-fire-season.pdf
[10] https://www.epa.gov/air-research/smoke-ready-toolbox-wildfires
[11] https://airgeorgia.org/

- https://www.atlantanewsfirst.com/2023/07/18/canadian-wildfires-bring-poor-air-quality-north-georgia/ (Metro Atlanta/North Georgia, 7/18/2023)
- https://www.cnn.com/2023/07/17/weather/canada-wildfires-shatter-burning-records/index.html (North Georgia, 7/18/2023)
- https://www.iqair.com/us/newsroom/atlanta-air-quality-alert (Atlanta 7/18/2023)
- https://www.houstonchronicle.com/news/houston-texas/environment/article/houston-pollution-canadian-wildfire-saharan-dust-18206844.php (Atlanta/Georgia, 7/18/2023)
- https://www.wsfa.com/2023/07/18/details-behind-canadian-wildfire-smoke-alabamas-sky/ (Montgomery/Alabama, 7/18/2023)
- https://news.gatech.edu/news/2023/07/19/canadian-wildfire-smoke-affects-atlanta-2 (Atlanta, 7/19/2023)
- https://www.gpb.org/news/2023/07/26/macon-had-georgias-worst-air-quality-last-week-thanks-canadian-wildfires-heat-dome (Macon, 7/26/2023)
- https://www.savannahnow.com/story/weather/2023/10/03/savannah-ga-air-quality-canadian-wildfire-smoke-moves-down-u-s-coast/71045920007/ (Savannah, 10/3/2023)
- https://www.gpb.org/news/2023/10/04/have-you-noticed-haze-in-the-air-heres-why-georgia-dealing-smoke (South/Middle Georgia, 10/4/2023)

4. Clear Causal Relationship and Supporting Analyses

This section addresses the EER requirements at 40 CFR 50.14(c)(3)(iv)(B) by showing that the events affected air quality in such a way that there exists a clear, causal relationship between the specific events and the monitored exceedance, and at 40 CFR 50.14(c)(3)(iv)(C) by providing analyses comparing the claimed event-influenced concentrations to concentrations at the same monitoring site at other times. The *Guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events that May Influence Ozone Concentrations* and *$PM_{2.5}$ Wildland Fire Exceptional Events Tiering Document* outline the expected components of a clear causal relationship portion of a demonstration. These include a comparison of the event-related concentration to historical concentrations, evidence that the emissions from wildfires were transported to the monitor, and evidence that the prescribed fire emissions affected the monitor.

Figures B1 and B2 (Appendix B) show smoke from the NOAA Hazard Mapping System (HMS), plotted via the AirNow Navigator[12]. Active fires and smoke are shown for the dates the event was registered as well as up to three days beforehand. During the exceptional events, smoke pervaded the air throughout much of the eastern half of the United States, if not the entire country.

The historical data analysis section of this demonstration focuses on 2019-2023 $PM_{2.5}$ FRM data at the Columbus-Baker site monitor. Table 3 contains a comparison of exceptional event concentrations to historic 2019-2023 concentrations for the monitor. Generally, the exceptional event concentrations are at least double the 5-year annual average, quarterly average, and monthly average, and in some cases can be up to three times higher.

[12] https://airnowtech.org/navigator/

Table 3. Comparison of exceptional event concentrations to historic 2019-2023 concentrations at the Columbus-Baker site monitor (AQS ID: 13-215-0012).

EE Date	EE Concentration ($\mu g/m^3$)	5-Year Annual Average ($\mu g/m^3$)	5-Year Quarterly Average ($\mu g/m^3$)	5-Year Monthly Average ($\mu g/m^3$)	Ratio EE to 5-Year Annual Average	Ratio EE to 5-Year Quarterly Average	Ratio EE to 5-Year Monthly Average
06/29/23	20.8	9.0	8.82	9.75	2.3	2.4	2.1
07/17/23	25.3	9.0	8.58	9.06	2.8	3.0	2.8

Figure 1 plots the 24-hour $PM_{2.5}$ concentrations for 2019-2023. Exceedances caused by wild or prescribed fires are delineated by marker shape. Concentrations generally fall within the Tier 3 range, below 17.8 $\mu g/m^3$, except when smoke from fires is present. The selected exceptional events days fall just below into the Tier 2 threshold (< 26.7 $\mu g/m^3$). Tier 2 events are greater than or equal to a threshold of the minimum annual 98th percentile for 24-hour $PM_{2.5}$ data over the previous 5-years, but less than 1.5 times this threshold per the EPA's Tiering Tool.

Figure 1. 24-hour $PM_{2.5}$ concentrations for 2019-2023 observed at the Columbus-Baker site.

Maps from the AirNow Navigator are provided in Appendix C for each exceedance event in Table 3. The maps include NOAA HMS satellite detected fires, HMS smoke plumes, 24-hour $PM_{2.5}$ concentrations across the United States, and HYSPLIT back-trajectories. These trajectories originate at the Columbus-Baker monitor's geographic location and extend 72 hours back in time. Three different starting times were modeled with HYSPLIT for each day: (1) midnight at the start of the exceedance day, (2) noon of the exceedance day, and (3) midnight at the end of the exceedance day. Each trajectory starts at a different elevation above ground level

(100 m, 1500 m, and 3000 m). The 1500 m and 3000 m tails are used to estimate the trajectories of smoke transported over a long range. The 100 m tail, nearer to the surface, is used to show local transport. Additionally, these values are chosen to estimate vertical transport near-surface and up to several hundred meters above the planetary boundary layer. Figures in Appendix D are provided to show ground level, daily $PM_{2.5}$ concentrations, and air quality indices (AQIs) in the southeast of the United States. Figures in Appendix E show hourly $PM_{2.5}$ time series for both the event day and the day before. Figures in Appendix F show upper air maps from the Storm Prediction Center[13] for the event day and three days prior. Maps are displayed at pressures of either 850 millibar (mb), equivalent to 1170-1590 m above mean sea level (MSL), or 700 mb, equivalent to 2350-3150 MSL[14], on midnight or noon (UTC) for each day. These pressure values are chosen to correspond with the 1500-m and 3000-m heights of the HYSPLIT trajectories. A specific pressure value is determined on a case-by-case basis depending on how clearly the corresponding upper air maps explain the sequence of events that led to the relevant exceedance.

June 29, 2023

Fires in Canada had been on-going for months at the time the exceedance was measured, and their emissions were likely mixed throughout the air column. From Figure E1, $PM_{2.5}$ concentrations were elevated above the 9.0 $\mu g/m^3$ standard throughout the event day and the day prior. Shown in Figure C1, the 1500-m HYSPLIT tail, released on midnight of the exceedance day, traveled from near a large plume in the northeast U.S. emitted by the Quebec fires. The 1500-m tails released at later times on the event day follow similar spatial trajectories, indicating the Quebec smoke plume was transported to the monitoring site. Wind barbs in Figures F1 and F2 corroborate the back-trajectories as they show a counterclockwise vortex centered over the northeast/Great Lakes region on June 26 and 27 that extended to the southeast. Smoke plumes were initially circulated in this vortex and then advected through the Midwest and down to the southeast (Figures F3-F5). This led to the daily $PM_{2.5}$ concentration at the Columbus-Baker site on June 29, 2023, increasing to 20.8 $\mu g/m^3$. Figure D1 shows that this enhancement occurred synchronously with elevated concentrations reported by monitors across the southeast, which follows from the large blanket of smoke over this region (Figure B1).

July 17, 2023

Fires in Canada had been on-going for months at the time the exceedance was measured, and their emissions were likely mixed throughout the air column. From Figure E2, $PM_{2.5}$ concentrations were elevated above the 9.0 $\mu g/m^3$ standard starting on 10:00 PM ET on July 16 and remained elevated throughout the event day. Shown in Figure C2, back-trajectories indicate that the smoke plume traveled through the Midwest of the United States. As a result, the plume detected by the monitor is most likely a mixture of emissions from fires in provinces of British Columbia, Alberta, and Saskatchewan. The back-trajectories converge in space approximately 24 hours before descending to near-surface level where observed, the daily $PM_{2.5}$ concentration at the Columbus-Baker site on July 17, 2023, increased to 25.3 $\mu g/m^3$. Figure D2 shows that this enhancement occurred synchronously with elevated concentrations reported by monitors across the southeast, which follows from the large blanket of smoke over this region (Figure B2).

[13] https://www.spc.noaa.gov/obswx/maps/
[14] https://www.noaa.gov/jetstream/upper-air-charts

The comparisons and analyses, provided here in this demonstration support the Georgia EPD's position that the fire 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 for the dates described in Table 1 and thus satisfies the clear causal relationship criterion.

5. Not reasonably Controllable or Preventable

This section satisfies the EER requirements at 40 CFR 50.14(c)(3)(iv)(A), CFR 50.1(j), 40 CFR 50.14(c)(3)(iv)(D), and 40 CFR 50.14(b)(4): The event was caused by a natural event; an exceptional event is one that is not reasonably controllable or preventable. Stated in section 40 CFR 50.14 (a)(8)(vii), the Administrator shall not require a State to provide case-specific justification to support the not reasonably controllable or preventable criterion for emissions-generating activity that occurs outside of the State's jurisdictional boundaries within which the concentration at issue was monitored.

6. Human Activity Unlikely to Recur at a Particular Location or Natural Event

This section satisfies the EER requirement at 40 CFR 50.14(c)(3)(iv)(E): A demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event. The definition of wildfire in the EER is: "…any fire started by an unplanned ignition caused by lightning; accidental, human causes actions, or a prescribed fire that has developed into a wildfire. A wildfire that predominately occurs on wildland is a natural event." As stated in sections 2 and 4, the origin and evolution of the wildfires described in this demonstration occurred in Canada.

Based on the documentation provided in sections 2 and 4 of this demonstration, these events qualify as natural events as they spread uncontrolled through remote, natural (i.e., non-agricultural or silvicultural) lands. The National Aeronautics and Space Administration (NASA) noted that many of the Canadian fires were ignited by summer lightning storms and largely burned in deeply wooded areas. The EPA generally considers the emissions of $PM_{2.5}$ from wildfires to meet the regulatory definition of a natural event, defined as one "in which human activity plays little or no direct causal role" (40 CFR 50.1(k)). As the Georgia EPD has shown that the demonstrated exceedances resulted from natural events, they should be considered for treatment as exceptional events.

7. Public Comment Period

The Georgia EPD held a 30-day public comment period starting on December 20, 2024, to receive public input regarding the Exceptional Event Demonstration. Notification of the public comment period was posted on the Georgia EPD website and emailed to interested stakeholders. Public comments received are included in Appendix G of this demonstration, along with the Georgia EPD's responses to these comments in Appendix H.

Appendix A: Active Wildfires in Canada

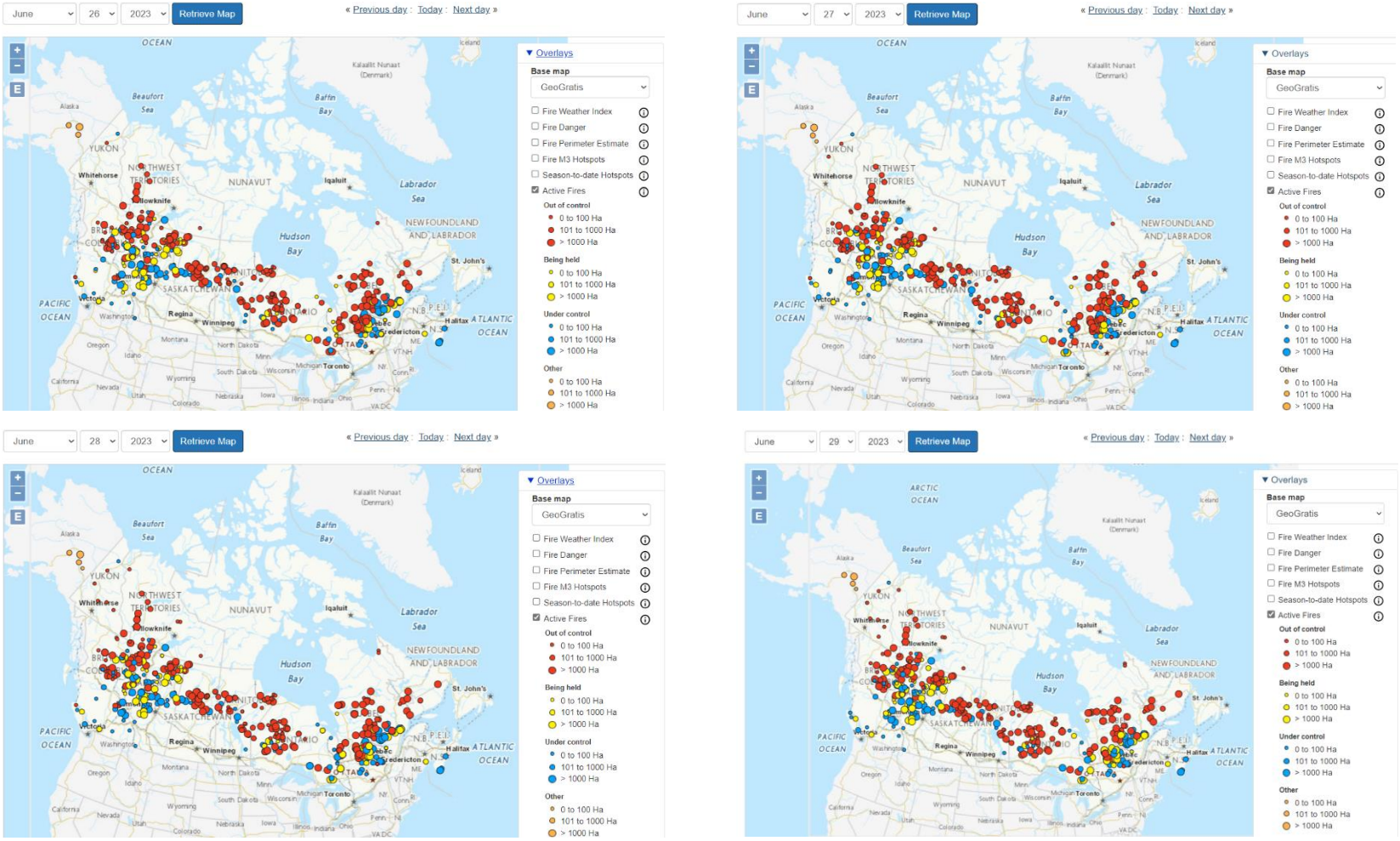


Figure A1. Active wildfires in Canada on June 26-29, 2023, as shown on an interactive map from Natural Resources Canada (https://cwfis.cfs.nrcan.gc.ca/interactive-map).

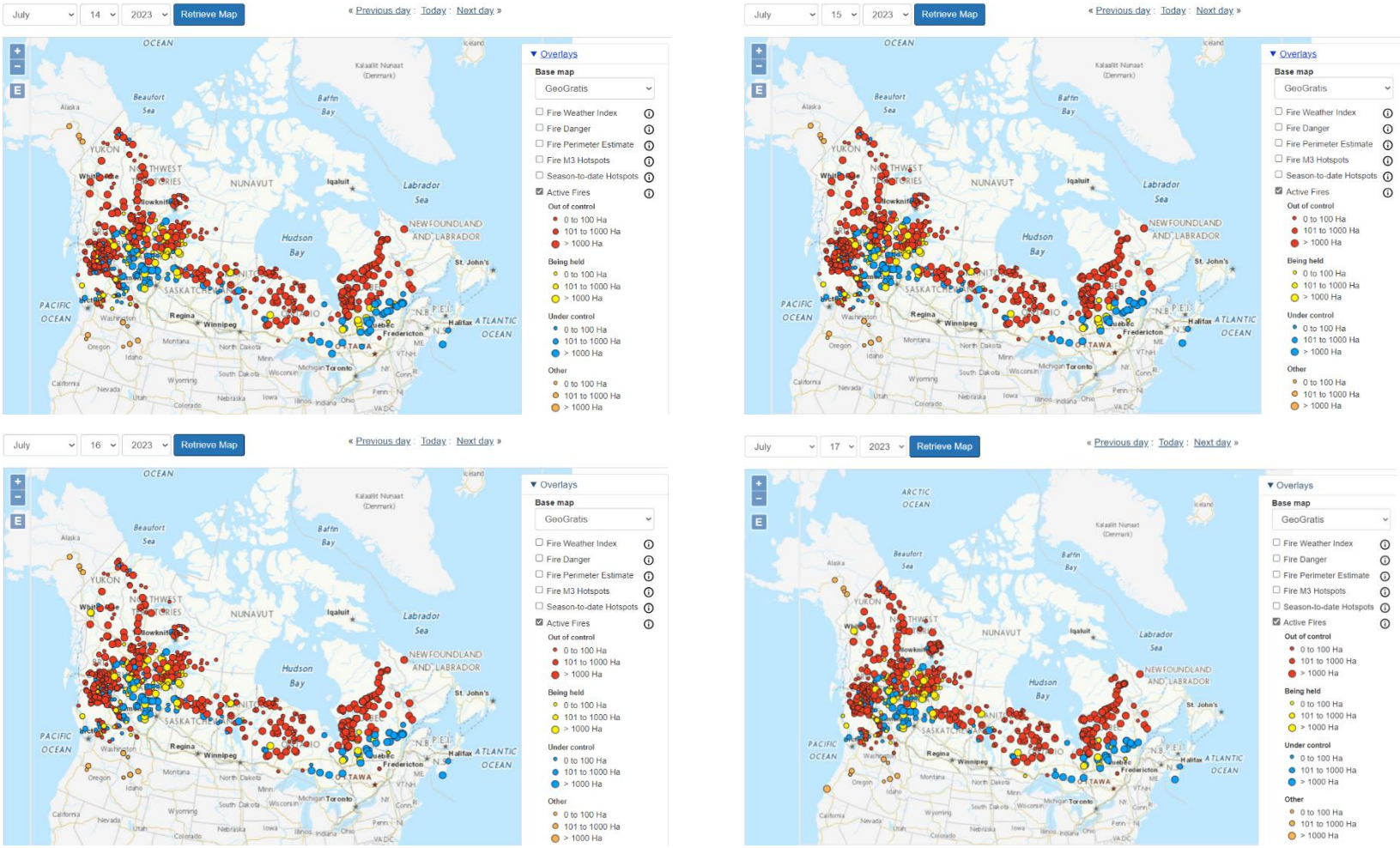


Figure A2. Active wildfires in Canada on July 14-17, 2023, as shown on an interactive map from Natural Resources Canada (https://cwfis.cfs.nrcan.gc.ca/interactive-map).

Appendix B: HMS Smoke and Active Fires

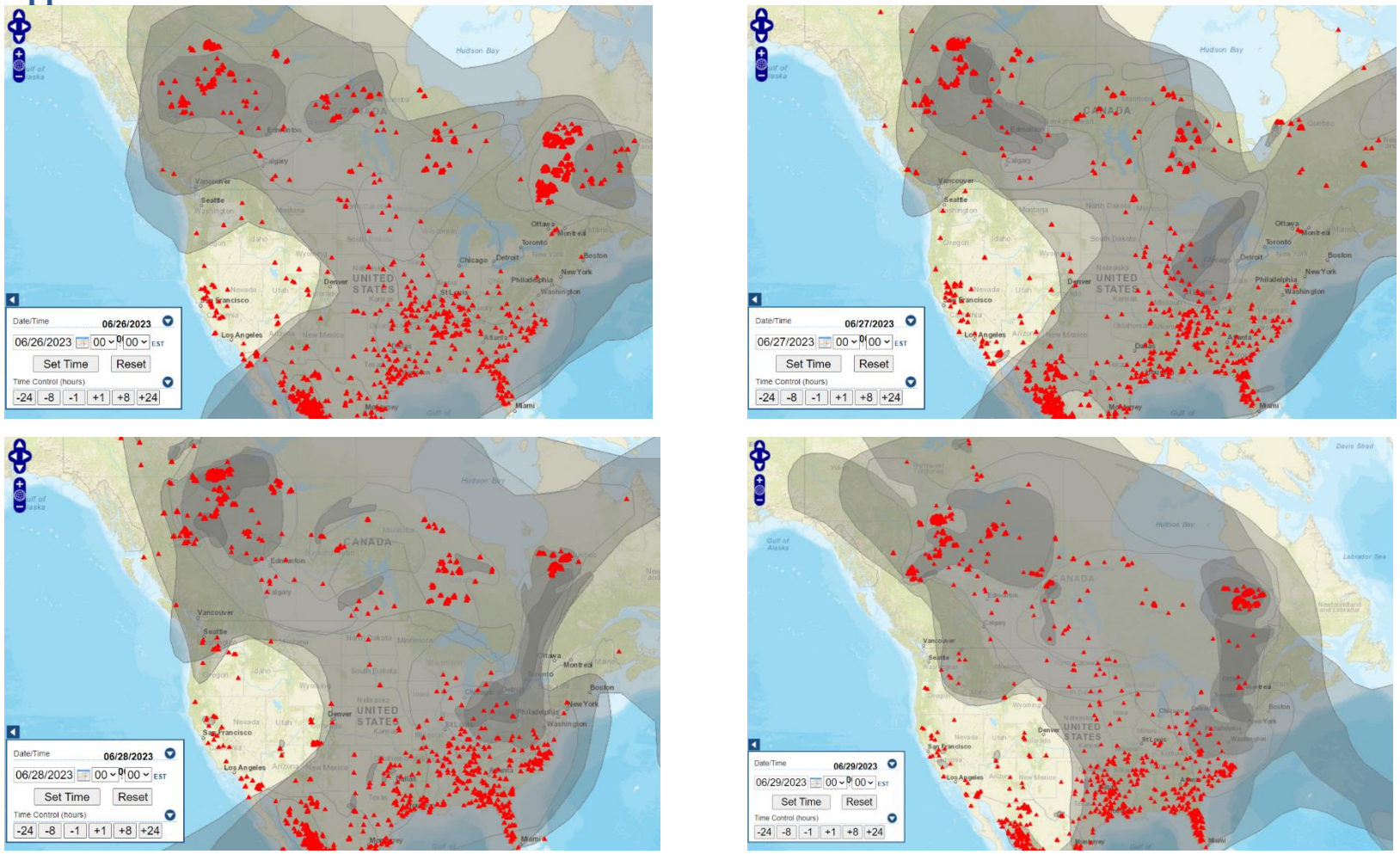


Figure B1. Map from the AirNow Navigator showing active fires (red triangles) and smoke (grey polygons) on June 26-29, 2023, over North America.

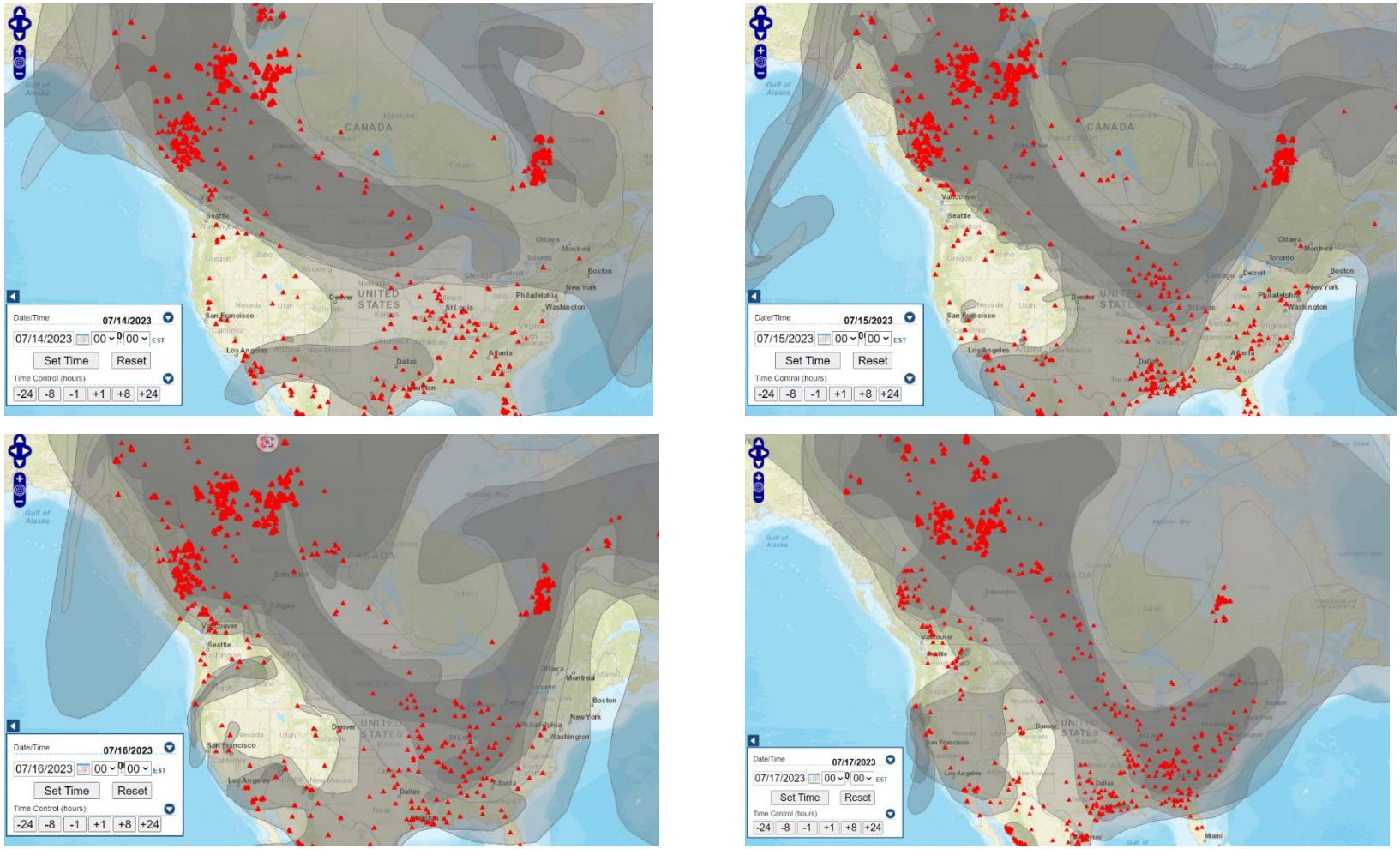


Figure B2. Map from the AirNow Navigator showing active fires (red triangles) and smoke (grey polygons) on July 14-17, 2023, over North America.

Appendix C: HYPLSIT Back-Trajectory Maps

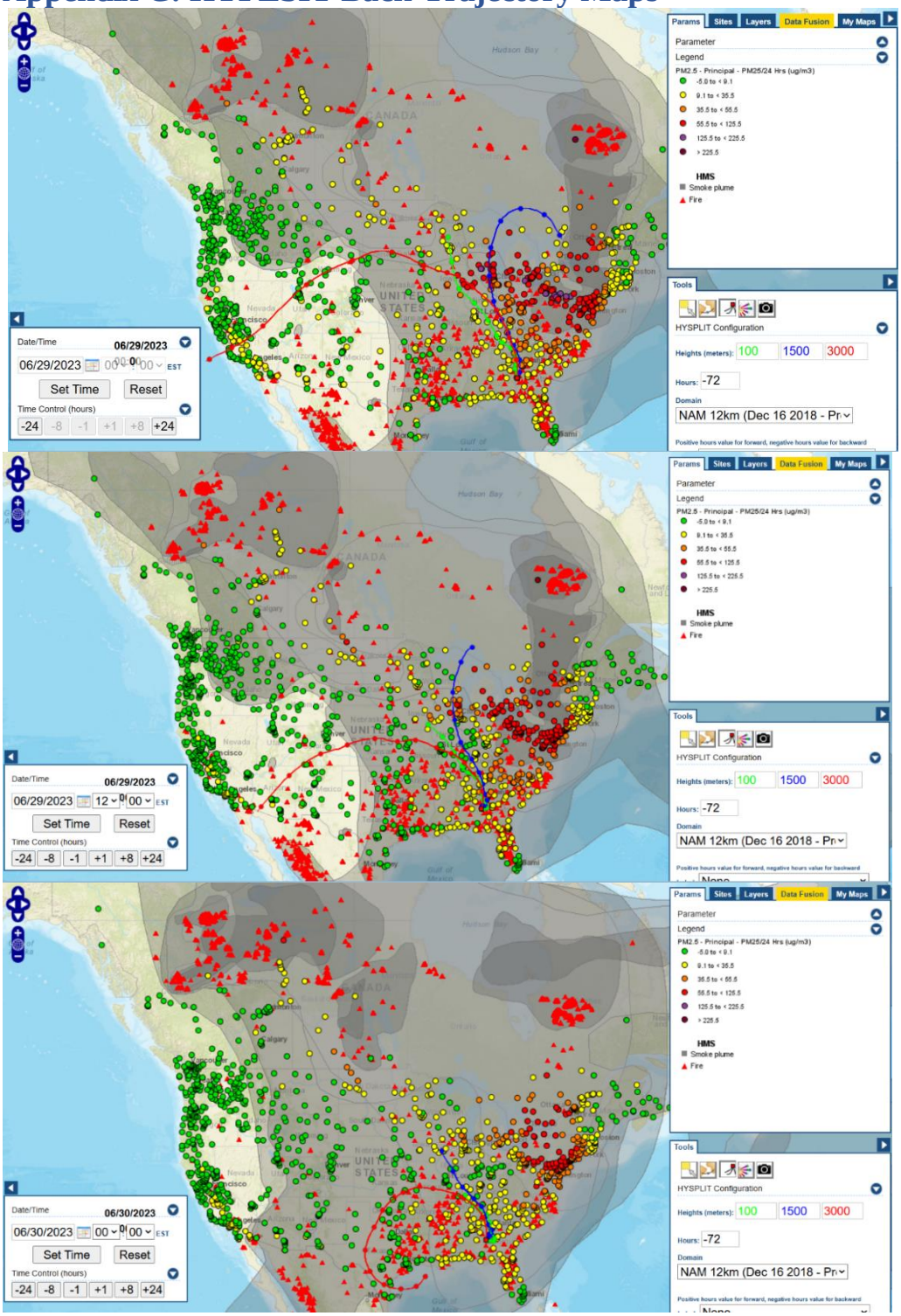


Figure C1. Map of HMS smoke plumes (grey polygons) and fires (red triangles), daily $PM_{2.5}$ concentrations (circles), and HYSPLIT back-trajectories of release heights at 100 m (green lines), 1500 m (blue lines), and 3000 m (red lines) for 0 AM EST on June 29, 2023 (top), 12 PM EST on June 29, 2023 (middle), and 0 AM EST on June 30, 2023 (bottom).

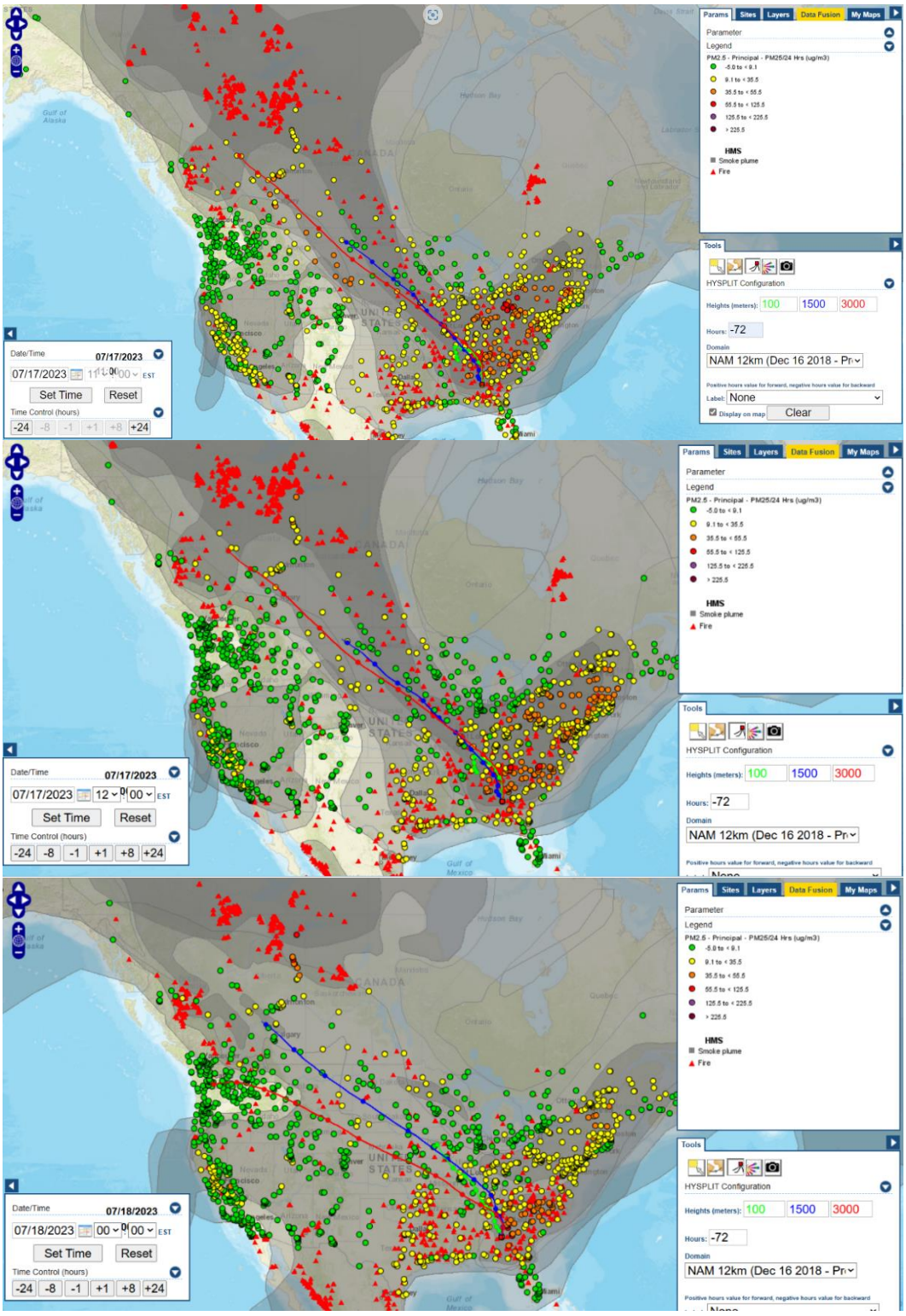
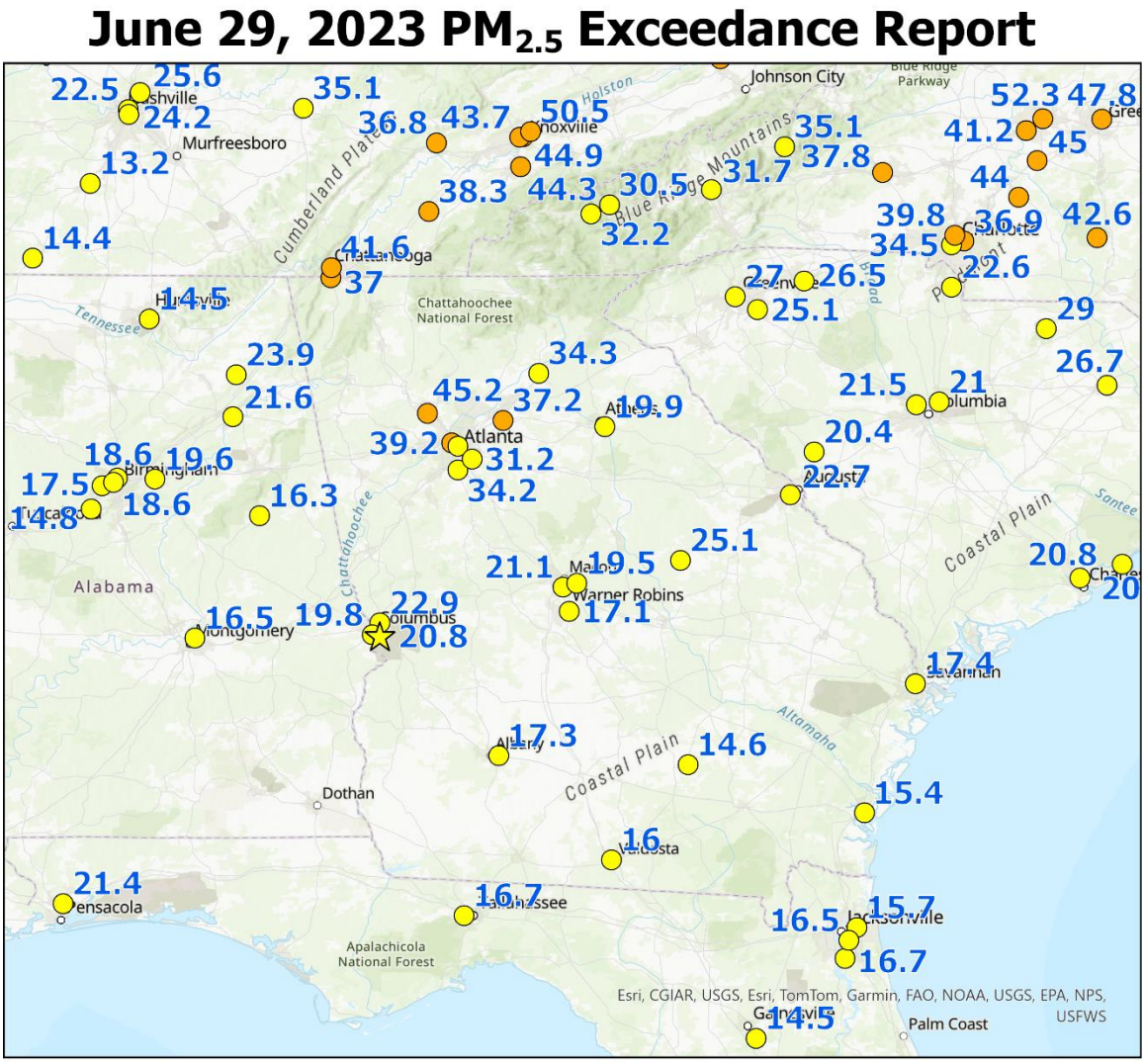


Figure C2. Map of HMS smoke plumes(grey polygons) and fires (red triangles), daily $PM_{2.5}$ concentrations (circles), and HYSPLIT back-trajectories of release heights at 100 m (green lines), 1500 m (blue lines), and 3000 m (red lines) for 0 AM EST on July 17, 2023 (top), 12 PM EST on July 17, 2023 (middle), and 0 AM EST on July 18, 2023 (bottom).

Appendix D: $PM_{2.5}$ Surface Concentrations in the Southeast

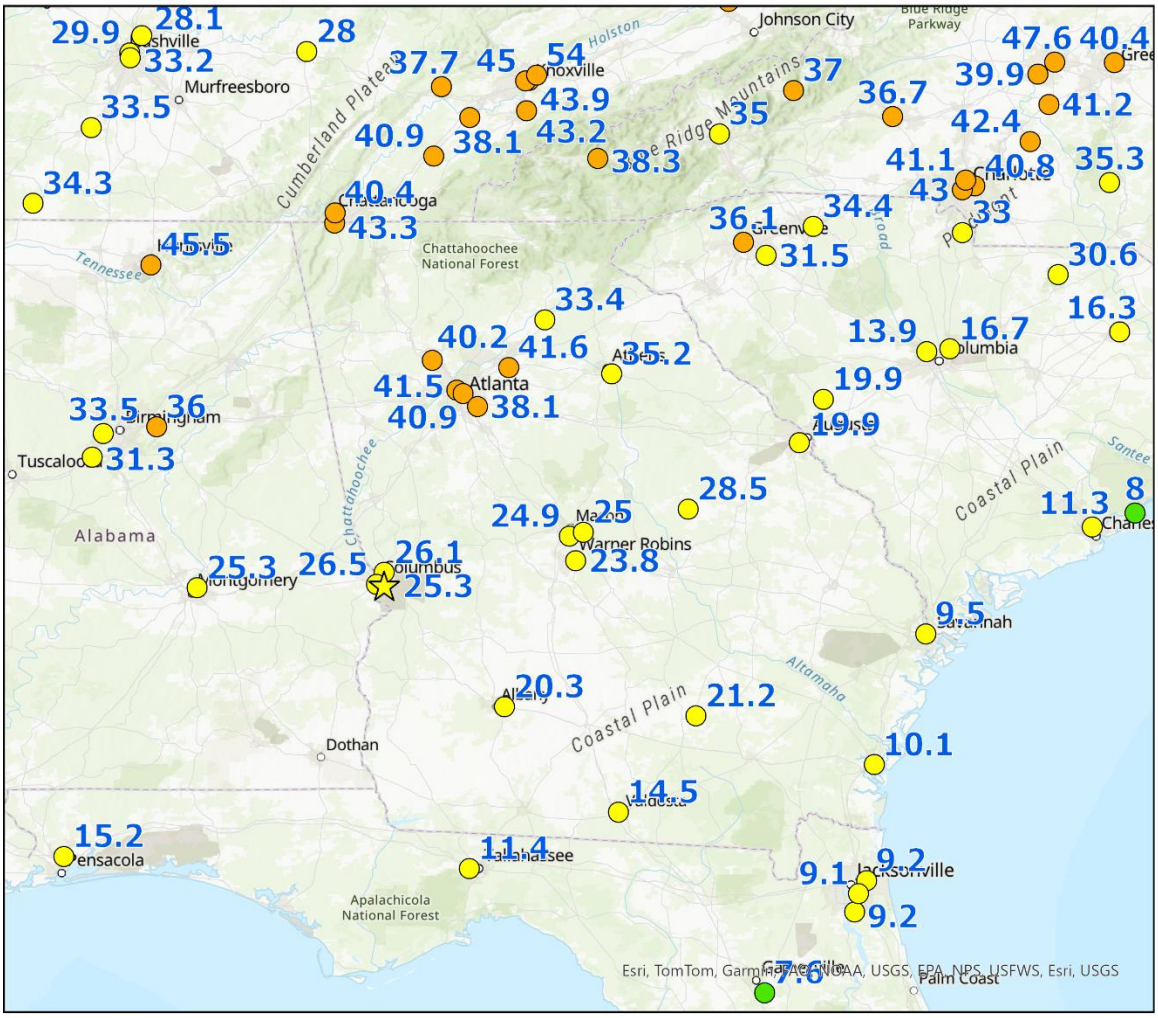


AQI category - 24-hr average $PM_{2.5}$

- Good (0-9 ug/m^3)
- Moderate (9.1-35.4 ug/m^3)
- Unhealthy for sensitive (35.5-55.4 ug/m^3)
- Unhealthy (55.5-150.4 ug/m^3)
- Very unhealthy (150.4-250.4 ug/m^3)
- Hazardous (>250.4 ug/m^3)

Figure D1. Surface level, daily $PM_{2.5}$ concentrations on June 29, 2023, across the southeast. The Columbus-Baker monitoring site is represented by a star. Numerous sites measured concentrations that exceeded the level of annual $PM_{2.5}$ NAAQS.

July 17, 2023 $PM_{2.5}$ Exceedance Report



AQI category - 24-hr average $PM_{2.5}$

- Good (0-9 ug/m^3)
- Moderate (9.1-35.4 ug/m^3)
- Unhealthy for sensitive (35.5-55.4 ug/m^3)
- Unhealthy (55.5-150.4 ug/m^3)
- Very unhealthy (150.4-250.4 ug/m^3)
- Hazardous (>250.4 ug/m^3)

Figure D2. Surface level, daily $PM_{2.5}$ concentrations on July 17, 2023, across the southeast. The Columbus-Baker monitoring site is represented by a star. Numerous sites measured concentrations that exceeded the level of annual $PM_{2.5}$ NAAQS.

Appendix E: Hourly $PM_{2.5}$ Time Series

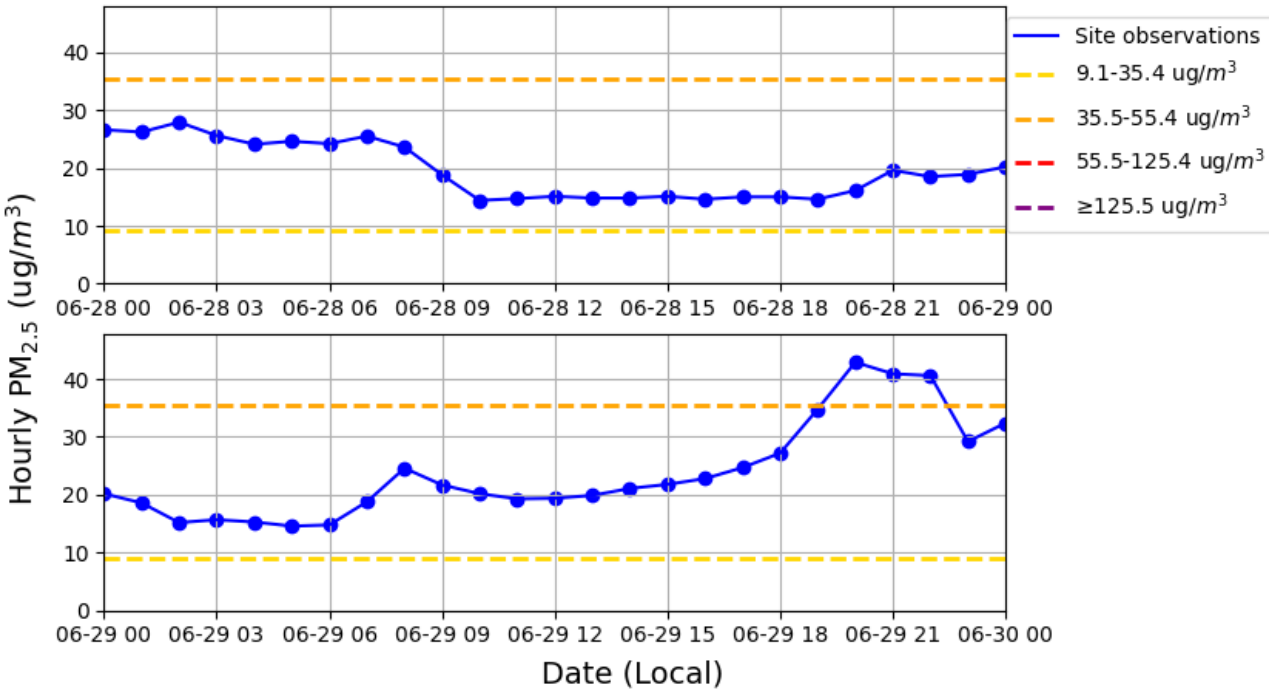


Figure E1. Hourly $PM_{2.5}$ concentrations at the Columbus-Baker monitoring site on June 28 and 29, 2023. The solid blue lines with dots show observations. The dashed lines show AQI breakpoints.

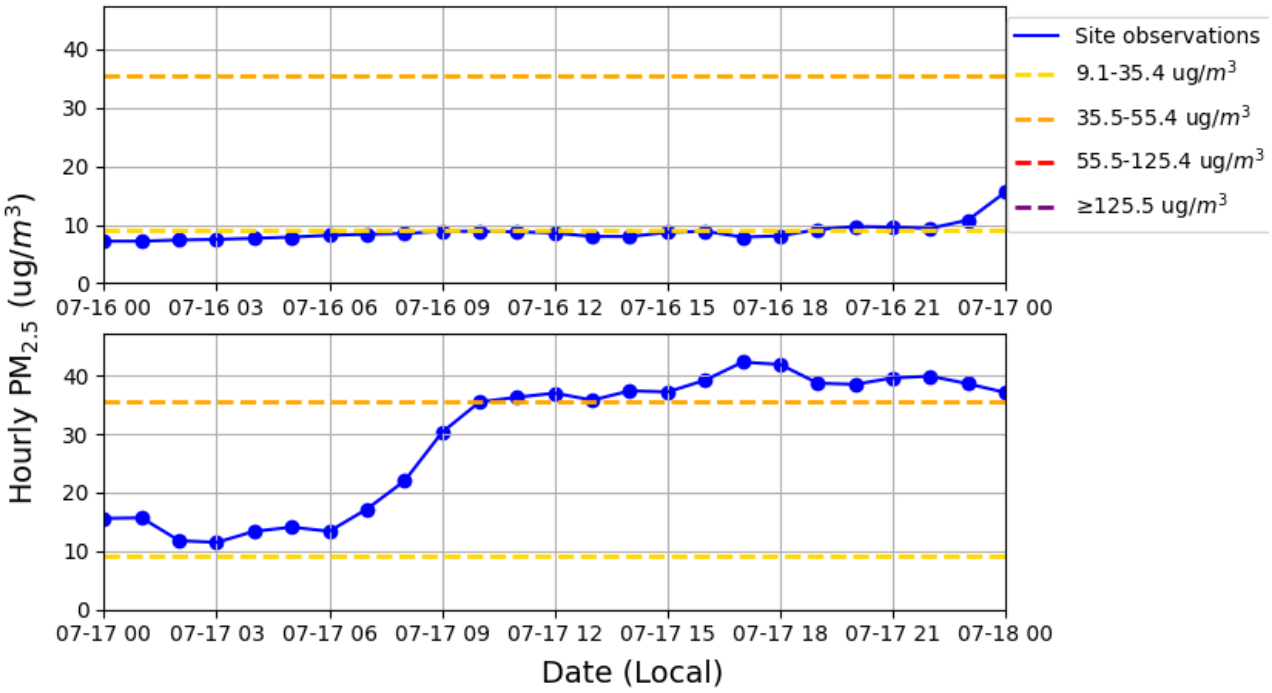


Figure E2. $PM_{2.5}$ concentrations at the Columbus-Baker monitoring site on July 16 and 17, 2023. The solid blue lines with dots show observations. The dashed lines show AQI breakpoints.

Appendix F: Upper Air Maps

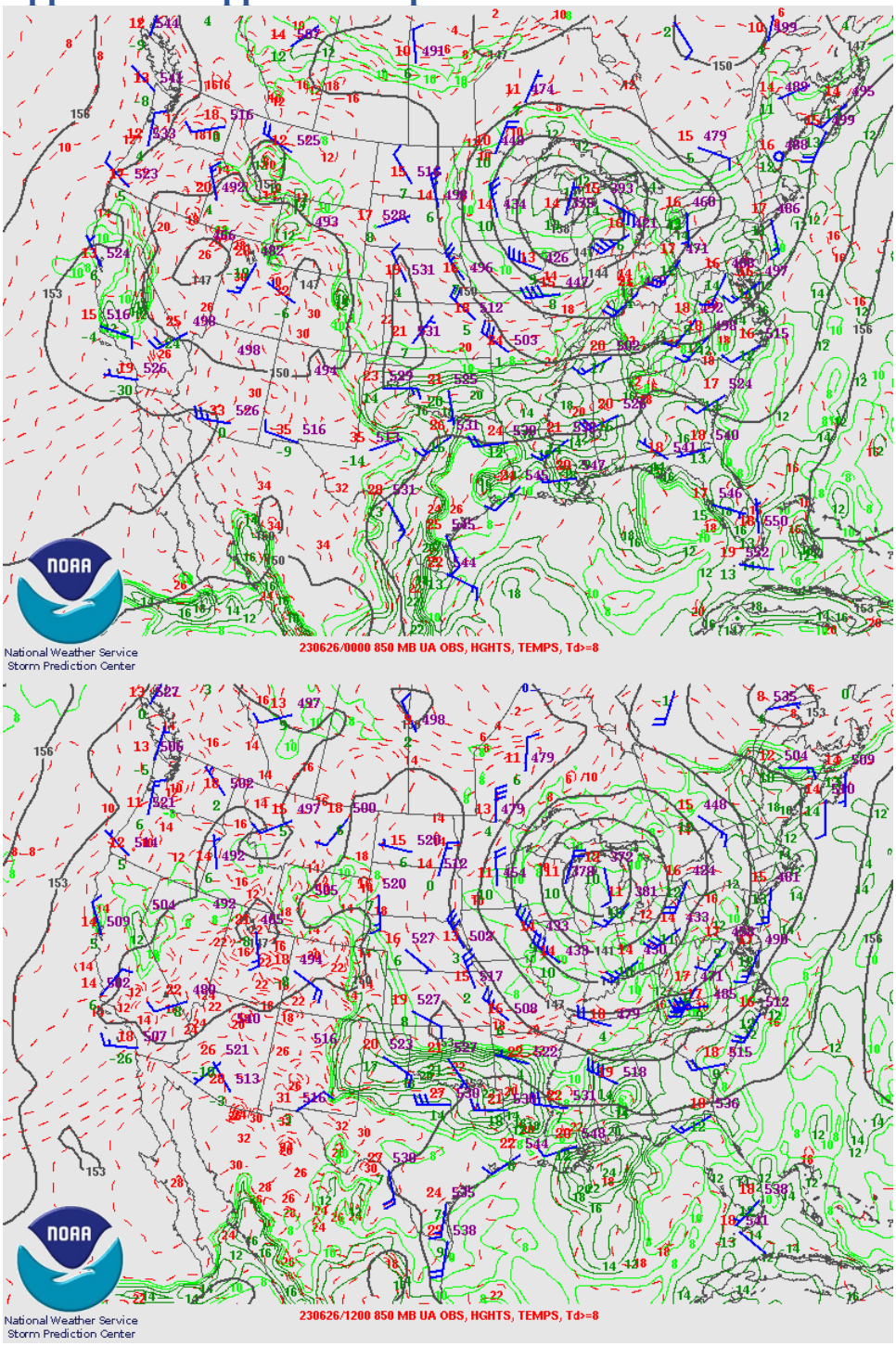


Figure F1. Storm Prediction Center upper air maps for June 26, 2023, at 00 UTC (top) and at 12 UTC (bottom). Maps are generated at a pressure of 850 mb (altitude of 1170-1590 MSL). Wind barbs (° from north, knots) are plotted in blue, isotherms (°C) in red, isodrosotherms (°C) in green contours, and isoheights (MSL) in dark grey.

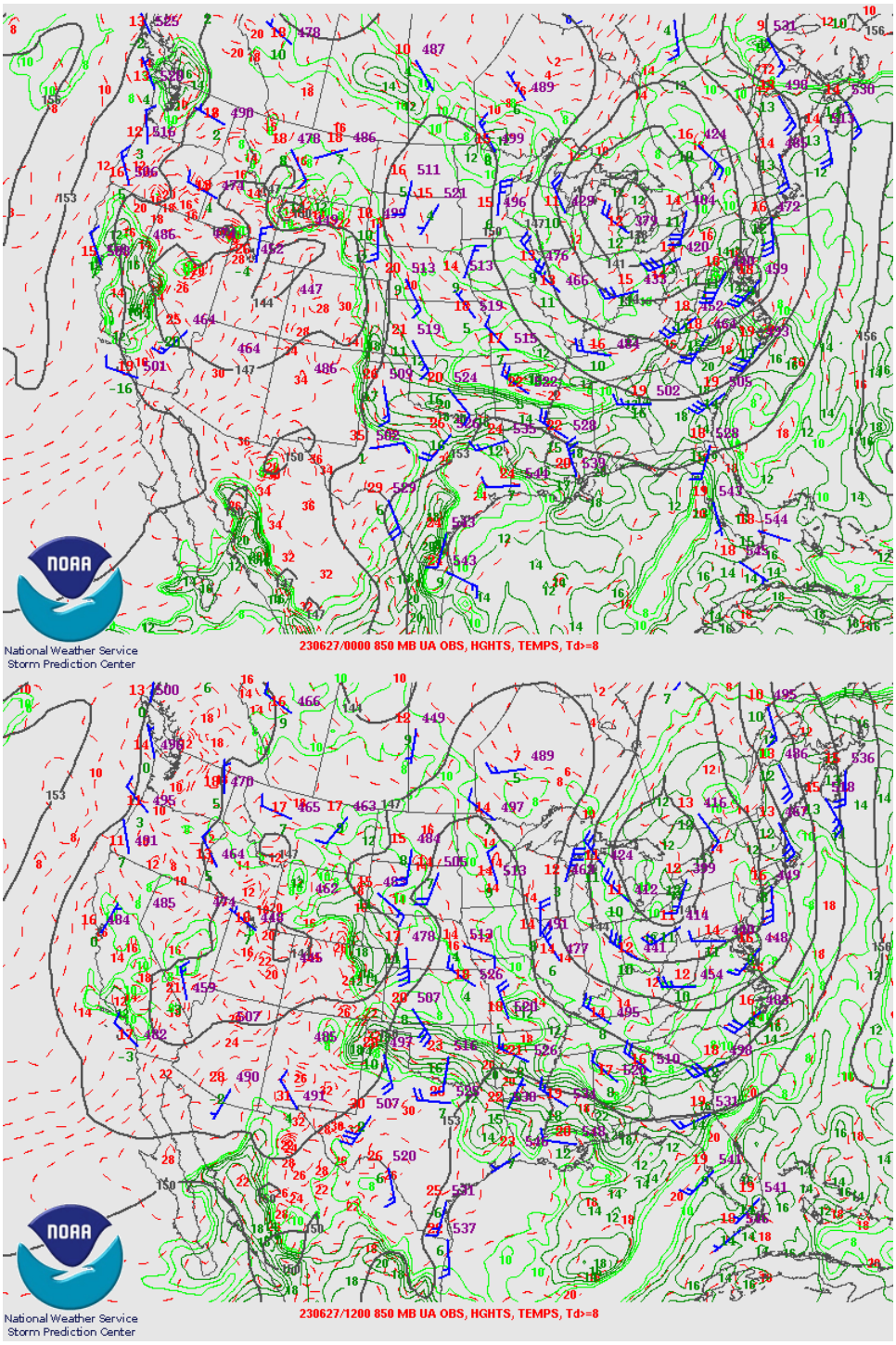


Figure F2. Storm Prediction Center upper air maps for June 27, 2023, at 00 UTC (top) and at 12 UTC (bottom). Maps are generated at a pressure of 850 mb (altitude of 1170-1590 MSL). Wind barbs (° from north, knots) are plotted in blue, isotherms (°C) in red, isodrosotherms (°C) in green, and isoheights (MSL) in dark grey.

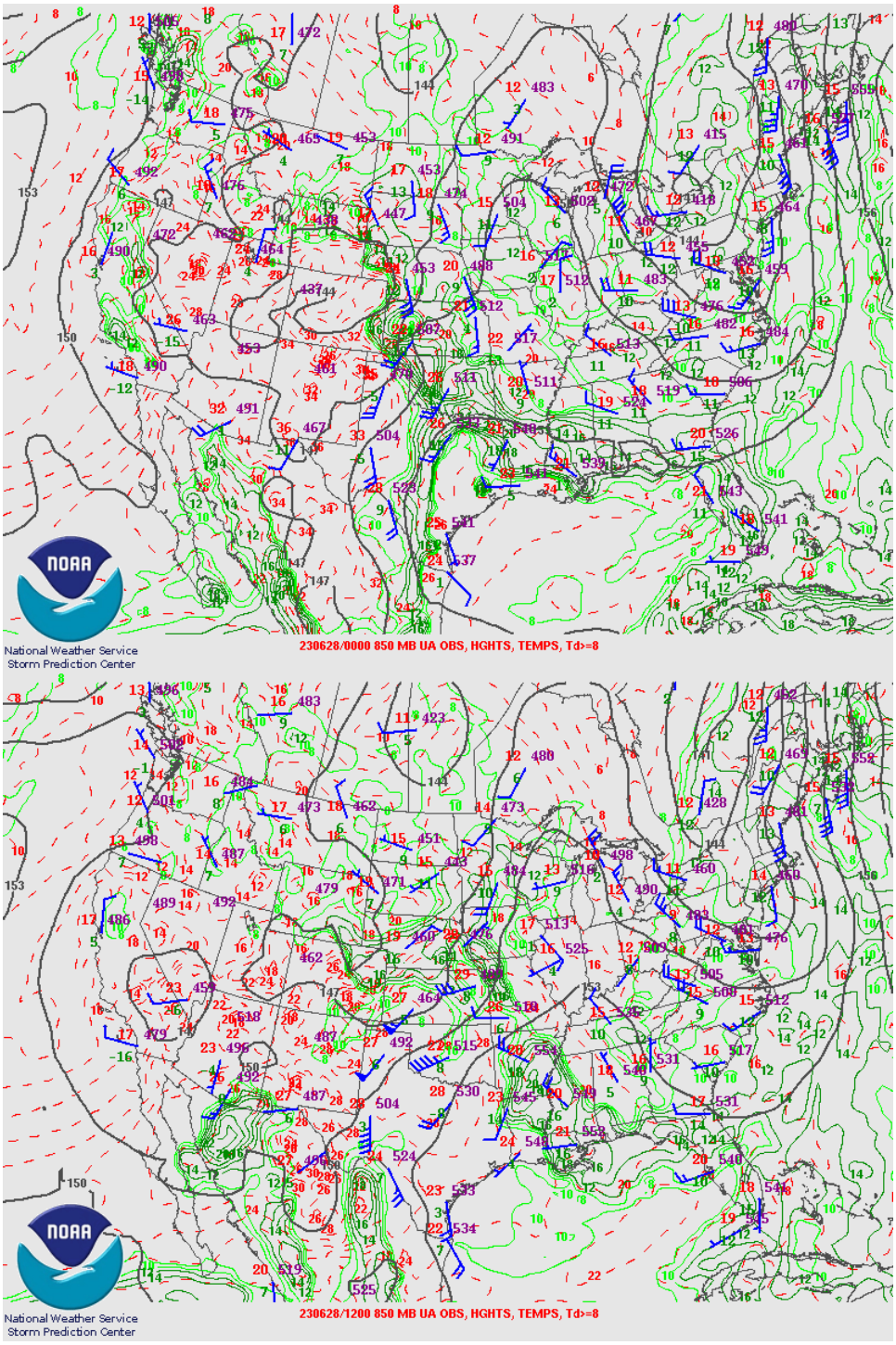


Figure F3. Storm Prediction Center upper air maps for June 28, 2023, at 00 UTC (top) and at 12 UTC (bottom). Maps are generated at a pressure of 850 mb (altitude of 1170-1590 MSL). Wind barbs (° from north, knots) are plotted in blue, isotherms (°C) in red, isodrosotherms (°C) in green, and isoheights (MSL) in dark grey.

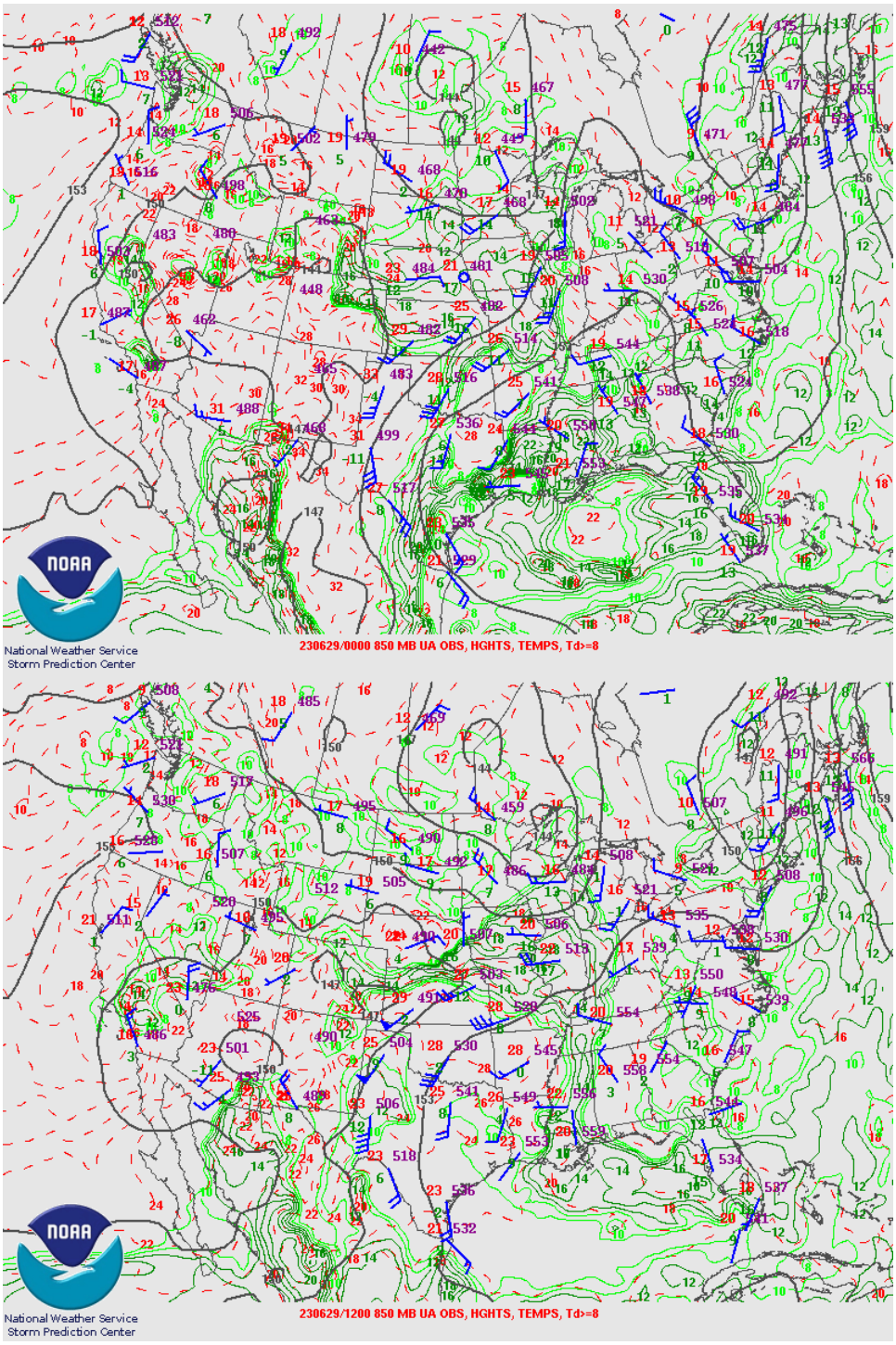


Figure F4. Storm Prediction Center upper air maps for June 29, 2023, at 00 UTC (top) and at 12 UTC (bottom). Maps are generated at a pressure of 850 mb (altitude of 1170-1590 MSL). Wind barbs (° from north, knots) are plotted in blue, isotherms (°C) in red, isodrosotherms (°C) in green, and isoheights (MSL) in dark grey.

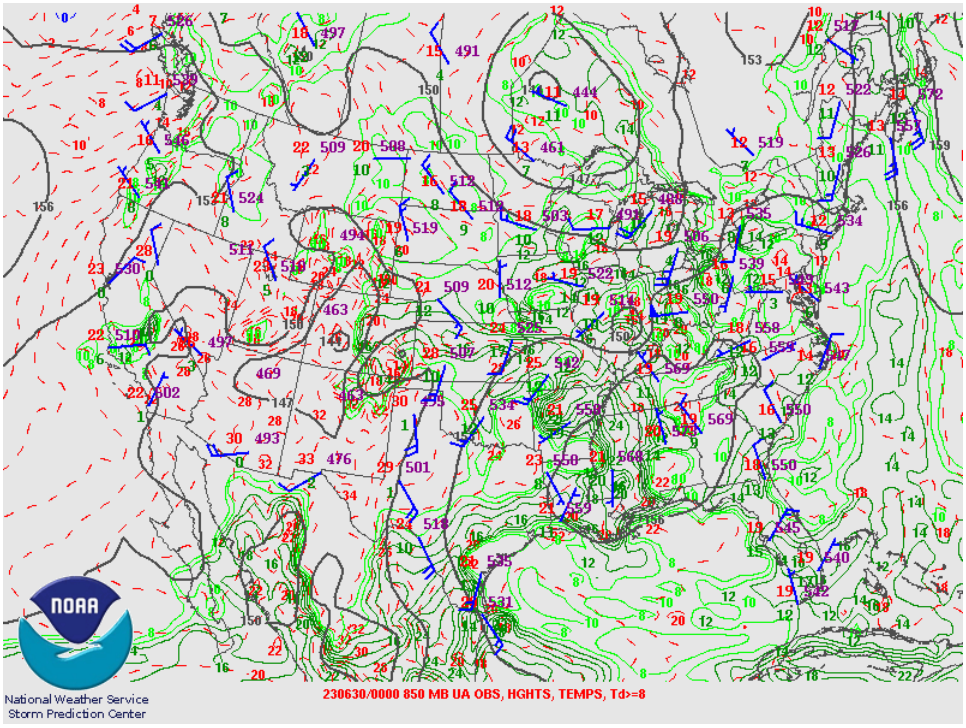


Figure F5. Storm Prediction Center upper air maps for June 30, 2023 (00 UTC). The map is generated at a pressure of 850 mb (altitude of 1170-1590 MSL). Wind barbs (° from north, knots) are plotted in blue, isotherms (°C) in red, isodrosotherms (°C) in green, and isoheights (MSL) in dark grey.

Appendix G: Public Comments

Appendix H: Responses to Public Comments