GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

# Draft Canadian Wildfire Exceptional Event Demonstration for the 2024 Annual $PM_{2.5}$ NAAQS at Gwinnett Tech, GA in 2022-2024

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## 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. For the purpose of this document, an "exceedance" is defined as a measured 24-hour $PM_{2.5}$ concentration that is greater than the level (9.0 $\mu g/m^3$) of the 2024 annual $PM_{2.5}$ NAAQS. Please note that "exceedance" as defined in this document (based on an averaging time of 24-hours) is not an actual exceedance of the 2024 annual $PM_{2.5}$ NAAQS since an exceedance of a NAAQS must be based on the averaging time for the NAAQS (in this case, annual) in addition to the level of the NAAQS (in this case, 9.0 $\mu g/m^3$).

Starting October 26, 2017, a continuous $PM_{2.5}$ FEM monitor was installed at the Gwinnett Tech site (Air Quality System (AQS) ID: 13-135-0002). From November 2, 2018, through July 31, 2023, this was the primary monitor at the site. Starting September 30, 2024, a $PM_{2.5}$ FRM monitor was deployed on a daily schedule and became the primary monitor for the site. The Georgia Ambient Air Monitoring Program has requested from EPA that data from October 2024 through August 2027 from the $PM_{2.5}$ FEM monitor be excluded from the annual $PM_{2.5}$ NAAQS. The Atlanta-Sandy Springs-Roswell Metropolitan Statistical Area (MSA) is in attainment of the 2012 $PM_{2.5}$ NAAQS.

This document discusses 10 different days from 2022-2024 that qualify for exceptional event demonstrations (Table 1) for the Gwinnett Tech air monitoring site located in Lawrenceville (Gwinnett County) in the state of Georgia, all of which were due to Canadian wildfires. These 10 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 Gwinnett Tech site 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 2022-2024. 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 9.1 $\mu g/m^3$, which violates the new 2024 $PM_{2.5}$ annual NAAQS; however, exclusion reduces the DV to 9.0 $\mu g/m^3$.

On July 30, 2025, the Georgia Environmental Protection Division (EPD) submitted an Initial Notification for these events to EPA. The request indicated that the data identified in Table 1 was impacted by smoke from Canadian wildfires and requested review of the events under the case-by-case provision at 40 CFR 50.14(a)(1)(i)(F). Georgia EPD formally requests that the EPA concur with the exclusion of these events.

**Table 1.** Exceedances observed at the Gwinnett Tech site in Lawrenceville, GA in 2022-2024 that qualify for removal under the EER.

| # | Date | 24-hour $PM_{2.5}$ (µg/m$^3$) | Tier | Cause of Exceedance |
|---|---|---|---|---|
| 1 | 06/07/23 | 20.7 | 1 | Canadian wildfires |
| 2 | 06/08/23 | 22.9 | 1 | Canadian wildfires |
| 3 | 06/09/23 | 25.6 | 1 | Canadian wildfires |
| 4 | 06/10/23 | 27.6 | 1 | Canadian wildfires |
| 5 | 06/18/23 | 24.9 | 1 | Canadian wildfires |
| 6 | 06/29/23 | 37.1 | 1 | Canadian wildfires |
| 7 | 06/30/23 | 32.1 | 1 | Canadian wildfires |
| 8 | 07/17/23 | 41.5 | 1 | Canadian wildfires |
| 9 | 07/18/23 | 44.8 | 1 | Canadian wildfires |
| 10 | 08/23/23 | 21.4 | 1 | Canadian wildfires |

**Table 2.** Design values at the Gwinnett Tech site for the 2024 annual $PM_{2.5}$ NAAQS.

| Monitor Site (AQS ID) | 2022-2024 DV without EPA Concurrence (µg/m$^3$) | 2022-2024 DV with EPA Concurrence (µg/m$^3$) |
|---|---|---|
| Gwinnett Tech (13-135-0002) | 9.1 | 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 events. This section describes the 2023 Canadian wildfires that impacted the air quality monitor in Lawrenceville, GA. Estimates from the National Oceanic and Atmospheric Administration (NOAA) Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT) model are used to describe the transport 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 far exceeded the average[3] of 21,000 km$^2$, with the most active burns situated in the eastern

[1] https://doi.org/10.1038/s41467-024-51154-7
[2] https://doi.org/10.1007/s00376-023-3241-0
[3] https://cwfis.cfs.nrcan.gc.ca/ha/nfdb

province of Quebec in June and July, and then in the western provinces of Alberta, Saskatchewan, and British Columbia.

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]. On the dates listed in Table 1 (Figures A1-A10), when the exceedances were recorded by the relevant site, 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 from fires in the Canadian provinces of British Columbia, Alberta, Saskatchewan, and Quebec. They then traveled along multiple routes either originating in Canada or by circulating smoke from Canadian wildfires from other (western and/or midwestern) regions of the United States.

This conceptual model describes how emissions from wildfires in Canada and environmental conditions contributed to the events dated in Table 1. Smoke emissions transported to the Gwinnett Tech site enhanced observed $PM_{2.5}$ concentrations and caused an exceedance of the annual $PM_{2.5}$ NAAQS. Georgia EPD requests EPA's concurrence on these dates 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 sites 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 Map[7],

[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
[7] https://fire.airnow.gov/

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.

Georgia EPD, in conjunction with the Georgia Institute of Technology, provides a daily forecast email that includes messaging concerning health advisories and smog alerts to Georgia Commute Options and the Atlanta Regional Commission for distribution. Each forecast email includes a reminder stating: "If you see or smell smoke and have respiratory concerns you may need to move indoors, close windows and doors. You can see the current air quality at https://airgeorgia.org or https://airnow.gov to help you determine when to continue outdoor activities."

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)

[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://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)
- 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 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* outlines the expected components of a clear causal relationship portion of a demonstration. These include evidence that emissions from wildfires were transported to the site, evidence that wildfire emissions affected the monitor, and a comparison of the event-related concentration to historical concentrations.

Figures B1-B10 (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 day 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 2020-2024 $PM_{2.5}$ FRM data at the Gwinnett Tech site. Table 3 contains a comparison of exceptional event concentrations to

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

historic 2020-2024 concentrations for the site. Generally, the exceptional event concentrations are nearly double the 5-year annual average, quarterly average, and monthly average, and in some cases can be more than five times greater.

**Table 3.** Comparison of exceptional event concentrations to historic 2020-2024 concentrations at the Gwinnett Tech site.

| 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 |
|---|---|---|---|---|---|---|---|
| 06/07/2023 | 20.7 | 8.7 | 9.37 | 9.94 | 2.4 | 2.2 | 2.1 |
| 06/08/2023 | 22.9 | 8.7 | 9.37 | 9.94 | 2.6 | 2.5 | 2.3 |
| 06/09/2023 | 25.6 | 8.7 | 9.37 | 9.94 | 3.0 | 2.7 | 2.6 |
| 06/10/2023 | 27.6 | 8.7 | 9.37 | 9.94 | 3.2 | 3.0 | 2.8 |
| 06/18/2023 | 24.9 | 8.7 | 9.37 | 9.94 | 2.9 | 2.7 | 2.5 |
| 06/29/2023 | 37.1 | 8.7 | 9.37 | 9.94 | 4.3 | 4.0 | 3.7 |
| 06/30/2023 | 32.1 | 8.7 | 9.37 | 9.94 | 3.7 | 3.4 | 3.2 |
| 07/17/2023 | 41.5 | 8.7 | 8.57 | 8.99 | 4.8 | 4.9 | 4.6 |
| 07/18/2023 | 44.8 | 8.7 | 8.57 | 8.99 | 5.2 | 5.2 | 5.0 |
| 08/23/2023 | 21.4 | 8.7 | 8.57 | 8.84 | 2.5 | 2.5 | 2.4 |

Figure 1 plots the 24-hour $PM_{2.5}$ concentrations for 2020-2024. Exceedances caused by wildfires are delineated by marker shape and color. The selected exceptional events are all above the Tier 1 threshold of 17.25 $\mu g/m^3$. Tier 1 events are 1.5 times greater than the highest $98^{th}$ percentile of data over the last 5 years, per the EPA's Tiering Tool.

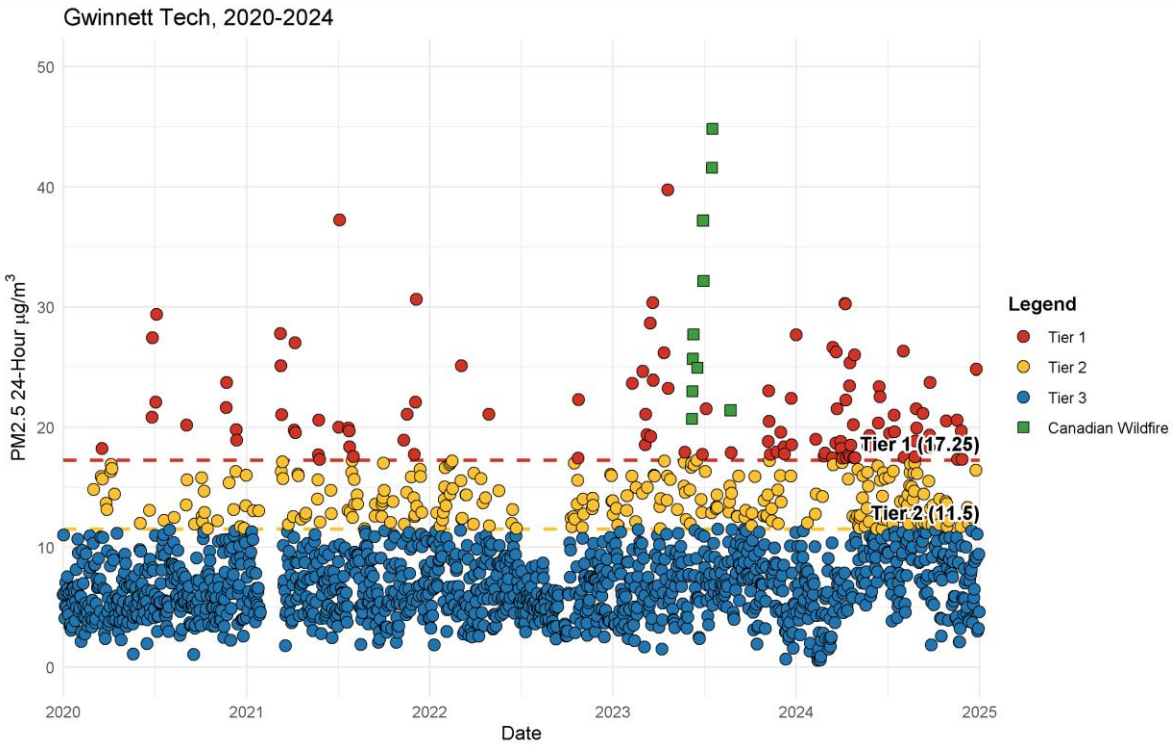



**Figure 1.** 24-hour $PM_{2.5}$ concentrations for 2020-2024 observed at the Gwinnett Tech site. Exceedances not related to fires are demarcated by color with Tier 1 in red, Tier 2 in yellow, and Tier 3 in blue. Canadian wildfires (green squares) are additionally differentiated.

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 rolling average $PM_{2.5}$ concentrations (including the time shown in the figure panel and the 23 hours following it) across the United States, and HYSPLIT back-trajectories. These trajectories originate at the Gwinnett Tech site'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 m MSL[14], at 00 Coordinated Universal Time (UTC) and 12 UTC for each day. These pressure values are chosen to correspond with the 1500-m and 3000-m heights

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

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 7, 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, back-trajectories indicate that the smoke plume traveled through the Midwest of the United States. The plume detected at the site is a mixture of emissions from fires in Quebec. The back-trajectories converge approximately 18 hours before descending to near-surface level where observed, daily $PM_{2.5}$ concentrations increased to 20.7 $\mu g/m^3$. Figure D1 shows that similar enhancements occurred synchronously at other monitoring sites across the southeast, which follows from the large blanket of smoke over this region (Figure B1).

June 8, 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 throughout the event day and the day prior. 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 at the site is a mixture of emissions from fires in the provinces of British Columbia, Alberta, Saskatchewan, and Quebec. The back-trajectories converge approximately 18 hours before descending to near-surface level where observed, daily $PM_{2.5}$ concentrations increased to 23.0 $\mu g/m^3$. Figure D2 shows that similar enhancements occurred synchronously at other monitoring sites across the southeast, which follows from the large blanket of smoke over this region (Figure B2).

June 9, 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 E3, $PM_{2.5}$ concentrations were elevated above the 9.0 $\mu g/m^3$ standard throughout the event day and the day prior. Shown in Figure C3, back-trajectories indicate that the smoke plume traveled through the Midwest of the United States. As a result, the plume detected at the site is a mixture of emissions from fires in Quebec. The back-trajectories do not converge before descending to near-surface level where observed, daily $PM_{2.5}$ concentrations increased to 25.7 $\mu g/m^3$. Figure D3 shows that similar enhancements occurred synchronously at other monitoring sites across the southeast, which follows from the large blanket of smoke over this region (Figure B3).

June 10, 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 E4, $PM_{2.5}$ concentrations were elevated above the 9.0 $\mu g/m^3$ standard throughout the event day and the day prior. Shown in Figure C4, back-trajectories indicate that the smoke plume traveled through the Midwest of the United States. As a result, the plume detected at the site is a mixture of emissions from fires in Quebec. The back-trajectories converge approximately 12 hours before descending to near-surface level where observed, daily $PM_{2.5}$ concentrations increased to 27.7

$\mu g/m^3$. Figure D4 shows that similar enhancements occurred synchronously at other monitoring sites across the southeast, which follows from the large blanket of smoke over this region (Figure B4).

June 18, 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 E5, $PM_{2.5}$ concentrations were elevated above the 9.0 $\mu g/m^3$ standard throughout the event day and the day prior. Shown in Figure C5, back-trajectories indicate that the smoke plume traveled through the Midwest of the United States. As a result, the plume detected at the site is a mixture of emissions from fires in the provinces of Saskatchewan, Ontario, and Quebec. The back-trajectories converge approximately 12 hours before descending to near surface level where observed, daily $PM_{2.5}$ concentrations increased to 24.9 $\mu g/m^3$. Figure D5 shows that similar enhancements occurred synchronously at other monitoring sites across the southeast, which follows from the large blanket of smoke over this region (Figure B5).

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 E6, $PM_{2.5}$ concentrations were elevated above the 9.0 $\mu g/m^3$ standard throughout the event day and the day prior. Shown in Figure C6, back-trajectories indicate that the smoke plume traveled through the Midwest of the United States. As a result, the plume detected at the site is a mixture of emissions from fires in the provinces of British Columbia, Alberta, Saskatchewan, and Quebec. The back-trajectories converge approximately 12 hours before descending to near-surface level where observed, daily $PM_{2.5}$ concentrations increased to 37.2 $\mu g/m^3$. Figure D6 shows that similar enhancements occurred synchronously at other monitoring sites across the southeast, which follows from the large blanket of smoke over this region (Figure B6).

June 30, 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 E7, $PM_{2.5}$ concentrations were elevated above the 9.0 $\mu g/m^3$ standard throughout the event day and the day prior. Shown in Figure C7, back-trajectories indicate that the smoke plume traveled from southern states to the west of Georgia. Wildfires were active in both eastern and western Canada at this time. Wind barbs from Figures F1-F4 (spanning a timeframe of June 27-30) show a southeastward transport of air masses from the west coast of Canada to the middle south of the United States. This is coupled with a synoptic-scale clockwise vortex over the south and southeast of the United States, indicating emissions from these fires were directed along this path. This corroborates the back-trajectory of the 1500-m and 3000-m HYSPLIT tails. Therefore, wildfire smoke traveled from western Canada, was circulated over the south of the United States, and ultimately arrived at the Gwinnett Tech site. As a result, the plume detected at the site is a mixture of emissions from fires in the provinces of British Columbia, Alberta, and Saskatchewan. This led to daily $PM_{2.5}$ concentrations increasing to 32.1 $\mu g/m^3$. Figure D7 shows that similar enhancements occurred synchronously at other monitoring sites across the southeast, which follows from the large blanket of smoke over this region (Figure B7).

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 E8, $PM_{2.5}$ concentrations were elevated above the 9.0 $\mu g/m^3$ standard throughout the event day and the day prior. Shown in Figure C8, back-trajectories indicate that the smoke plume traveled from the northwest corner of Canada through the Midwest of the United States. As a result, the plume detected at the site is a mixture of emissions from fires in the provinces of British Columbia, Alberta, and Saskatchewan. The back-trajectories converge approximately one day before descending to near-surface level where observed, daily $PM_{2.5}$ concentrations increased to 41.6 $\mu g/m^3$. Figure D8 shows that similar enhancements occurred synchronously at other monitoring sites across the southeast, which follows from the large blanket of smoke over this region (Figure B8).

July 18, 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 E9, $PM_{2.5}$ concentrations were elevated above the 9.0 $\mu g/m^3$ standard throughout the event day and the day prior. Shown in Figure C9, back-trajectories indicate that the smoke plume traveled from the northwest corner of Canada through the Midwest of the United States. As a result, the plume detected at the site is a mixture of emissions from fires in the provinces of British Columbia, Alberta, Saskatchewan, and Quebec. The back-trajectories converge approximately 12 hours before descending to near-surface level where observed, daily $PM_{2.5}$ concentrations increased to 44.8 $\mu g/m^3$. Figure D9 shows that similar enhancements occurred synchronously at other monitoring sites across the southeast, which follows from the large blanket of smoke over this region (Figure B9).

August 23, 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 E10, $PM_{2.5}$ concentrations were elevated above the 9.0 $\mu g/m^3$ standard throughout the event day and the day prior. Wildfires were active mostly in western Canada at this time. Shown in Figure C10, the 1500 and 3000 m back-trajectories indicate that a synoptic-scale, clockwise vortex circulated wildfire smoke over much of the United States, primarily impacting sites in the Midwest and the southeast. This is corroborated by the wind barbs in Figures F5-F8 (spanning a period of August 20-23), which show that this vortex forms early on August 23. As a result, the plume detected at the site is a mixture of emissions from fires in the provinces of British Columbia, Alberta, and Saskatchewan. The observed, daily $PM_{2.5}$ concentration increased to 21.4 $\mu g/m^3$. Figure D10 shows that similar enhancements occurred synchronously at other monitoring sites across the southeast, which follows from the large blanket of smoke over this region (Figure B10).

The comparisons and analyses provided in this demonstration support 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 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 noted that many of the Canadian fires were ignited by summer lightning storms and largely burned in deeply wooded areas[15]. 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 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

Georgia EPD will hold a public comment period to receive public input regarding the Exceptional Event Demonstration. Notification of the public comment period will be posted on the Georgia EPD website and emailed to interested stakeholders. Public comments received will be included in Appendix G of this demonstration, along with Georgia EPD's responses to these comments in Appendix H.

[15] https://earthobservatory.nasa.gov/images/151985/tracking-canadas-extreme-2023-fire-season

# Appendix A: Active Wildfires in Canada

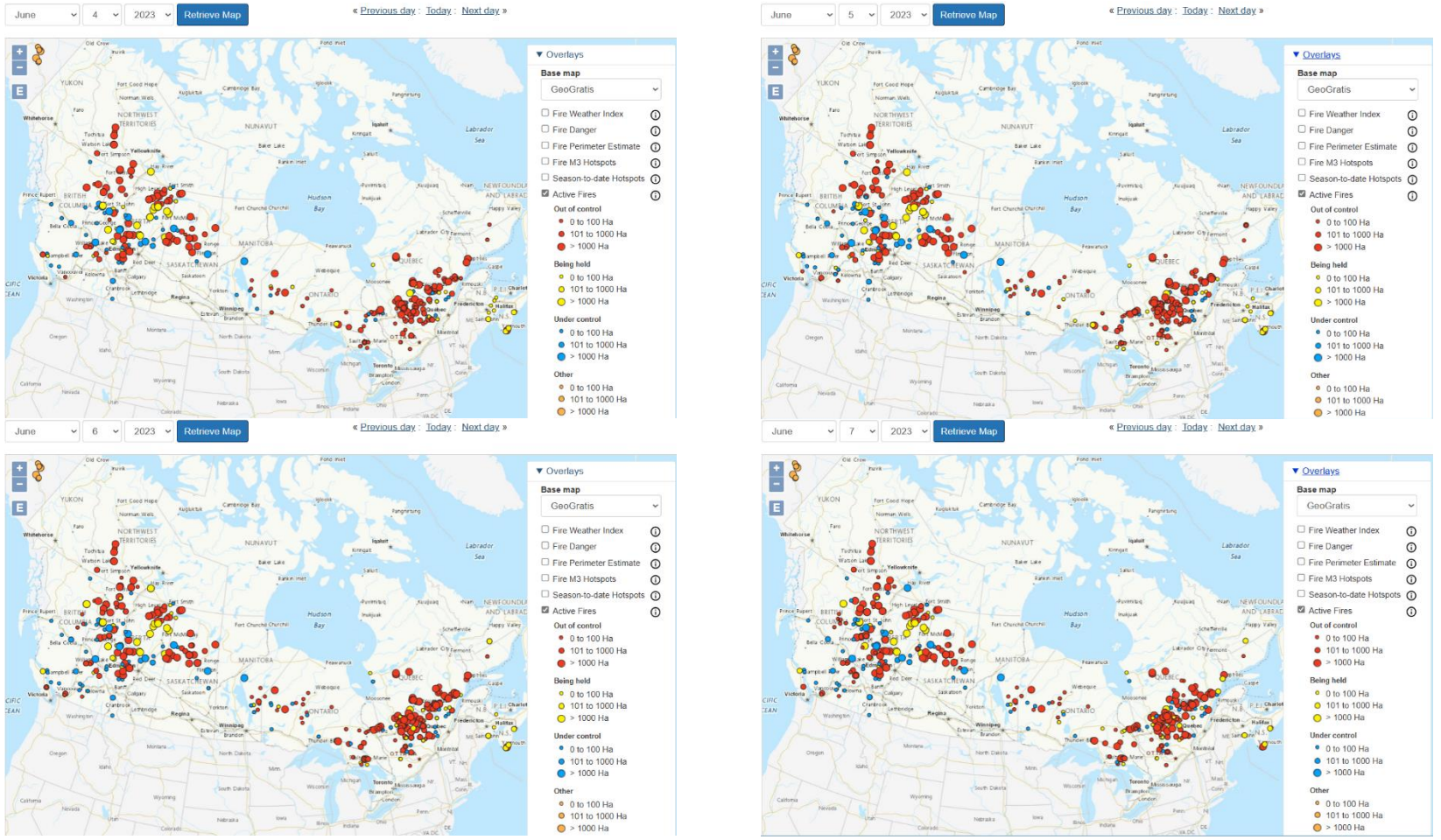



**Figure A1.** Active wildfires in Canada on June 4-7, 2023.

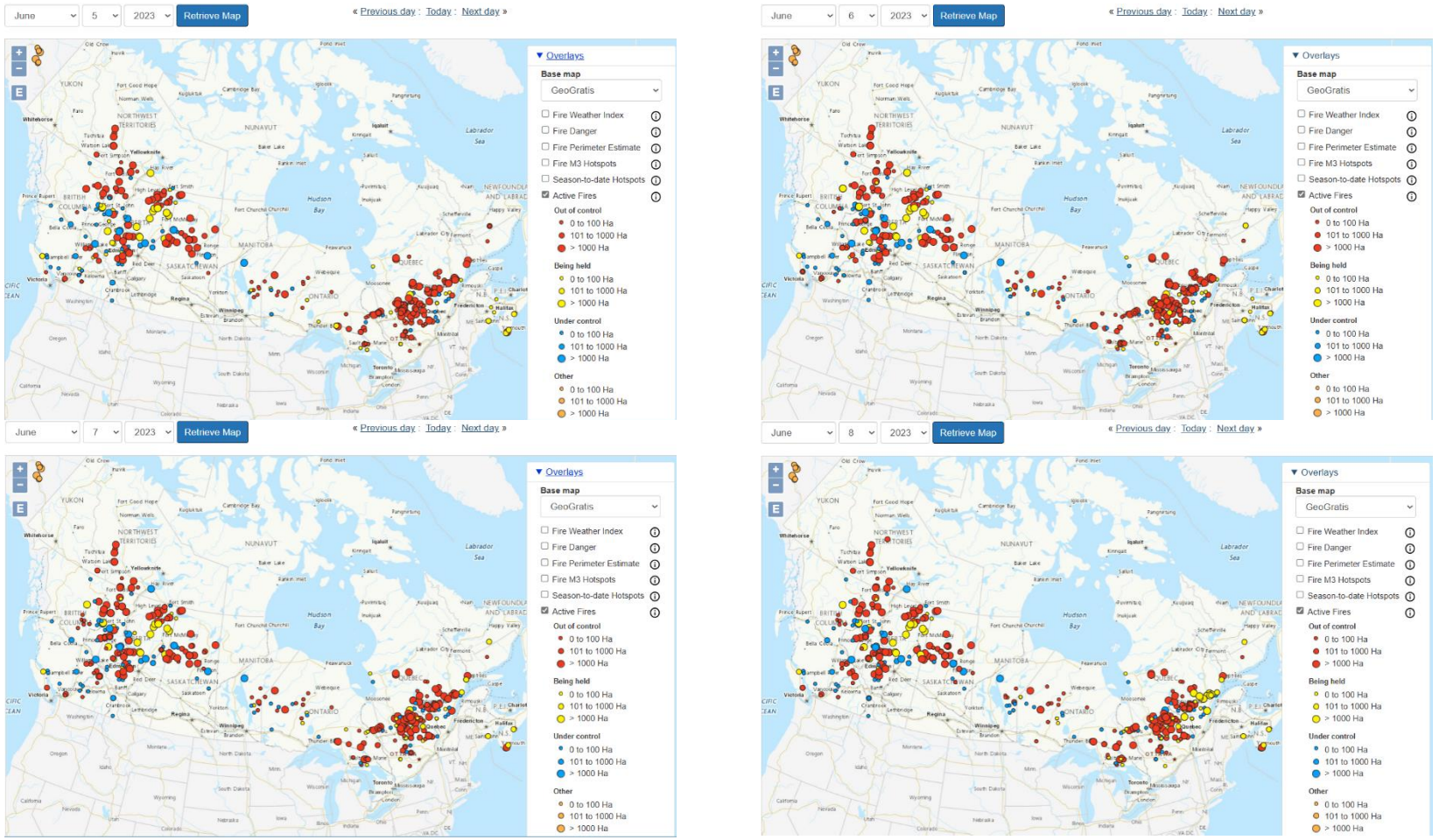



**Figure A2.** Active wildfires in Canada on June 5-8, 2023.

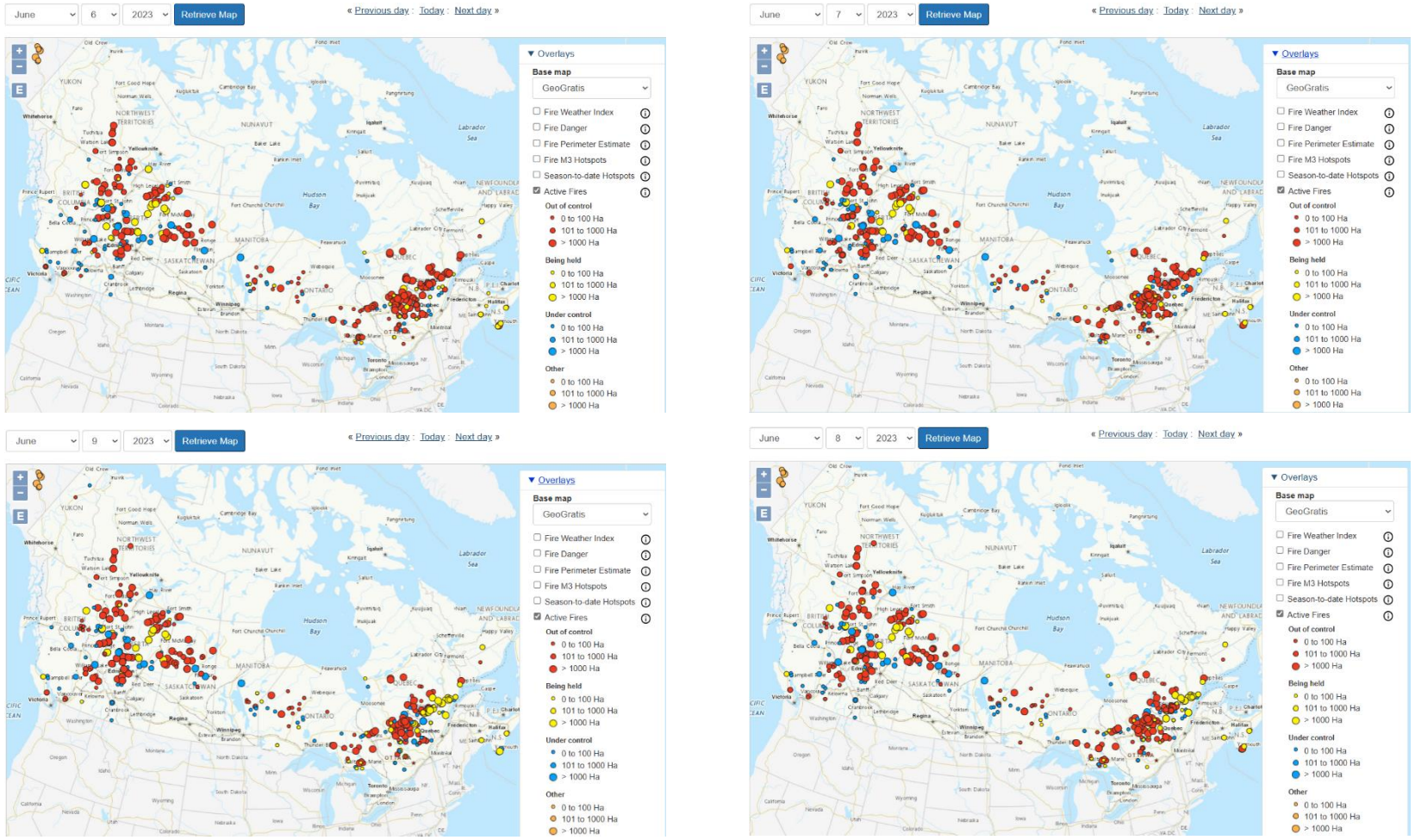



**Figure A3.** Active wildfires in Canada on June 6-9, 2023.

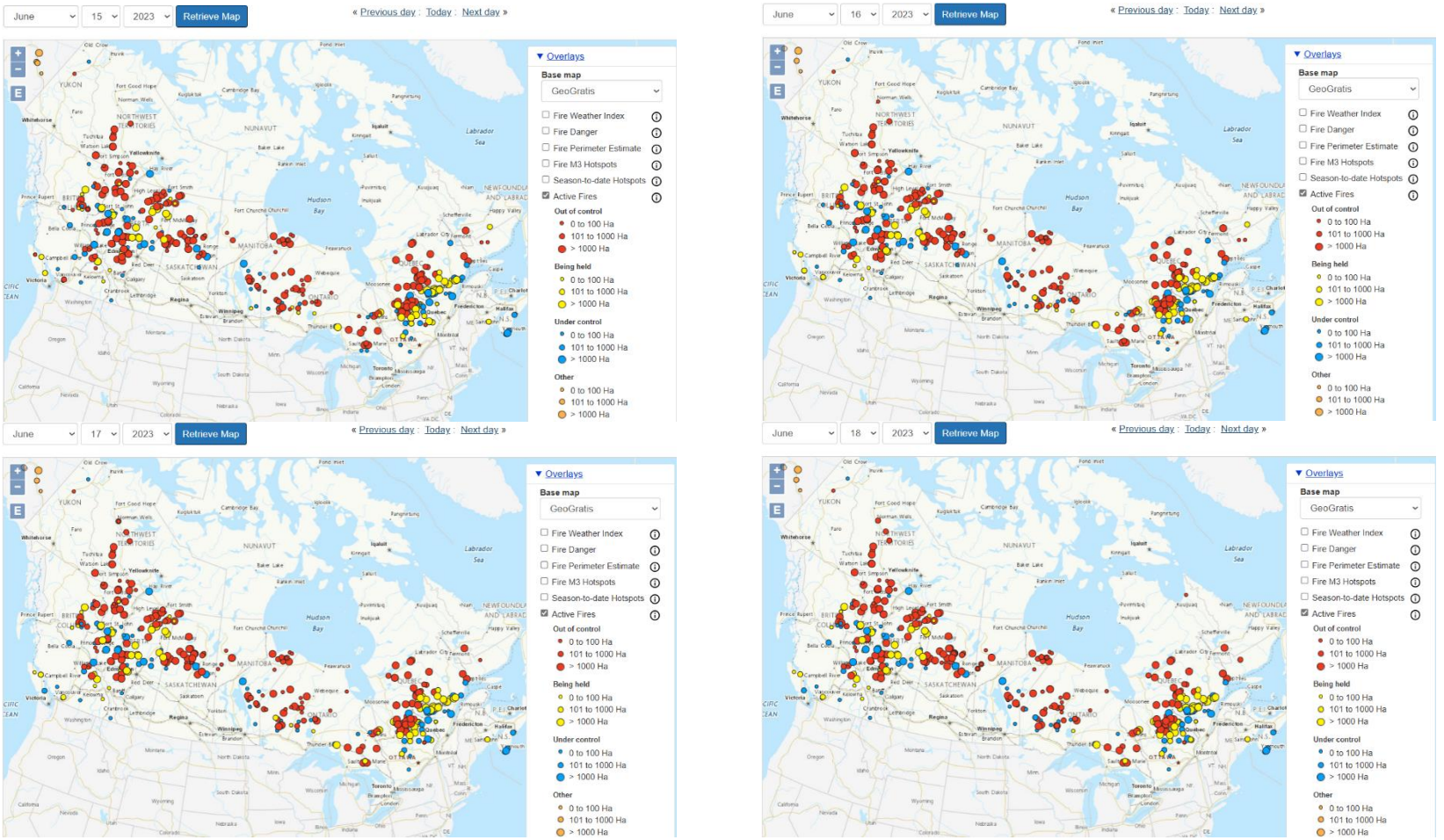



**Figure A4.** Active wildfires in Canada on June 15-18, 2023.

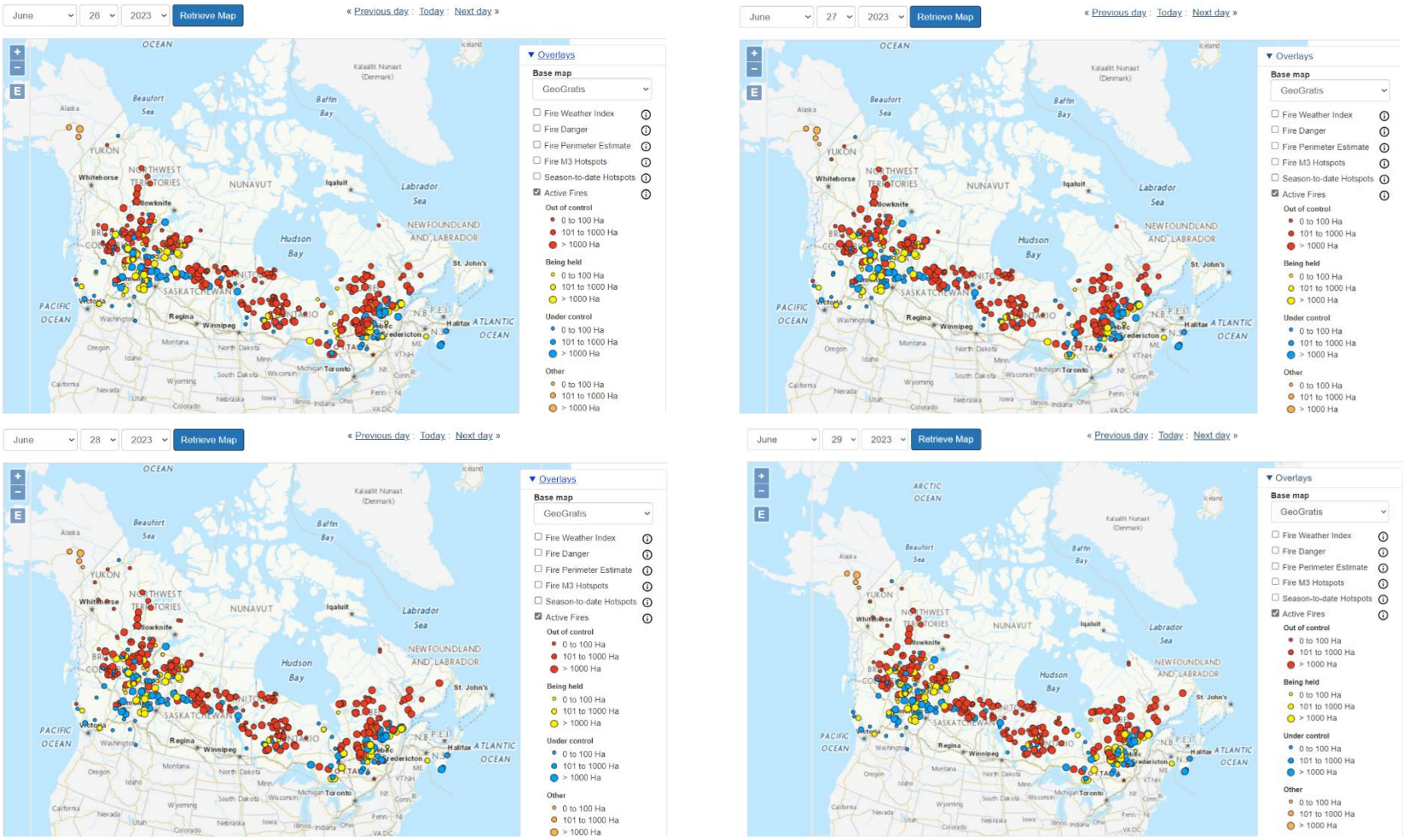



**Figure A5.** Active wildfires in Canada on June 26-29, 2023.

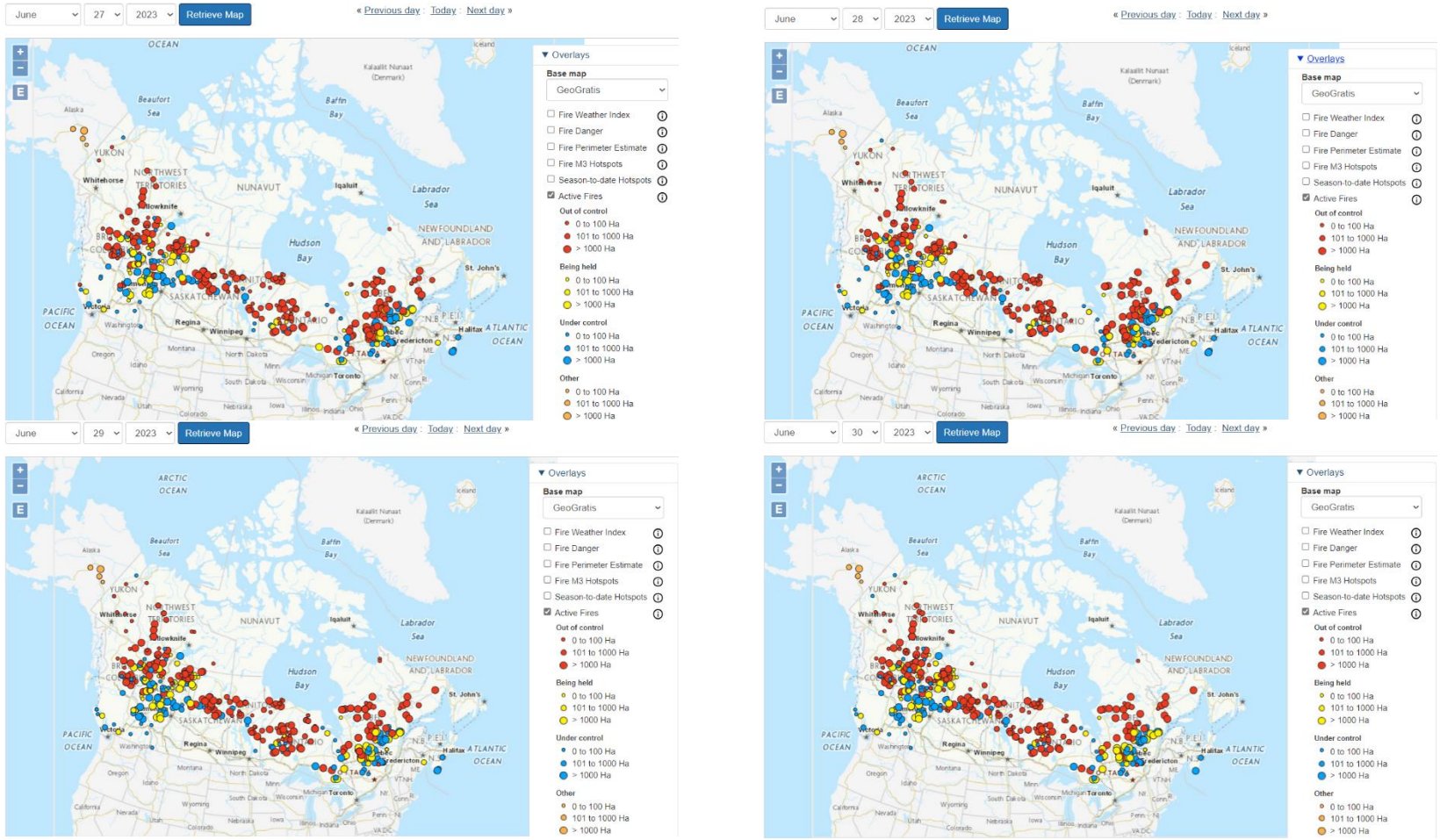



**Figure A6.** Active wildfires in Canada on June 27-30, 2023.

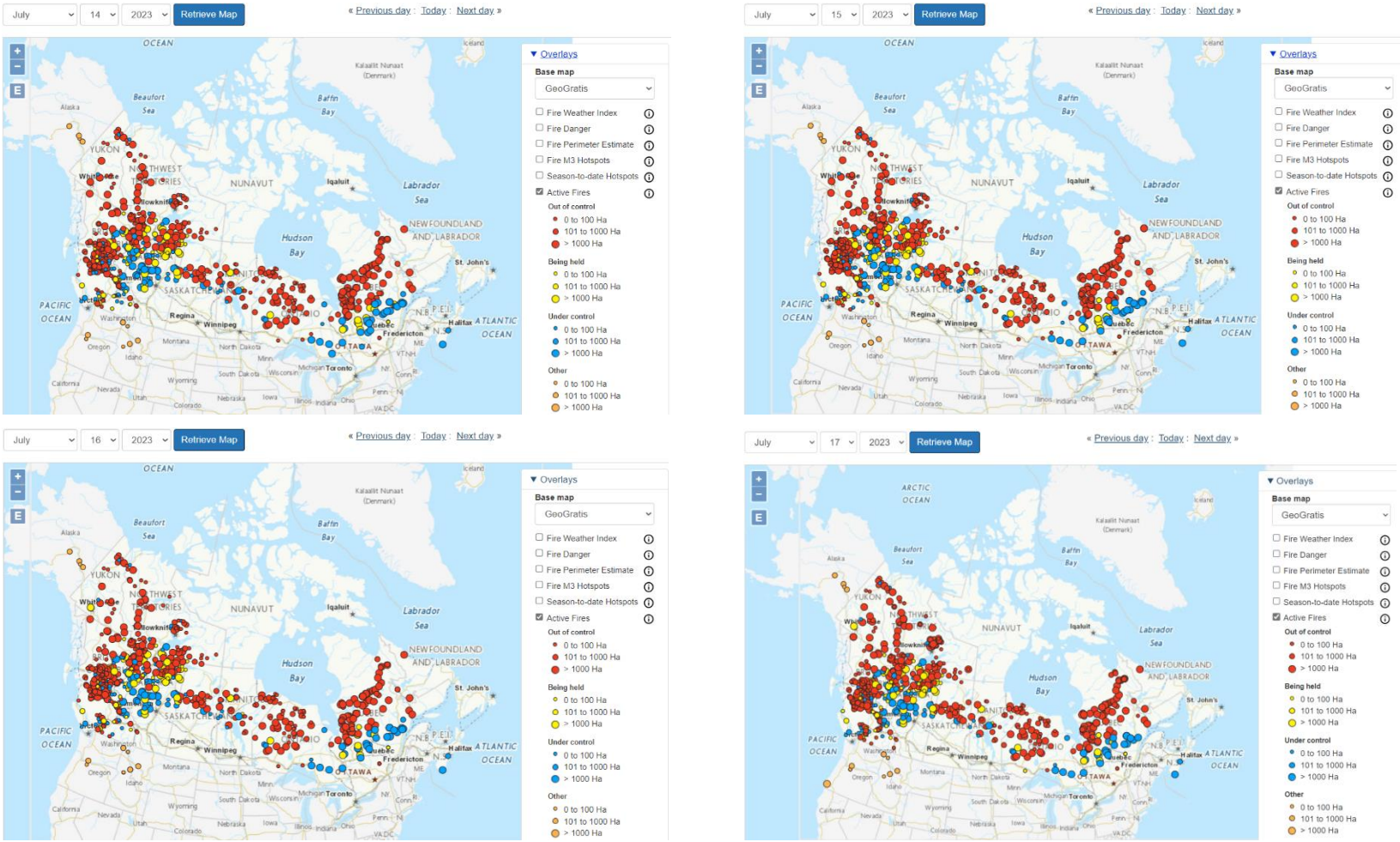



**Figure A7.** Active wildfires in Canada on July 14-17, 2023.

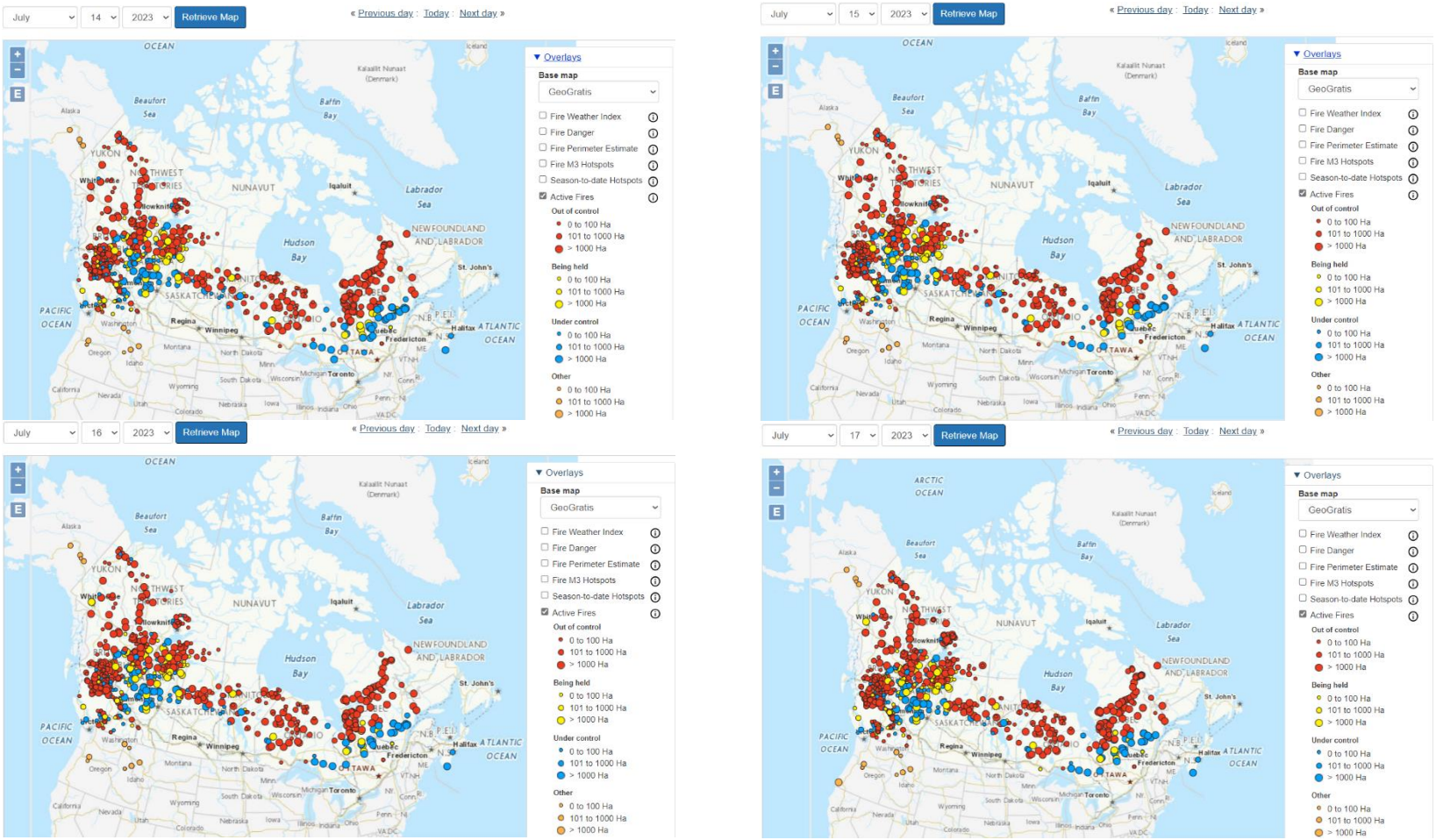



**Figure A8.** Active wildfires in Canada on July 14-17, 2023.

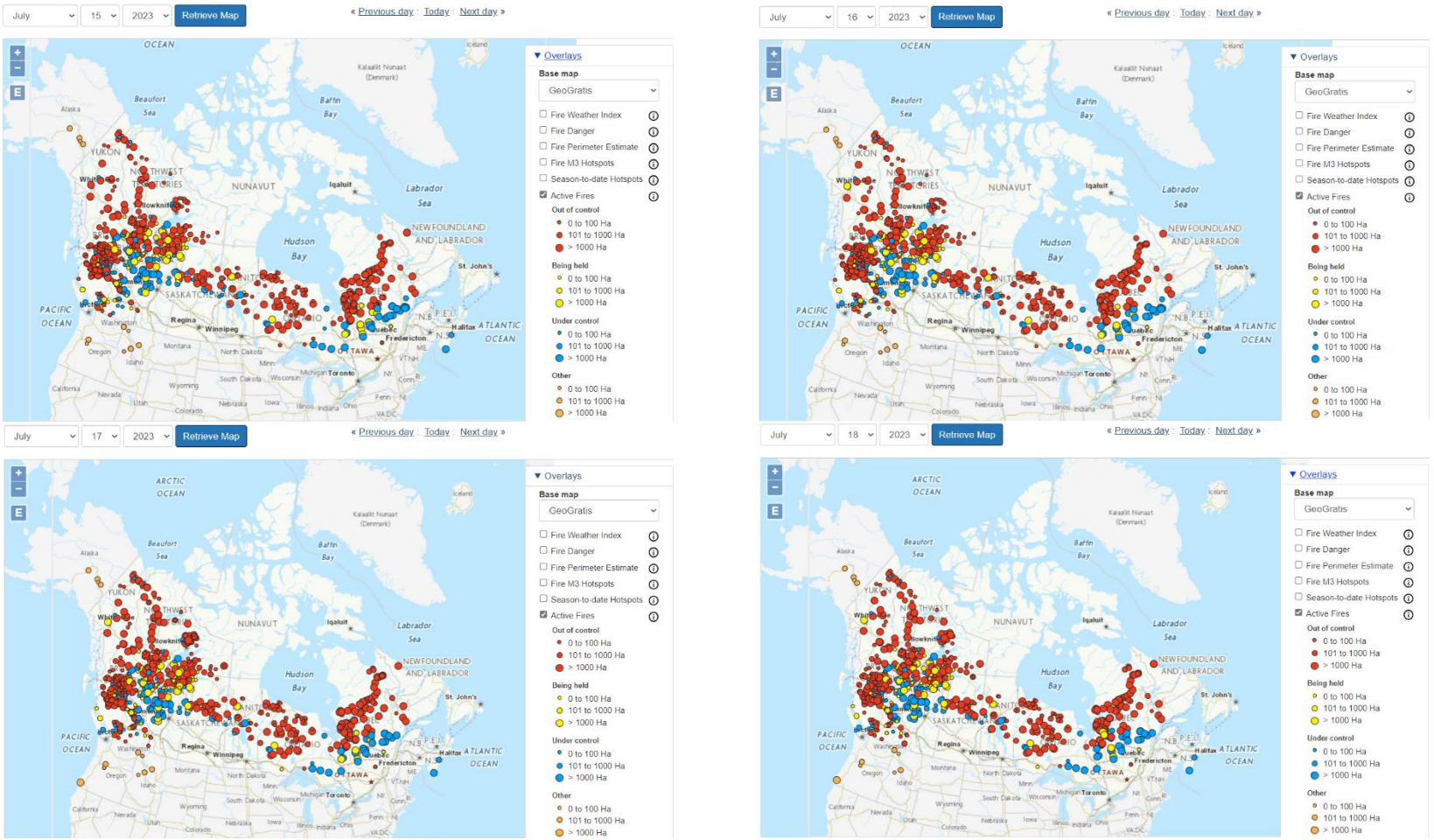



**Figure A9.** Active wildfires in Canada on July 15-18, 2023.

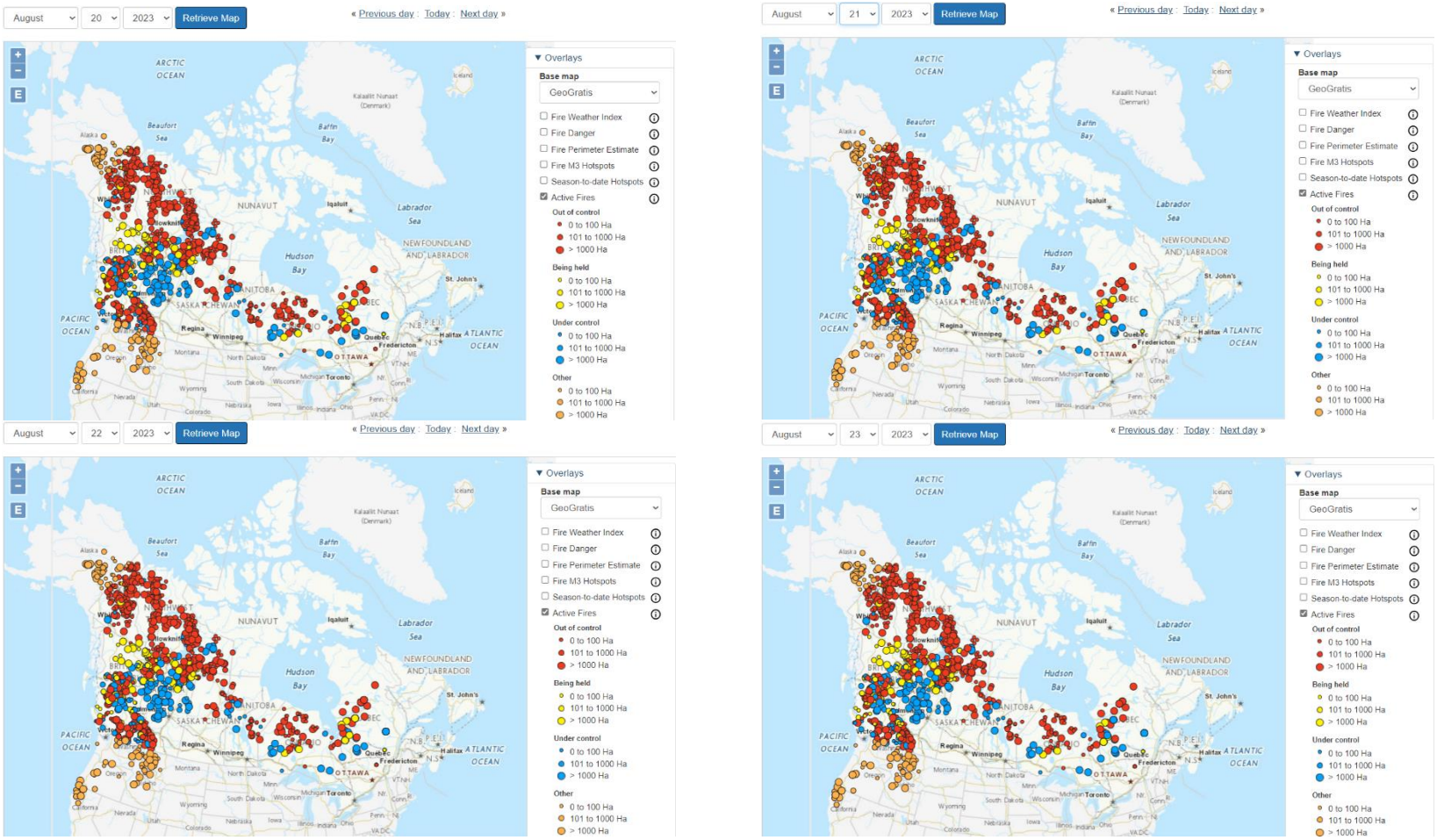



**Figure A10.** Active wildfires in Canada on August 20-23, 2023.

## Appendix B: HMS Smoke and Active Fires

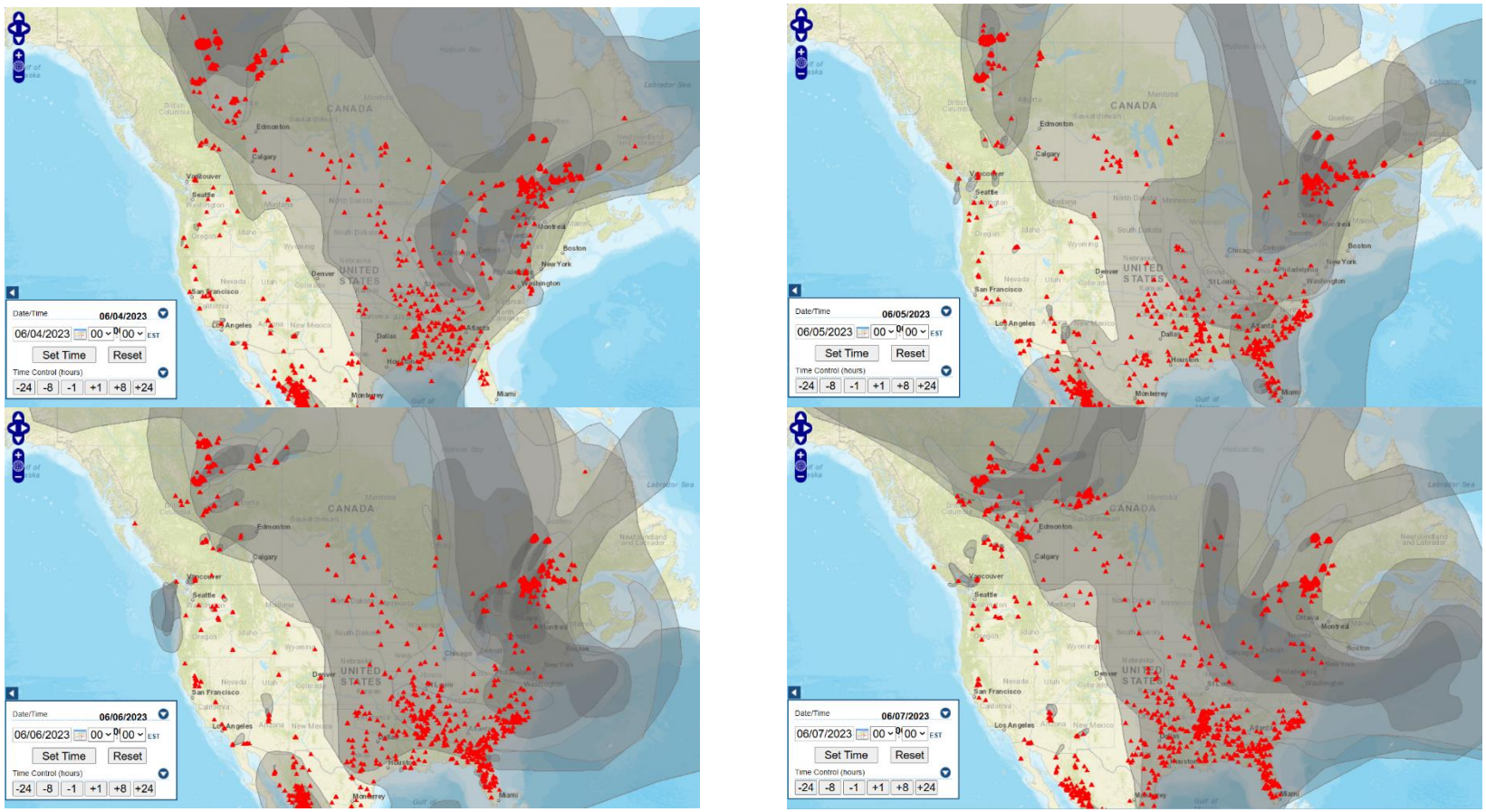



**Figure B1.** Map from the AirNow Navigator showing active fires (red) and smoke (grey) on June 4-7, 2023, plotted using the NOAA HMS over North America.

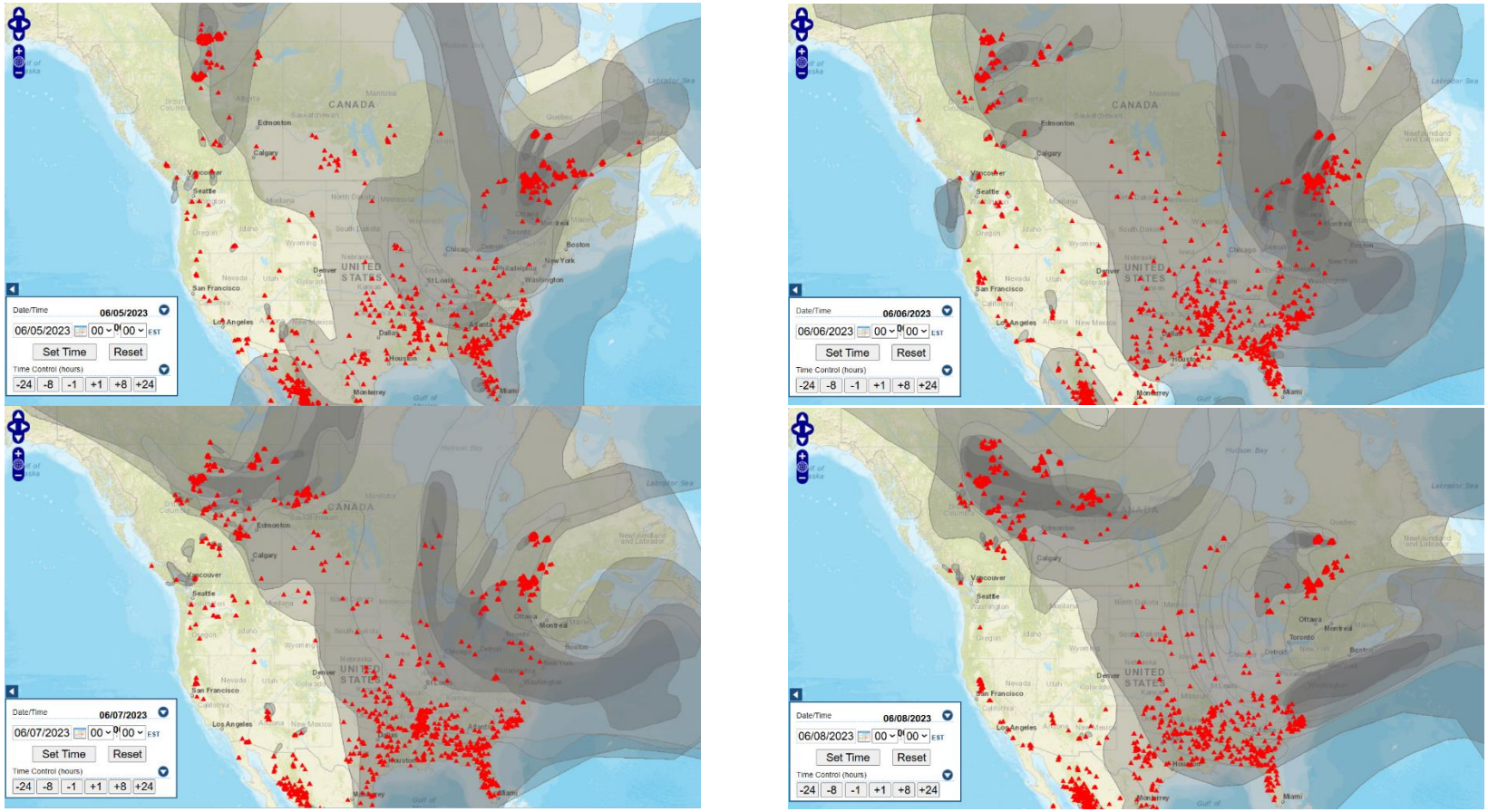



**Figure B2.** Map from the AirNow Navigator showing active fires (red) and smoke (grey) on June 5-8, 2023, plotted using the NOAA HMS over North America.

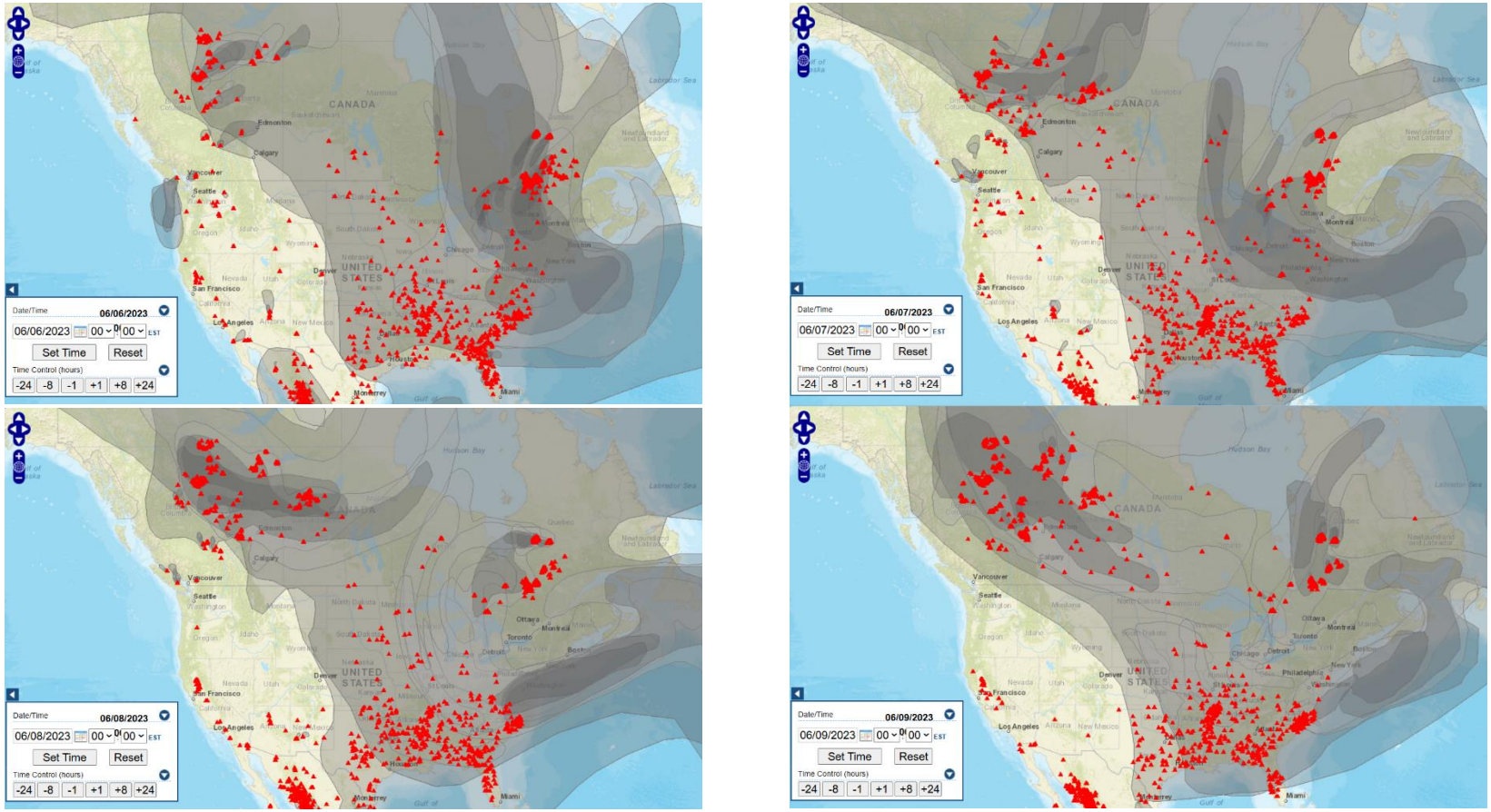



**Figure B3.** Map from the AirNow Navigator showing active fires (red) and smoke (grey) on June 6-9, 2023, plotted using the NOAA HMS over North America.

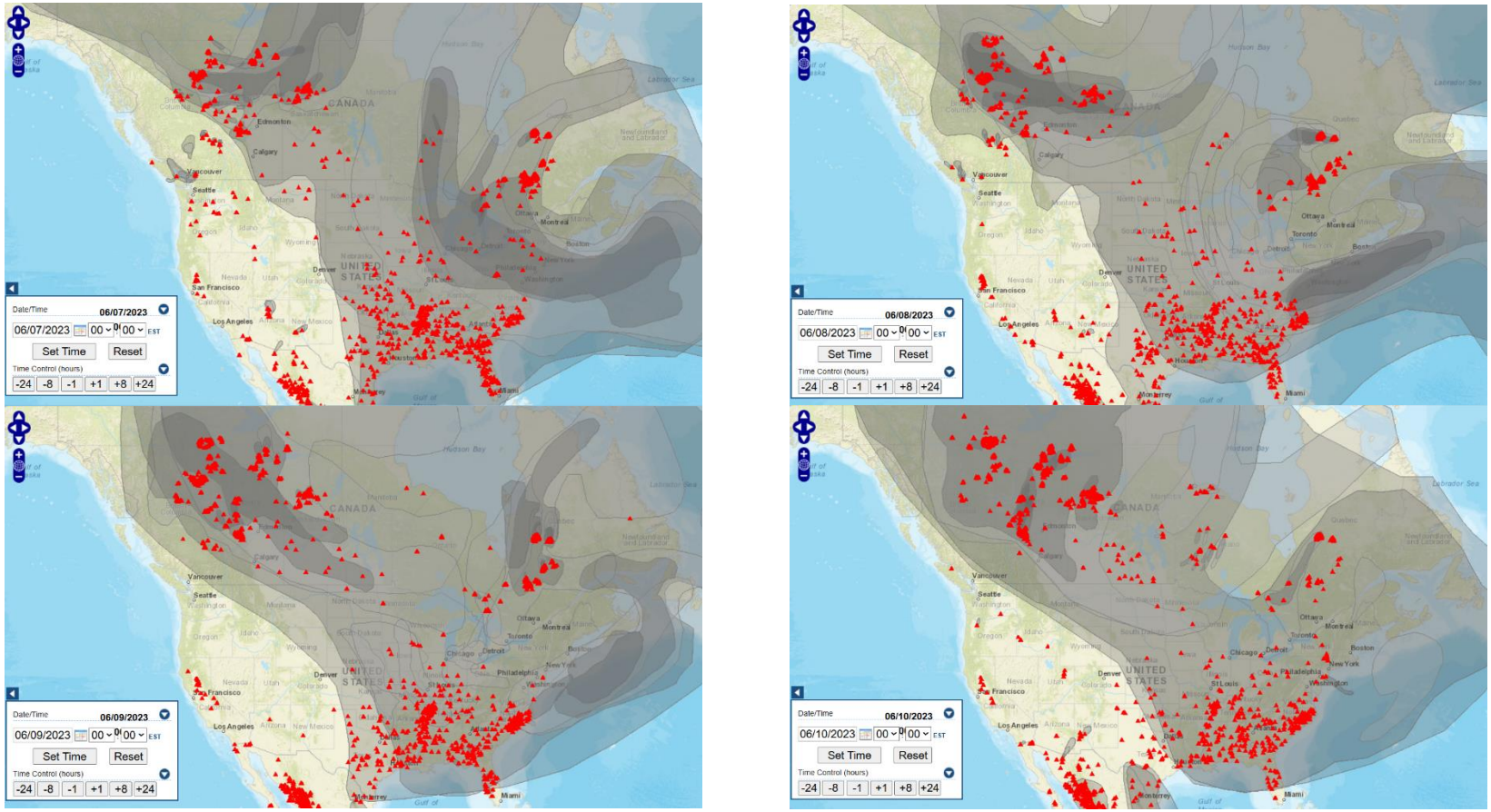



**Figure B4.** Map from the AirNow Navigator showing active fires (red) and smoke (grey) on June 7-10, 2023, plotted using the NOAA HMS over North America.

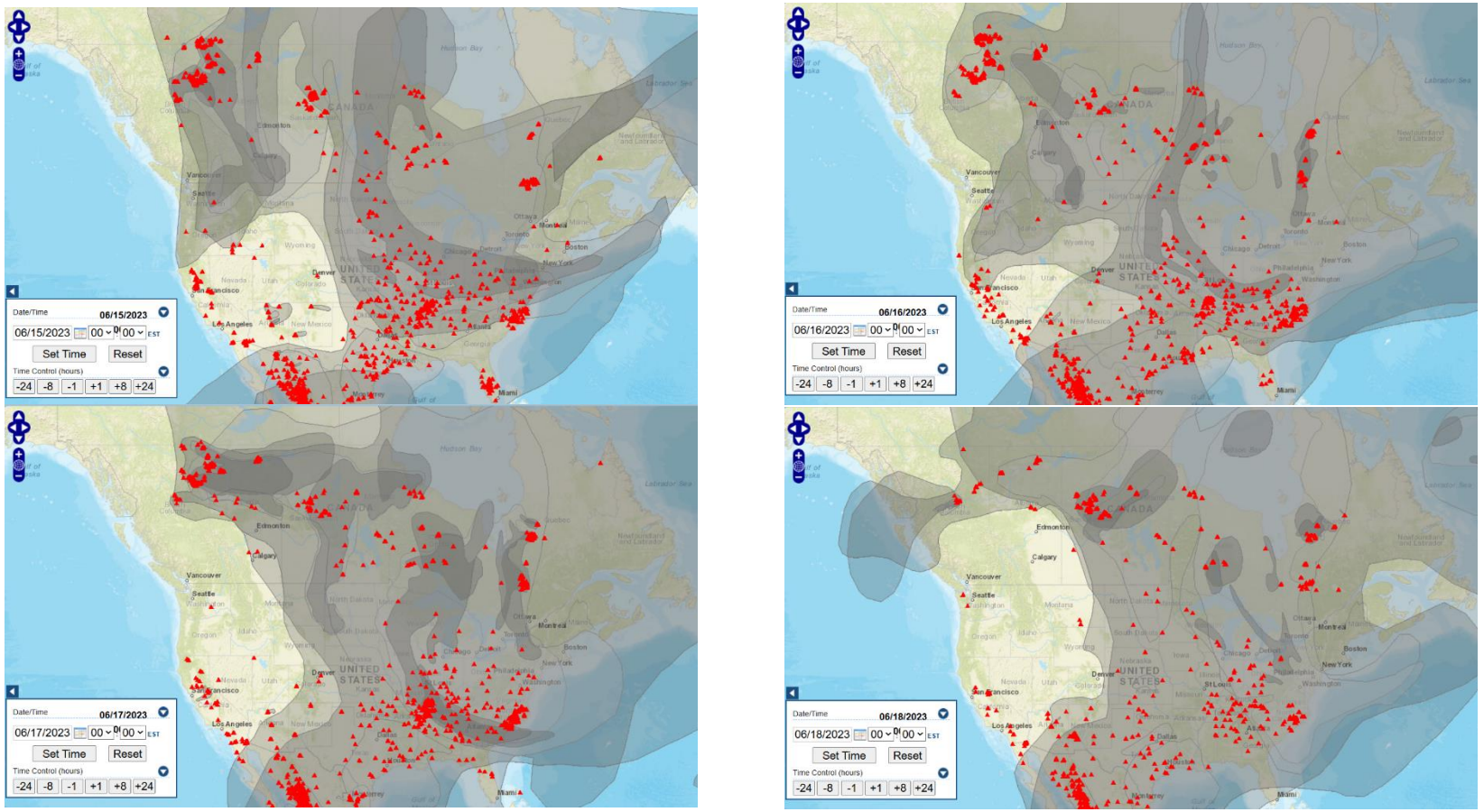



**Figure B5.** Map from the AirNow Navigator showing active fires (red) and smoke (grey) on June 15-18, 2023, plotted using the NOAA HMS over North America.

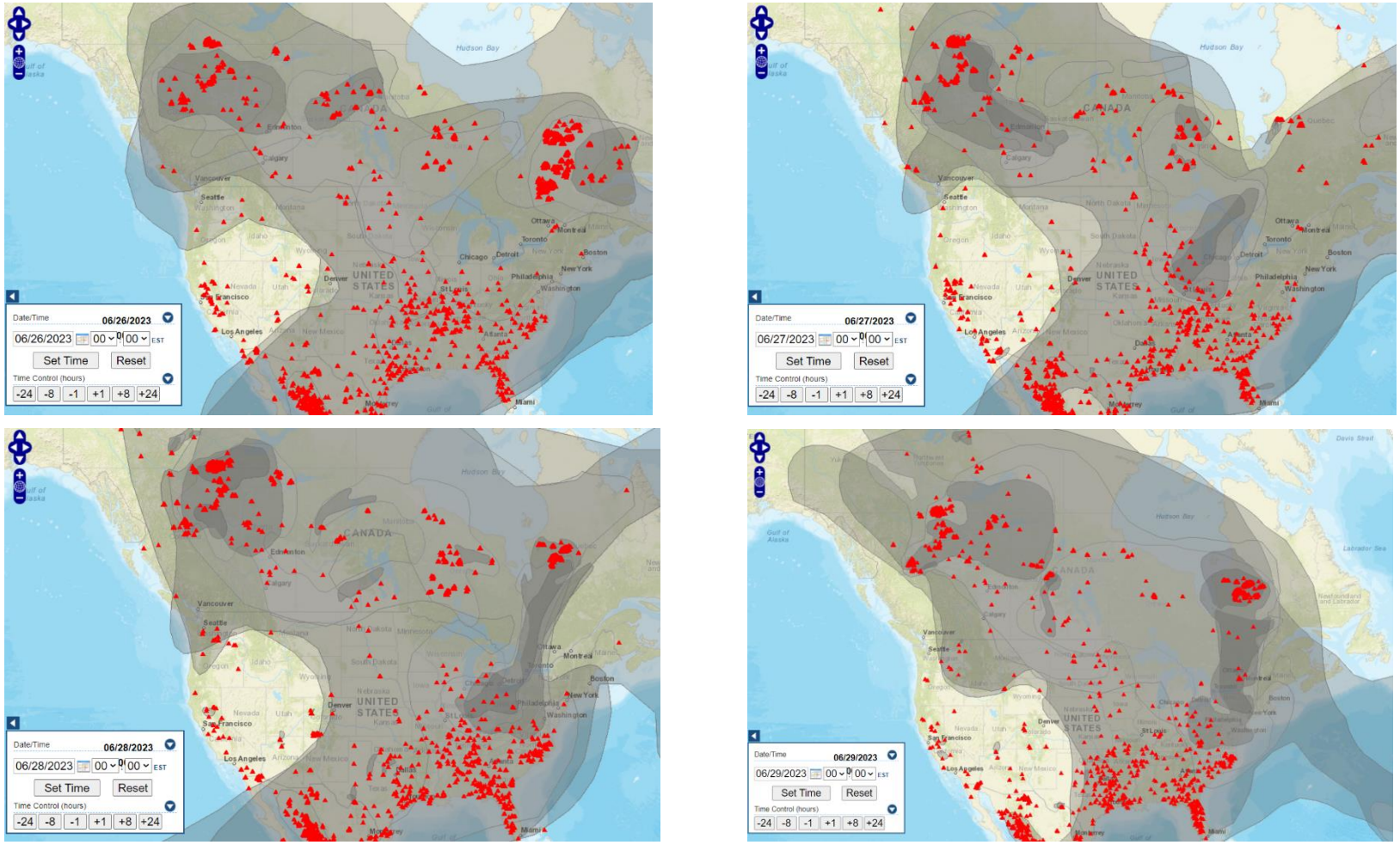



**Figure B6.** Map from the AirNow Navigator showing active fires (red) and smoke (grey) on June 26-29, 2023, plotted using the NOAA HMS over North America.

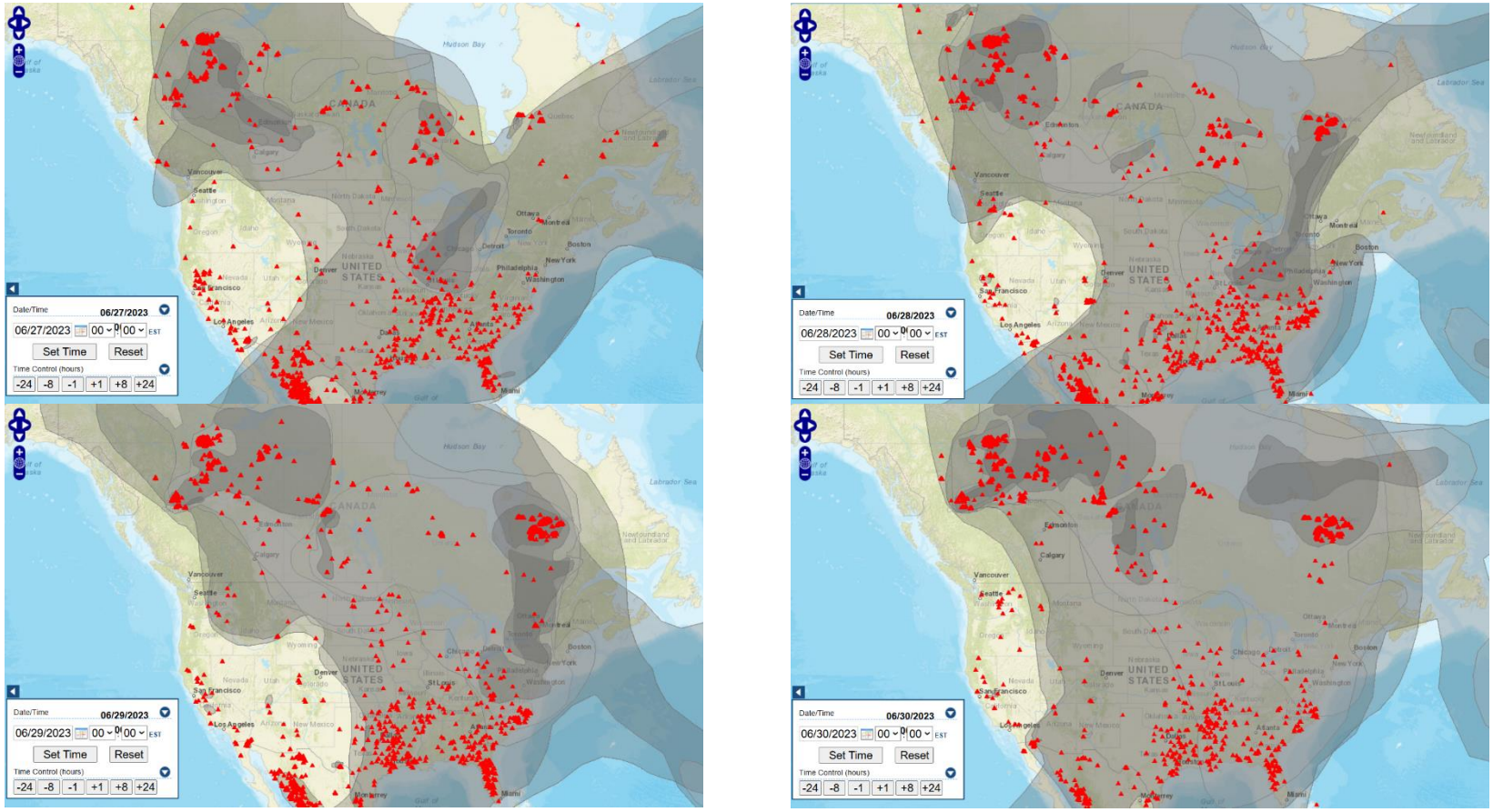



**Figure B7.** Map from the AirNow Navigator showing active fires (red) and smoke (grey) on June 27-30, 2023, plotted using the NOAA HMS over North America.

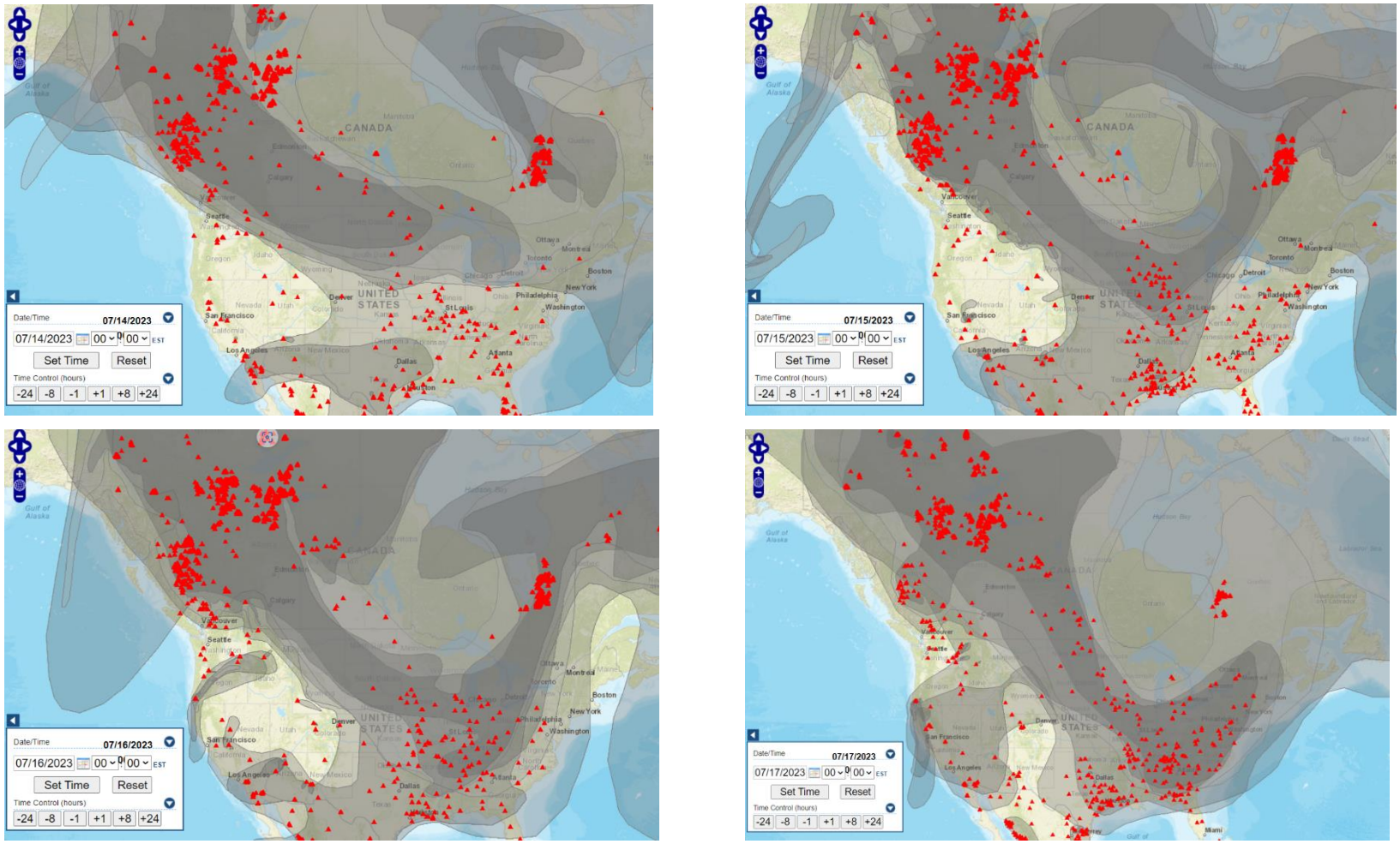



**Figure B8.** Map from the AirNow Navigator showing active fires (red) and smoke (grey) on July 14-17, 2023, plotted using the NOAA HMS over North America.

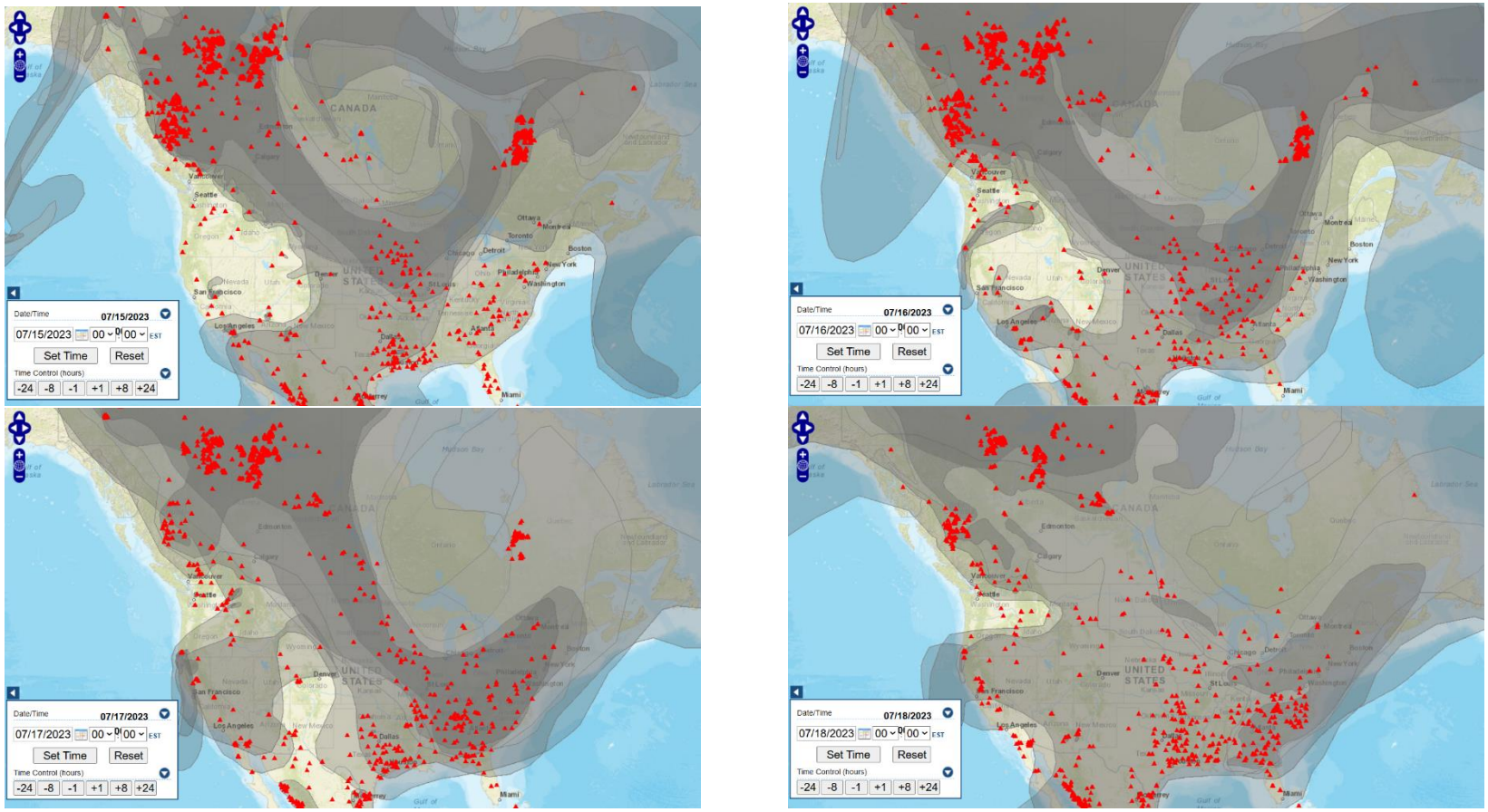



**Figure B9.** Map from the AirNow Navigator showing active fires (red) and smoke (grey) on July 15-18, 2023, plotted using the NOAA HMS over North America.

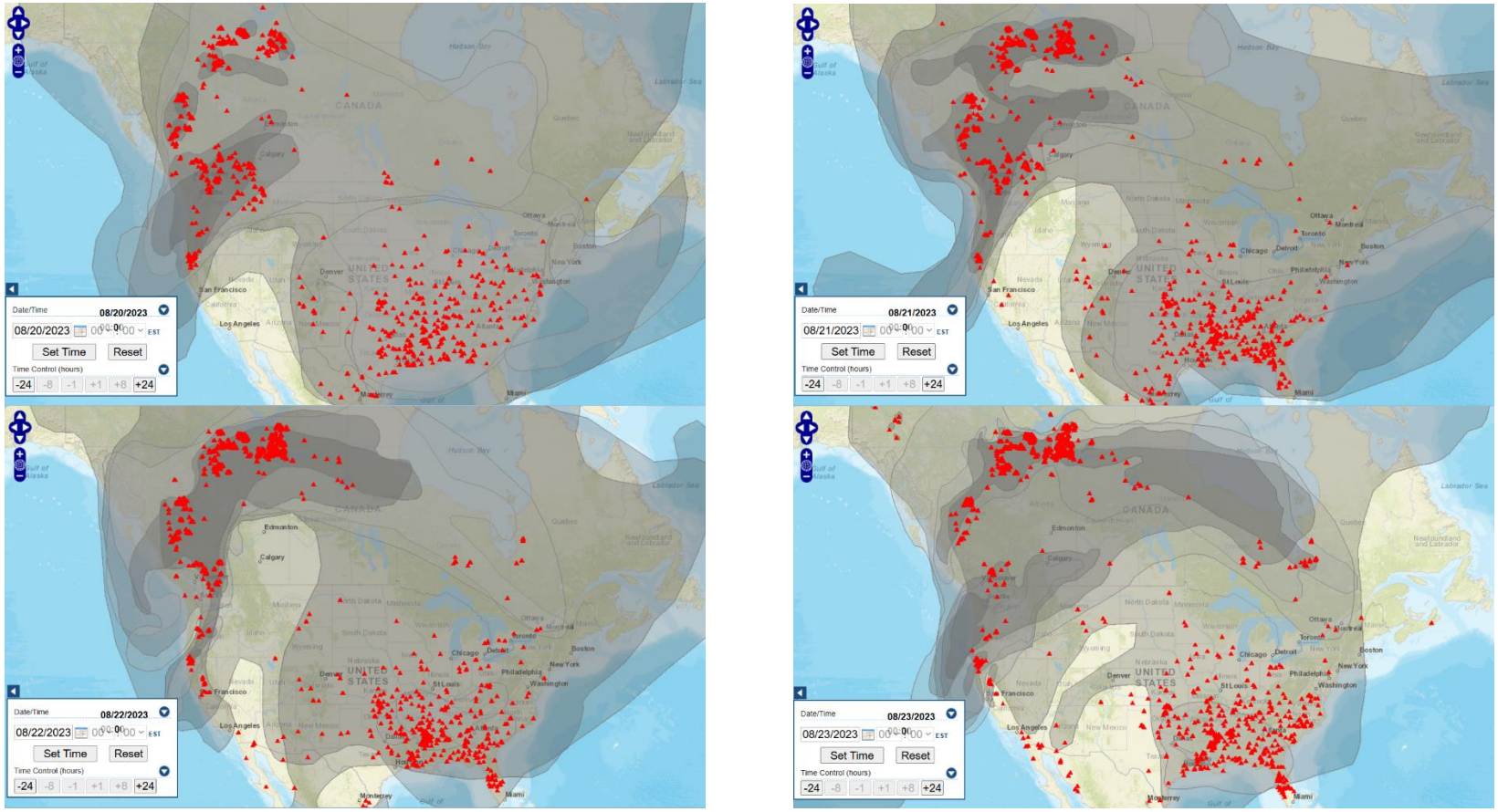



**Figure B10.** Map from the AirNow Navigator showing active fires (red) and smoke (grey) on August 20-23, 2023, plotted using the NOAA HMS over North America.

## Appendix C: HYSPLIT Back-Trajectory Maps

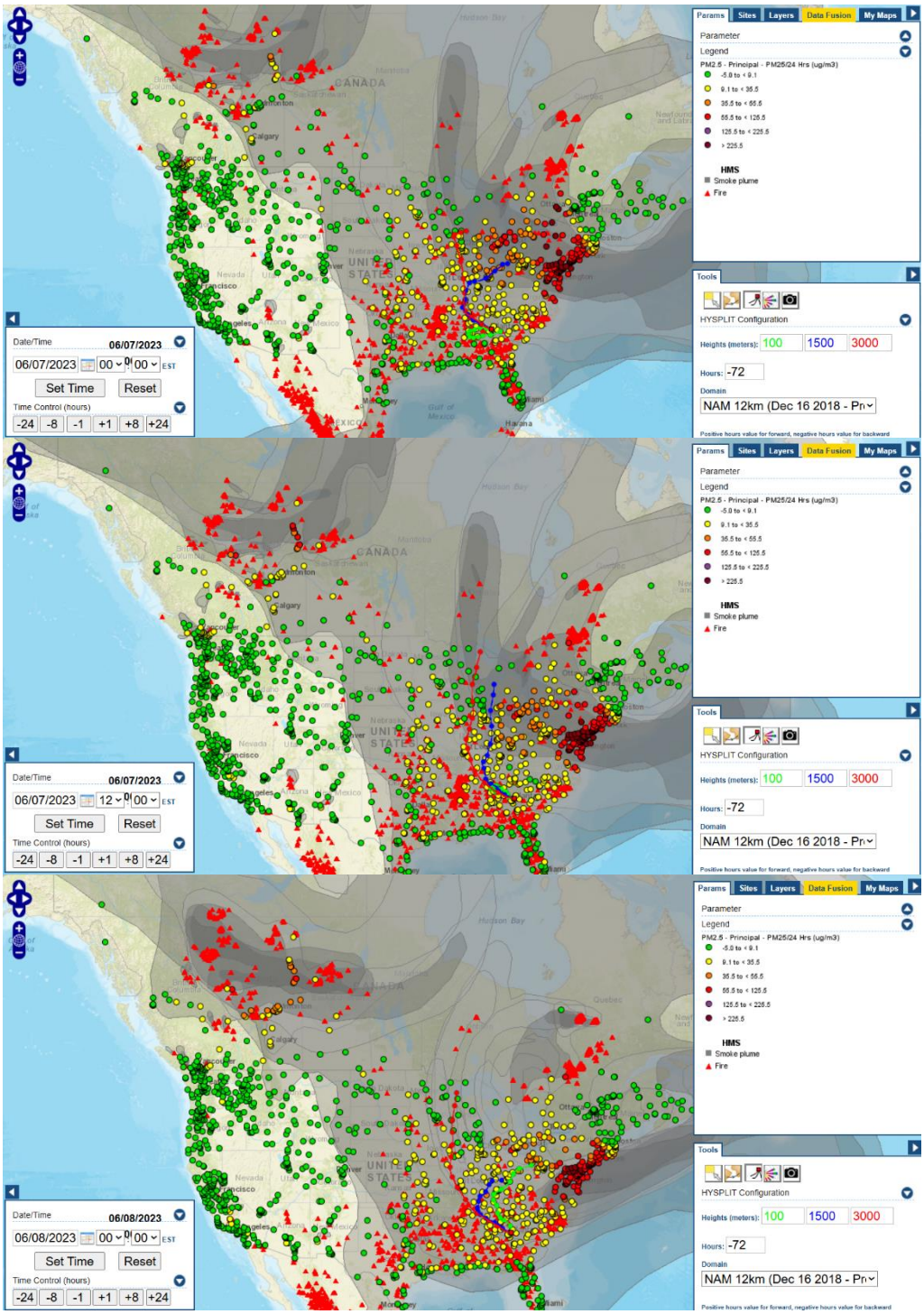



**Figure C1.** Map of HMS smoke plumes (grey polygons) and fires (red triangles), 24-hour rolling average $PM_{2.5}$ concentrations (circles), and HYSPLIT back-trajectories of release heights at 100 m (green lines), 1500 m (blue lines), and 3000 m (red lines) for 0 AM EST on June 7, 2023 (top), 12 PM EST on June 7, 2023 (middle), and 0 AM EST on June 8, 2023 (bottom).

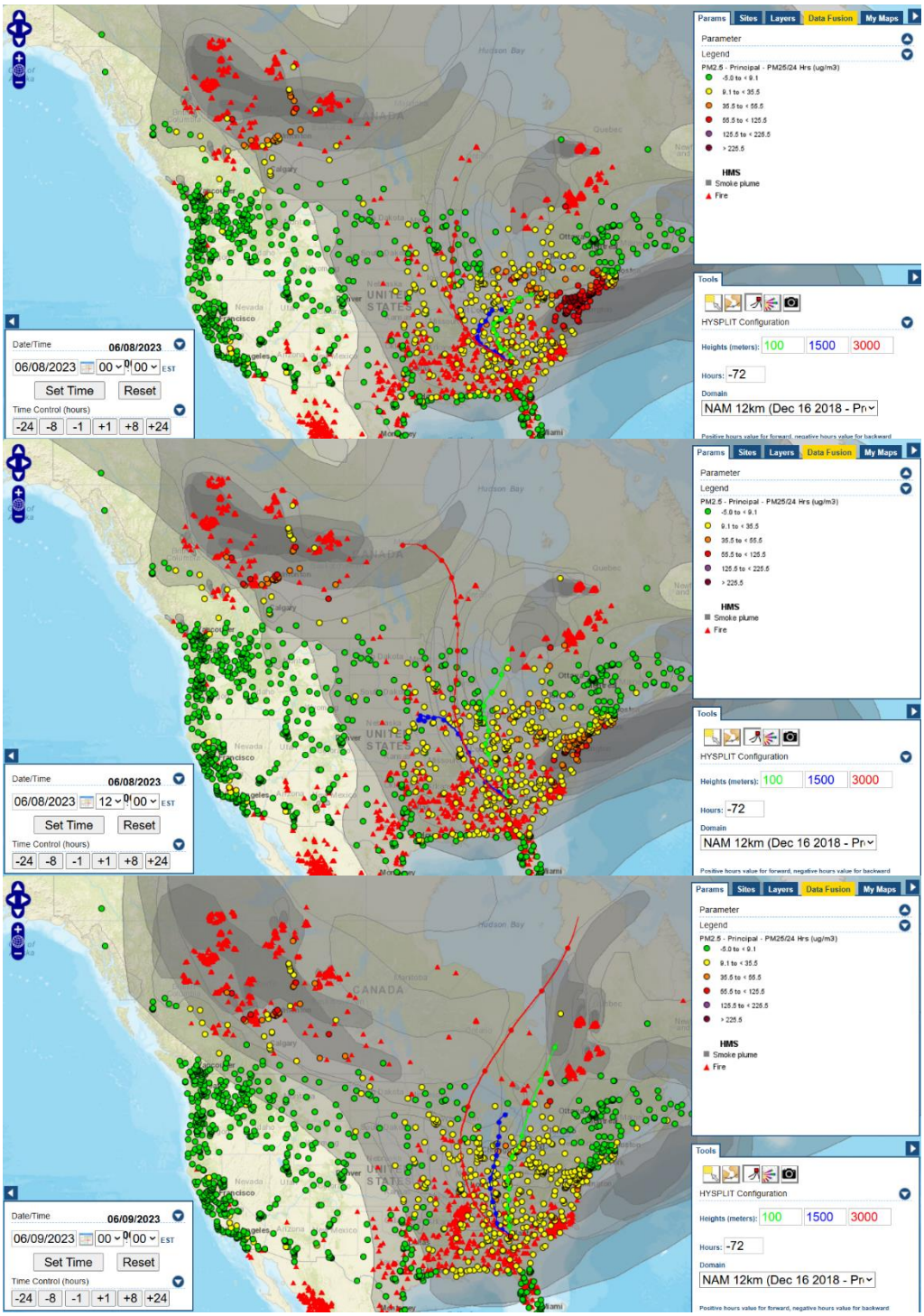



**Figure C2.** Map of HMS smoke plumes (grey polygons) and fires (red triangles), 24-hour rolling average $PM_{2.5}$ concentrations (circles), and HYSPLIT back-trajectories of release heights at 100 m (green lines), 1500 m (blue lines), and 3000 m (red lines) for 0 AM EST on June 8, 2023 (top), 12 PM EST on June 8, 2023 (middle), and 0 AM EST on June 9, 2023 (bottom).

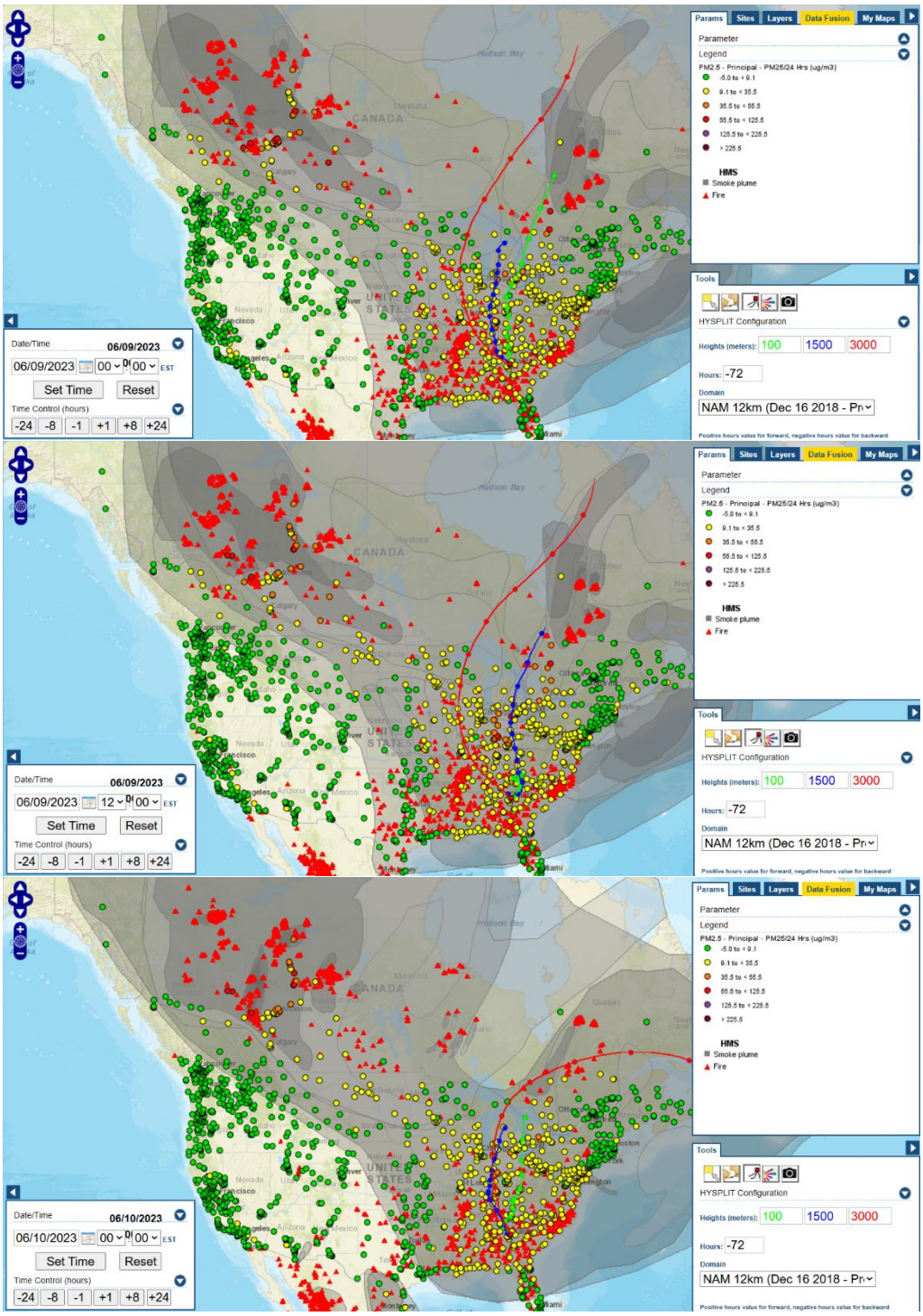



**Figure C3.** Map of HMS smoke plumes (grey polygons) and fires (red triangles), 24-hour rolling average $PM_{2.5}$ concentrations (circles), and HYSPLIT back-trajectories of release heights at 100 m (green lines), 1500 m (blue lines), and 3000 m (red lines) for 0 AM EST on June 9, 2023 (top), 12 PM EST on June 9, 2023 (middle), and 0 AM EST on June 10, 2023 (bottom).

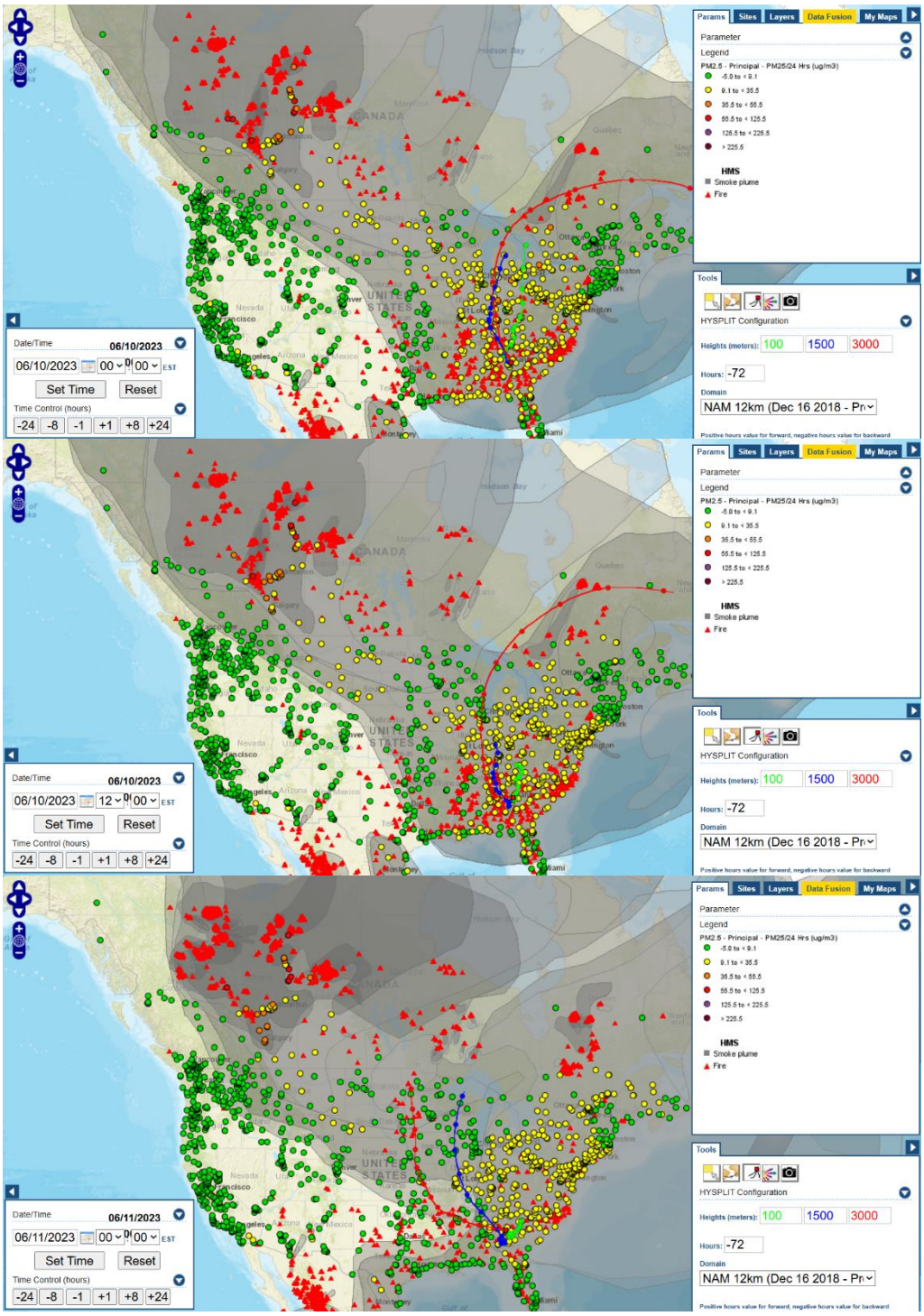



**Figure C4.** Map of HMS smoke plumes (grey polygons) and fires (red triangles), 24-hour rolling average $PM_{2.5}$ concentrations (circles), and HYSPLIT back-trajectories of release heights at 100 m (green lines), 1500 m (blue lines), and 3000 m (red lines) for 0 AM EST on June 10, 2023 (top), 12 PM EST on June 10, 2023 (middle), and 0 AM EST on June 11, 2023 (bottom).

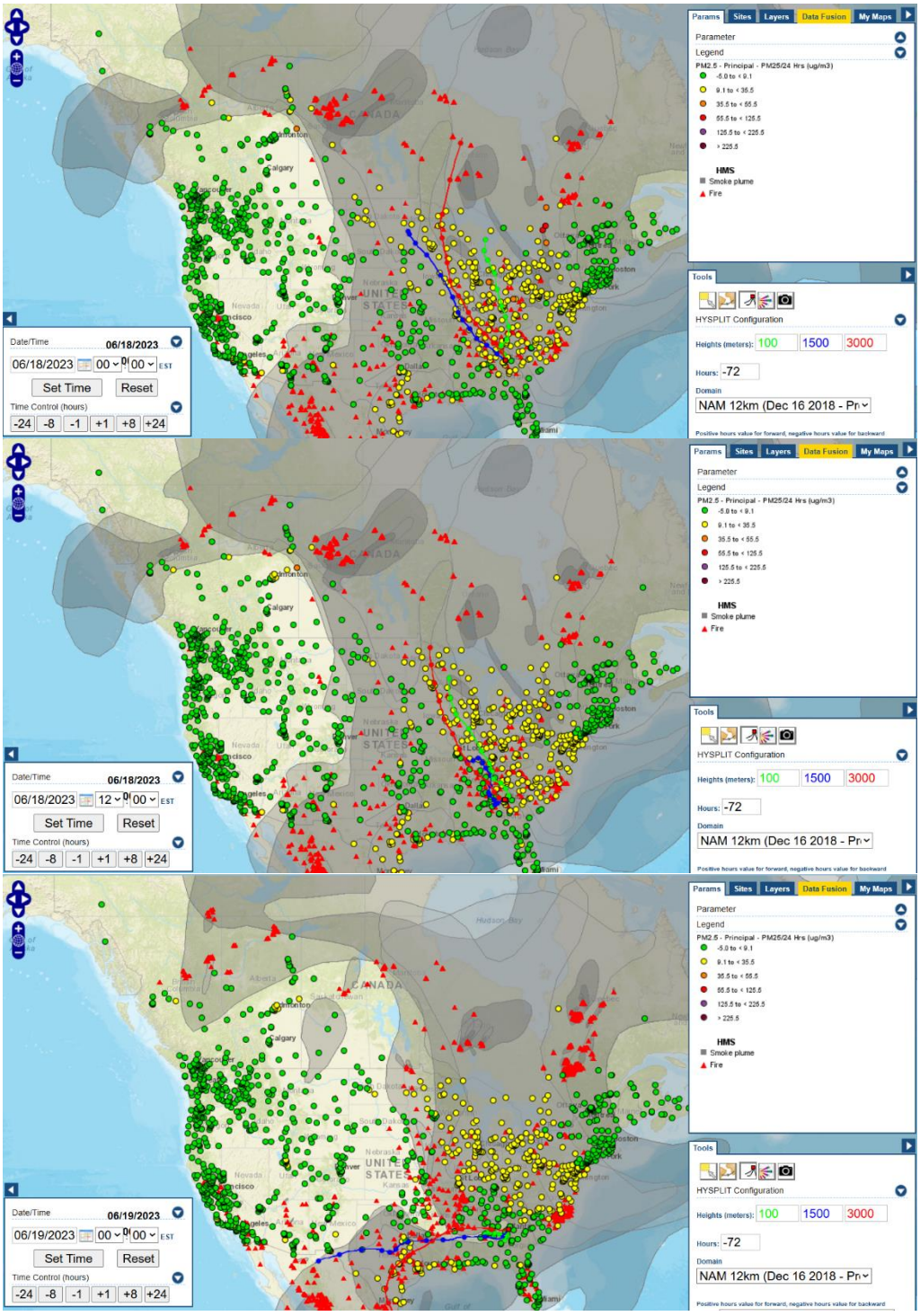



**Figure C5.** Map of HMS smoke plumes (grey polygons) and fires (red triangles), 24-hour rolling average $PM_{2.5}$ concentrations (circles), and HYSPLIT back-trajectories of release heights at 100 m (green lines), 1500 m (blue lines), and 3000 m (red lines) for 0 AM EST on June 18, 2023 (top), 12 PM EST on June 18, 2023 (middle), and 0 AM EST on June 19, 2023 (bottom).

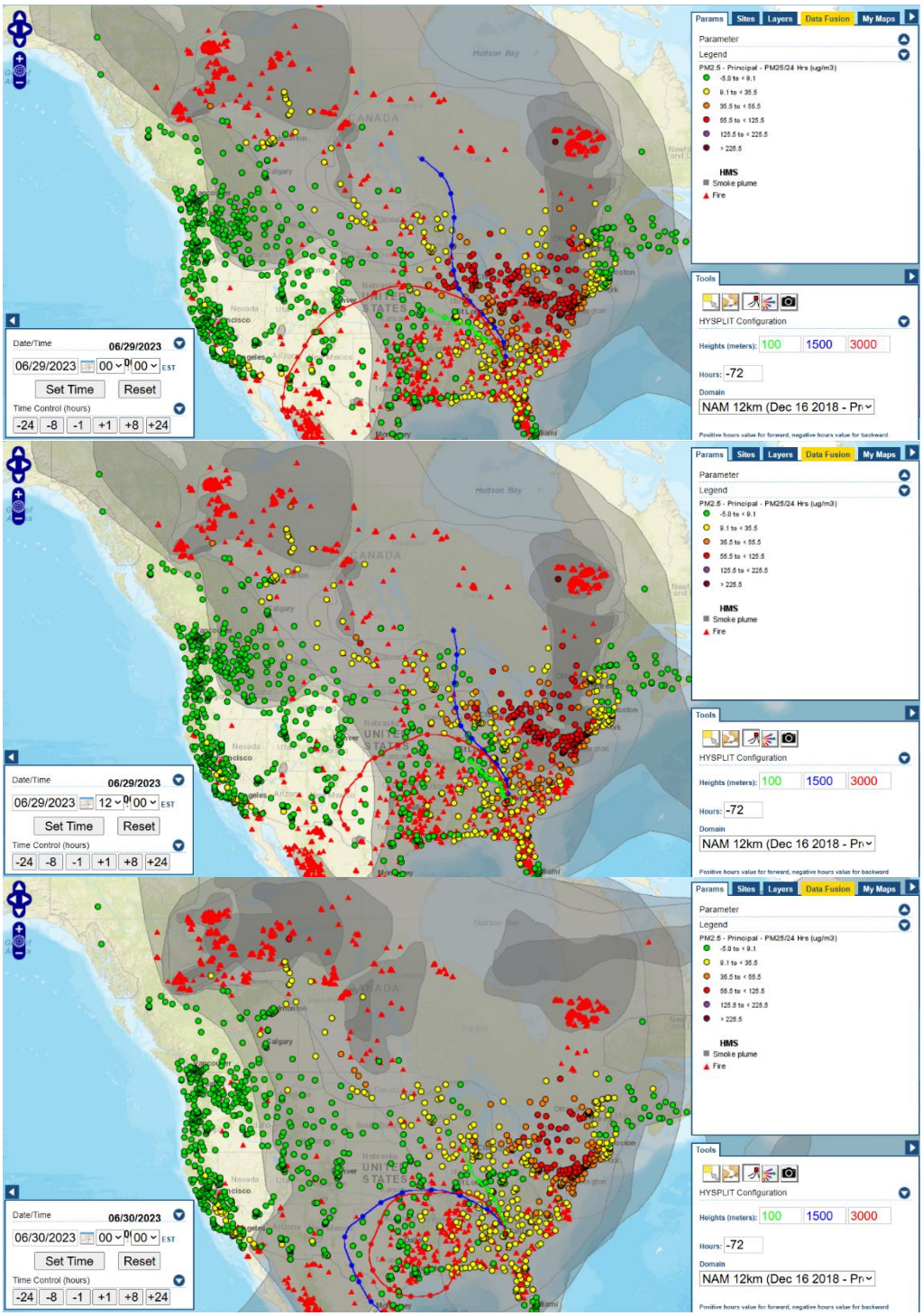



**Figure C6.** Map of HMS smoke plumes (grey polygons) and fires (red triangles), 24-hour rolling average $PM_{2.5}$ concentrations (circles), and HYSPLIT back-trajectories of release heights at 100 m (green lines), 1500 m (blue lines), and 3000 m (red lines) for 0 AM EST on June 29, 2023 (top), 12 PM EST on June 29, 2023 (middle), and 0 AM EST on June 30, 2023 (bottom).

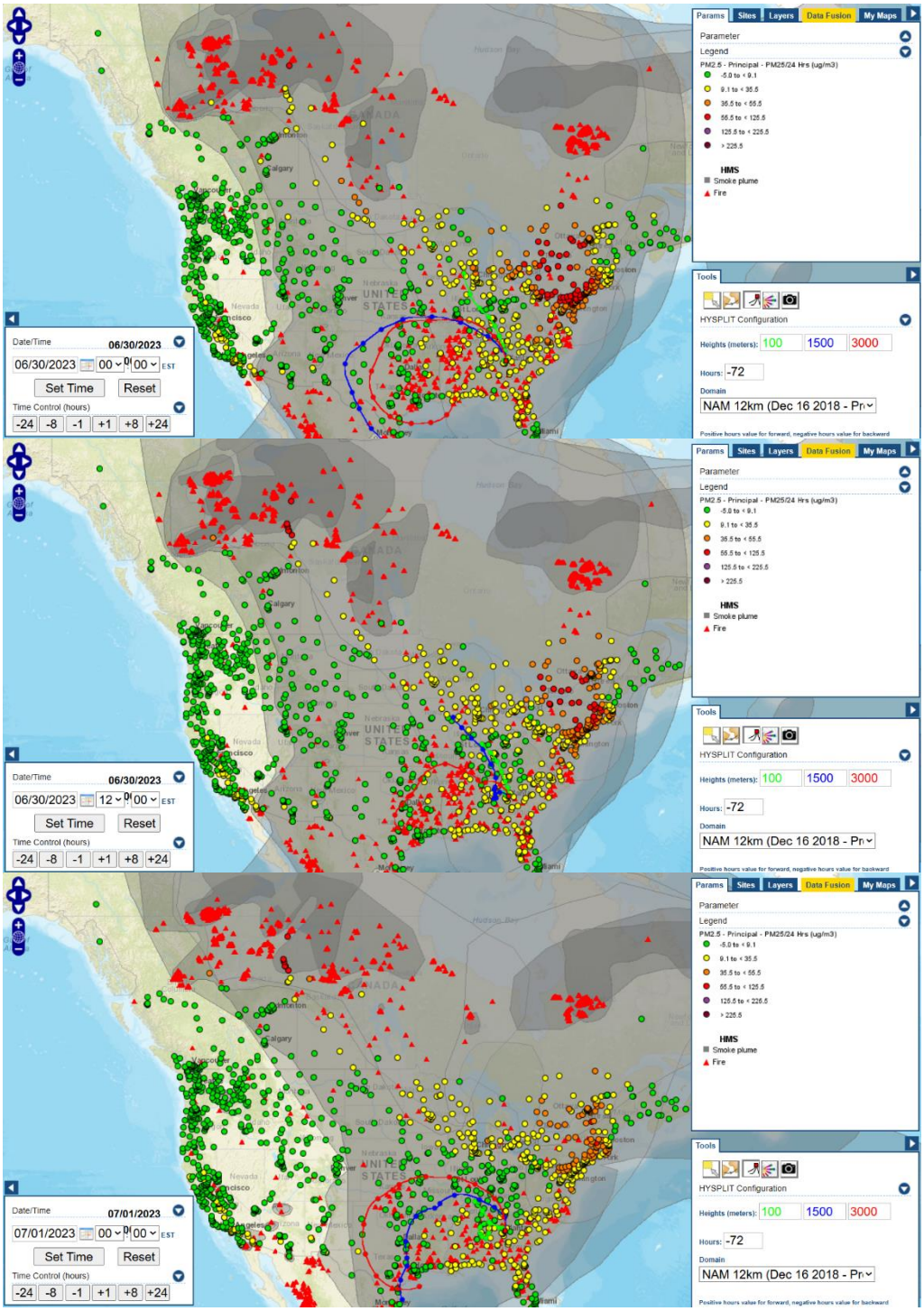



**Figure C7.** Map of HMS smoke plumes (grey polygons) and fires (red triangles), 24-hour rolling average $PM_{2.5}$ concentrations (circles), and HYSPLIT back-trajectories of release heights at 100 m (green lines), 1500 m (blue lines), and 3000 m (red lines) for 0 AM EST on June 30, 2023 (top), 12 PM EST on June 30, 2023 (middle), and 0 AM EST on July 1, 2023 (bottom).

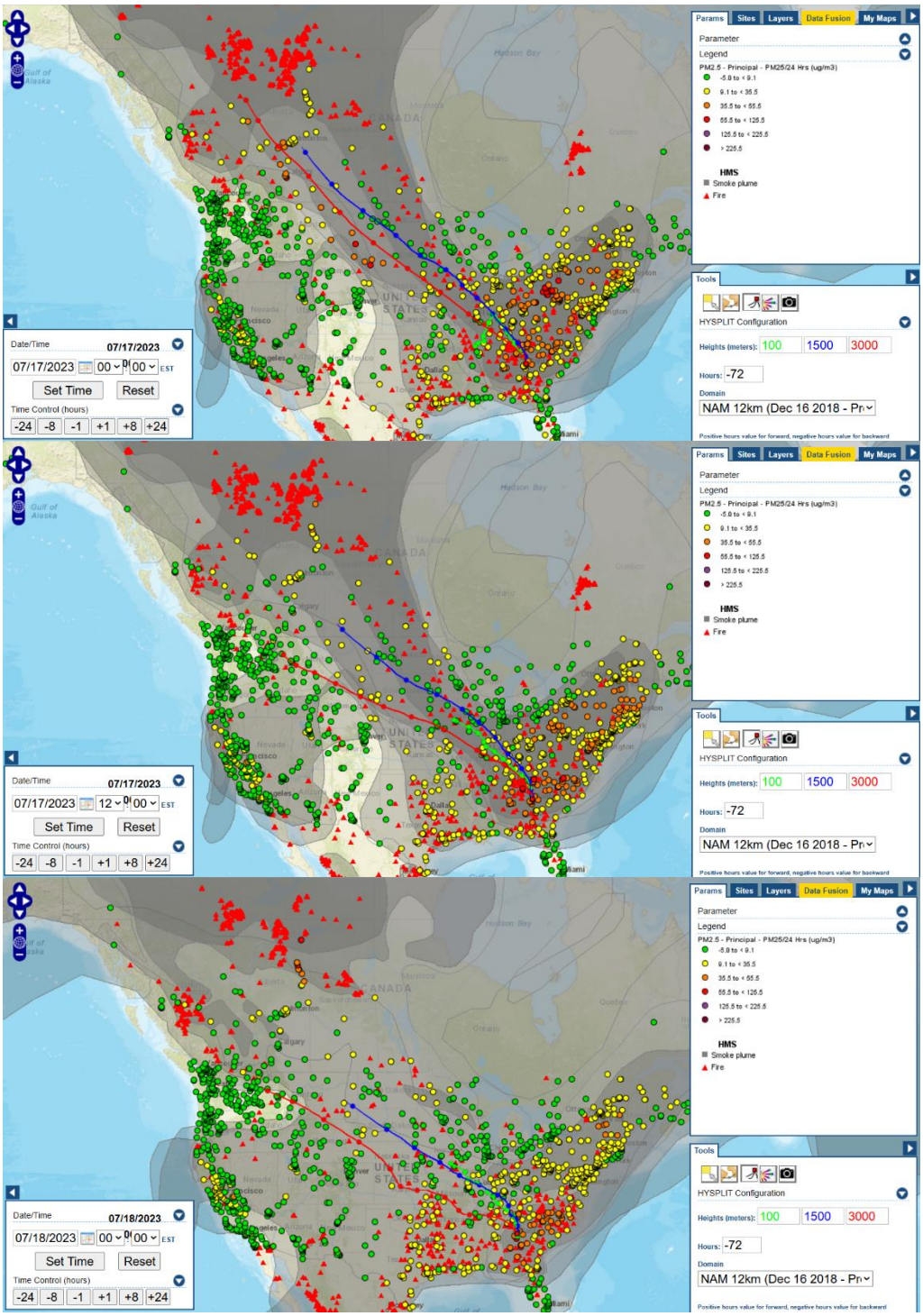



**Figure C8.** Map of HMS smoke plumes (grey polygons) and fires (red triangles), 24-hour rolling average $PM_{2.5}$ concentrations (circles), and HYSPLIT back-trajectories of release heights at 100 m (green lines), 1500 m (blue lines), and 3000 m (red lines) for 0 AM EST on July 17, 2023 (top), 12 PM EST on July 17, 2023 (middle), and 0 AM EST on July 18, 2023 (bottom).

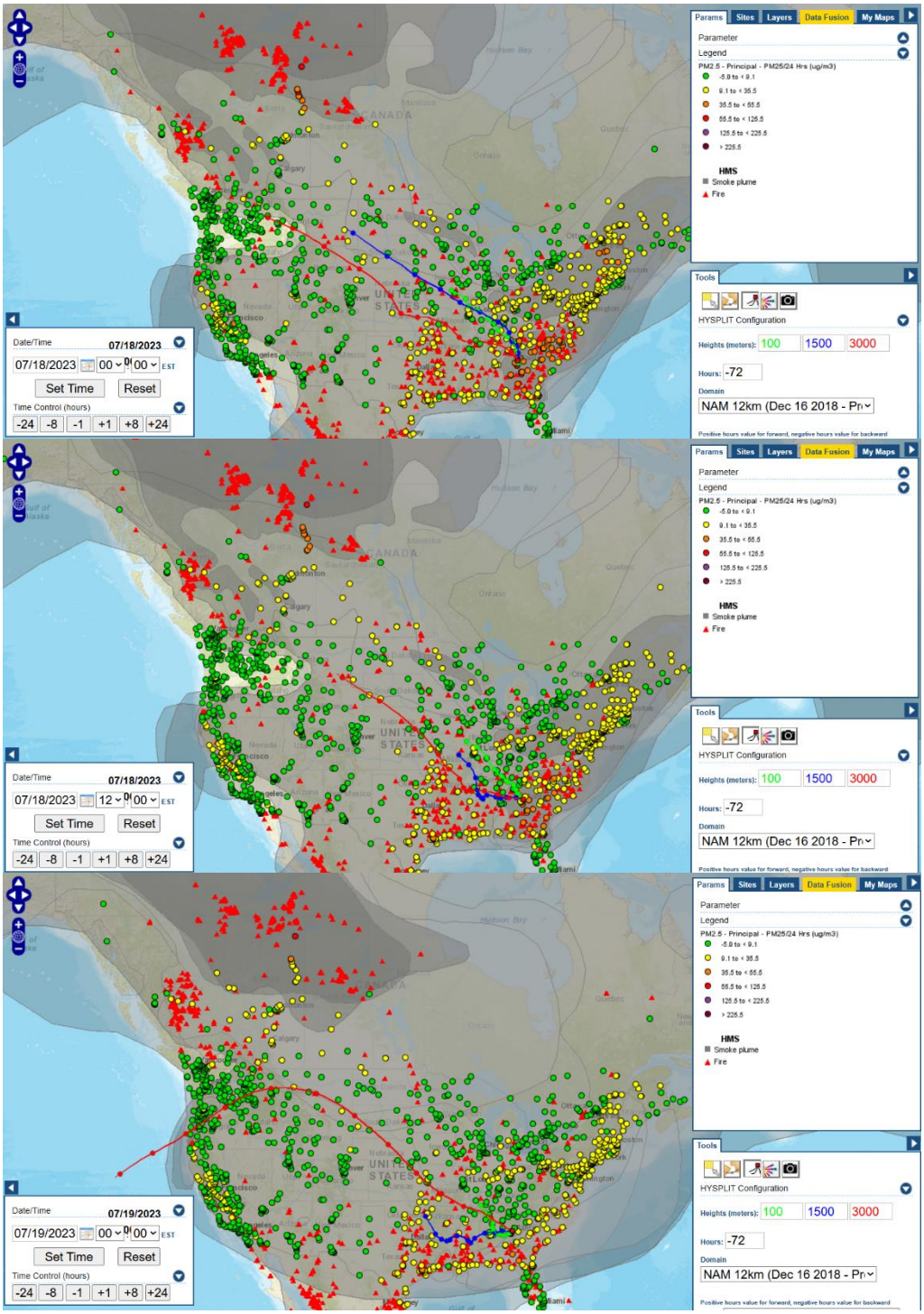



**Figure C9.** Map of HMS smoke plumes (grey polygons) and fires (red triangles), 24-hour rolling average $PM_{2.5}$ concentrations (circles), and HYSPLIT back-trajectories of release heights at 100 m (green lines), 1500 m (blue lines), and 3000 m (red lines) for 0 AM EST on July 18, 2023 (top), 12 PM EST on July 18, 2023 (middle), and 0 AM EST on July 19, 2023 (bottom).

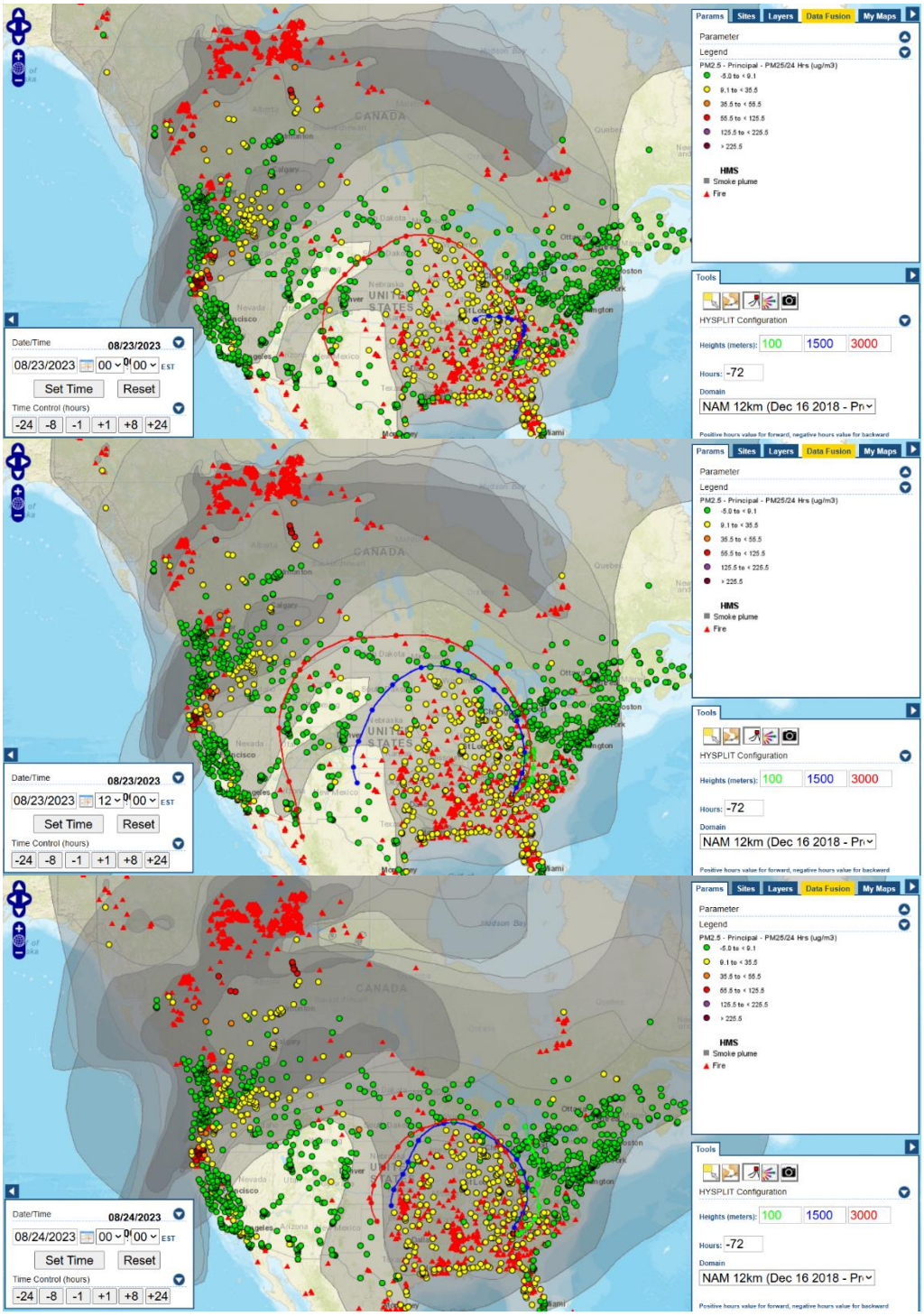
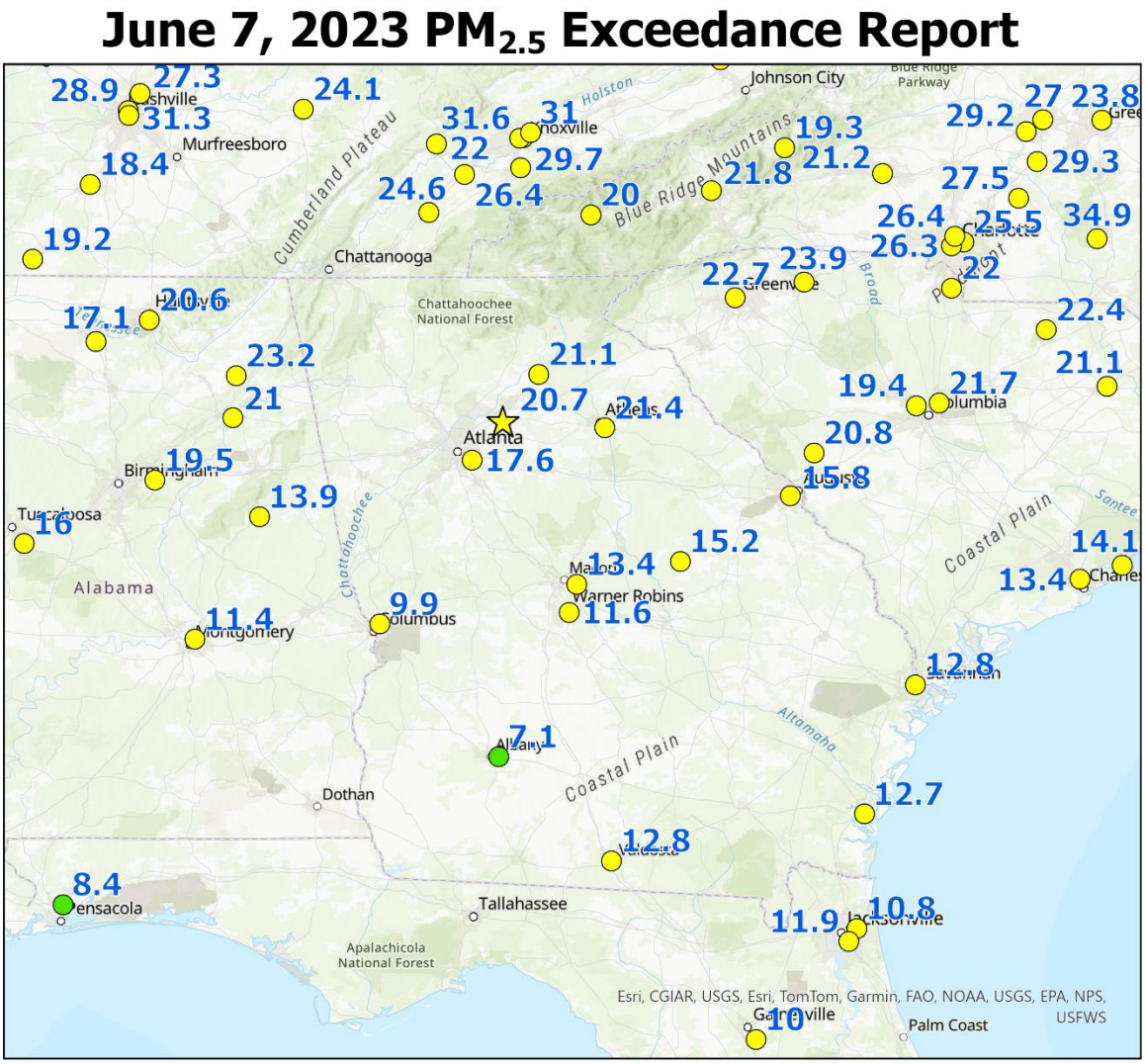



**Figure C10.** Map of HMS smoke plumes (grey polygons) and fires (red triangles), 24-hour rolling average $PM_{2.5}$ concentrations (circles), and HYSPLIT back-trajectories of release heights at 100 m (green lines), 1500 m (blue lines), and 3000 m (red lines) for 0 AM EST on August 23, 2023 (top), 12 PM EST on August 23, 2023 (middle), and 0 AM EST on August 24, 2023 (bottom).

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

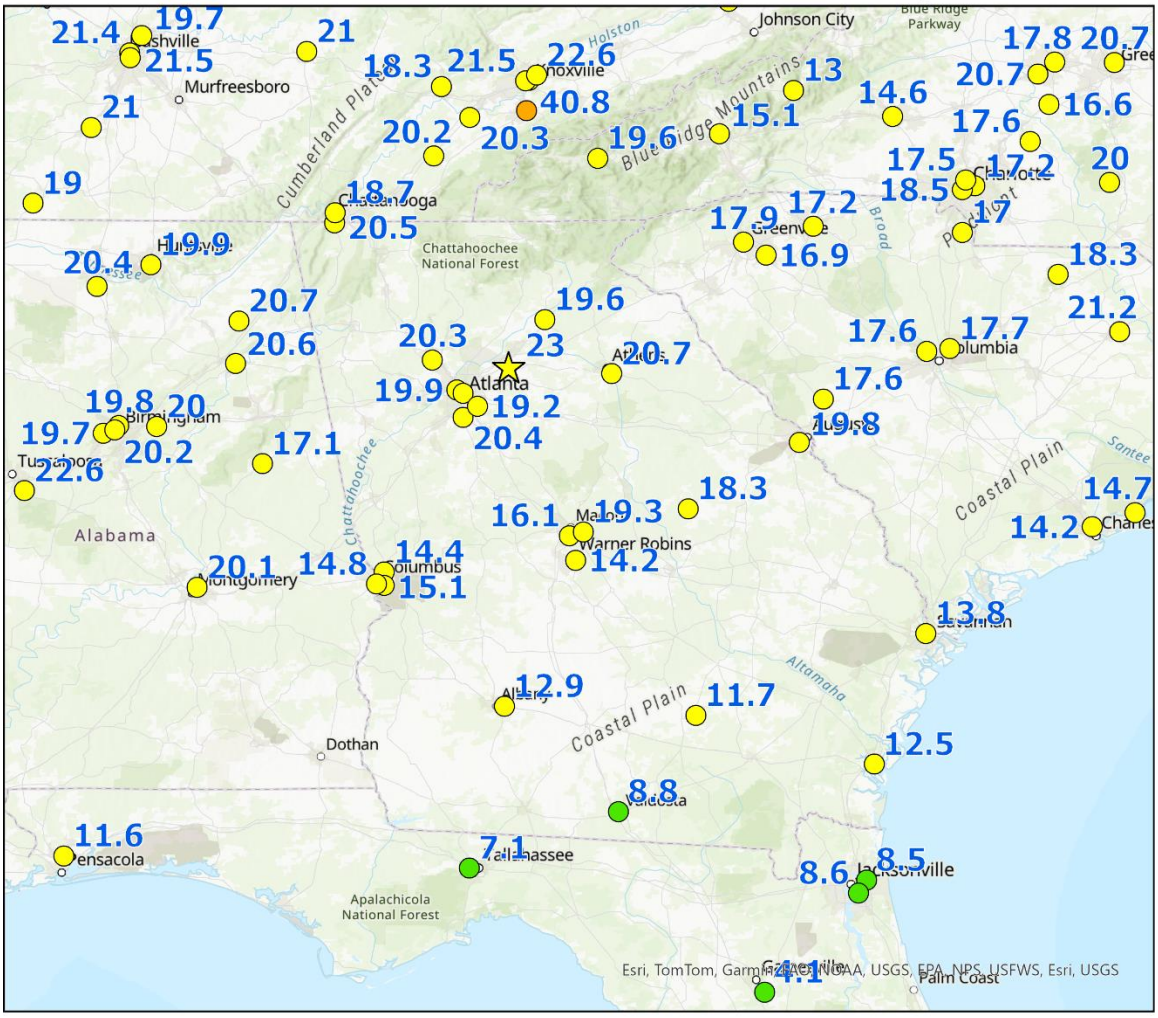



**AQI category - 24-hr average $PM_{2.5}$**

FINAL

- 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 7, 2023, across the southeast. The Gwinnett Tech site is represented by a star. Numerous sites measured concentrations that exceeded the level of annual $PM_{2.5}$ NAAQS.

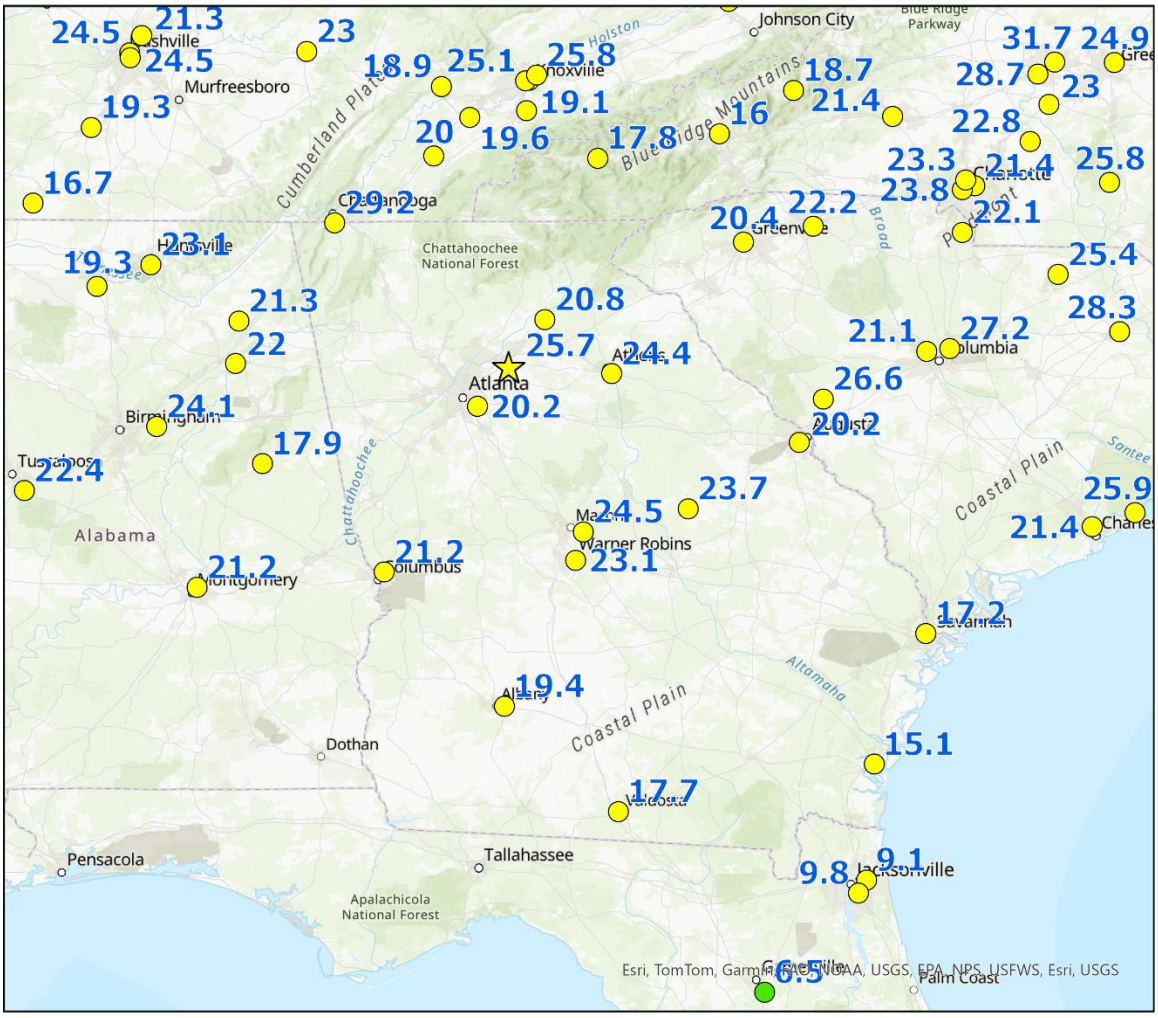



**AQI category - 24-hr average $PM_{2.5}$**

FINAL

- 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 June 8, 2023, across the southeast. The Gwinnett Tech site is represented by a star. Numerous sites measured concentrations that exceeded the level of annual $PM_{2.5}$ NAAQS.



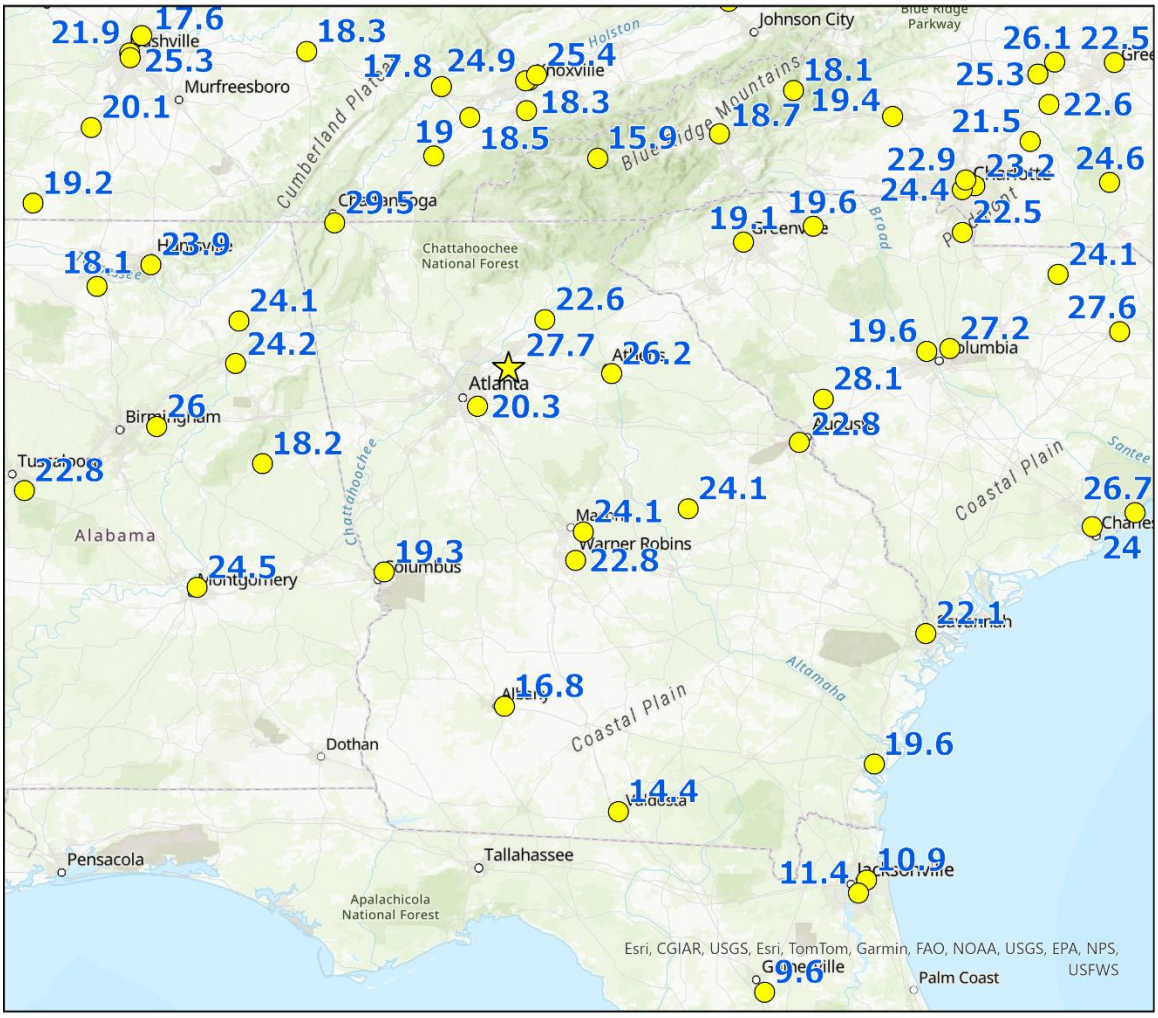

**AQI category - 24-hr average $PM_{2.5}$**

FINAL

- 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 D3.** Surface level, daily $PM_{2.5}$ concentrations on June 9, 2023, across the southeast. The Gwinnett Tech site is represented by a star. Numerous sites measured concentrations that exceeded the level of annual $PM_{2.5}$ NAAQS.

# June 10, 2023 $PM_{2.5}$ Exceedance Report



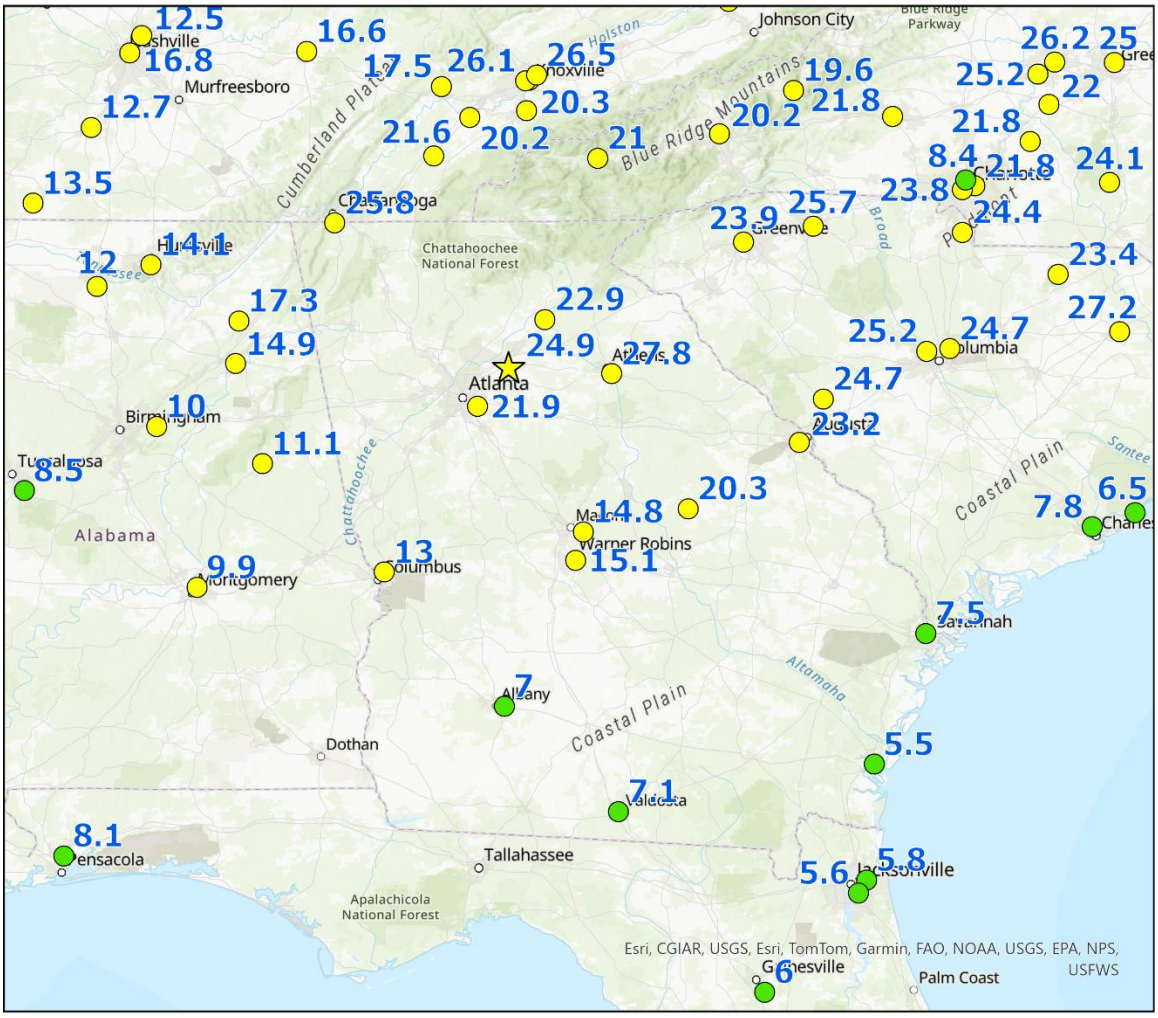

**AQI category - 24-hr average $PM_{2.5}$**

FINAL

- 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 D4.** Surface level, daily $PM_{2.5}$ concentrations on June 10, 2023, across the southeast. The Gwinnett Tech site is represented by a star. Numerous sites measured concentrations that exceeded the level of annual $PM_{2.5}$ NAAQS.

# June 18, 2023 $PM_{2.5}$ Exceedance Report




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

FINAL

- 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 D5.** Surface level, daily $PM_{2.5}$ concentrations on June 18, 2023, across the southeast. The Gwinnett Tech site is represented by a star. Numerous sites measured concentrations that exceeded the level of annual $PM_{2.5}$ NAAQS.

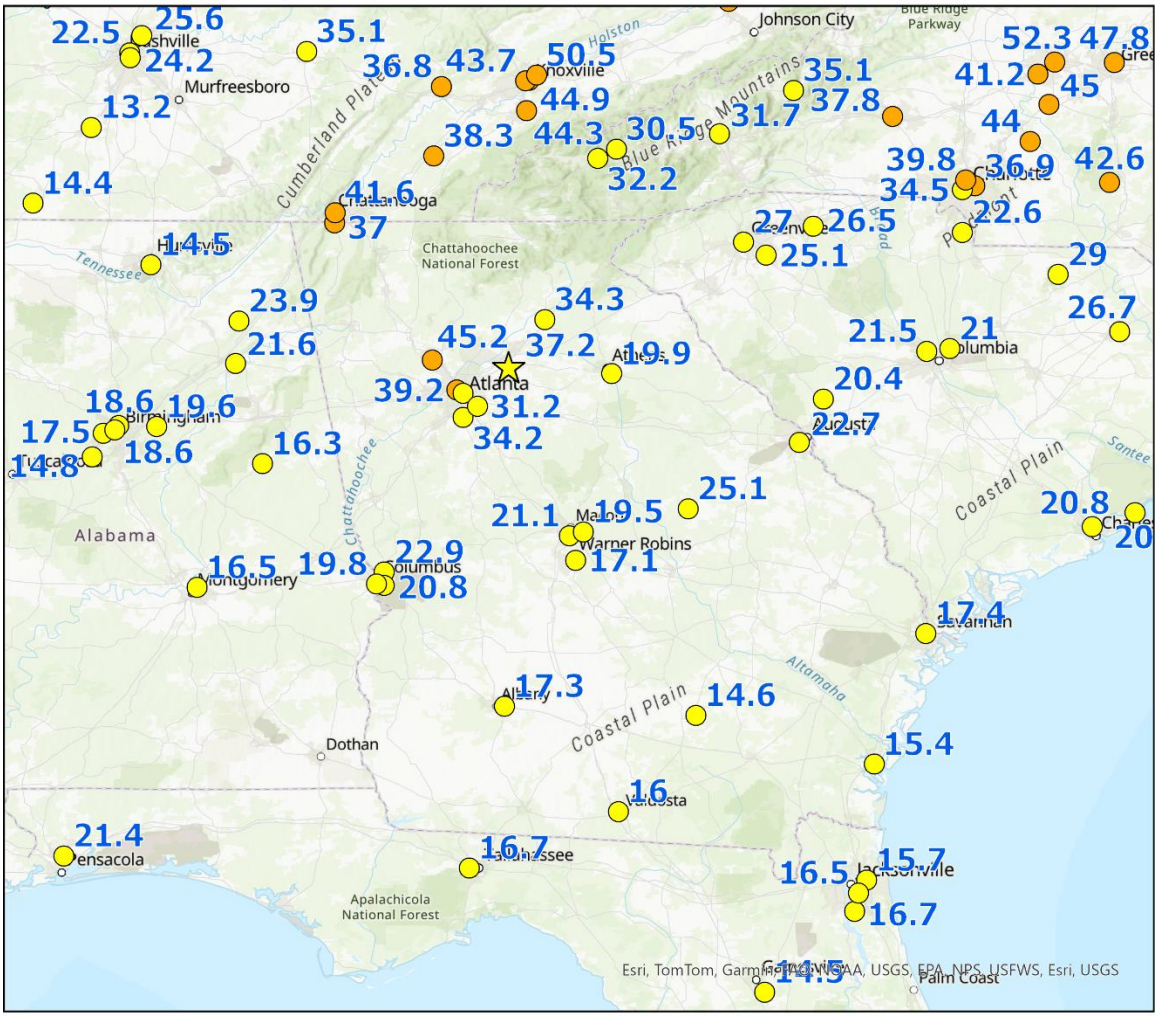
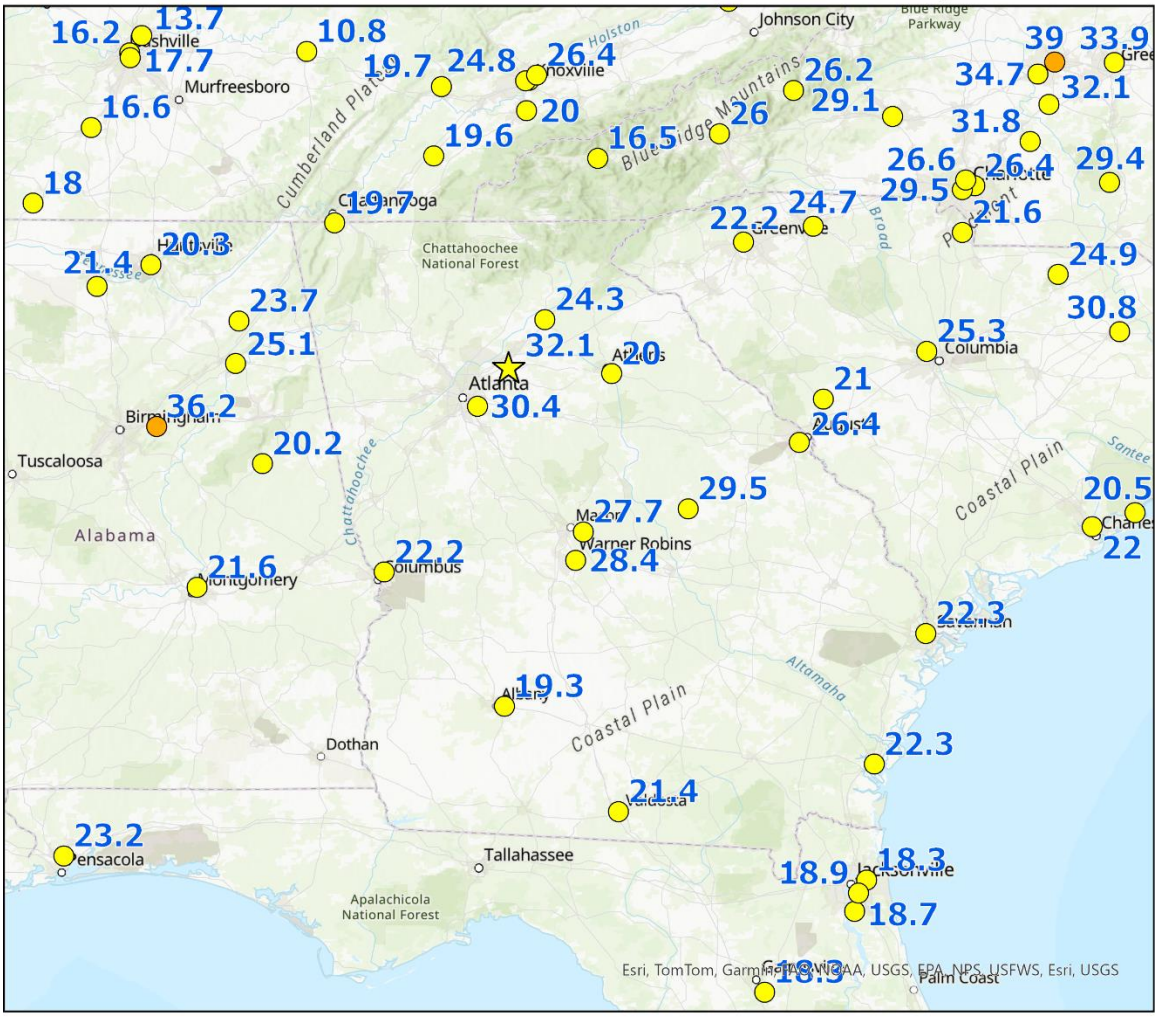



**Figure D6.** Surface level, daily $PM_{2.5}$ concentrations on June 29, 2023, across the southeast. The Gwinnett Tech site is represented by a star. Numerous sites measured concentrations that exceeded the level of annual $PM_{2.5}$ NAAQS.

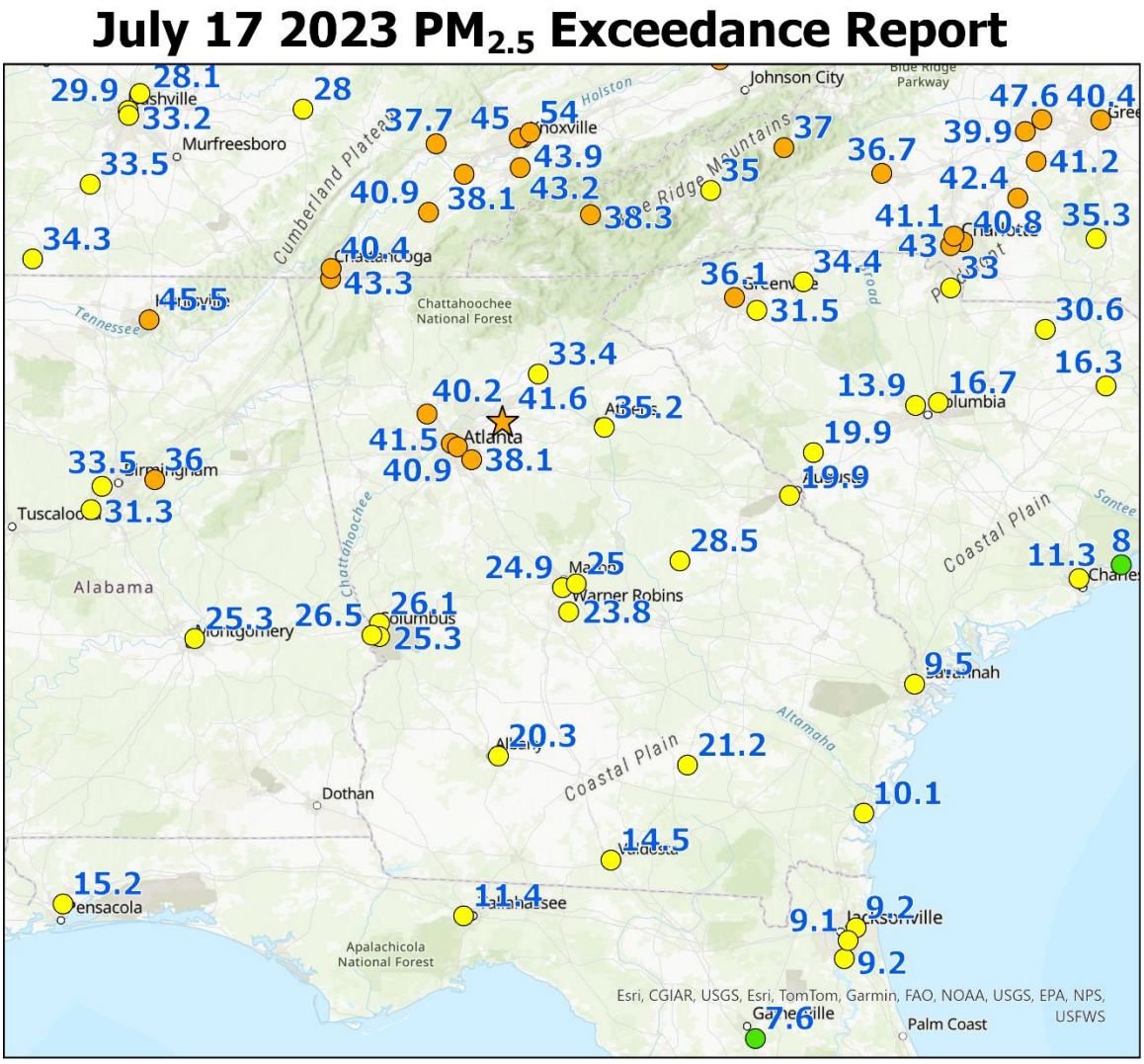



**AQI category - 24-hr average $PM_{2.5}$**

FINAL

- 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 D7.** Surface level, daily $PM_{2.5}$ concentrations on June 30, 2023, across the southeast. The Gwinnett Tech site is represented by a star. Numerous sites measured concentrations that exceeded the level of annual $PM_{2.5}$ NAAQS.

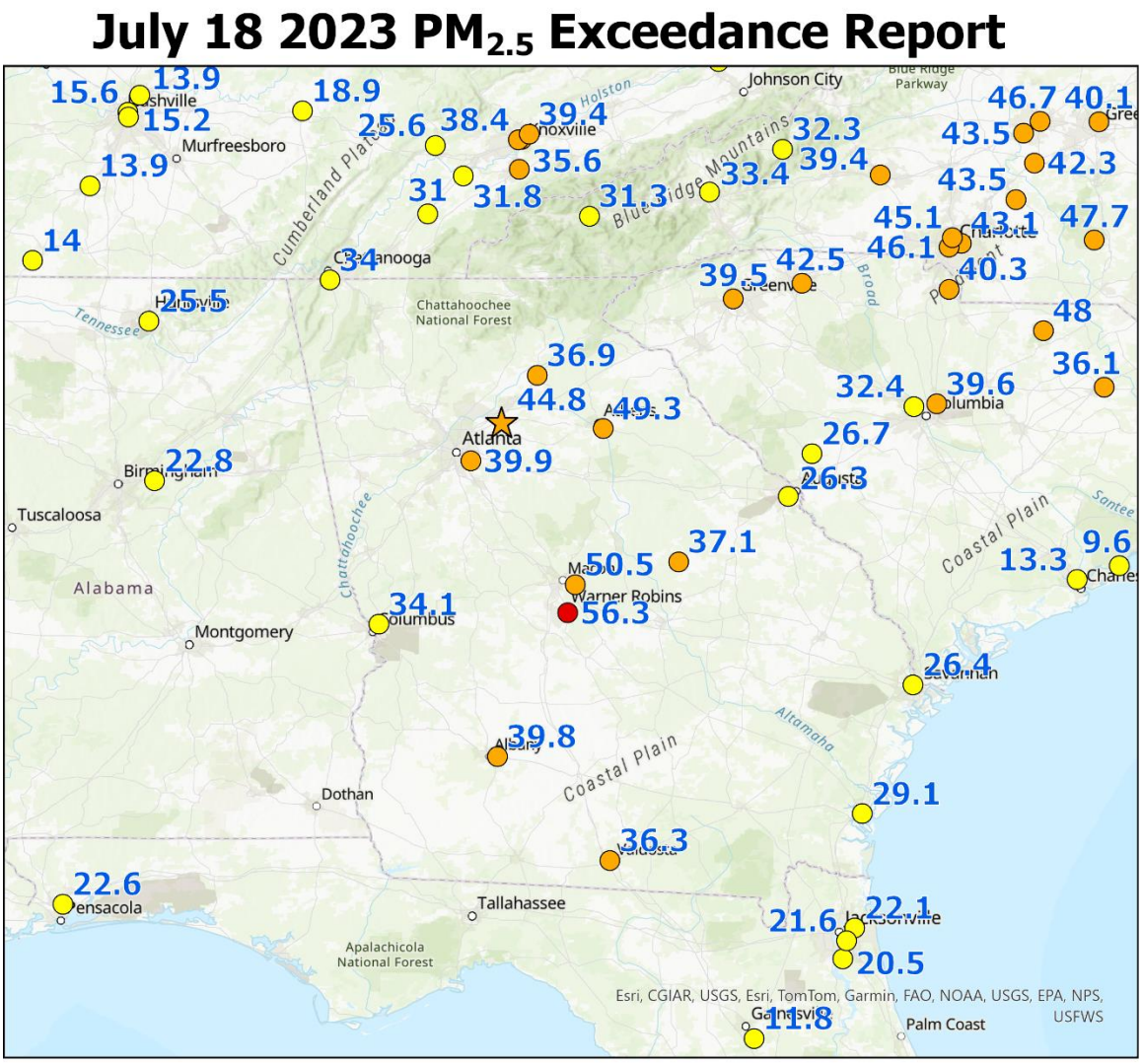



**AQI category - 24-hr average $PM_{2.5}$**

FINAL

- 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 D8.** Surface level, daily $PM_{2.5}$ concentrations on July 17, 2023, across the southeast. The Gwinnett Tech site is represented by a star. Numerous sites measured concentrations that exceeded the level of annual $PM_{2.5}$ NAAQS.

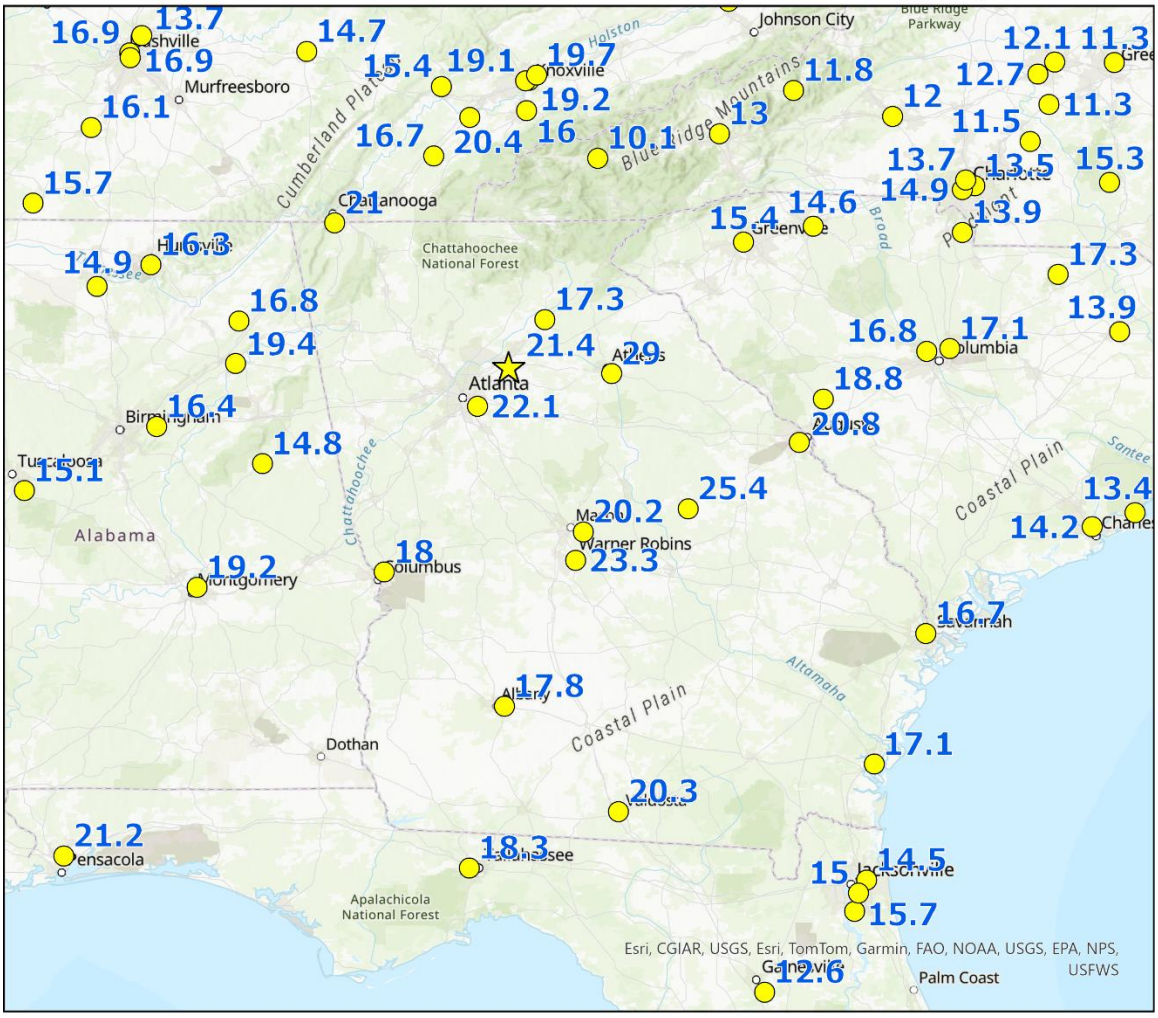



**AQI category - 24-hr average $PM_{2.5}$**

FINAL

- 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 D9.** Surface level, daily $PM_{2.5}$ concentrations on July 18, 2023, across the southeast. The Gwinnett Tech site is represented by a star. Numerous sites measured concentrations that exceeded the level of annual $PM_{2.5}$ NAAQS.




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

FINAL

- 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 D10.** Surface level, daily $PM_{2.5}$ concentrations on August 23, 2023, across the southeast. The Gwinnett Tech 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

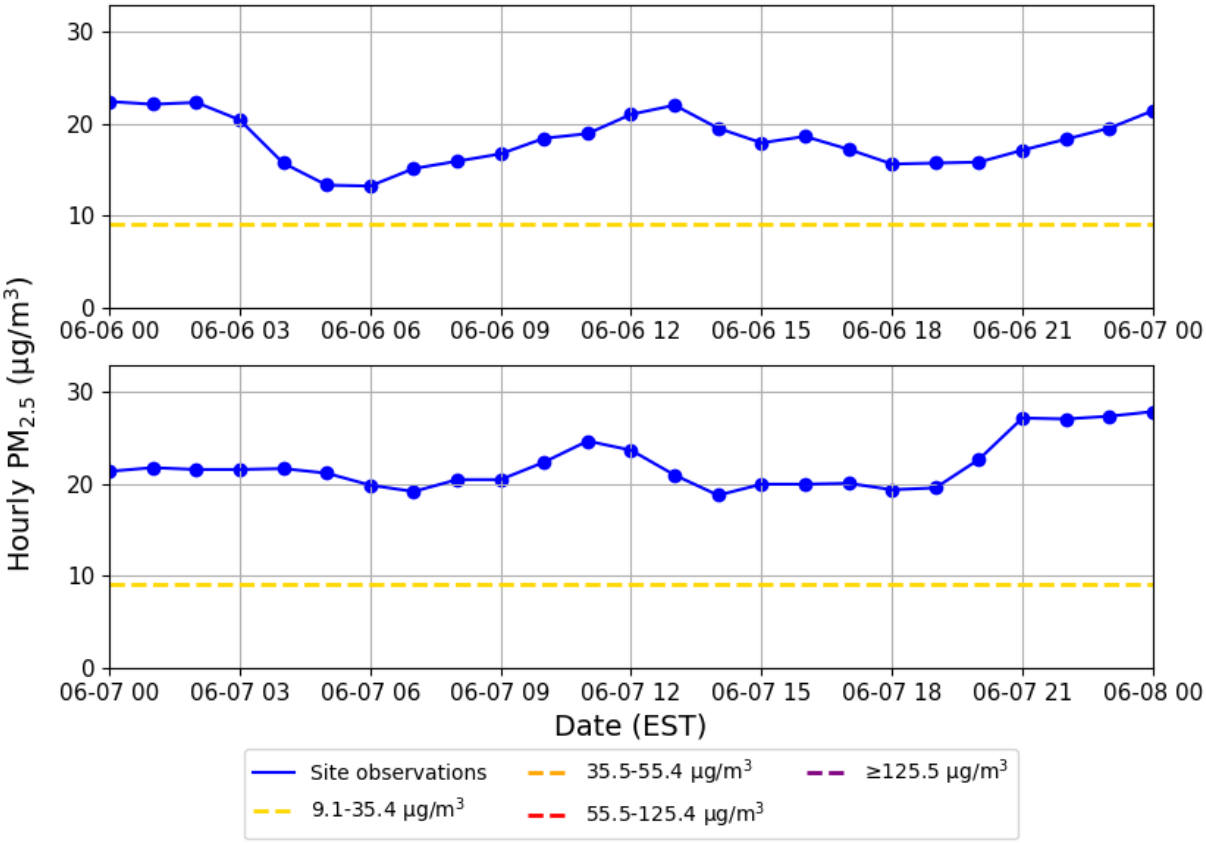



**Figure E1.** Hourly $PM_{2.5}$ concentrations at the Gwinnett Tech site on June 6 and 7, 2023. The solid, dotted line shows observations, and the dashed lines show AQI tiers adjusted for the 2024 $PM_{2.5}$ NAAQS.

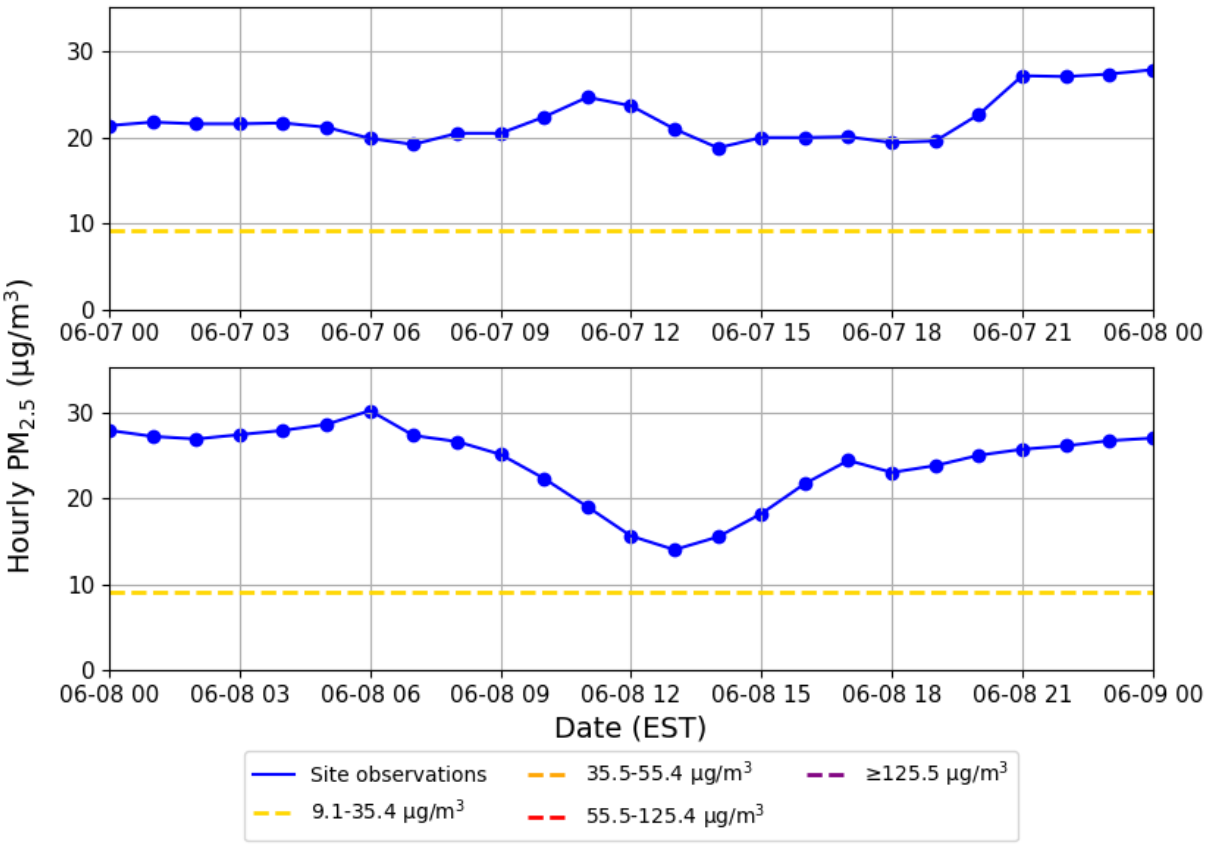



**Figure E2.** Hourly $PM_{2.5}$ concentrations at the Gwinnett Tech site on June 7 and 8, 2023. The solid, dotted line shows observations, and the dashed lines show AQI tiers adjusted for the 2024 $PM_{2.5}$ NAAQS.

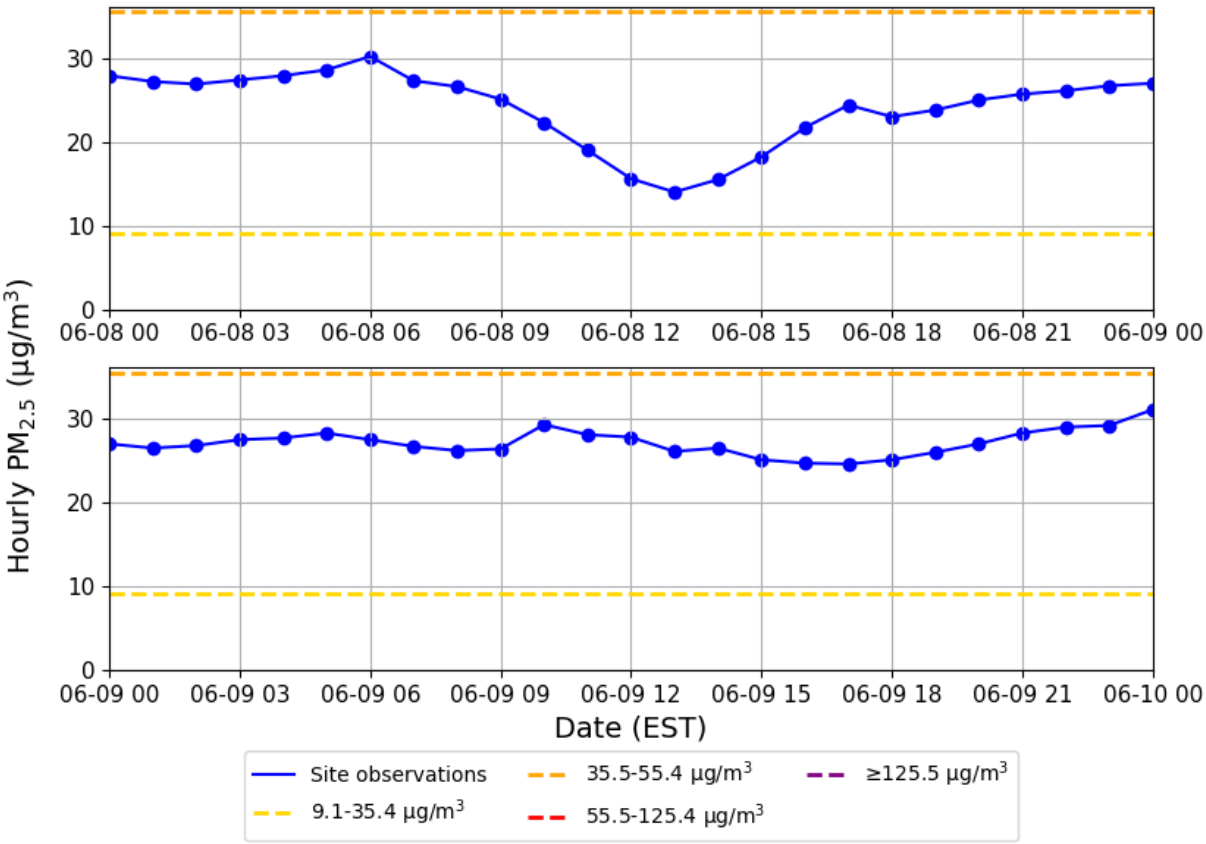



**Figure E3.** Hourly $PM_{2.5}$ concentrations at the Gwinnett Tech site on June 8 and 9, 2023. The solid, dotted line shows observations, and the dashed lines show AQI tiers adjusted for the 2024 $PM_{2.5}$ NAAQS.

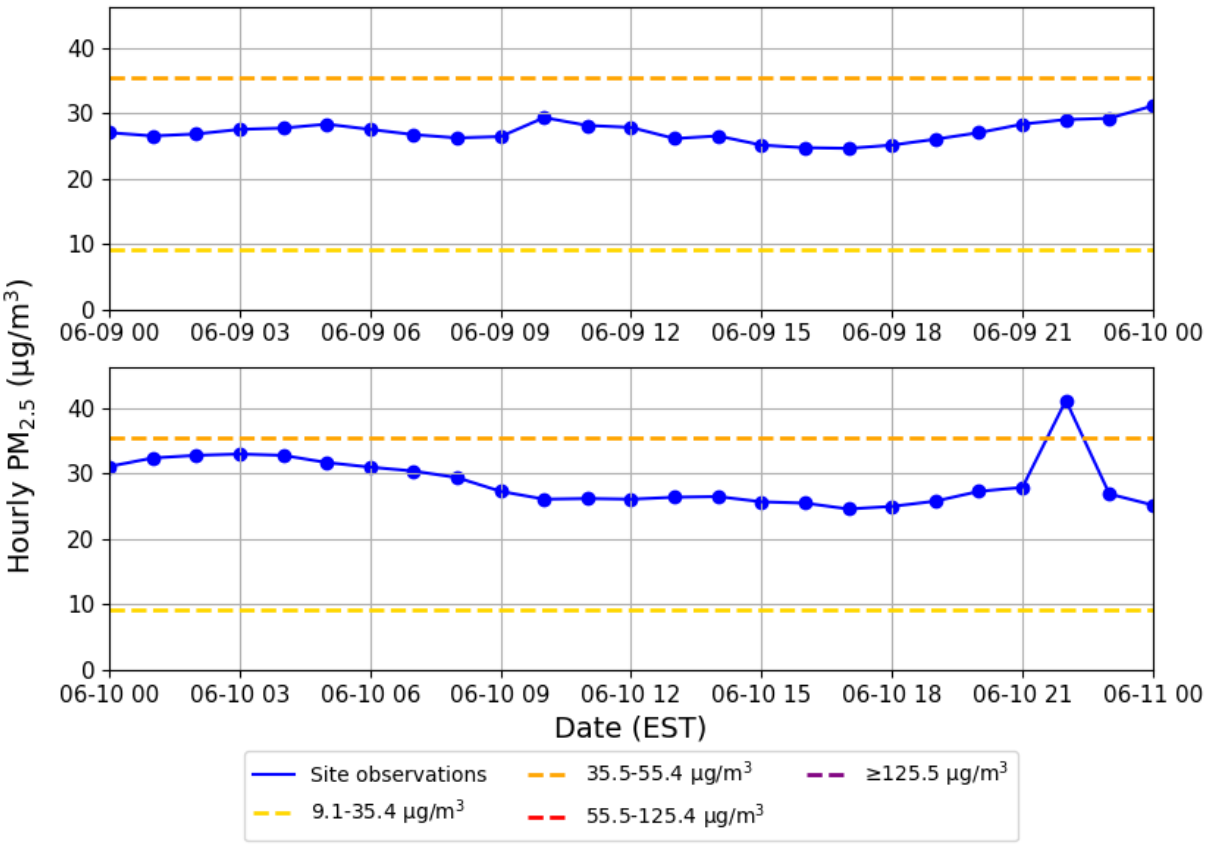



**Figure E4.** Hourly $PM_{2.5}$ concentrations at the Gwinnett Tech site on June 9 and 10, 2023. The solid, dotted line shows observations, and the dashed lines show AQI tiers adjusted for the 2024 $PM_{2.5}$ NAAQS.

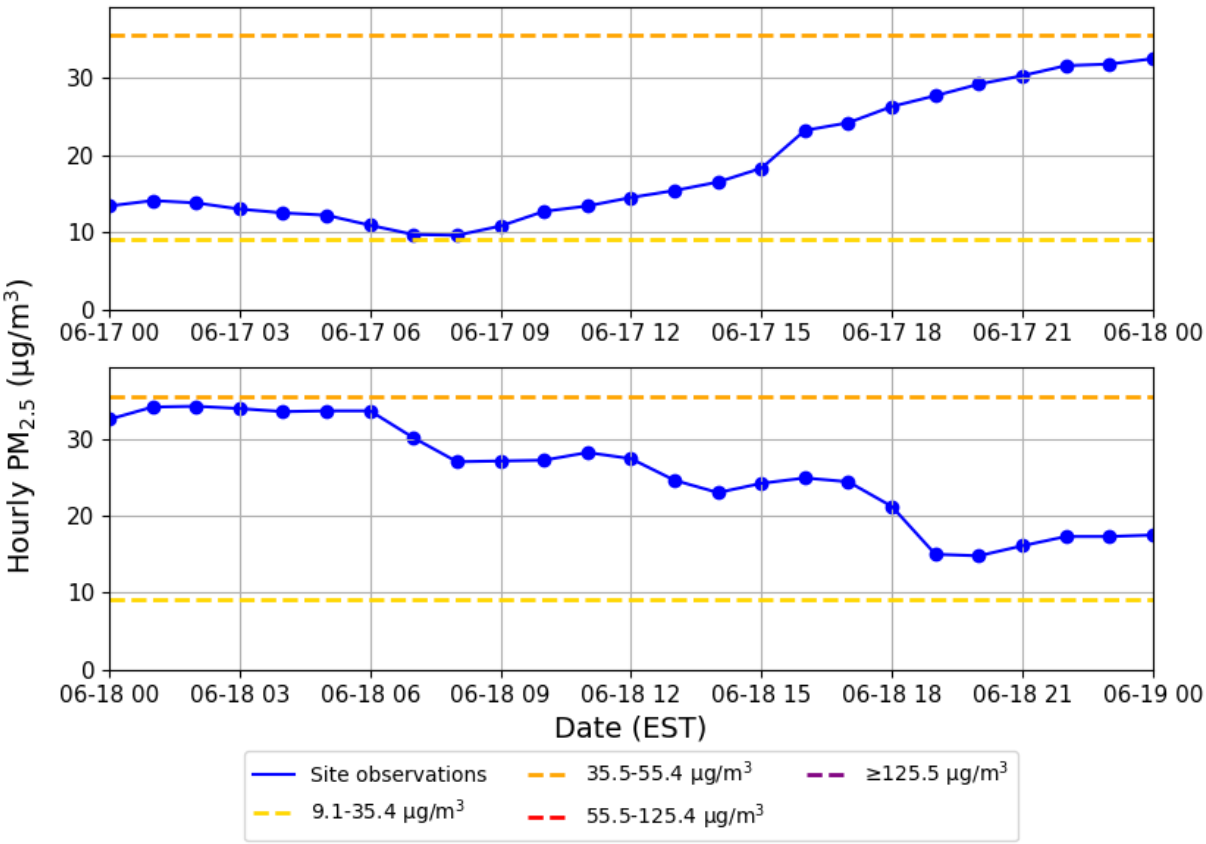



**Figure E5.** Hourly $PM_{2.5}$ concentrations at the Gwinnett Tech site on June 17 and 18, 2023. The solid, dotted line shows observations, and the dashed lines show AQI tiers adjusted for the 2024 $PM_{2.5}$ NAAQS.

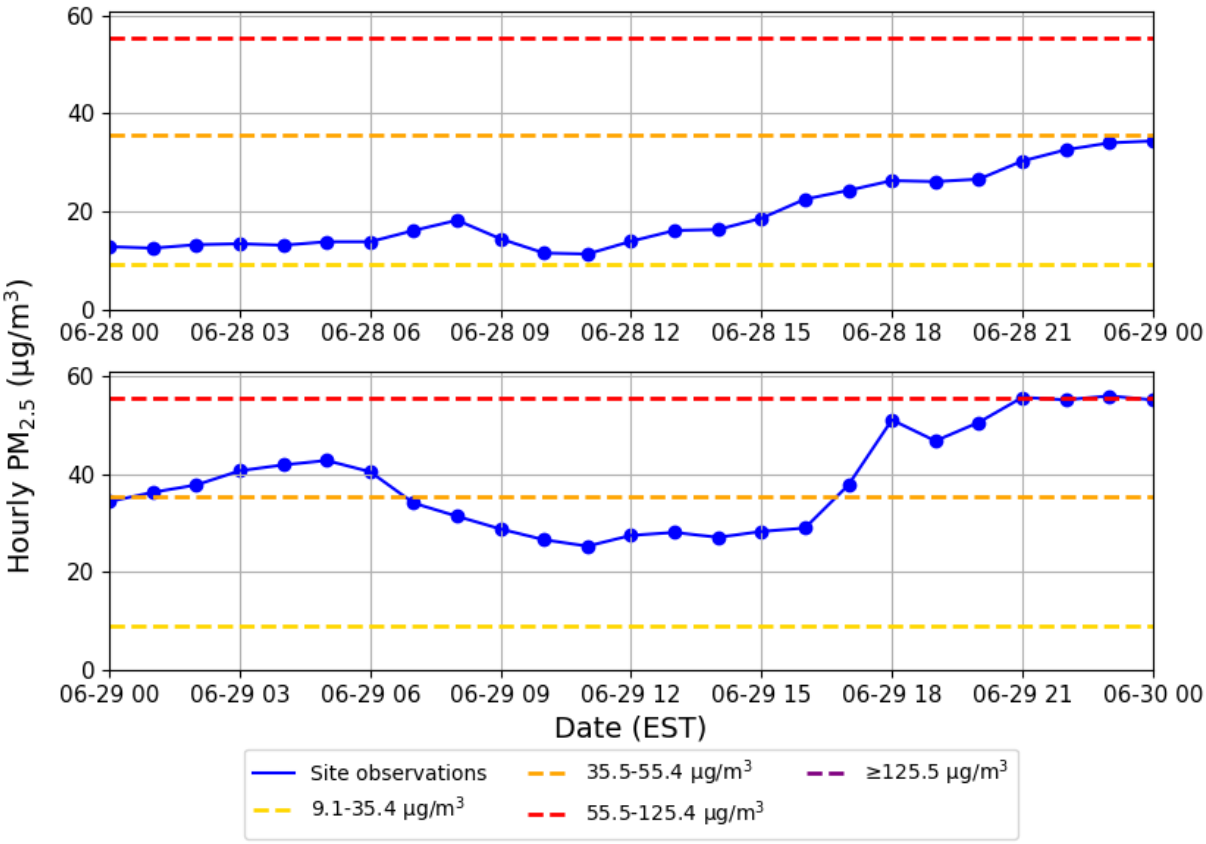



**Figure E6.** Hourly $PM_{2.5}$ concentrations at the Gwinnett Tech site on June 28 and 29, 2023. The solid, dotted line shows observations, and the dashed lines show AQI tiers adjusted for the 2024 $PM_{2.5}$ NAAQS.

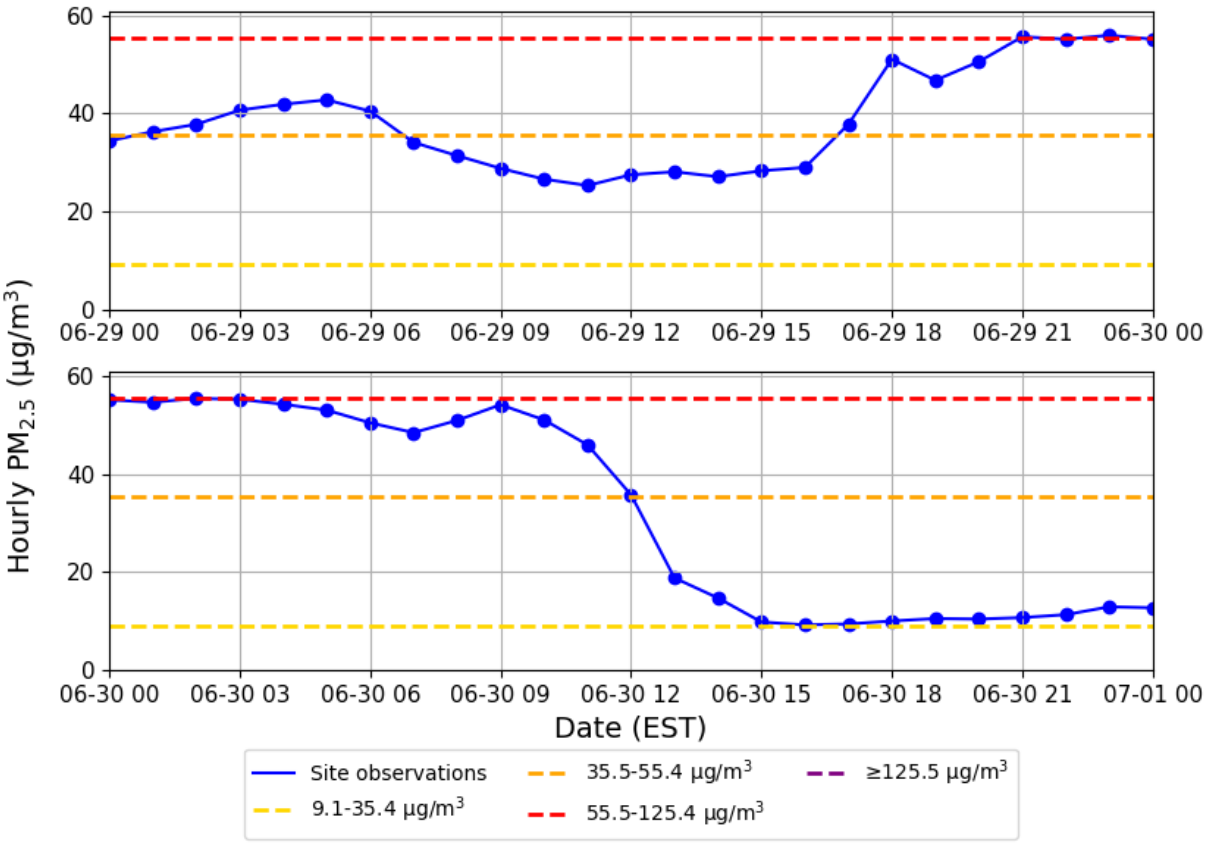



**Figure E7.** Hourly $PM_{2.5}$ concentrations at the Gwinnett Tech site on June 29 and 30, 2023. The solid, dotted line shows observations, and the dashed lines show AQI tiers adjusted for the 2024 $PM_{2.5}$ NAAQS.

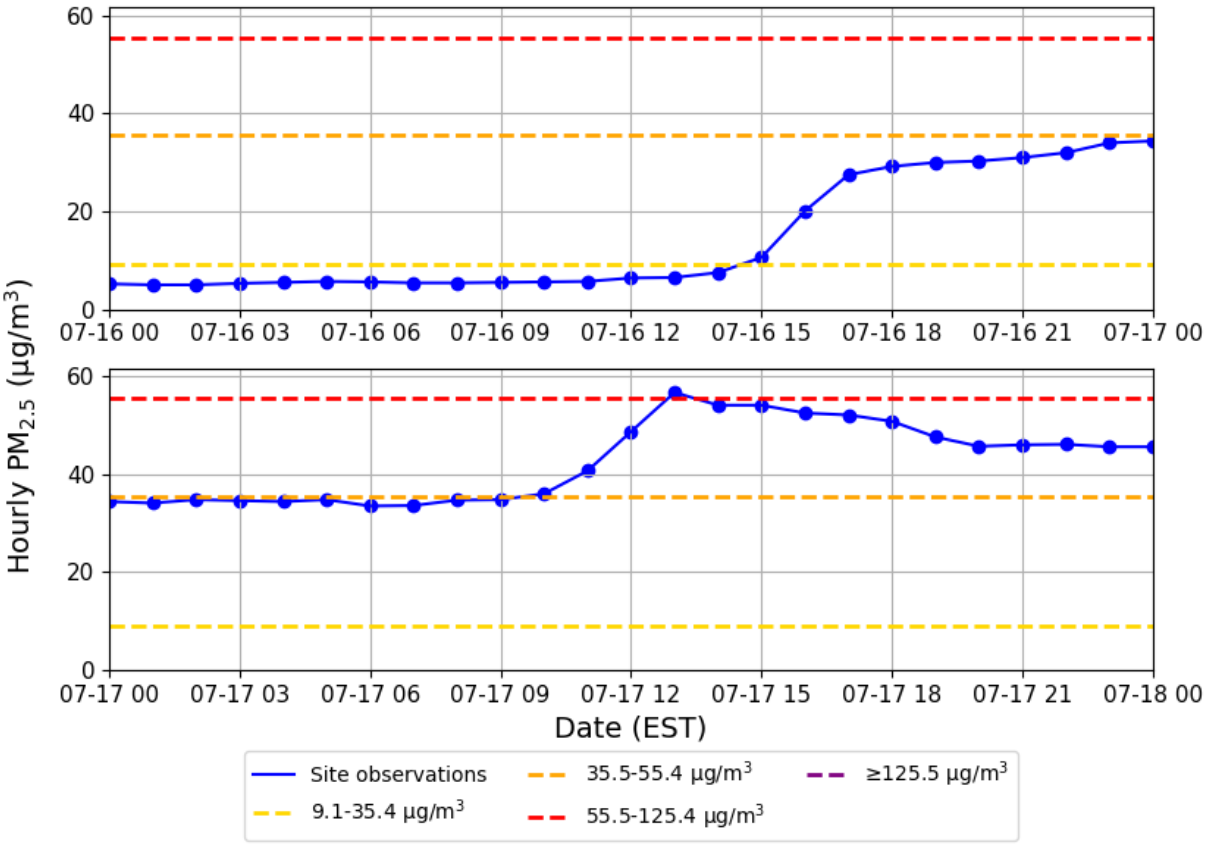



**Figure E8.** $PM_{2.5}$ concentrations at the Gwinnett Tech site on July 16 and 17, 2023. The solid, dotted line shows observations, and the dashed lines show AQI tiers adjusted for the 2024 $PM_{2.5}$ NAAQS.

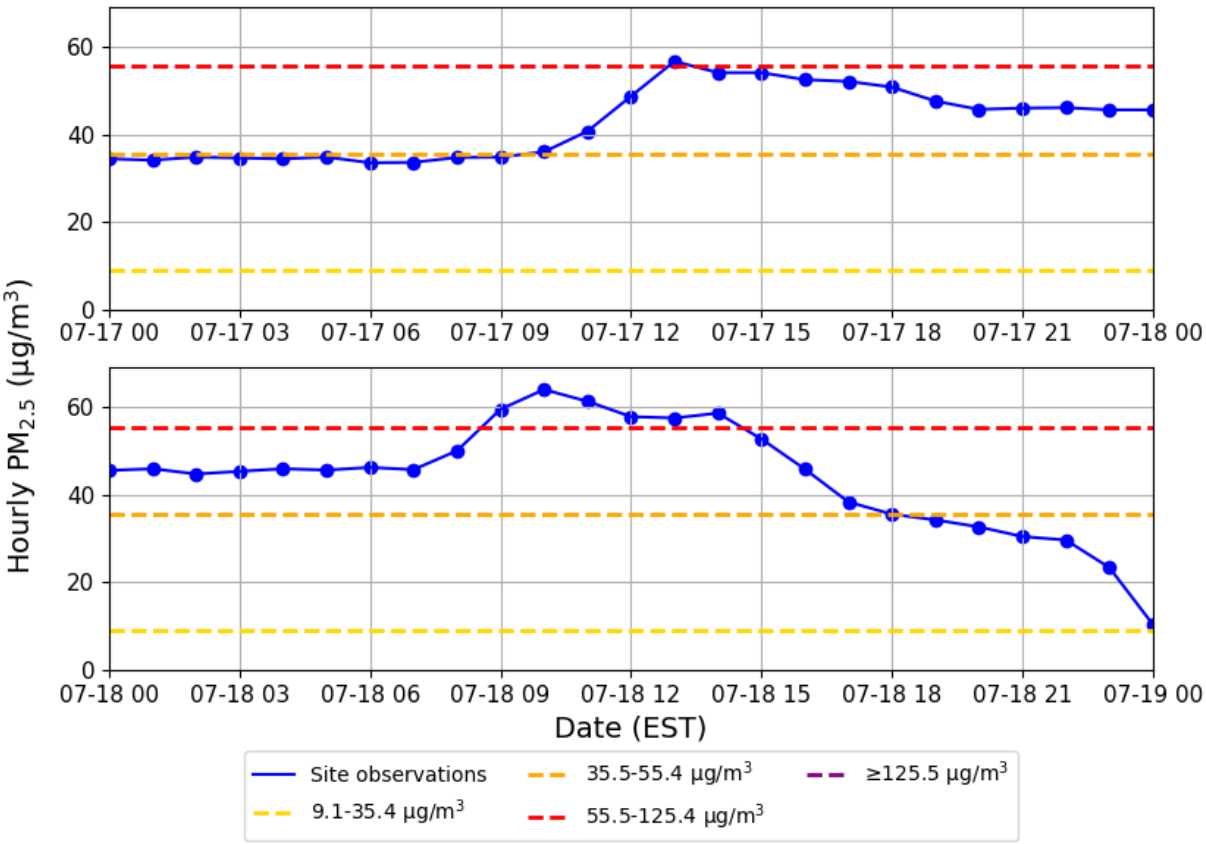



**Figure E9.** $PM_{2.5}$ concentrations at the Gwinnett Tech site on July 17 and 18, 2023. The solid, dotted line shows observations, and the dashed lines show AQI tiers adjusted for the 2024 $PM_{2.5}$ NAAQS.

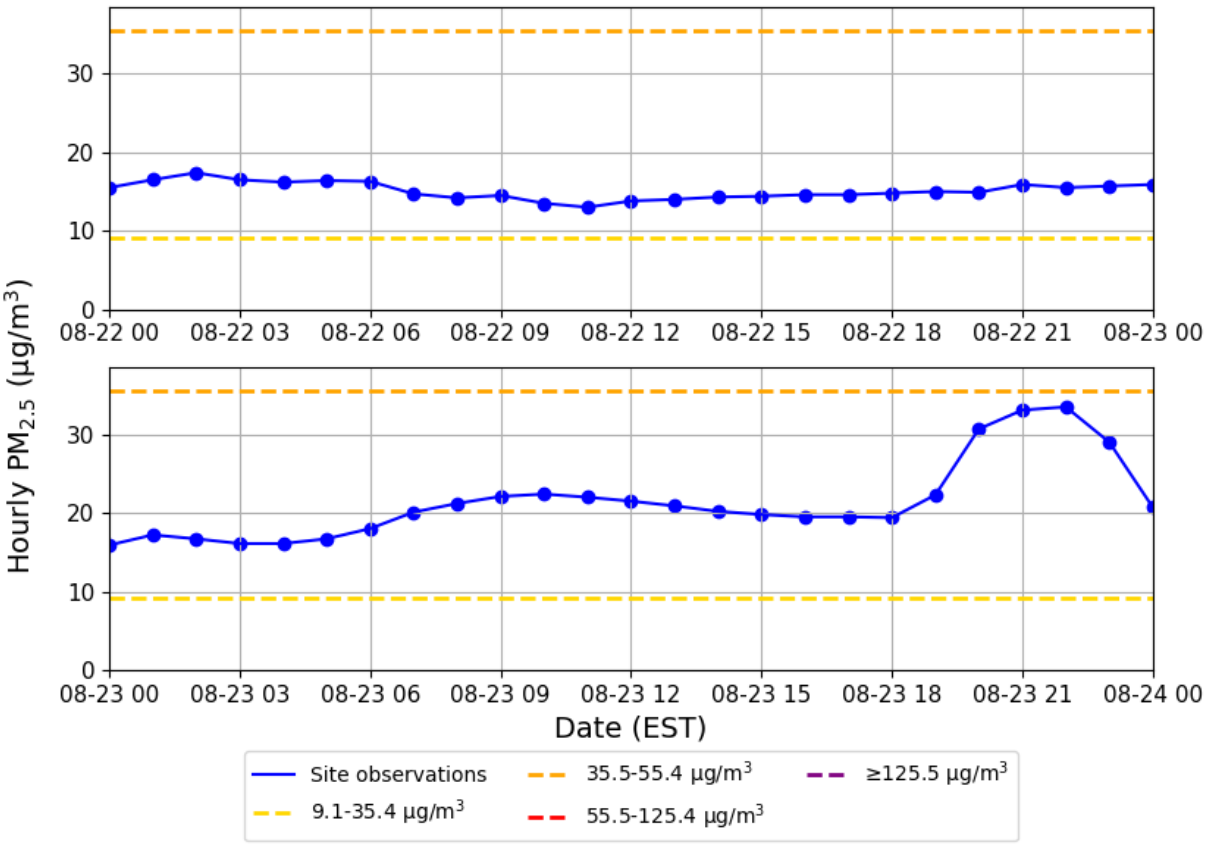



**Figure E10.** Hourly $PM_{2.5}$ concentrations at the Gwinnett Tech site on August 22 and 23, 2023. The solid blue lines with dots show observations. The dashed lines show AQI breakpoints.

## Appendix F: Upper Air Maps

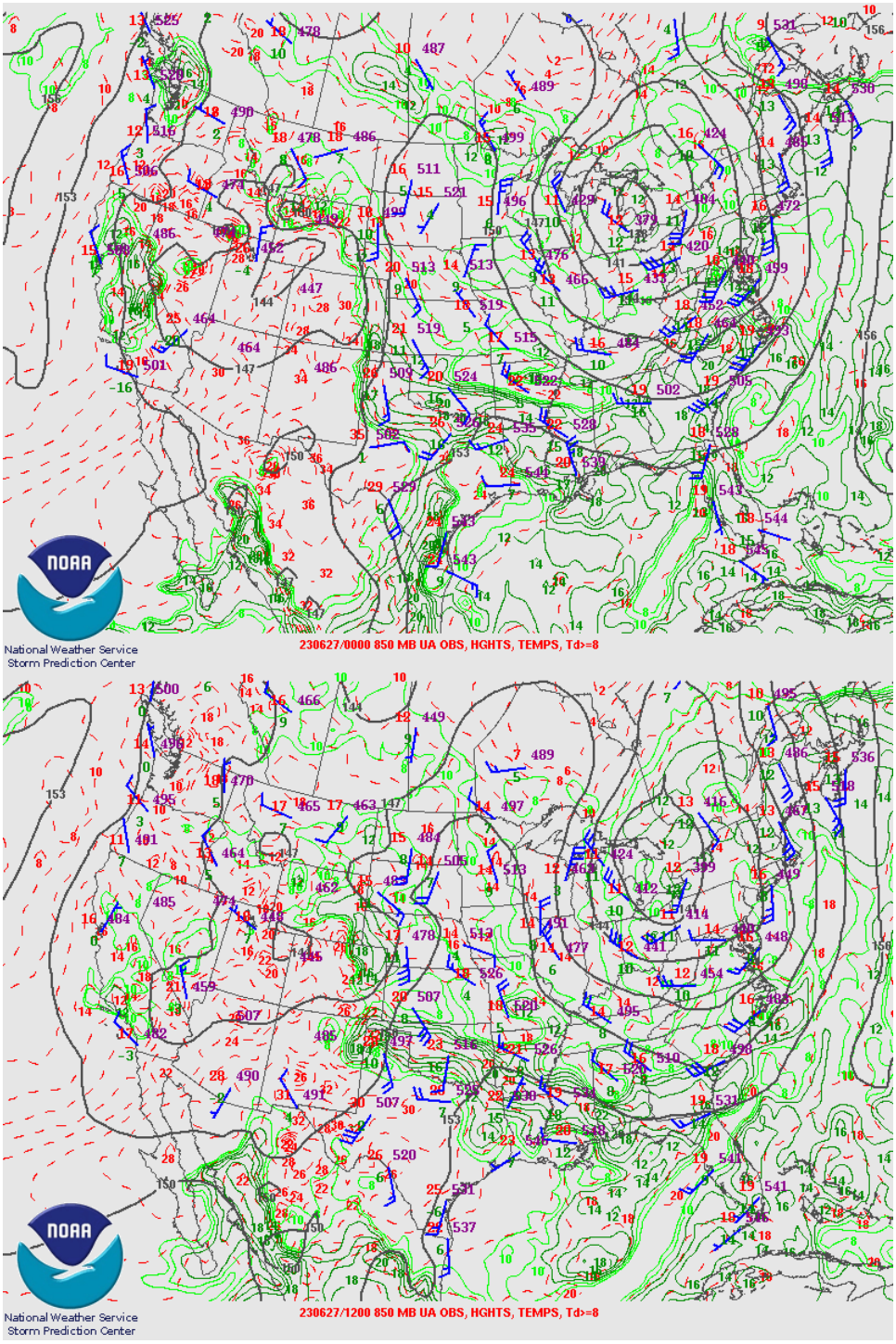



**Figure F1.** Storm Prediction Center upper air maps for June 27, 2023 at 00 UTC (top) and at 12 UTC (bottom). Maps are generated at a pressure of 850 mb (altitude of 1170-1590 m MSL). Wind barbs (degrees from north, knots) are plotted in blue, isotherms (degrees Celsius (°C)) in red, isodrosotherms (°C) in green contours, and isoheights (m MSL) in dark grey.

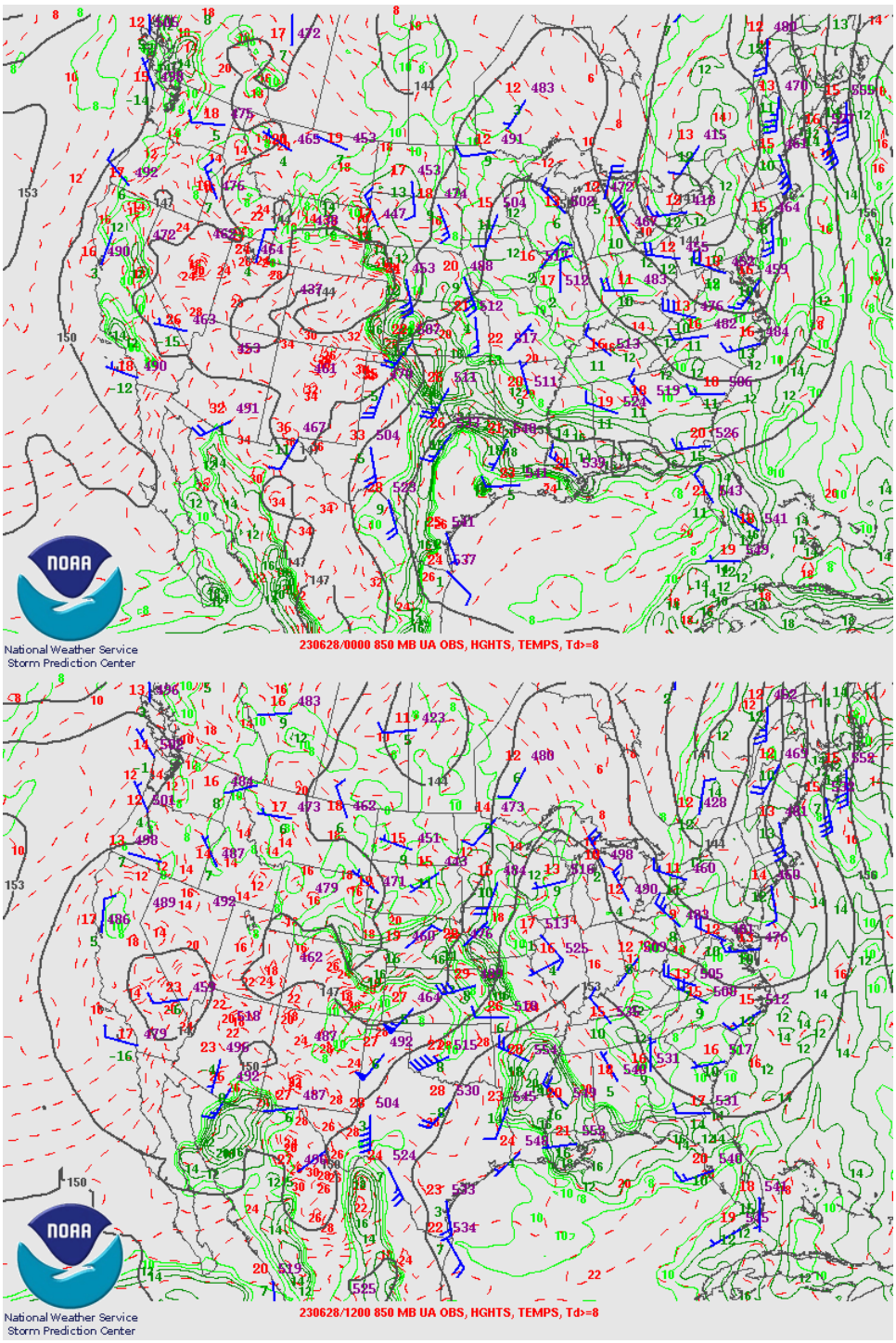



**Figure F2.** Storm Prediction Center upper air maps for June 28, 2023 at 00 UTC (top) and at 12 UTC (bottom). Maps are generated at a pressure of 850 mb (altitude of 1170-1590 m MSL). Wind barbs (degrees from north, knots) are plotted in blue, isotherms (°C) in red, isodrosotherms (°C) in green contours, and isoheights (m MSL) in dark grey.

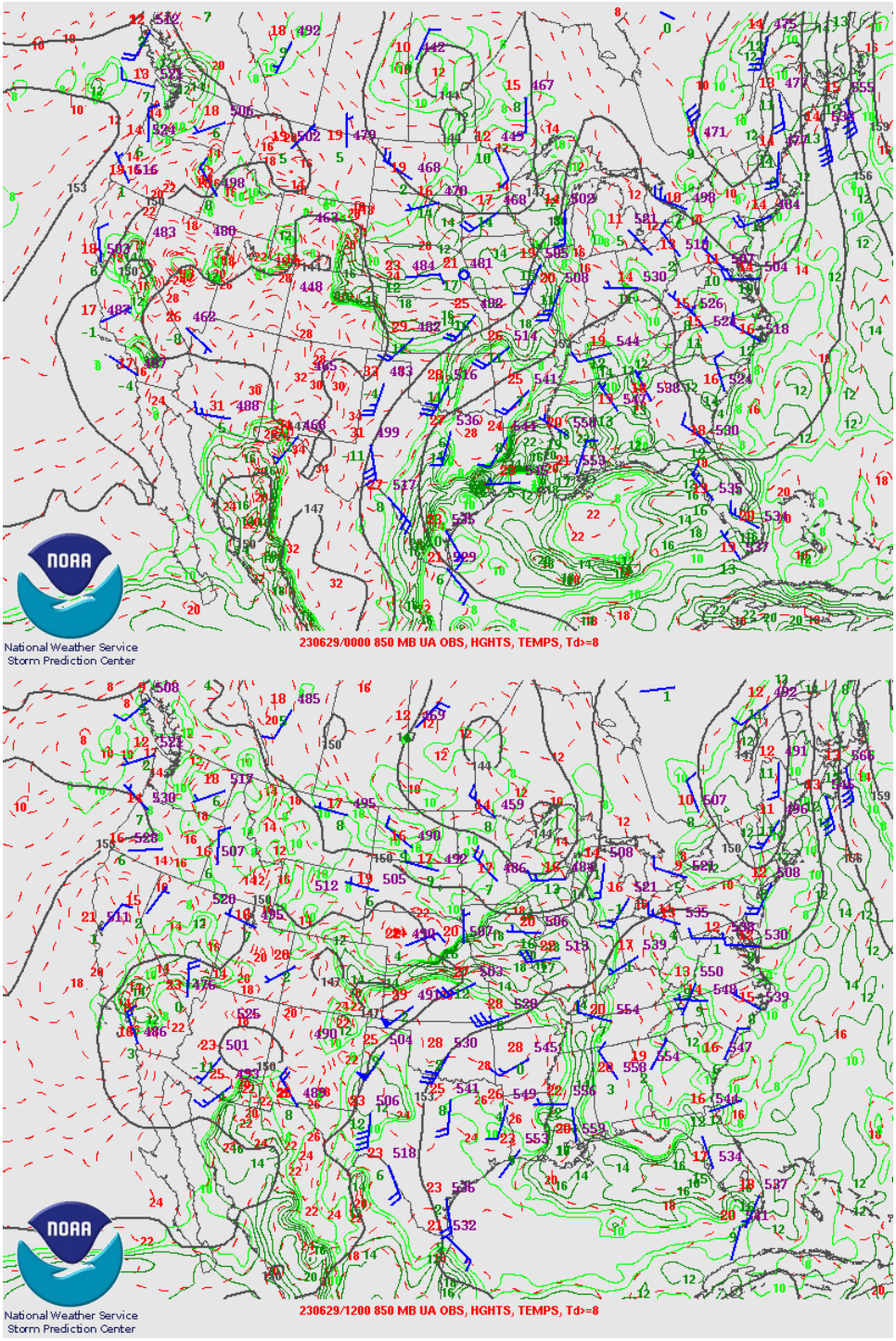



**Figure F3.** Storm Prediction Center upper air maps for June 29, 2023 at 00 UTC (top) and at 12 UTC (bottom). Maps are generated at a pressure of 850 mb (altitude of 1170-1590 m MSL). Wind barbs (degrees from north, knots) are plotted in blue, isotherms (°C) in red, isodrosotherms (°C) in green contours, and isoheights (m MSL) in dark grey.

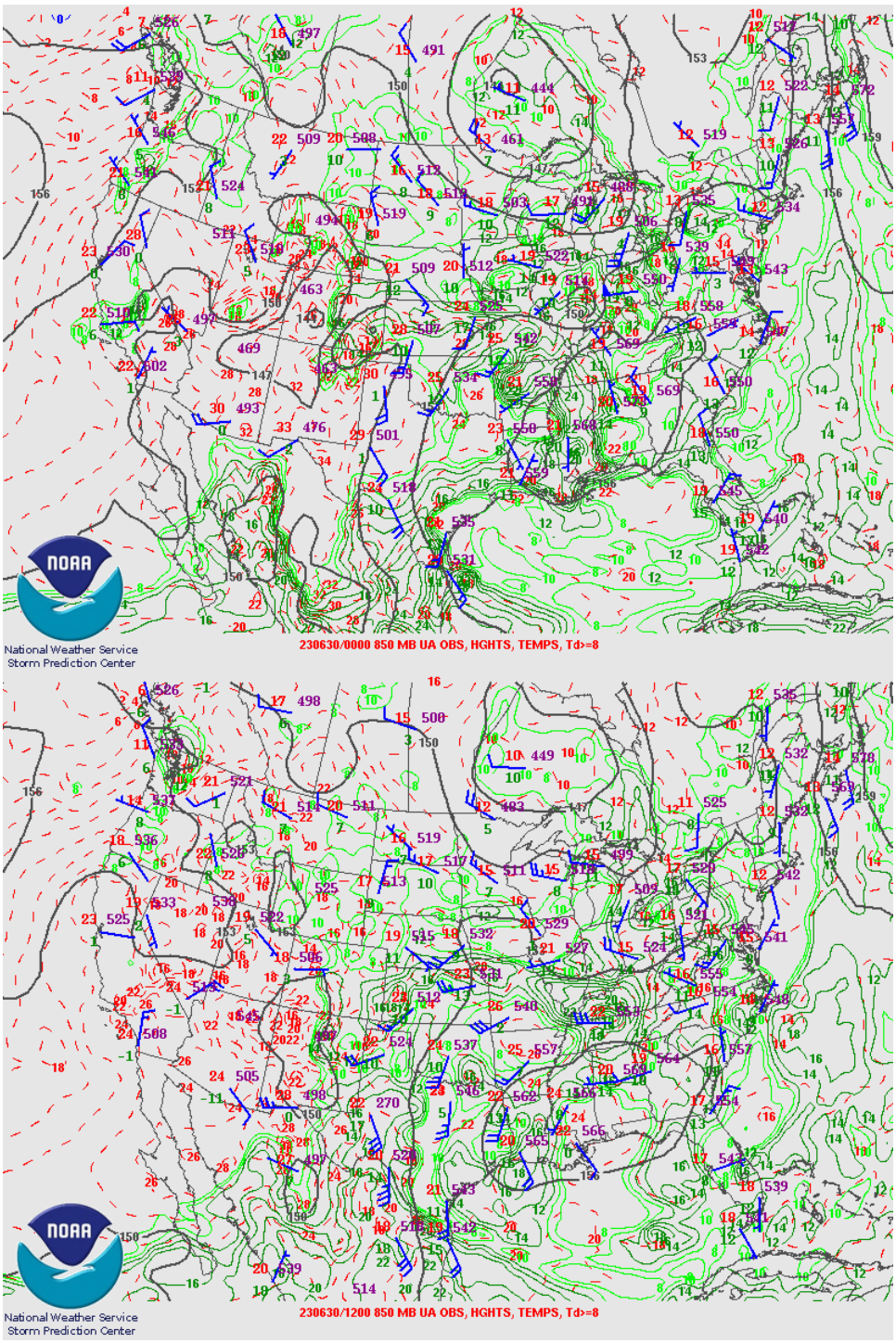



**Figure F4.** Storm Prediction Center upper air maps for June 30, 2023 at 00 UTC (top) and at 12 UTC (bottom). Maps are generated at a pressure of 850 mb (altitude of 1170-1590 m MSL). Wind barbs (degrees from north, knots) are plotted in blue, isotherms (°C) in red, isodrosotherms (°C) in green contours, and isoheights (m MSL) in dark grey.

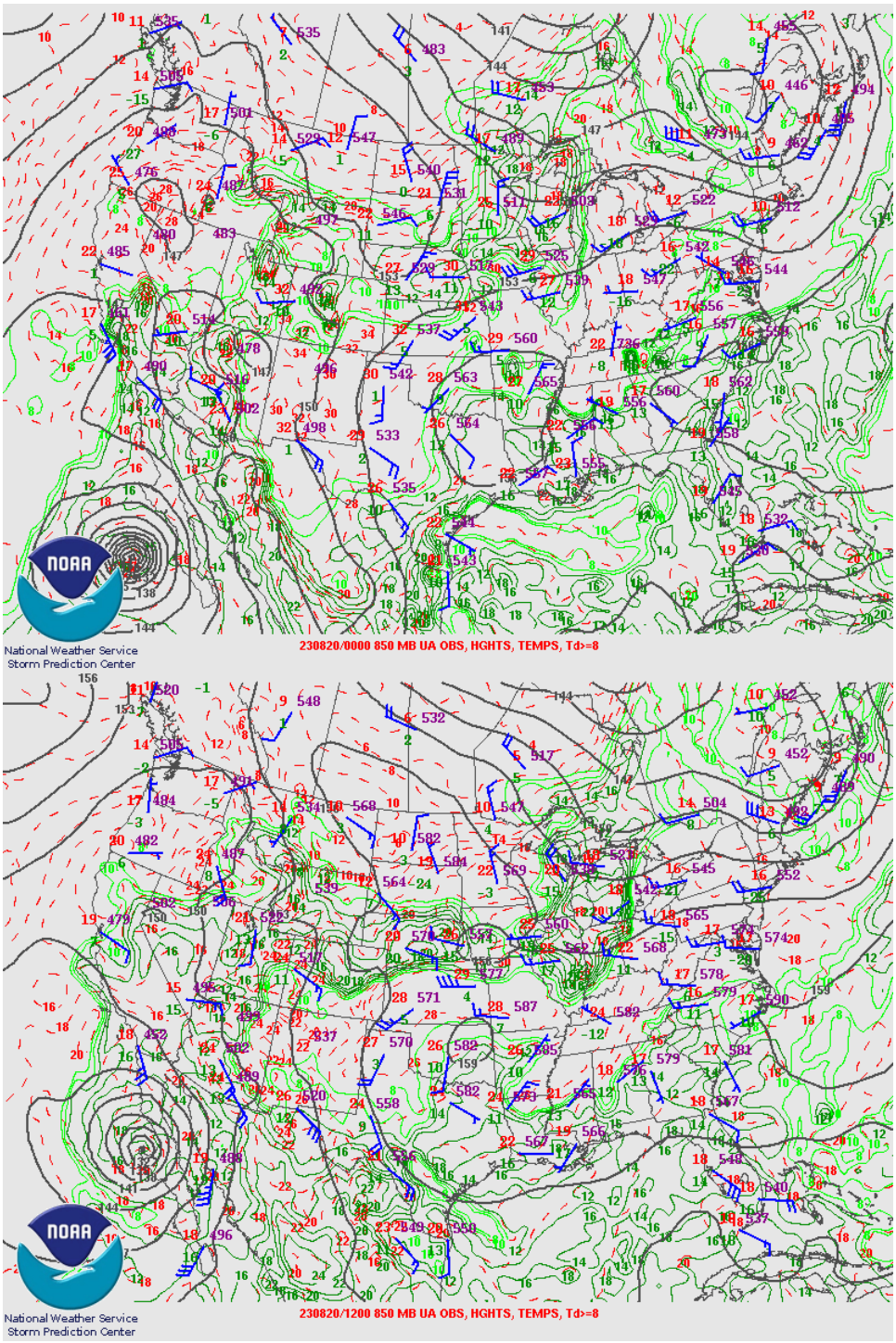



**Figure F5.** Storm Prediction Center upper air maps for August 20, 2023 at 00 UTC (top) and at 12 UTC (bottom). Maps are generated at a pressure of 850 mb (altitude of 1170-1590 m MSL). Wind barbs (degrees from north, knots) are plotted in blue, isotherms (°C) in red, isodrosotherms (°C) in green contours, and isoheights (m MSL) in dark grey

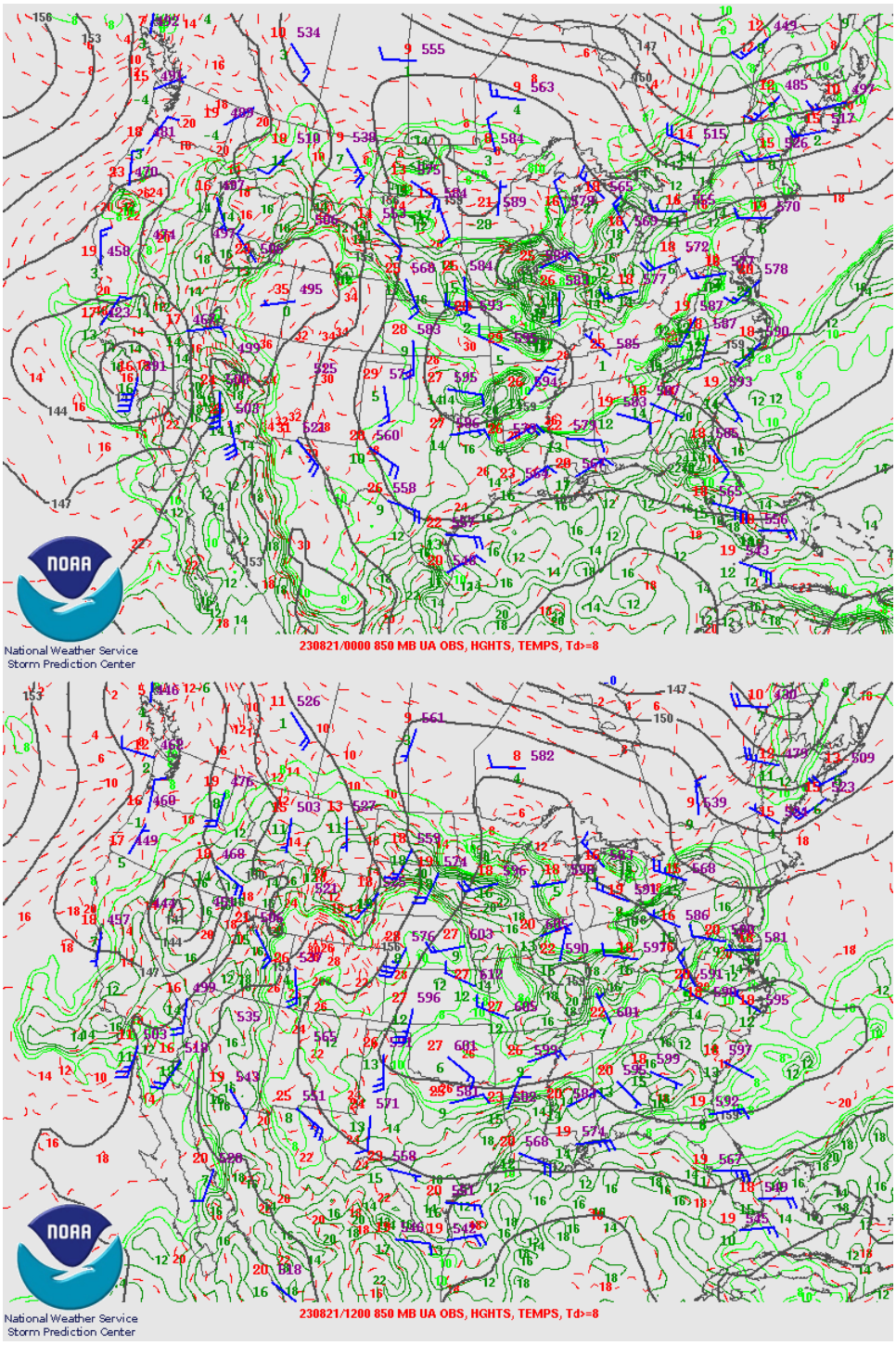



**Figure F6.** Storm Prediction Center upper air maps for August 21, 2023 at 00 UTC (top) and at 12 UTC (bottom). Maps are generated at a pressure of 850 mb (altitude of 1170-1590 m MSL). Wind barbs (degrees from north, knots) are plotted in blue, isotherms (°C) in red, isodrosotherms (°C) in green contours, and isoheights (m MSL) in dark grey.

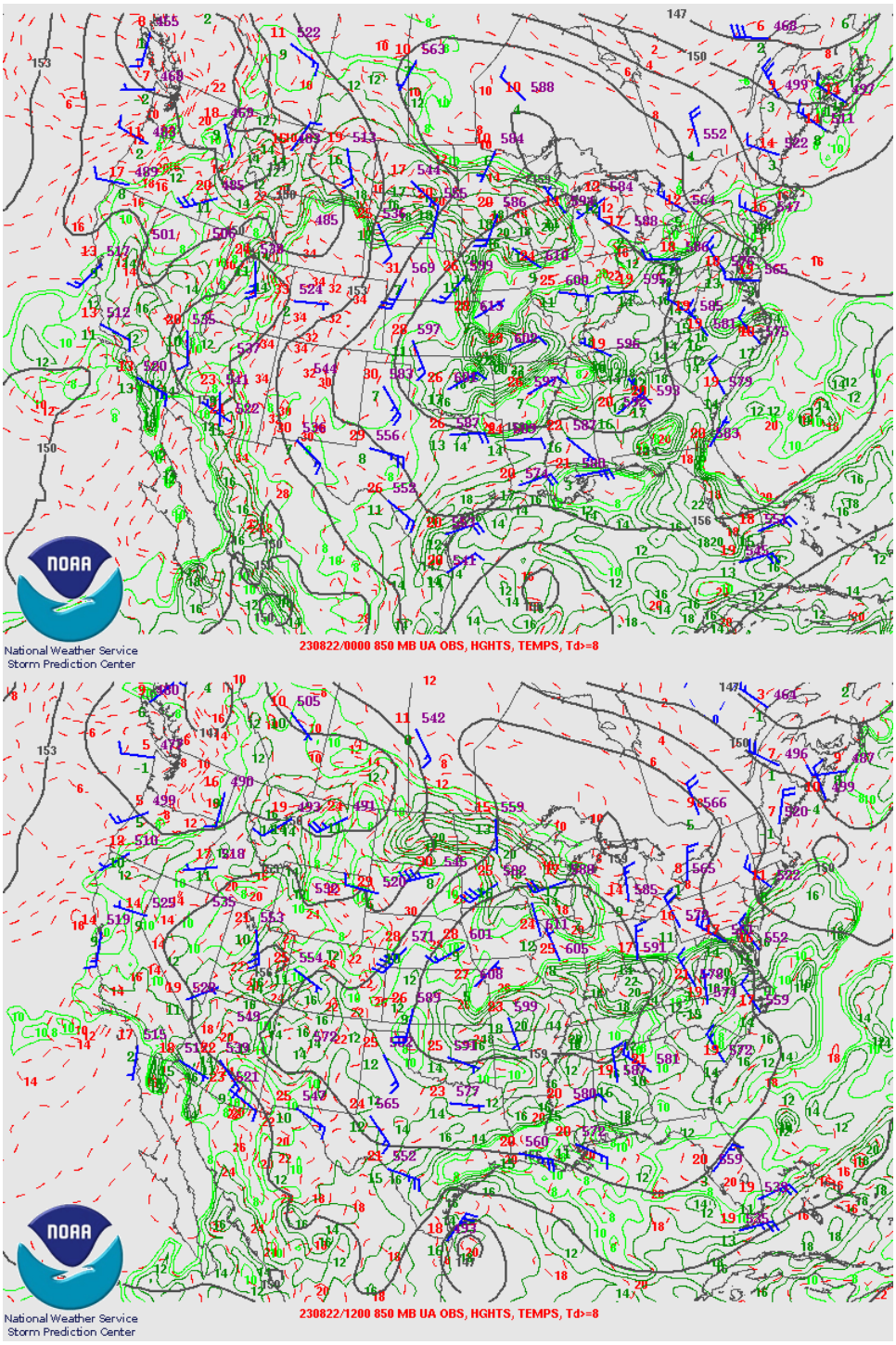



**Figure F7.** Storm Prediction Center upper air maps for August 22, 2023 at 00 UTC (top) and at 12 UTC (bottom). Maps are generated at a pressure of 850 mb (altitude of 1170-1590 m MSL). Wind barbs (degrees from north, knots) are plotted in blue, isotherms (°C) in red, isodrosotherms (°C) in green contours, and isoheights (m MSL) in dark grey.

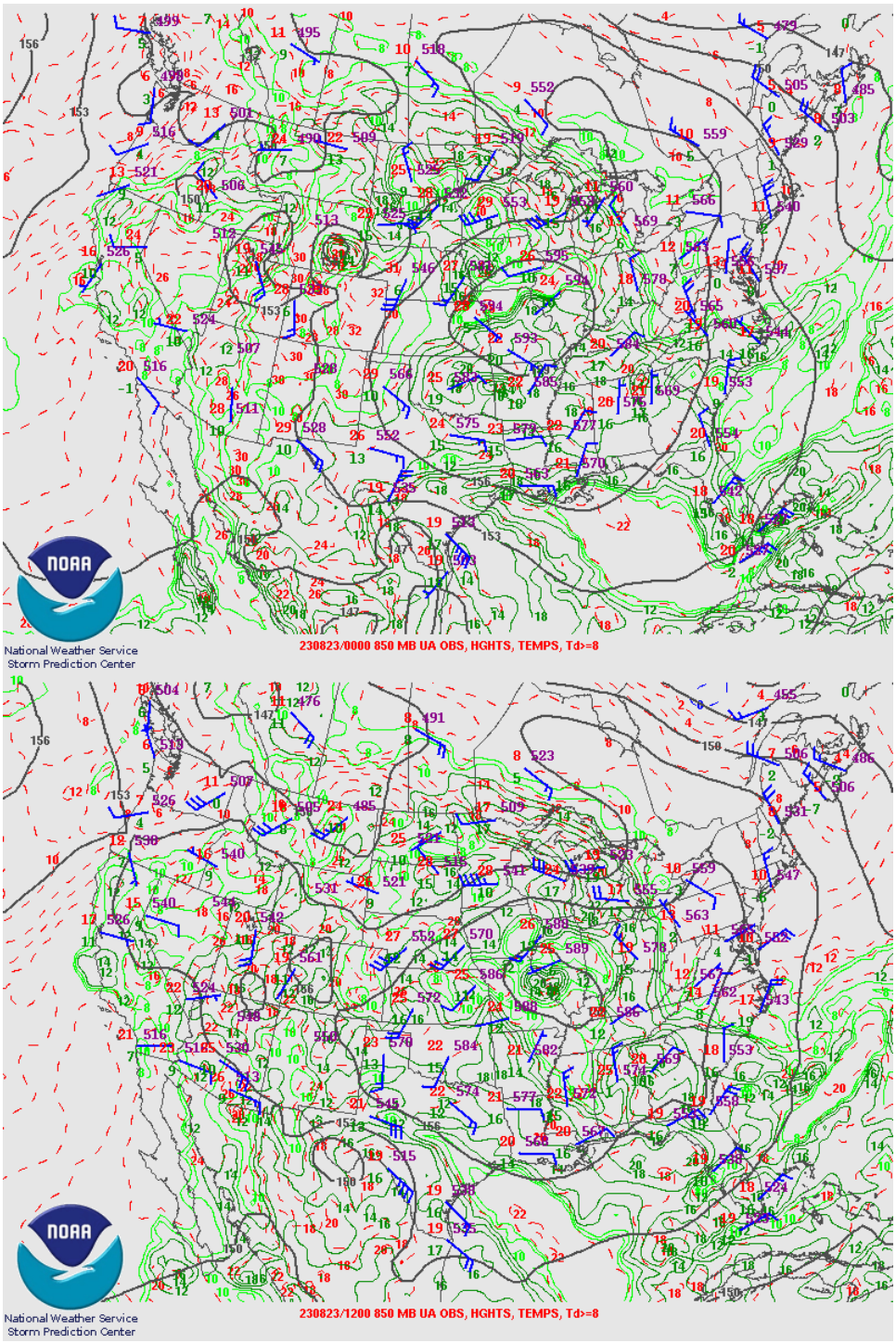



**Figure F8.** Storm Prediction Center upper air maps for August 23, 2023 at 00 UTC (top) and at 12 UTC (bottom). Maps are generated at a pressure of 850 mb (altitude of 1170-1590 m MSL). Wind barbs (degrees from north, knots) are plotted in blue, isotherms (°C) in red, isodrosotherms (°C) in green contours, and isoheights (m MSL) in dark grey.

## Appendix G: Public Comments

## Appendix H: Responses to Public Comments