



# **Environmental Protection Agency**

**Ohio's  
Exceptional Events Demonstration for 2023 Wildfire  
Smoke-Driven PM<sub>2.5</sub> Episodes in the Columbus, OH  
Metropolitan Statistical Area**

**Prepared by:  
The Ohio Environmental Protection Agency  
Division of Air Pollution Control**

**January 2025**

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## **1. Introduction**

### **1.1. Overview**

On February 7, 2024, the United States Environmental Protection Agency (U.S. EPA) promulgated a revised National Ambient Air Quality Standard (NAAQS) for fine particulate matter (PM<sub>2.5</sub>), with an effective date of May 6, 2024 (89 FR 16202). The level of the new annual PM<sub>2.5</sub> NAAQS was set to 9.0 µg/m<sup>3</sup>. In advance of the February 7, 2025 deadline for nonattainment area designation recommendations, U.S. EPA asked state and local air agencies to submit demonstrations to exclude days impacted by exceptional events from consideration in the designations process.

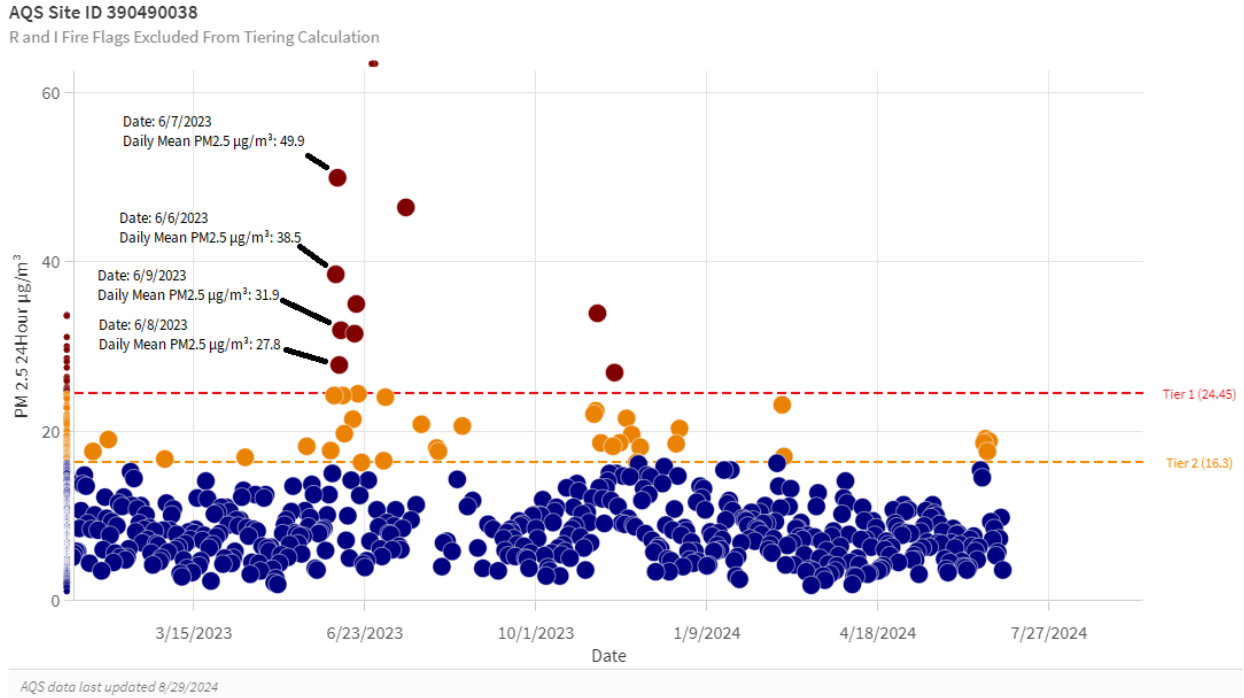
In the Columbus, OH Metropolitan Statistical Area (MSA), consisting of Delaware, Fairfield, Franklin, Hocking, Licking, Madison, Morrow, Perry, Pickaway, and Union counties in Ohio, air quality was impacted from June to August 2023 by smoke entering the region from wildfires in Canada. Wildfires across Canada during this period produced smoke plumes that impacted surface air quality throughout the Great Lakes region. The smoke from these fires produced PM<sub>2.5</sub> pollution episodes across the region that had significant health and regulatory implications. One of the regulatory impacts of the fire smoke was the effect on air quality design values for CBSAs in the Great Lakes region.

Table 1 shows the seven days in 2023 affected by regulatorily significant wildfire smoke-driven PM<sub>2.5</sub> episodes that, if excluded from the three-year (2021-2023) PM<sub>2.5</sub> design value calculation, would result in a design value for the Smoky Row Near Road (39-049-0038) monitoring site in the Columbus, OH MSA that attains the 2024 PM<sub>2.5</sub> NAAQS. All seven days are PM<sub>2.5</sub> Tier 1 category days according to the online U.S. EPA PM<sub>2.5</sub> Tiering Tool, and the seven daily mean PM<sub>2.5</sub> concentrations rank as the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 6<sup>th</sup>, 11<sup>th</sup>, and 17<sup>th</sup> highest observed concentration days at this monitor in the 2019-2023 period. These seven days were affected by two distinct regulatorily significant wildfire smoke-driven PM<sub>2.5</sub> episodes lasting from June 6-9 and June 27-29, respectively. Figure 1 was generated by the online U.S. EPA PM<sub>2.5</sub> Tiering Tool for the Smoky Row Near Road (39-049-0038) monitoring site in Franklin County within the Columbus, OH MSA and identifies four dates in 2023 (June 6, June 7, June 8, and June 9) as Tier 1 category days affected by a regulatorily significant wildfire-smoke driven PM<sub>2.5</sub> episode. Figure 2 was generated by the online U.S. EPA PM<sub>2.5</sub> Tiering Tool for the Smoky Row Near Road (39-049-0038) monitoring site in Franklin County within the Columbus, OH MSA and identifies three dates in 2023 (June 27, June 28, and June 29) as Tier 1 category days affected by an additional regulatorily significant wildfire-smoke driven PM<sub>2.5</sub> episode.

**Table 1. Data requested for exclusion at the Smoky Row Near Road (39-049-0038) monitoring site due to regulatorily significant wildfire smoke-driven PM<sub>2.5</sub> episodes.**

<b>Date of Event</b>	<b>U.S. EPA PM<sub>2.5</sub> Tier</b>	<b>24-Hour Average PM<sub>2.5</sub> Concentration (µg/m<sup>3</sup>)</b>	<b>5-Year Percentile</b>	<b>5-Year Rank</b>
June 6, 2023	Tier 1	38.5	99.72	6
June 7, 2023	Tier 1	49.9	99.83	4
June 8, 2023	Tier 1	27.8	99.10	17
June 9, 2023	Tier 1	31.9	99.43	11
June 27, 2023	Tier 1	68.8	99.89	3
June 28, 2023	Tier 1	133.5	100.00	1
June 29, 2023	Tier 1	83.2	99.94	2

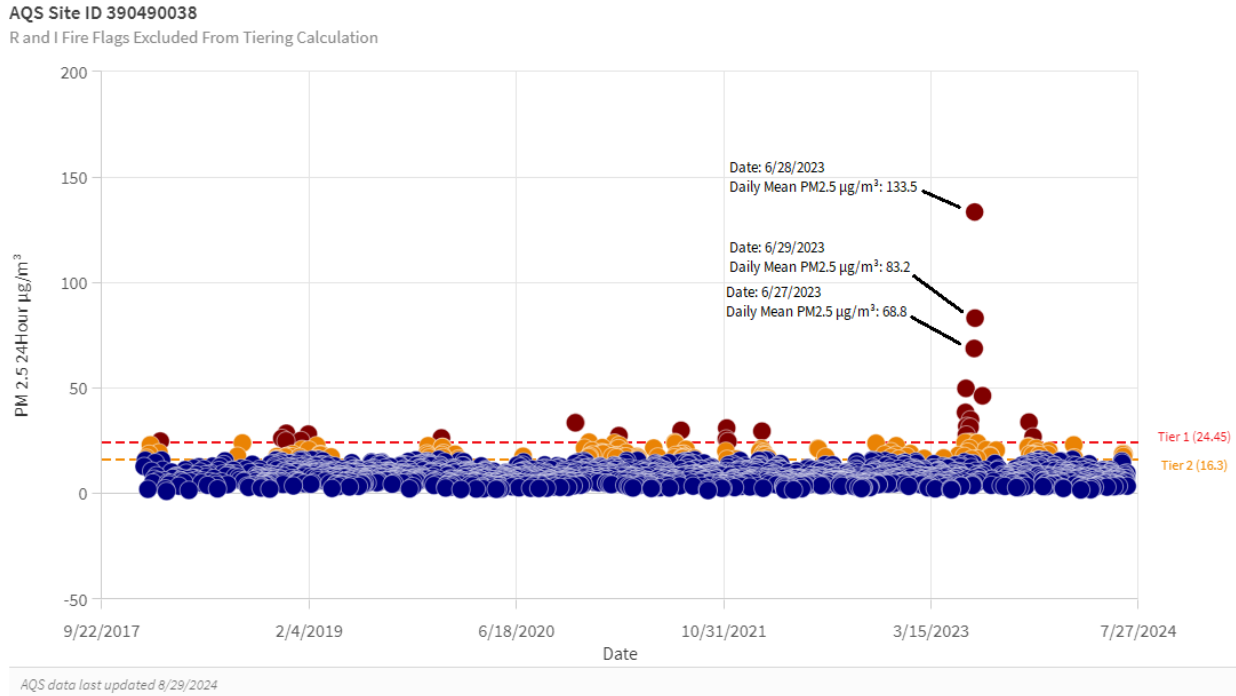
**Figure 1. Time series plot of PM<sub>2.5</sub> daily combined site data for the Smoky Row Near Road (39-049-0038) monitoring site in the Columbus, OH MSA from 2023-2024, with the data points requested for exclusion that were affected by the June 6-9 wildfire smoke-driven PM<sub>2.5</sub> episode labeled. The tier thresholds, shown for the month of June, are based on 2019-2023, the most recent 5-year period of certified data at the time of publication of this document<sup>1</sup>.**



<sup>1</sup> This figure was created on September 13, 2024, from the online U.S. EPA PM<sub>2.5</sub> Tiering Tool available at <https://www.epa.gov/air-quality-analysis/pm25-tiering-tool-exceptional-events-analysis>



**Figure 2. Time series plot of PM<sub>2.5</sub> daily combined site data for the Smoky Row Near Road (39-049-0038) monitoring site in the Columbus, OH MSA from 2018-2024, with the data points requested for exclusion that were affected by the June 27-29 wildfire smoke-driven PM<sub>2.5</sub> episode labeled. The tier thresholds, shown for the month of June, are based on 2019-2023, the most recent 5-year period of certified data at the time of publication of this document<sup>2</sup>.**



The Ohio Environmental Protection Agency (Ohio EPA) requests that U.S. EPA exclude June 6, June 7, June 8, June 9, June 27, June 28, and June 29, 2023, from regulatory determinations, including calculations of annual PM<sub>2.5</sub> design values, due to the influence of Canadian wildfire smoke on the monitored concentrations during those days. When the 24-hour average PM<sub>2.5</sub> concentrations measured at the Smoky Row Near Road monitoring site on these dates are included, the valid 2021-2023 annual PM<sub>2.5</sub> design value is 9.3  $\mu\text{g}/\text{m}^3$ , above the 2024 revised annual PM<sub>2.5</sub> NAAQS value of 9.0  $\mu\text{g}/\text{m}^3$ . However, if these four 24-hour average PM<sub>2.5</sub> concentrations were excluded, the Smoky Row Near Road monitoring site in the Columbus, OH MSA would have a valid 2021-2023 annual PM<sub>2.5</sub> design value of 9.0  $\mu\text{g}/\text{m}^3$ , which represents attainment of the 2024 revised annual PM<sub>2.5</sub> NAAQS. Excluding the observed PM<sub>2.5</sub> data from the seven identified dates has regulatory significance because it reduces the 2021-

<sup>2</sup> This figure was created on September 13, 2024, from the online U.S. EPA PM<sub>2.5</sub> Tiering Tool available at <https://www.epa.gov/air-quality-analysis/pm25-tiering-tool-exceptional-events-analysis>

2023 annual PM<sub>2.5</sub> design value for the Columbus, OH MSA to a value that is at or below the 2024 revised annual PM<sub>2.5</sub> NAAQS value of 9.0 µg/m<sup>3</sup> and will preclude the Columbus, OH MSA from being designated a nonattainment area for the 2024 revised annual PM<sub>2.5</sub> NAAQS.

It should also be noted that three additional PM<sub>2.5</sub> monitoring sites, Fairgrounds (39-049-0034), Jackson Pike WWTP (39-049-0040), and Maple Canyon (39-049-0081), also operate within Franklin County in the Columbus, OH MSA. These sites were each similarly affected by the regulatorily significant wildfire smoke-driven PM<sub>2.5</sub> episode in the Columbus, OH MSA on June 8, 2023. Additionally, the Fairgrounds monitoring site was impacted by the regulatorily significant wildfire smoke events on June 9 and June 29, 2023, and the Maple Canyon monitoring site was similarly impacted by the regulatorily significant wildfire smoke event on June 29, 2023. The Fairgrounds monitoring site currently has a valid 2021-2023 annual PM<sub>2.5</sub> design value of 9.0 µg/m<sup>3</sup>, which attains the 2024 revised annual PM<sub>2.5</sub> NAAQS. The Jackson Pike WWTP monitoring site currently has a 2021-2023 annual PM<sub>2.5</sub> design value of 9.4 µg/m<sup>3</sup>, although this design value is invalid due to data incompleteness in all quarters of calendar year 2021 and the first two quarters of calendar year 2022, as the site did not begin operating until May 2022. The Maple Canyon monitoring site currently has a valid 2021-2023 annual PM<sub>2.5</sub> design value of 8.7 µg/m<sup>3</sup>, which attains the 2024 revised annual PM<sub>2.5</sub> NAAQS. Since these PM<sub>2.5</sub> data at the Fairgrounds, Jackson Pike WWTP, and Maple Canyon monitoring sites have also been impacted by the regulatorily significant wildfire smoke events, Ohio EPA is also requesting the exclusion of these data from regulatory determinations, including calculations of annual PM<sub>2.5</sub> design values, for the Fairgrounds, Jackson Pike WWTP, and Maple Canyon monitoring sites.

Table 2 shows the three days in 2023 on which regulatorily significant wildfire smoke-driven PM<sub>2.5</sub> episodes affected the Fairgrounds (39-049-0034) monitoring site. All three days are PM<sub>2.5</sub> Tier 1 category days according to the online U.S. EPA PM<sub>2.5</sub> Tiering Tool, and they rank as the first, fourth, and sixth highest observed concentration days at this monitor in the 2019-2023 period. Figure 3 was generated by the online U.S. EPA PM<sub>2.5</sub> Tiering Tool for the Fairgrounds (39-049-0034) monitoring site in Franklin County within the Columbus, OH MSA. This figure identifies June 8, June 9, and June 29, 2023 as Tier 1 category days.

**Table 2. Data requested for exclusion at the Fairgrounds (39-049-0034) monitoring site due to wildfire smoke-driven PM<sub>2.5</sub> episodes.**

Date of Event	U.S. EPA PM <sub>2.5</sub> Tier	24-Hour Average PM <sub>2.5</sub> Concentration (µg/m <sup>3</sup> )	5-Year Percentile	5-Year Rank
June 8, 2023	Tier 1	29.1	99.51	4
June 9, 2023	Tier 1	24.3	99.19	6
June 29, 2023	Tier 1	82.6	100.00	1

**Figure 3. Time series plot of PM<sub>2.5</sub> daily combined site data for the Fairgrounds (39-049-0034) monitoring site in the Columbus, OH MSA from 2018-2024. The tier thresholds, shown for the month of June, are based on 2019-2023, the most recent 5-year period of certified data at the time of publication of this document<sup>3</sup>.**

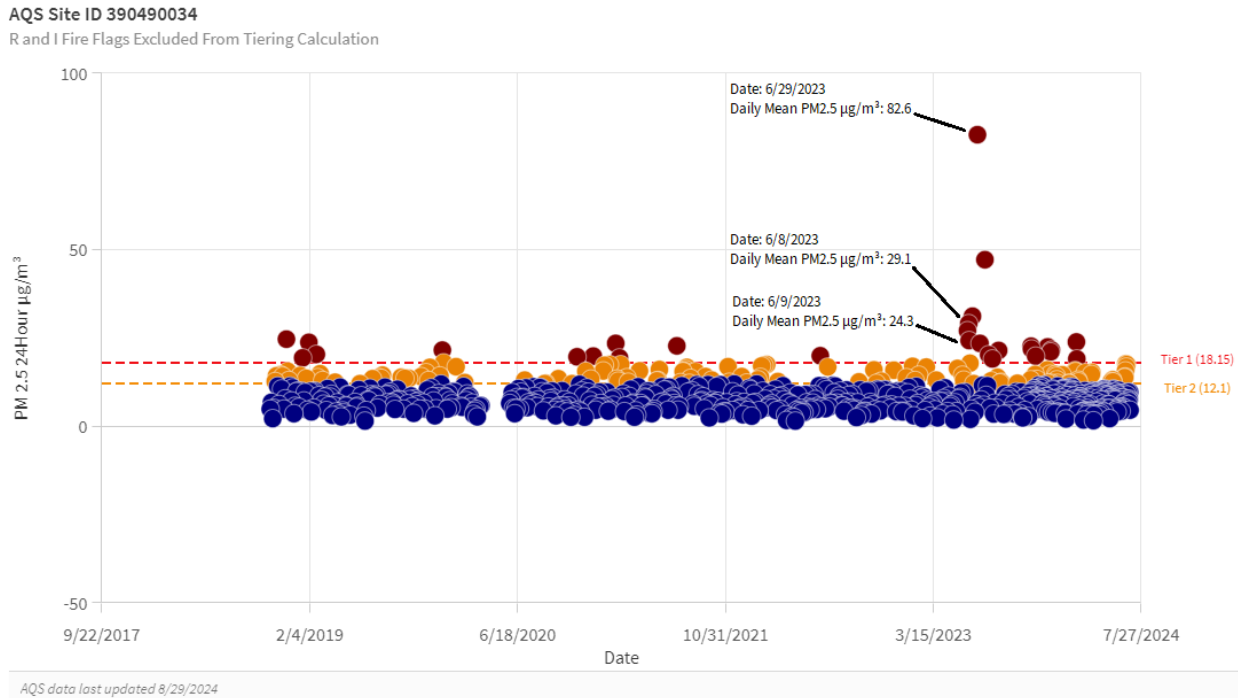


Table 3 shows data from June 8, 2023, on which a regulatorily significant wildfire smoke-driven PM<sub>2.5</sub> episode affected the Jackson Pike WWTP (39-049-0040) monitoring site. This day is a PM<sub>2.5</sub> Tier 1 category day according to the online U.S. EPA PM<sub>2.5</sub> Tiering Tool, and it ranks

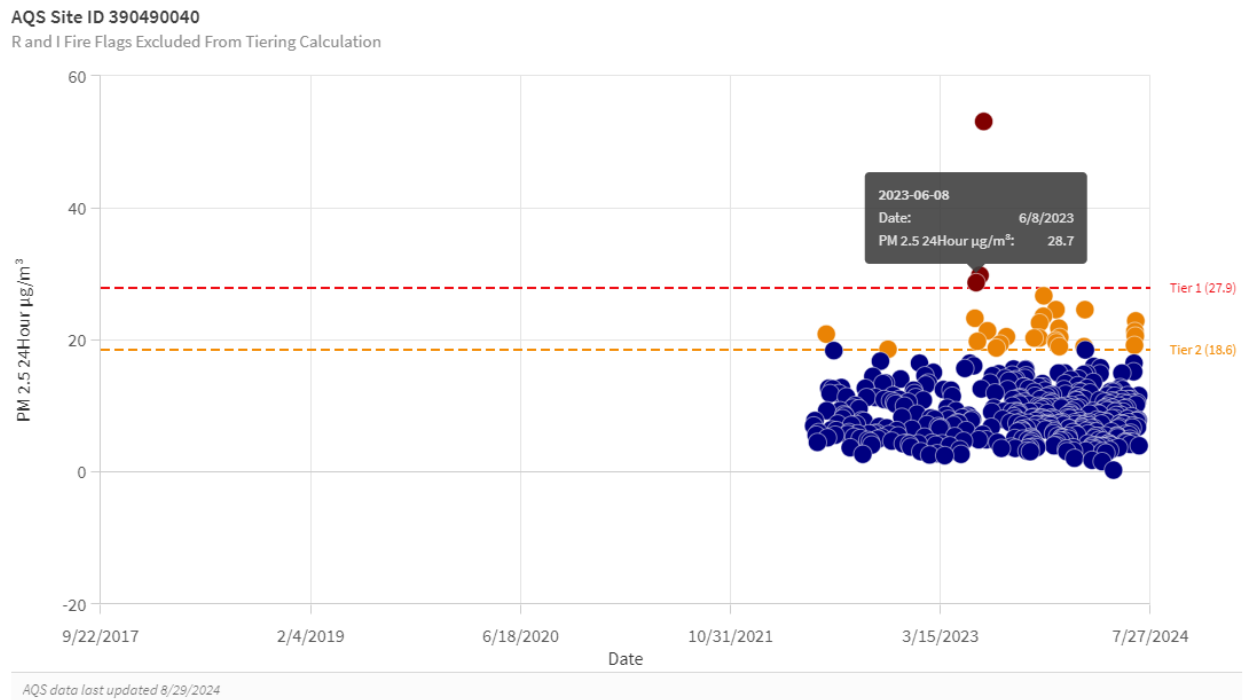
<sup>3</sup> This figure was created on September 13, 2024, from the online U.S. EPA PM<sub>2.5</sub> Tiering Tool available at <https://www.epa.gov/air-quality-analysis/pm25-tiering-tool-exceptional-events-analysis>

as the third highest observed concentration day at this monitor in the 2022-2023 period. Figure 4 was generated by the online U.S. EPA PM<sub>2.5</sub> Tiering Tool for the Jackson Pike WWTP (39-049-0040) monitoring site in Franklin County within the Columbus, OH MSA. This figure identifies June 8, 2023 as a Tier 1 category day.

**Table 3. Data requested for exclusion at the Jackson Pike WWTP (39-049-0040) monitoring site due to wildfire smoke-driven PM<sub>2.5</sub> episodes.**

Date of Event	U.S. EPA PM <sub>2.5</sub> Tier	24-Hour Average PM <sub>2.5</sub> Concentration (µg/m <sup>3</sup> )	5-Year Percentile	5-Year Rank
June 8, 2023	Tier 1	28.7	99.27	3

**Figure 4. Time series plot of PM<sub>2.5</sub> daily combined site data for the Jackson Pike WWTP (39-049-0040) monitoring site in the Columbus, OH MSA from 2022-2024. The tier thresholds, shown for the month of June, are based on 2022-2023, the most recent period of certified data at the time of publication of this document<sup>4</sup>.**



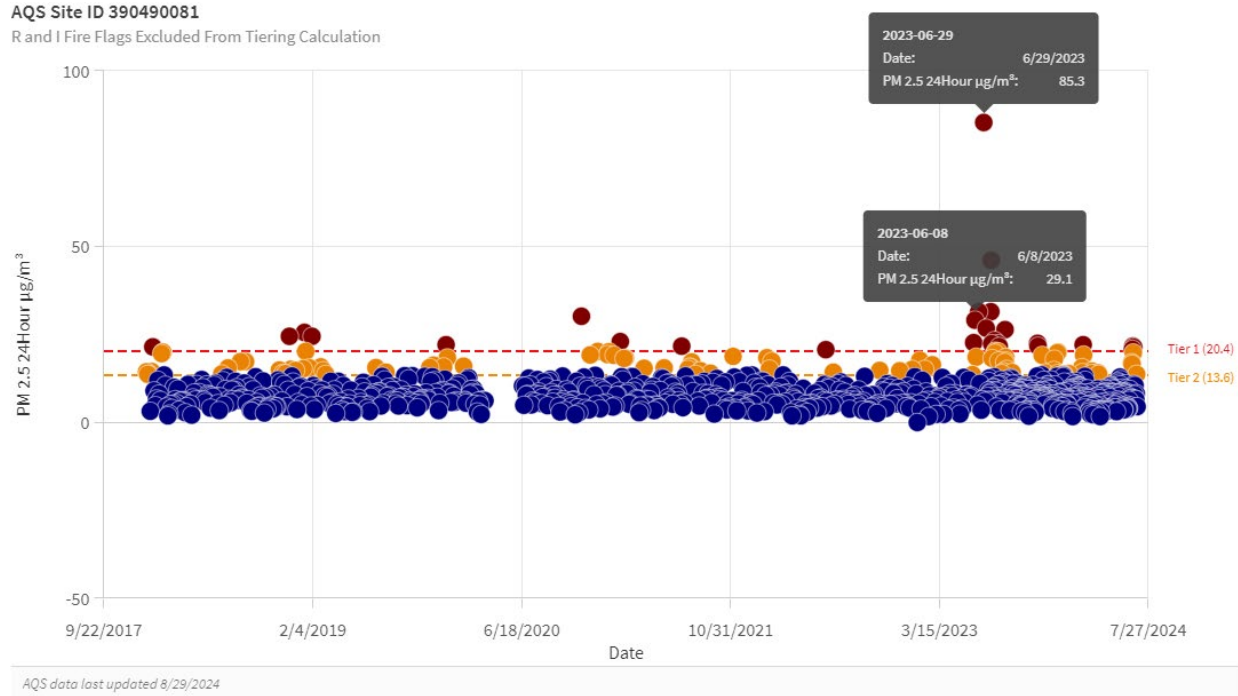
<sup>4</sup> This figure was created on September 13, 2024, from the online U.S. EPA PM<sub>2.5</sub> Tiering Tool available at <https://www.epa.gov/air-quality-analysis/pm25-tiering-tool-exceptional-events-analysis>

Table 4 shows the two days in 2023 on which regulatorily significant wildfire smoke-driven PM<sub>2.5</sub> episodes affected the Maple Canyon (39-049-0081) monitoring site. Both days are PM<sub>2.5</sub> Tier 1 category days according to the online U.S. EPA PM<sub>2.5</sub> Tiering Tool, and they rank as the first and sixth highest observed concentration days at this monitor in the 2019-2023 period. Figure 5 was generated by the online U.S. EPA PM<sub>2.5</sub> Tiering Tool for the Maple Canyon (39-049-0081) monitoring site in Franklin County within the Columbus, OH MSA. This figure identifies June 8 and June 29, 2023 as Tier 1 category days.

**Table 4. Data requested for exclusion at the Maple Canyon (39-049-0081) monitoring site due to wildfire smoke-driven PM<sub>2.5</sub> episodes.**

<b>Date of Event</b>	<b>U.S. EPA PM<sub>2.5</sub> Tier</b>	<b>24-Hour Average PM<sub>2.5</sub> Concentration (µg/m<sup>3</sup>)</b>	<b>5-Year Percentile</b>	<b>5-Year Rank</b>
June 8, 2023	Tier 1	29.1	99.27	6
June 29, 2023	Tier 1	85.3	100.00	1

**Figure 5. Time series plot of PM<sub>2.5</sub> daily combined site data for the Maple Canyon (39-049-0081) monitoring site in the Columbus, OH MSA from 2018-2024. The tier thresholds, shown for the month of June, are based on 2019-2023, the most recent 5-year period of certified data at the time of publication of this document<sup>5</sup>.**



<sup>5</sup> This figure was created on September 13, 2024, from the online U.S. EPA PM<sub>2.5</sub> Tiering Tool available at <https://www.epa.gov/air-quality-analysis/pm25-tiering-tool-exceptional-events-analysis>

## **1.2. Exceptional Events Rule Requirements**

U.S. EPA's Treatment of Data Influenced by Exceptional Events ("Exceptional Events Rule", 81 FR 68216) provides the requirements that air agencies must meet when requesting U.S. EPA to exclude exceptional event-related concentrations from regulatory determinations. All of the required elements under 40 CFR 50.14(c)(1)(i), 40 CFR 50.14(c)(3)(iv)(A-E), and 40 CFR 50.14(c)(3)(v)(A-C) are included in this demonstration.

- A narrative conceptual model that describes the event(s) causing the exceedance or violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s) is presented in Section 2 of this document.
- A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation, including analyses comparing the event-influenced concentrations to concentrations at the same monitoring site at other times, is presented in Section 3 of this document.
- A demonstration that the event was both not reasonably controllable and not reasonably preventable is presented in Section 4 of this document.
- A demonstration that the event was a human activity that is unlikely to recur at a location or was a natural event is presented in Section 5 of this document.
- A demonstration that the public was promptly notified of the occurrence of the event(s) that may result in the exceedance of an applicable air quality standard is presented in Section 6 of this document.
- A demonstration that Ohio followed the public comment process for the submission of this document, including a copy of all public comments received and Ohio's responses to those comments received, is presented in Section 7 of this document.

## 2. Narrative Conceptual Model

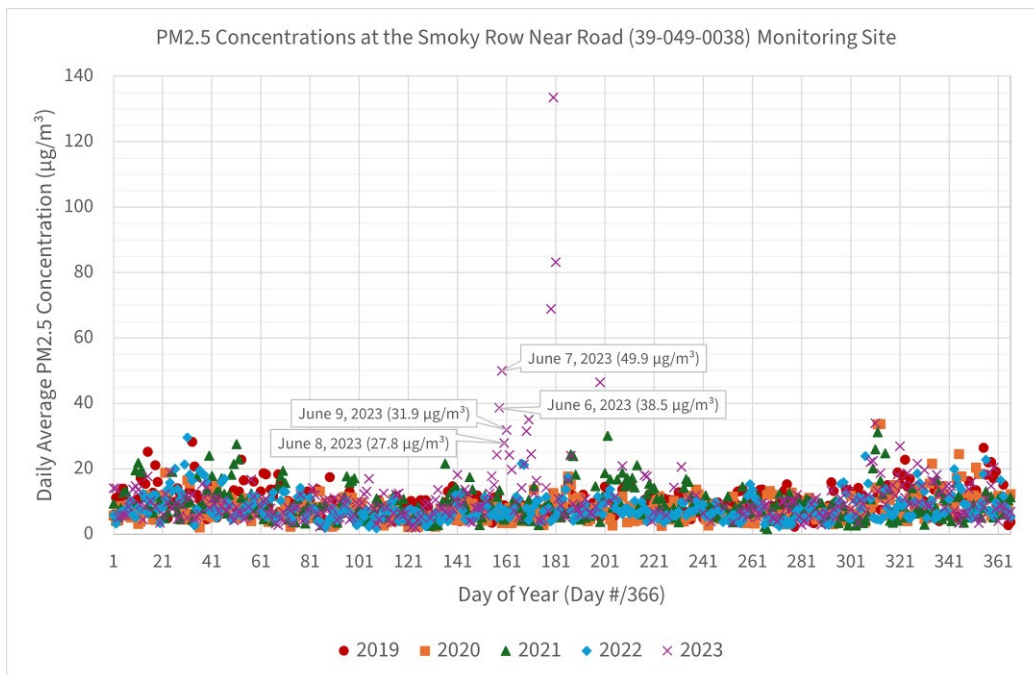
The narrative conceptual models for the June 6-9, 2023 and June 27-29, 2023 wildfire smoke-driven PM<sub>2.5</sub> episodes are presented in this section. Narrative conceptual models are presented separately for each episode.

### 2.1. June 6-9, 2023 Wildfire Smoke-Driven PM<sub>2.5</sub> Episode

#### 2.1.1. Episode Description

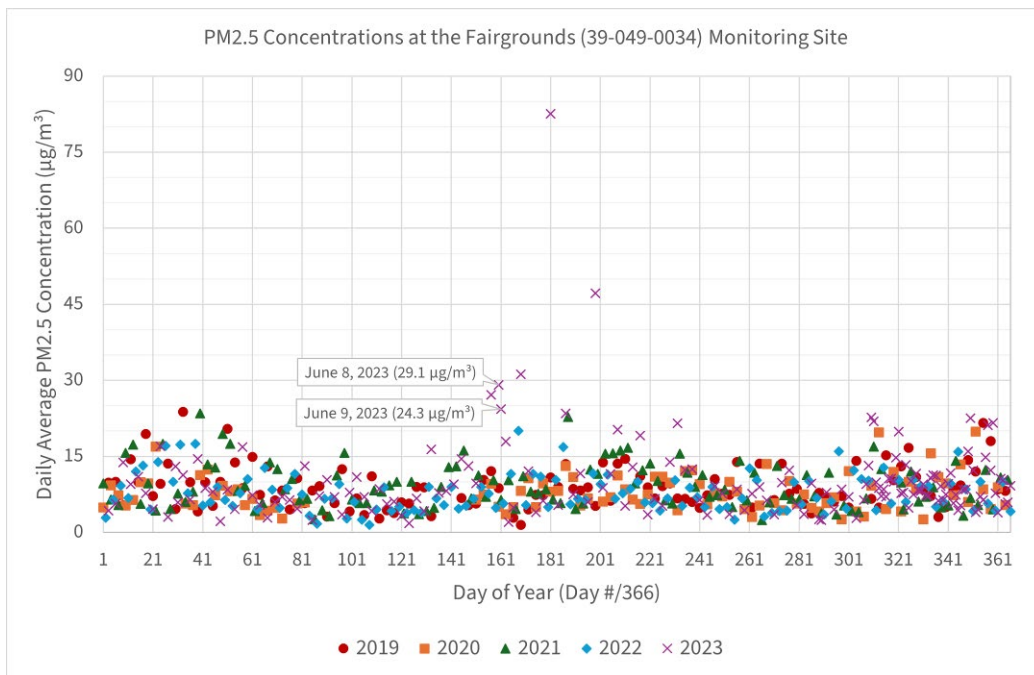
Air quality in the Columbus, OH MSA was impacted in June 2023 by wildfire smoke entering the region from Quebec, Canada. Smoke plumes impacted the Columbus, OH MSA during multiple episodes in the summer of 2023. Figures 6, 7, 8, and 9 show the daily average PM<sub>2.5</sub> concentrations for the years 2019-2023 at the Smoky Row Near Road, Fairgrounds, Jackson Pike WWTP, and Maple Canyon monitoring sites in the Columbus, OH MSA. These figures illustrate the severity of the wildfire smoke-driven PM<sub>2.5</sub> episodes in the summer of 2023 relative to other periods of the year and compared to the same period in the past five years. Data collected during the June 6-9, 2023 wildfire smoke-driven PM<sub>2.5</sub> episode are labeled in each figure.

**Figure 6. 2019-2023 daily average PM<sub>2.5</sub> concentrations at the Smoky Row Near Road (39-049-0038) monitoring site in the Columbus, OH MSA, with data from the June 6-9, 2023 episode labeled.**

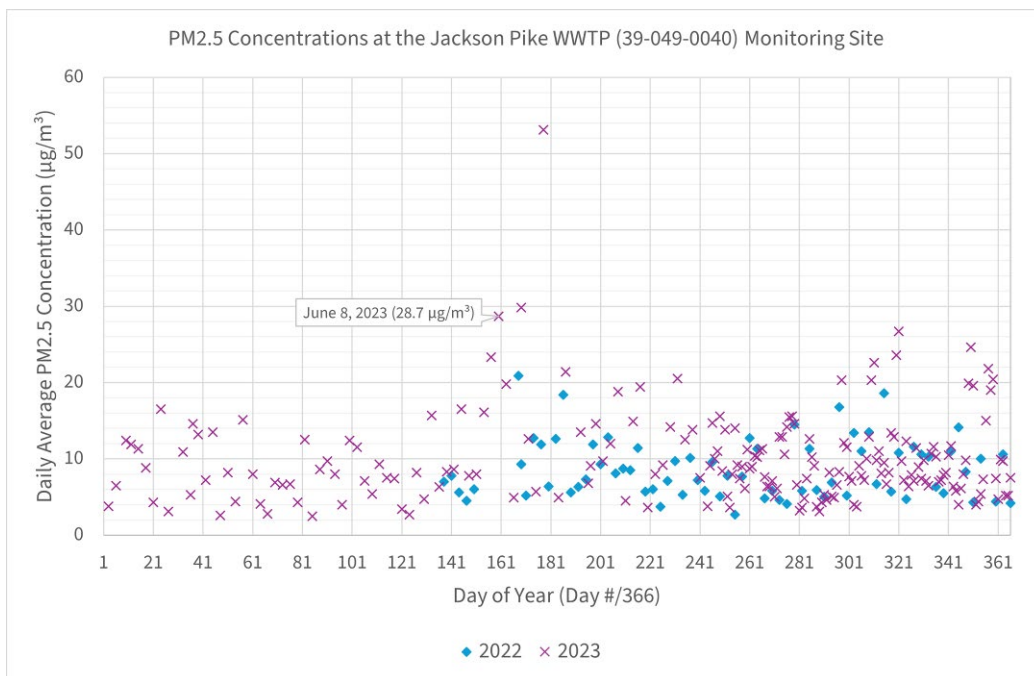




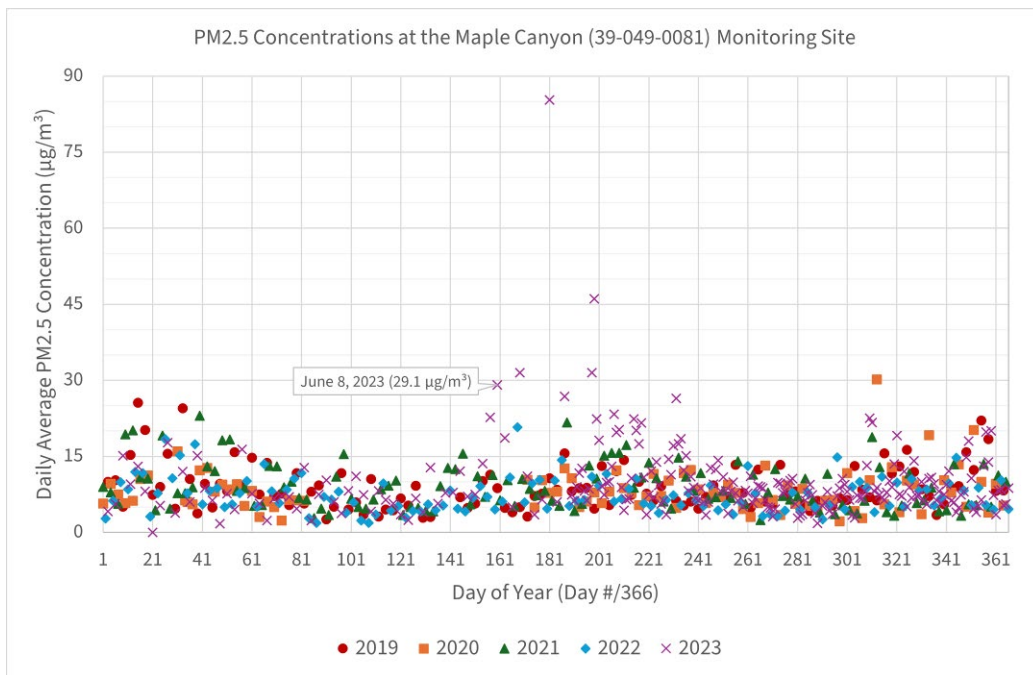
**Figure 7. 2019-2023 daily average PM<sub>2.5</sub> concentrations at the Fairgrounds (39-049-0034) monitoring site in the Columbus, OH MSA, with data from the June 6-9, 2023 episode labeled.**



**Figure 8. 2019-2023 daily average PM<sub>2.5</sub> concentrations at the Jackson Pike WWTP (39-049-0040) monitoring site in the Columbus, OH MSA, with data from the June 6-9, 2023 episode labeled.**



**Figure 9. 2019-2023 daily average PM<sub>2.5</sub> concentrations at the Maple Canyon (39-049-0081) monitoring site in the Columbus, OH MSA, with data from the June 6-9, 2023 episode labeled.**



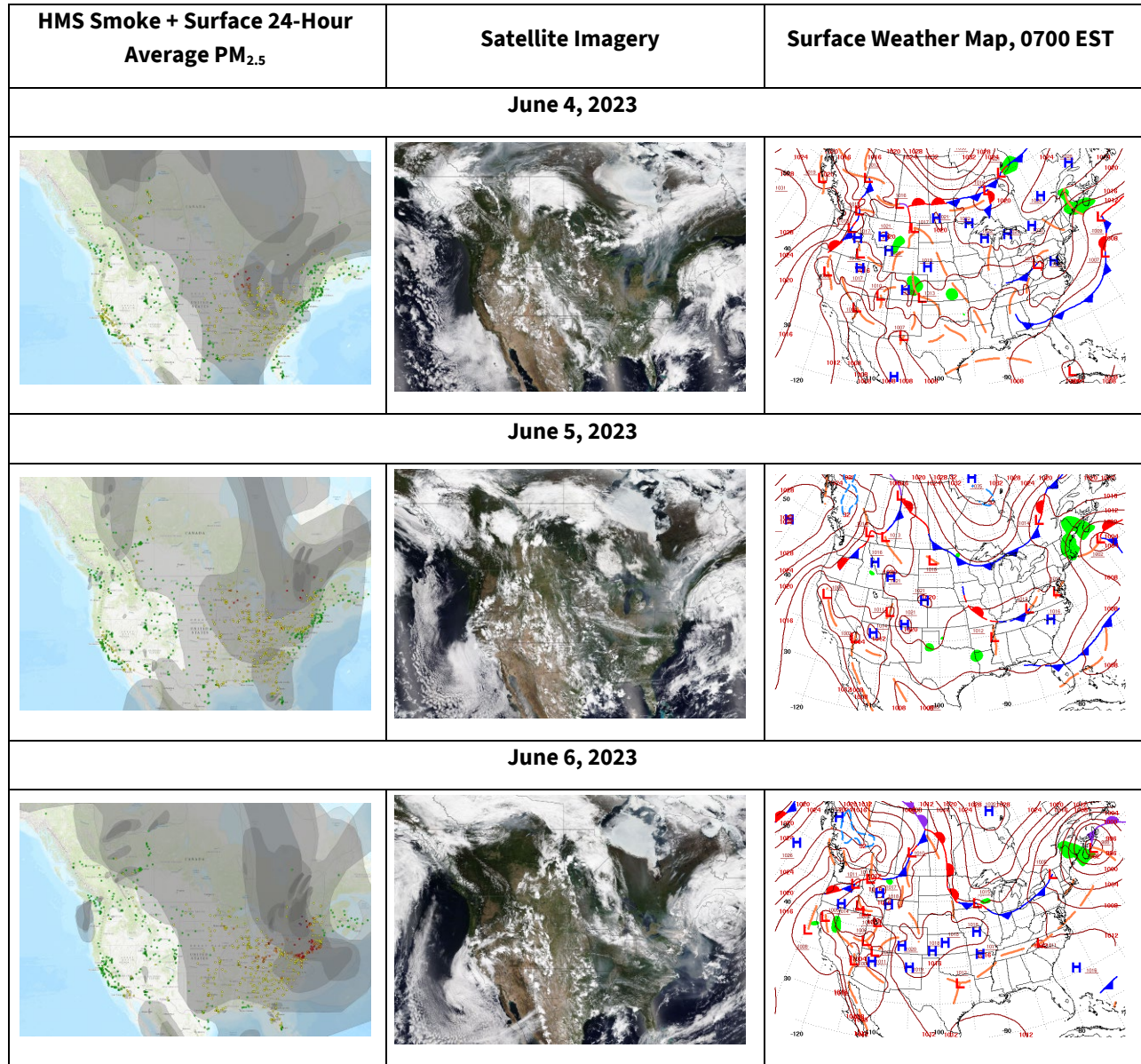
### 2.1.2. Meteorology

From June 2 to June 9, 2023, two distinct weather patterns connected the upper Midwest with Canada and brought wildfire smoke into the Great Lakes Basin. Early in the episode (June 2-4), a cold front moved across southern Canada and the trailing high-pressure system brought with it smoke from wildfires burning in southeastern Quebec south into the Great Lakes region. Starting on June 5, an area of low-pressure formed along the southeastern coast of Canada near Maine, and an area of high-pressure formed over Hudson Bay in Canada. These features remained in place until June 7 and were the primary physical drivers of the smoke transport into the Great Lakes Basin that impacted air quality in the Columbus, OH MSA on June 6-9, 2023.

Figure 10 shows Hazard Mapping System (HMS) smoke maps, daily average PM<sub>2.5</sub> concentrations, satellite imagery, and surface weather maps for June 4-6, 2023, while Figure 11 shows the same for June 7-9, 2023. These figures show an area of high pressure with clear skies connecting Hudson Bay to the Great Lakes. The strong low-pressure system off to the east produced cyclonic (counterclockwise) flow, which created a northerly wind transport corridor along its western edge. Combined with the stationary front along the Ohio River

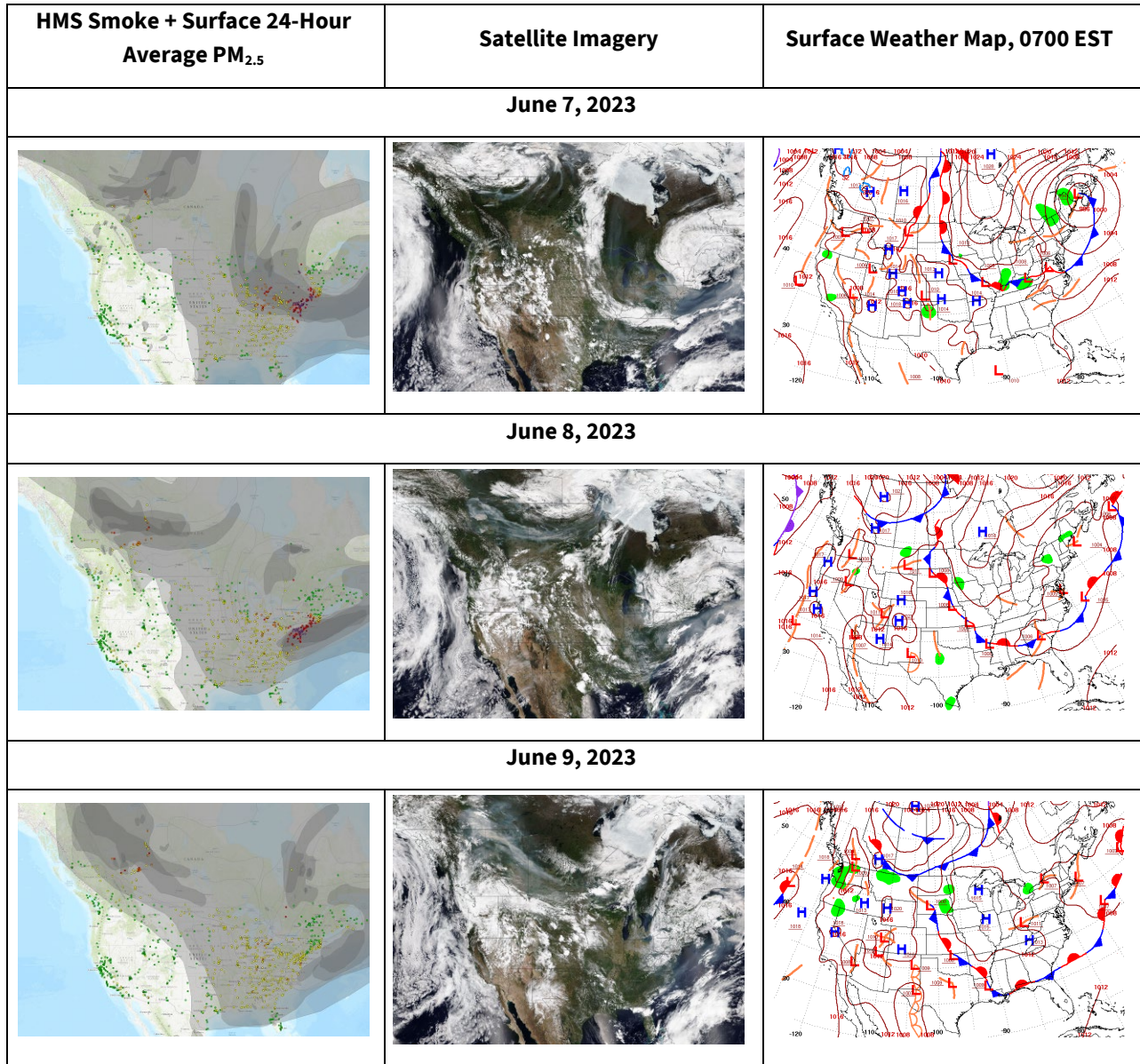
Valley, the synoptic conditions were ideal for smoke transport and buildup in central Ohio. The western edge of the low-pressure system created northerly flow and a descending air mass with accompanying high pressure. This flow pattern brought smoke south from the wildfires burning near the southern end of James Bay in Quebec and Ontario and carried it to the surface in the Great Lakes Basin. The stationary front along the southern edge of the Great Lakes region caused the air mass to stall, allowing the smoke to build up, resulting in high concentrations of PM<sub>2.5</sub> at the surface.

**Figure 10. Daily average PM<sub>2.5</sub> concentrations overlapped with NOAA’s Hazard Mapping System (HMS) smoke layers (left), daily snapshot of the NOAA-20 satellite imagery of cloud cover, and the surface weather map (right) during June 4-6, 2023.**





**Figure 11. Daily average PM<sub>2.5</sub> concentrations overlapped with NOAA’s Hazard Mapping System (HMS) smoke layers (left), daily snapshot of the NOAA-20 satellite imagery of cloud cover, and the surface weather map (right) during June 7-9, 2023.**



### **2.1.3. Canadian Wildfires**

Starting on May 27, 2023, the Canadian Wildland Fire Information System (CWFIS)<sup>6</sup> began to report extreme fire danger conditions from the southwest border of Ontario northeast across Quebec to the Gulf of St. Lawrence. The area of Quebec centered around the southern end of James Bay remained almost continuously under high to extreme fire danger through most of the month. On June 2, the Quebec provincial fire-management authority, Société de Protection des Forêts Contre le Feu (SOPFEU<sup>7</sup>), reported to the Canadian Interagency Forest Fire Center (CIFFC) a fire preparedness level 5 for the province, which is the highest alert level in Canada for mobilizing resources to fight wildfires and protect life and structures<sup>8</sup>. The province remained at a level 5 alert continuously until it was lowered to level 4 on July 17. On June 4, the Aviation, Forest Fire, and Emergency Services division of the Ontario Ministry of Natural Resources and Forestry (OMNRF-AFFES)<sup>9</sup>, reported to CIFFC a fire preparedness level 4 for the province<sup>10</sup>, which remained until being lowered to level 3 on July 11.

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<sup>6</sup> <https://cwfis.cfs.nrcan.gc.ca/home>

<sup>7</sup> <https://sopfeu.qc.ca/>

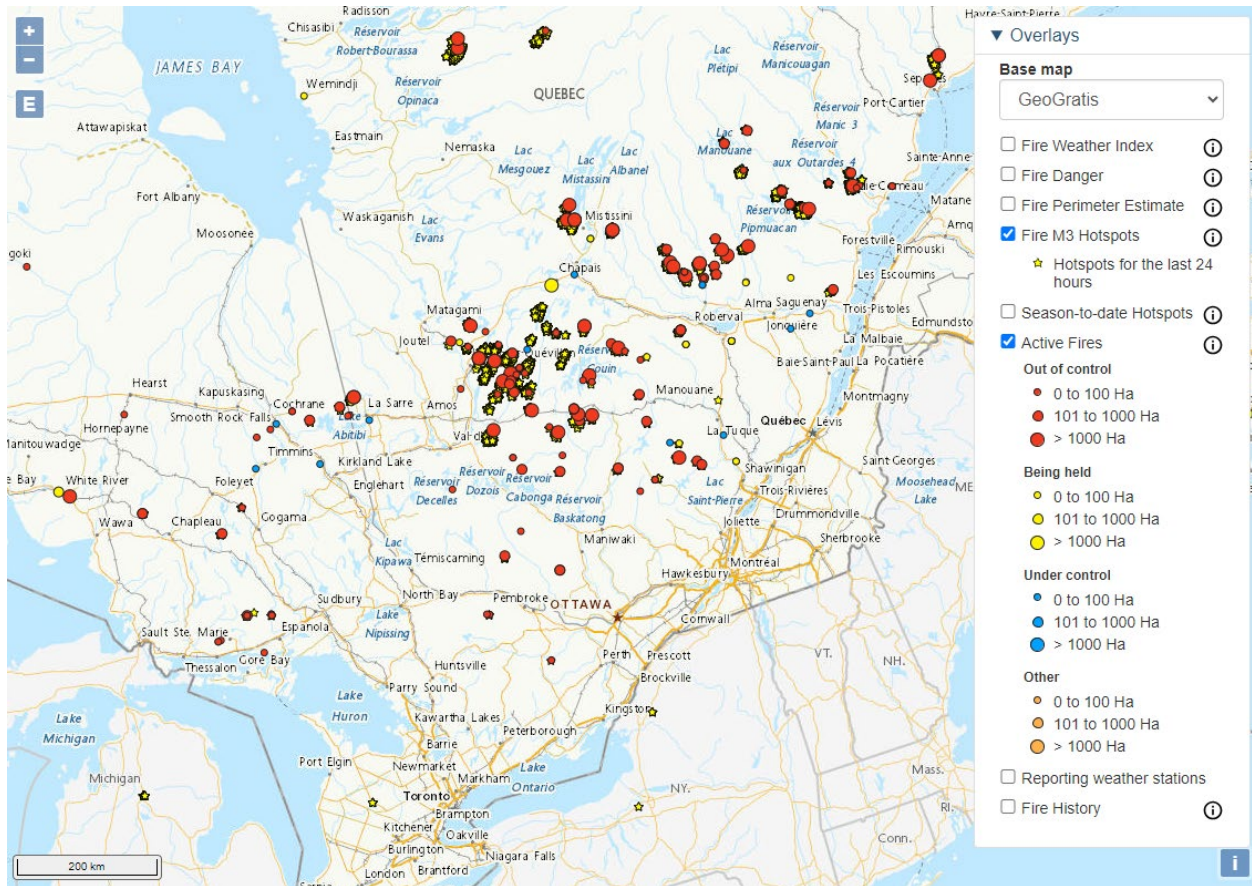
<sup>8</sup> <https://ciffc.net/situation/2023-06-02>

<sup>9</sup> <https://www.ontario.ca/page/forest-fire-management>

<sup>10</sup> <https://ciffc.net/situation/2023-06-04>

Figure 12 is a CWFIS map showing the active fires and fire hotspots in Quebec on June 4, 2023. On June 4 there were 150 active fires burning 382,578 acres in the province<sup>11</sup>. Most of these fires and recent hotspots were clustered in a large complex northeast of Val-d’Or, southeast of Matagami, and south of Chapais, with a smaller fire complex burning northwest of Trois-Rivières, and additional fires burning east of Wemindji. The smoke plumes arising from the fires and recent hotspots northwest of Trois-Rivières, east of Val-d’Or, and northeast of Val-d’or were located in the source regions intersected by the June 6, 2023 HYSPLIT 48-hour back and forward trajectory plots shown in Figure 24 in Section 3 of this document.

**Figure 12. Map from CWFIS of active fires in Quebec on June 4, 2023.**

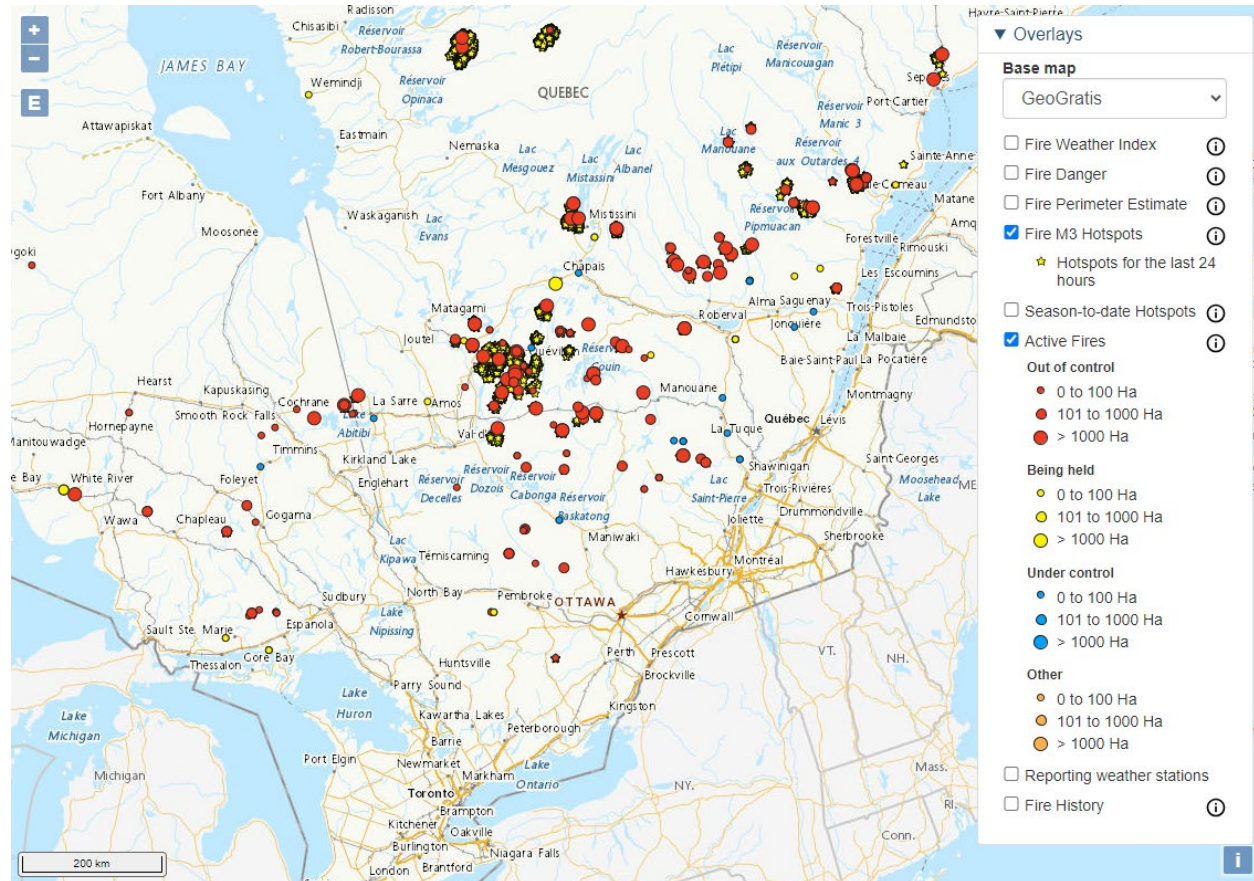


<sup>11</sup> <https://ciffc.net/situation/2023-06-04>



Figure 13 is a CWFIS map showing the active fires and fire hotspots in Quebec on June 5, 2023. On June 5 there were 154 active fires burning 384,401 acres in the province<sup>12</sup>. The fire complex east of Wemindji continued to burn, with additional hotspots appearing quickly. The smoke plumes arising from the fires and recent hotspots east of Wemindji were located in the source region intersected by the June 7, 2023 HYSPLIT 48-hour back and forward trajectory plots shown in Figure 26 in Section 3 of this document.

**Figure 13. Map from CWFIS of active fires in Quebec on June 5, 2023.**

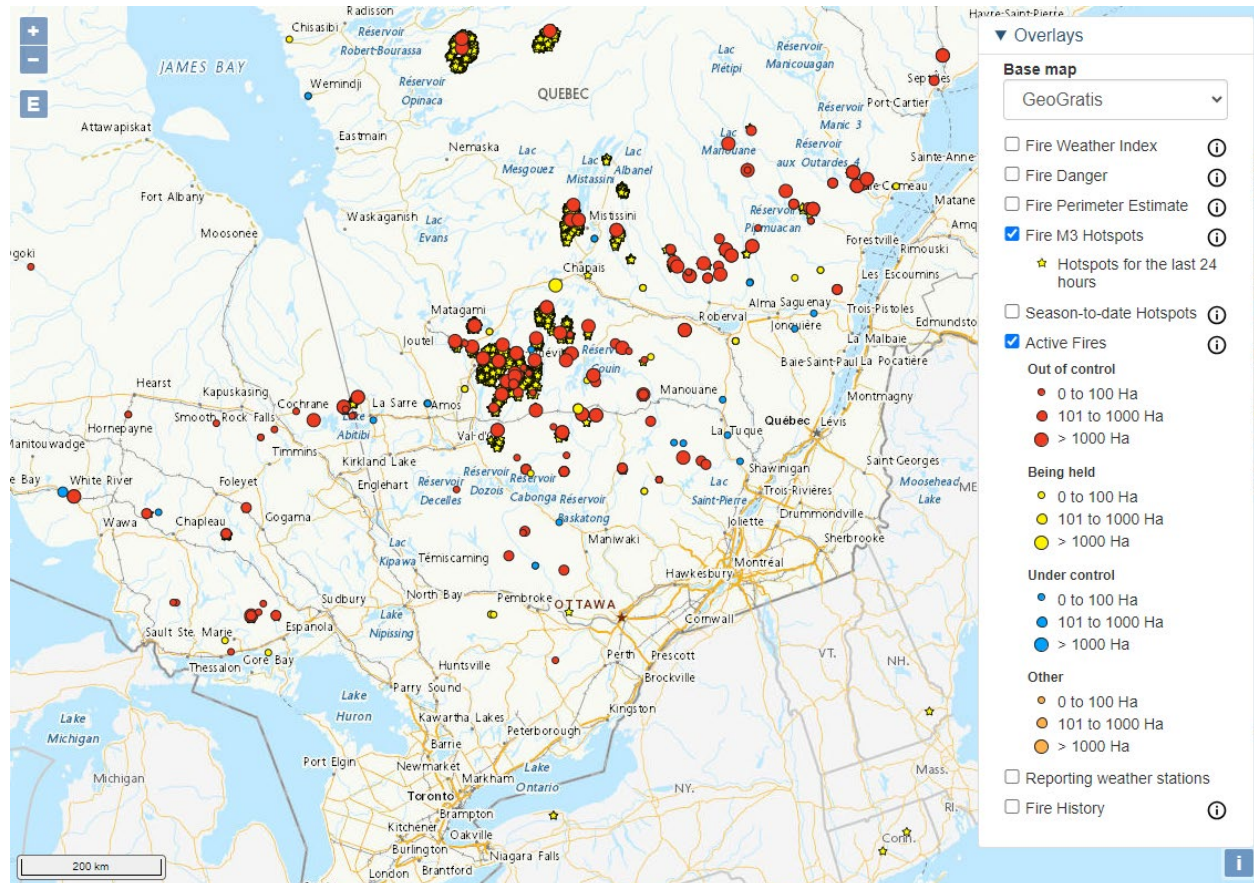


<sup>12</sup> <https://ciffc.net/situation/2023-06-05>



Figure 14 is a CWFIS map showing the active fires and fire hotspots in Quebec on June 6, 2023. On June 6 there were 154 active fires burning 651,405 acres in the province<sup>13</sup>. The smoke plumes arising from the fires and recent hotspots east of Wemindji were located in the source region intersected by the June 8, 2023 HYSPLIT 48-hour trajectory plots shown in Figure 28 in Section 3 of this document.

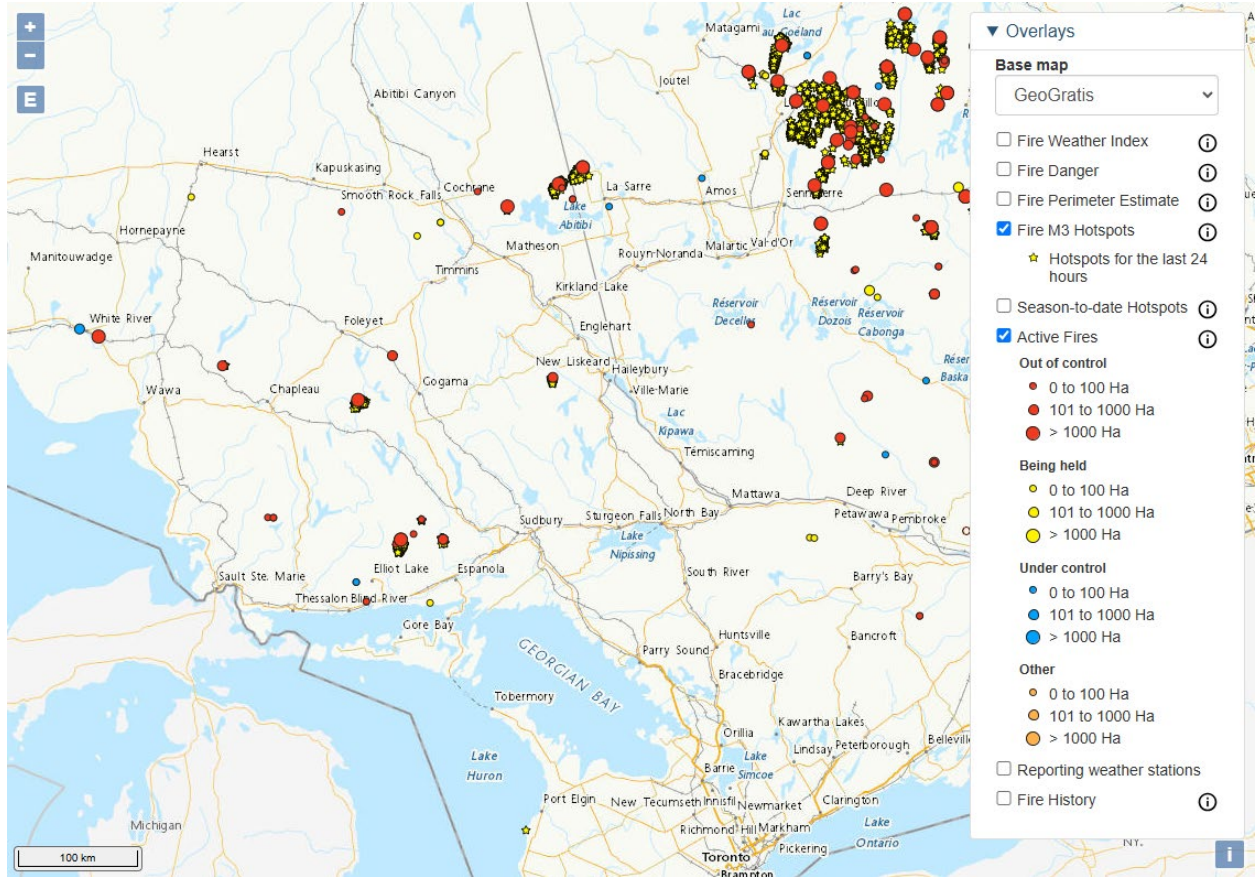
**Figure 14. Map from CWFIS of active fires in Quebec on June 6, 2023.**



<sup>13</sup> <https://ciffc.net/situation/2023-06-06>

Figure 15 is a CWFIS map showing the active fires and fire hotspots in eastern Ontario on June 7, 2023. The smoke plumes arising from the fires and recent hotspots southwest of Timmins and east of Chapleau were located in the source region intersected by the June 9, 2023 HYSPLIT 48-hour trajectory plots shown in Figure 30 in Section 3 of this document.

**Figure 15. Map from CWFIS of active fires in eastern Ontario on June 7, 2023.**



### 2.1.4. Media Coverage

News media across the country reported on the wildfire smoke in the Great Lakes region during June 2023. The coverage of the smoke, particularly by media outlets that typically only report on extreme weather and air quality events, indicated the historic nature of the Canadian wildfire smoke impacts in the Great Lakes region, including the Columbus, OH MSA. While the list of news stories in Table 5 is not exhaustive, it illustrates the severe nature of the June 6-9, 2023 PM<sub>2.5</sub> pollution episode in the Great Lakes region and central Ohio in particular, and serves as further evidence that the June 6-9, 2023 episode was not local in nature but driven by transported wildfire smoke from Canada that blanketed the region.

**Table 5. News media reporting of early June 2023 Canadian wildfire smoke in the Great Lakes region.**

Date	Source	Headline
June 6, 2023	The New York Times	Wildfire smoke blots sun and prompts health alerts in much of U.S. <sup>14</sup>
June 6, 2023	The Washington Post	Where wildfire smoke is hitting the U.S. the hardest — and when it will end <sup>15</sup>
June 7, 2023	The Columbus Dispatch	Columbus to remain under an air quality alert Thursday as wildfire haze lingers <sup>16</sup>
June 8, 2023	WHIO	First-ever statewide Air Quality Advisory extended through today as Canadian wildfire smoke lingers <sup>17</sup>
June 9, 2023	Cleveland.com	When will we get relief from Canadian wildfire smoke? <sup>18</sup>
June 9, 2023	WOSU	Central Ohio air quality is improving, but problematic for some due to Canadian wildfires <sup>19</sup>

<sup>14</sup> <https://www.nytimes.com/2023/06/06/us/canada-wildfires-us-smoke-air-quality.html>

<sup>15</sup> <https://www.washingtonpost.com/weather/2023/06/06/northeast-wildfire-smoke-canada-pollution>

<sup>16</sup> <https://www.dispatch.com/story/weather/2023/06/07/columbus-hazy-skies-may-soon-clear-up-air-quality-alert/70296741007>

<sup>17</sup> <https://www.whio.com/news/local/first-ever-statewide-air-quality-advisory-extended-through-today-canadian-wildfire-smoke-lingers/ENH7E7AWDVAPBMEBAC4GSZUU7M>

<sup>18</sup> <https://www.cleveland.com/news/2023/06/when-will-we-get-relief-from-canadian-wildfire-smoke.html>

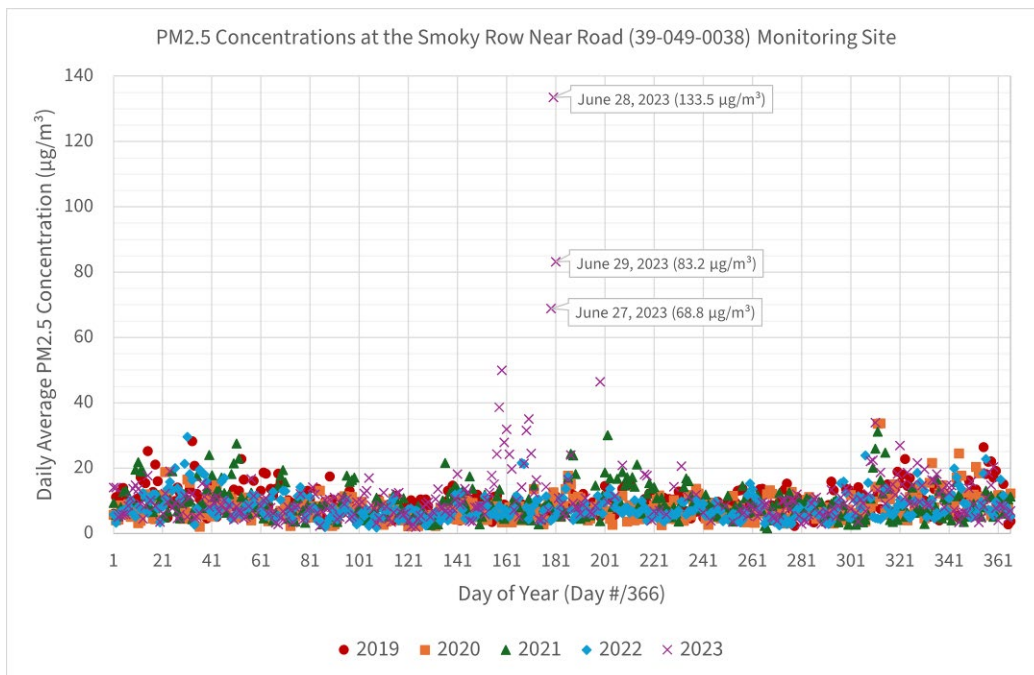
<sup>19</sup> <https://www.wosu.org/2023-06-08/ohioans-advised-to-take-precautions-due-to-poor-air-quality-from-canadian-wildfires>

## 2.2. June 27-29, 2023 Wildfire Smoke-Driven PM<sub>2.5</sub> Episode

### 2.2.1. Episode Description

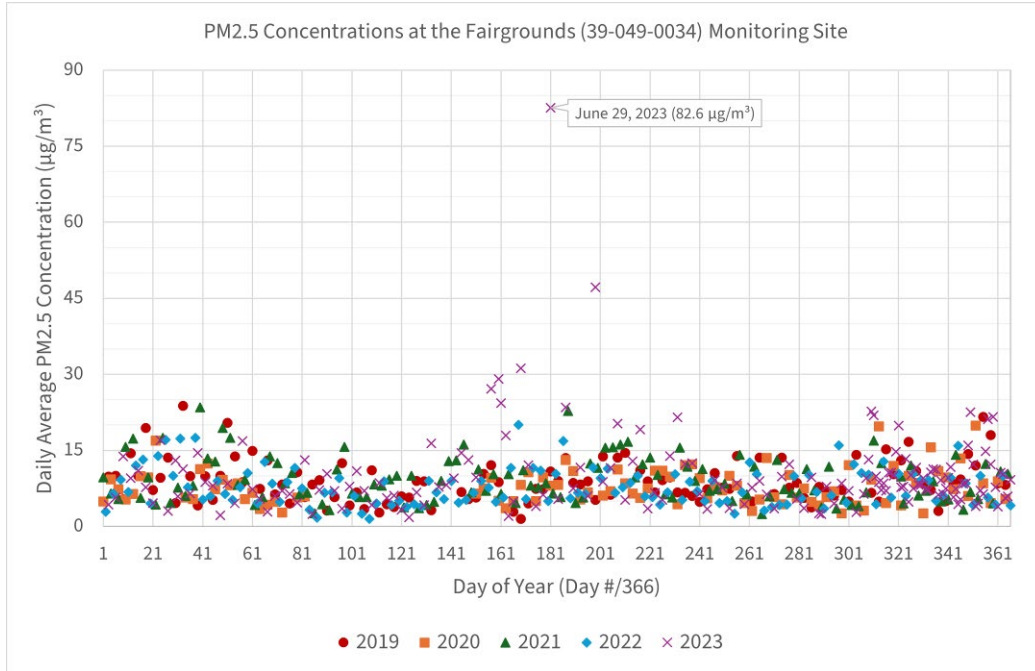
As with the June 6-9, 2023 smoke episode, Figures 16, 17, and 18 illustrate the severity of the June 2023 wildfire smoke-driven PM<sub>2.5</sub> episodes relative to other periods of the year and compared to the same period in the past five years at the Smoky Row Near Road, Fairgrounds, and Maple Canyon monitoring sites, respectively. The PM<sub>2.5</sub> concentrations measured during the June 27-29, 2023 wildfire smoke-driven PM<sub>2.5</sub> episode are labeled in each of the plots in Figures 16, 17, and 18.

**Figure 16. 2019-2023 daily average PM<sub>2.5</sub> concentrations at the Smoky Row Near Road (39-049-0038) monitoring site in the Columbus, OH MSA, with data from the June 27-29, 2023 episode labeled.**

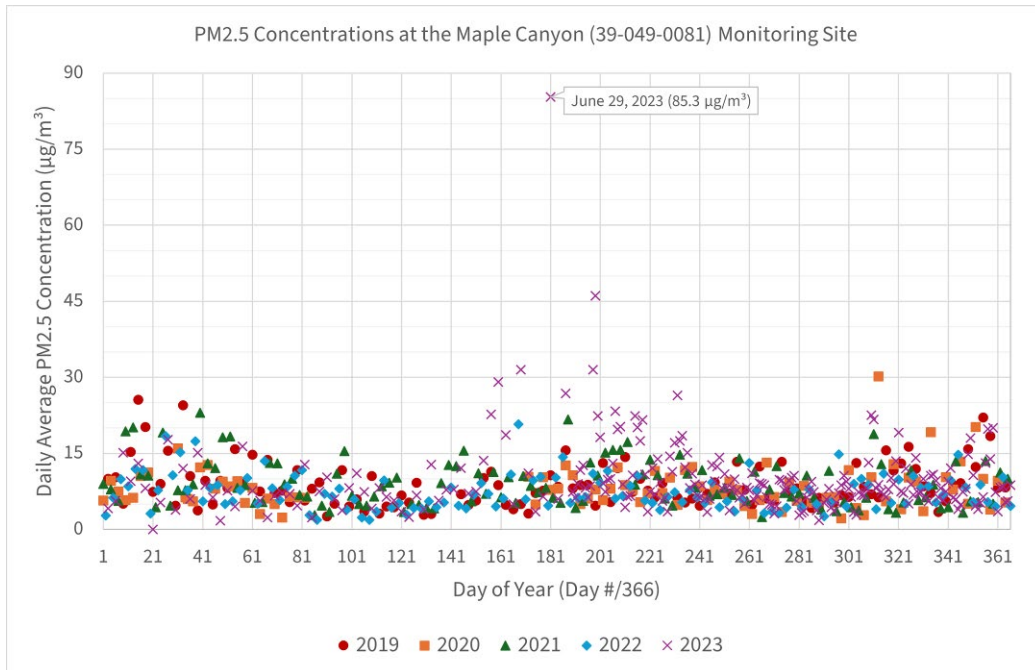




**Figure 17. 2019-2023 daily average PM<sub>2.5</sub> concentrations at the Fairgrounds (39-049-0034) monitoring site in the Columbus, OH MSA, with data from the June 27-29, 2023 episode labeled.**



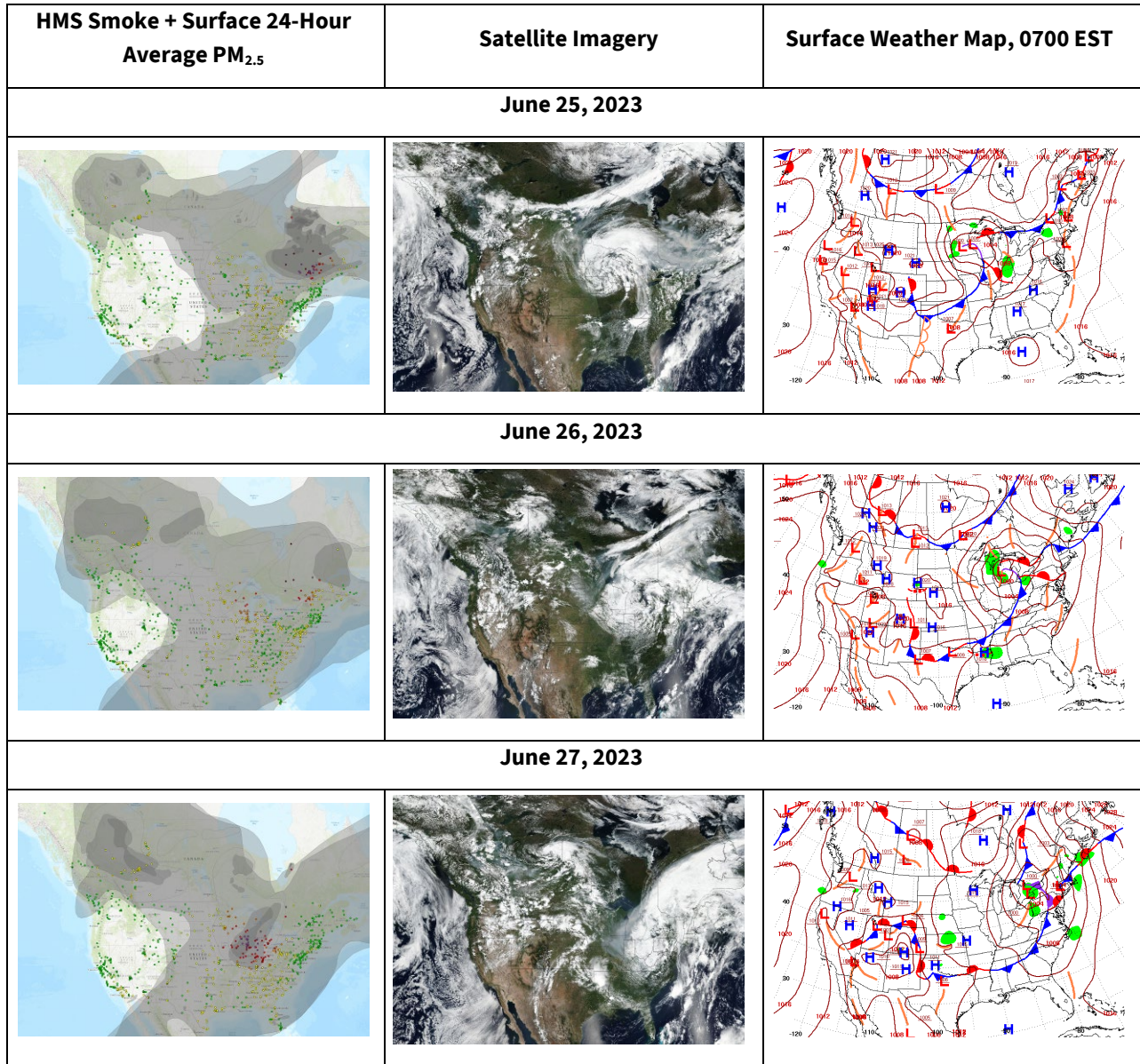
**Figure 18. 2019-2023 daily average PM<sub>2.5</sub> concentrations at the Maple Canyon (39-049-0081) monitoring site in the Columbus, OH MSA, with data from the June 27-29, 2023 episode labeled.**



### **2.2.2. Meteorology**

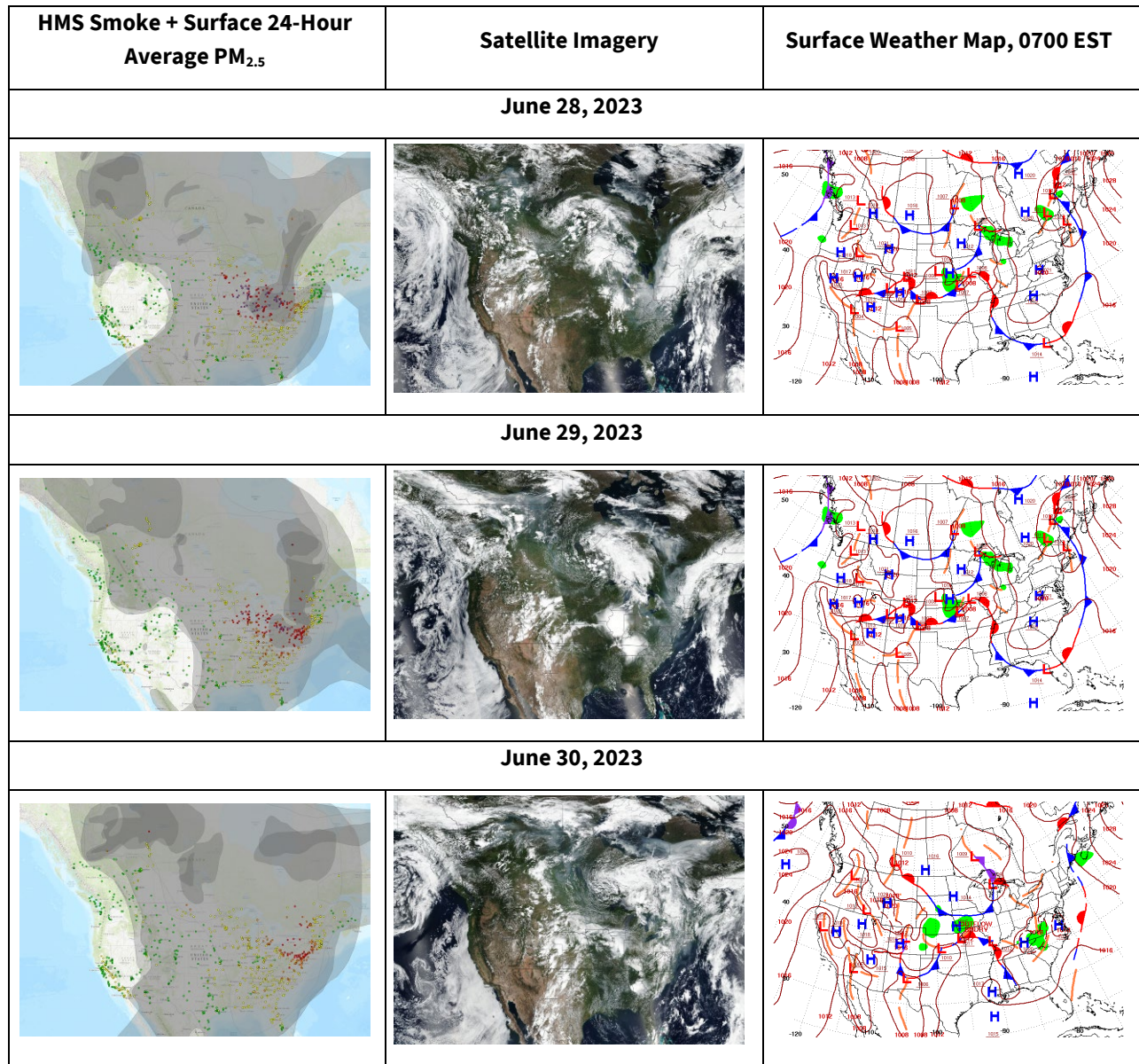
From June 25 through June 30, 2023, distinct airmass transport patterns connected the upper Midwest with Canada and brought smoke into the Great Lakes Basin. Figure 19 shows Hazard Mapping System (HMS) smoke maps, daily average PM<sub>2.5</sub> concentrations, satellite imagery, and surface weather maps for June 25-27, 2023, while Figure 20 shows the same for June 28-30, 2023. During June 25-27, a cyclonic (e.g., counterclockwise) circulation around a large low-pressure system centered on the Great Lakes carried smoke into the upper Midwest from source regions in Ontario and Quebec, Canada. Thick smoke from the Canadian wildfires was transported along the trailing edge of the low-pressure system as it moved east through the Great Lakes Basin. Stable air featured during this period with a consistent northerly to northwesterly wind of 7-15 m/s (16-34 mph).

**Figure 19. Daily average PM<sub>2.5</sub> concentrations overlapped with NOAA’s Hazard Mapping System (HMS) smoke layers (left), daily snapshot of the Suomi NPP satellite imagery of cloud cover, and the surface weather map (right) during June 25-27, 2023.**





**Figure 20. Daily average PM<sub>2.5</sub> concentrations overlapped with NOAA’s Hazard Mapping System (HMS) smoke layers (left), daily snapshot of the Suomi NPP satellite imagery of cloud cover, and the surface weather map (right) during June 28-30, 2023.**



A blocking “omega” pattern formed in the upper air during June 25-27, which featured two strong low-pressure systems sitting over the Pacific Northwest and the northern Great Lakes blocked by a ridge of high pressure over the Great Plains. This feature allowed smoke from Canada to transport into the Great Lake region and build up at the surface across the region.

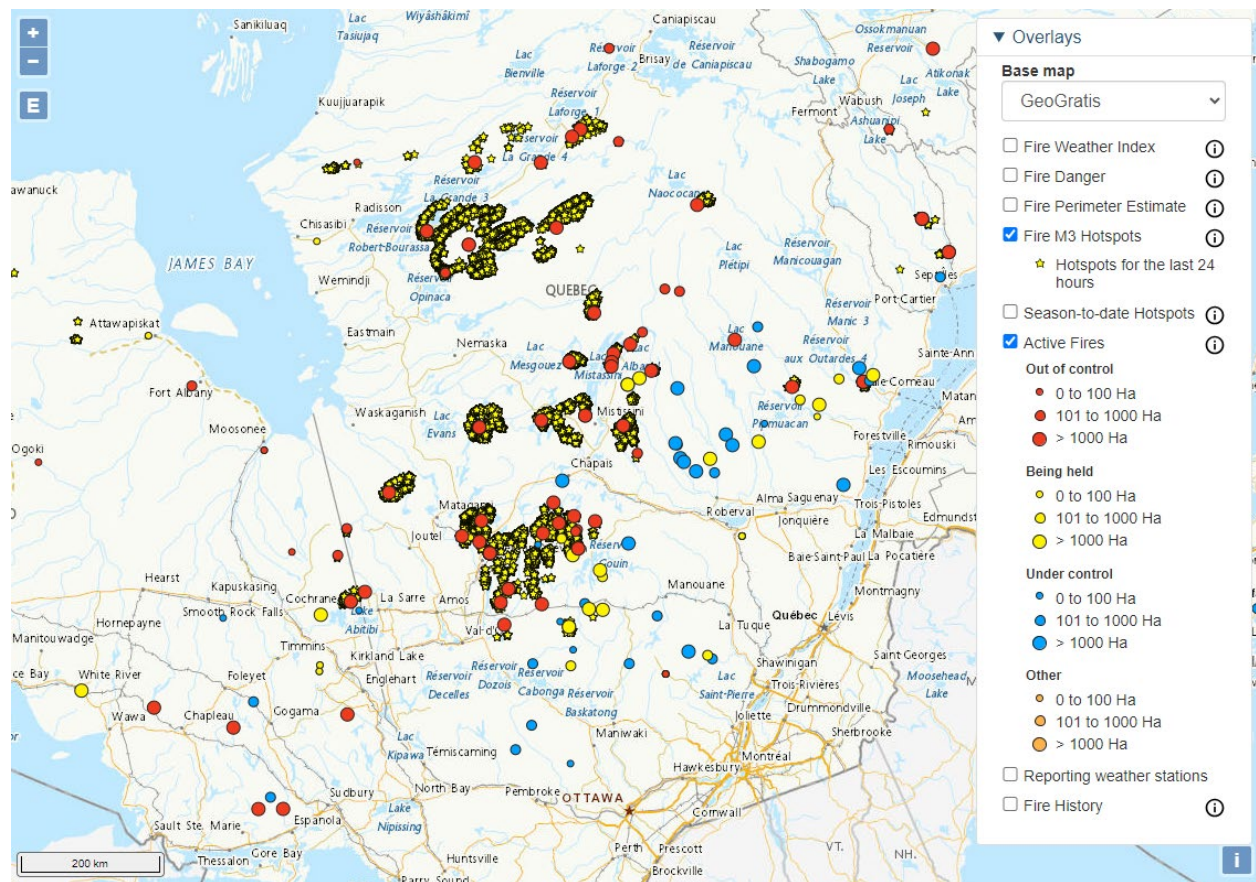


Starting on June 28, 2023, the low-pressure system aloft weakened and moved towards eastern Canada. As a result, a long, weak ridge of high-pressure centered in the Midwest covered most of the eastern U.S. This weak high-pressure system that persisted until the evening of June 29 produced a dry, stagnant air mass in the Great Lakes region that trapped the smoke from the Canadian fires over the region and caused high surface PM<sub>2.5</sub> conditions at the surface. On June 28, a large low-pressure system formed east of Lake Winnipeg in Manitoba, Canada. At the same time, two well-established meso-scale convective systems that formed in Nebraska and Kansas moved into Illinois on the morning of June 29. Between these two features, a smoke transport corridor formed across the central Great Lakes Basin that brought smoke from Quebec, Canada along with a smoke-enriched airmass from the central Canadian provinces into the region. This corridor persisted until June 30 when the smoke started to clear out of the region to the east.

### 2.2.3. Canadian Wildfires

Quebec continued to be in state of fire preparedness level 5 for the province in late June 2023. Figure 21 is a CWFIS map showing the active fires and fire hotspots in Quebec on June 25, 2023. On June 25 there were 79 active fires burning 3,003,034 acres in the province<sup>20</sup>. Most of these fires and recent hotspots were clustered in a large complex northeast of Val-d'Or, southeast of Matagami, and south of Chapais. The smoke plumes arising from these fires and recent hotspots northeast of Val-d'Or were located in the source region intersected by the June 27, 2023 HYSPLIT 48-hour trajectory plots shown in Figure 32 in Section 3 of this document.

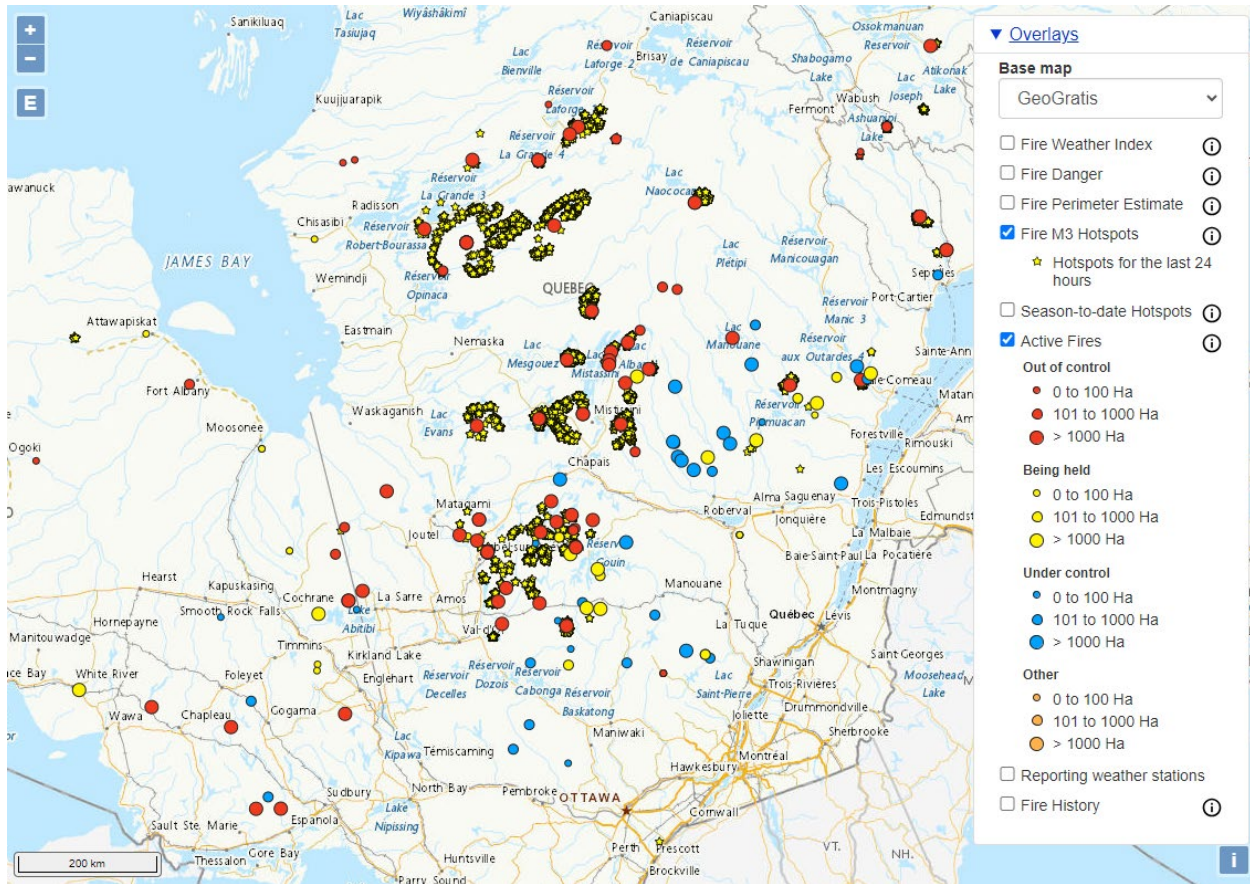
**Figure 21. Map from CWFIS of active fires in Quebec on June 25, 2023.**



<sup>20</sup> <https://ciffc.net/situation/2023-06-25>

Figure 22 is a CWFIS map showing the active fires and fire hotspots in Quebec on June 26, 2023. On June 26 there were 81 active fires burning 3,013,848 acres in the province<sup>21</sup>. Most of these fires and recent hotspots were clustered in a large complex northeast of Val-d'Or, southeast of Matagami, and south of Chapais. The smoke plumes arising from these fires and recent hotspots were located in the source regions intersected by the June 28, 2023 HYSPLIT 48-hour trajectory plots shown in Figure 34 in Section 3 of this document.

**Figure 22. Map from CWFIS of active fires in Quebec on June 26, 2023.**

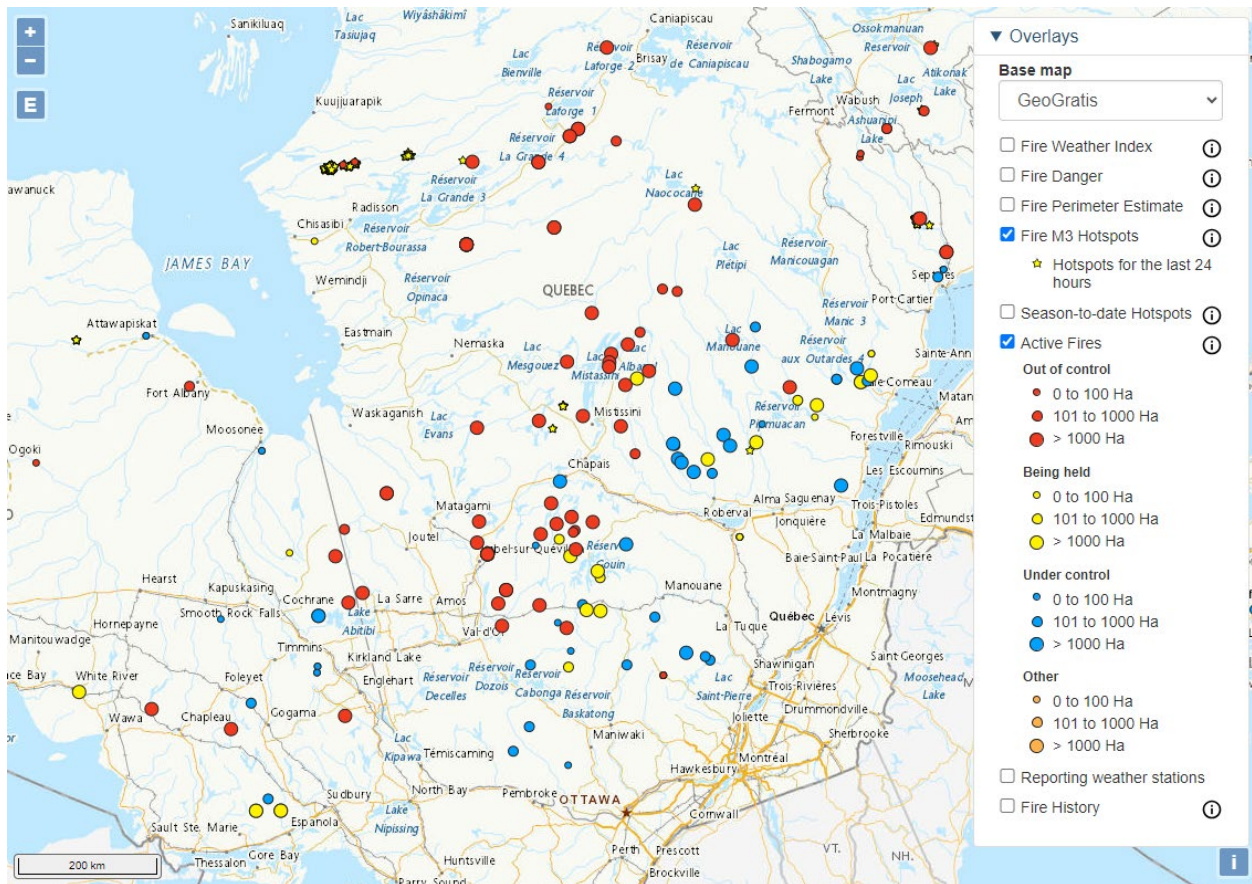


<sup>21</sup> <https://ciffc.net/situation/2023-06-26>



Figure 23 is a CWFIS map showing the active fires and fire hotspots in Quebec on June 27, 2023. On June 27 there were 80 active fires burning 3,200,677 acres in the province<sup>22</sup>. The large fire complex northeast of Val-d’Or, southeast of Matagami, and south of Chapais had begun to die down as rain pushed through the area on June 26-27. However, the smoke plumes arising from this fire complex had already reached central Ohio and begun to affect local air quality by June 27, and the stalled airmass containing this wildfire smoke was situated over Ohio through June 29.

**Figure 23. Map from CWFIS of active fires in Quebec on June 27, 2023.**



<sup>22</sup> <https://ciffc.net/situation/2023-06-27>

#### 2.1.4. Media Coverage

Similar to the media and messaging coverage shown for the June 6-9, 2023 wildfire smoke-driven PM<sub>2.5</sub> episode, Table 6 illustrates the severe nature of the June 27-29, 2023 PM<sub>2.5</sub> pollution episode in the Great Lakes region and central Ohio in particular, and serves as further evidence that the June 27-29, 2023 episode was not local in nature but driven by transported wildfire smoke from Canada that blanketed the region.

**Table 6. News media reporting of late June 2023 Canadian wildfire smoke episodes in the Great Lakes region.**

Date	Source	Headline
June 27, 2023	Dayton Daily News	Air Quality Alert: Air unhealthy because of smoke from Canadian wildfires <sup>23</sup>
June 27, 2023	The Cincinnati Enquirer	Poor air quality, haze return to the Ohio Valley Region. Here's what you should know <sup>24</sup>
June 28, 2023	The New York Times	Wildfire smoke from Canadian fires blankets Great Lakes region <sup>25</sup>
June 28, 2023	The Columbus Dispatch	Canadian wildfire haze drifts into Columbus. See photos <sup>26</sup>
June 29, 2023	Reuters	Canadian wildfire smoke spreads, 100 million Americans under air-quality alerts <sup>27</sup>
June 29, 2023	Mahoning Matters	Mahoning Valley air quality back to 'very unhealthy' levels <sup>28</sup>

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<sup>23</sup> <https://www.daytondailynews.com/local/air-quality-unhealthy-due-to-smoke-from-canadian-wildfires/AJXBRQ6WABERPLDASDLD5AW7YU>

<sup>24</sup> <https://www.cincinnati.com/story/news/2023/06/27/canada-wildfires-lead-to-poor-air-quality-haze-quebec/70359750007>

<sup>25</sup> <https://www.nytimes.com/live/2023/06/28/us/canada-wildfires-air-quality-smoke>

<sup>26</sup> <https://www.dispatch.com/picture-gallery/news/2023/06/28/canadian-wildfire-haze-drifts-into-columbus-see-photos/12177063002>

<sup>27</sup> <https://www.reuters.com/world/us/smoke-canadian-wildfires-settles-over-us-midwest-east-2023-06-29>

<sup>28</sup> <https://www.mahoningmatters.com/news/local/article276862193.html>

### **3. Clear Causal Relationship**

While the regional wildfire smoke episodes spanned multiple days in the summer of 2023, the Columbus, OH MSA experienced some of the worst smoke impacts from June 6-9 and June 27-29, 2023. The impacts of both smoke episodes on the Columbus, OH MSA are clearly seen in satellite imagery, remote sensing products, and surface PM<sub>2.5</sub> monitors. The figures in this section that are used to establish the clear and causal relationship between the Canadian wildfires and the PM<sub>2.5</sub> pollution episodes in the Columbus, OH MSA show data from AirNowTech.gov and include the following information:

- Hazard Mapping System (HMS) fire and smoke layers
- Air Quality System (AQS) 24-hour average PM<sub>2.5</sub> surface concentrations
- HYSPLIT 48-hour back trajectories released at 50, 250, and 1000 meters
- HYSPLIT 48-hour forward trajectories corresponding to back trajectories

NASA Worldview<sup>29</sup> data are also used in this section, and include the following information:

- Aerosol optical depth (AOD) from the MODIS combined Terra and Aqua Multi-Angle Implementation of Atmospheric Correction (MAIAC) Land Aerosol Optical Depth level 2 product (left plot)
- Moderate Resolution Imaging Spectroradiometer (MODIS) Terra corrected reflectance (true color) and NOAA-20 Visible Infrared Imaging Radiometer Suite (VIIRS) Fire and Thermal Anomalies (day and night, 375m) layer showing active fire detections and thermal anomalies (right plot)

The clear causal relationship between the Canadian wildfires and PM<sub>2.5</sub> concentrations in the Columbus, OH MSA for the June 6-9, 2023 and June 27-29, 2023 episodes are presented in this section. Clear causal relationship descriptions are presented separately for each episode.

#### ***3.1. June 6-9, 2023 Wildfire Smoke-Driven PM<sub>2.5</sub> Episode***

##### **3.1.1. June 6, 2023**

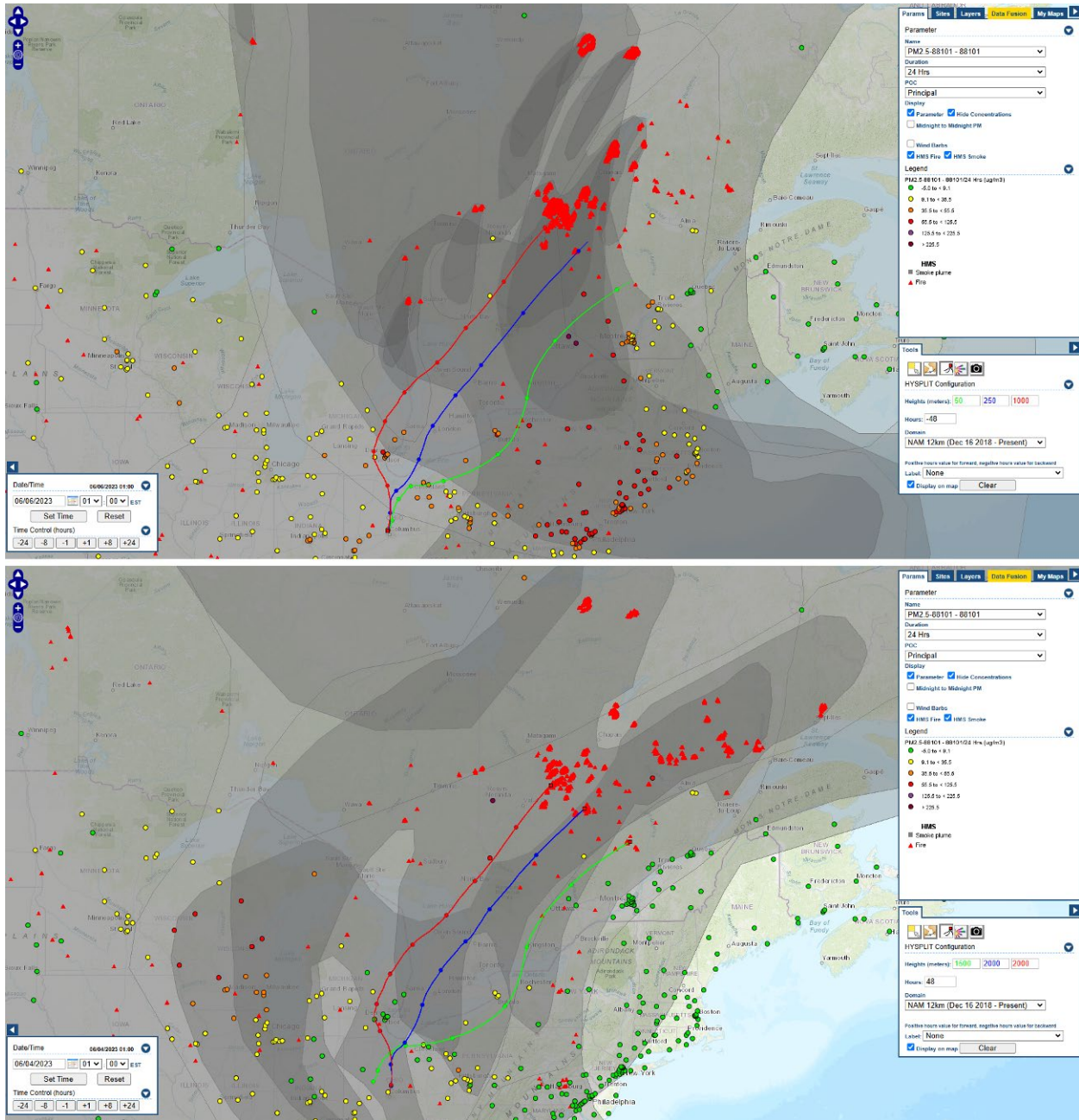
The HYSPLIT 48-hour back and forward trajectory plots show the origin and transport of the smoke plumes that caused the high surface PM<sub>2.5</sub> concentrations in the Columbus, OH MSA on June 6, 2023. Figure 24 shows the HYSPLIT 48-hour back trajectory plot from June 6, overlaid

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<sup>29</sup> <https://worldview.earthdata.nasa.gov>

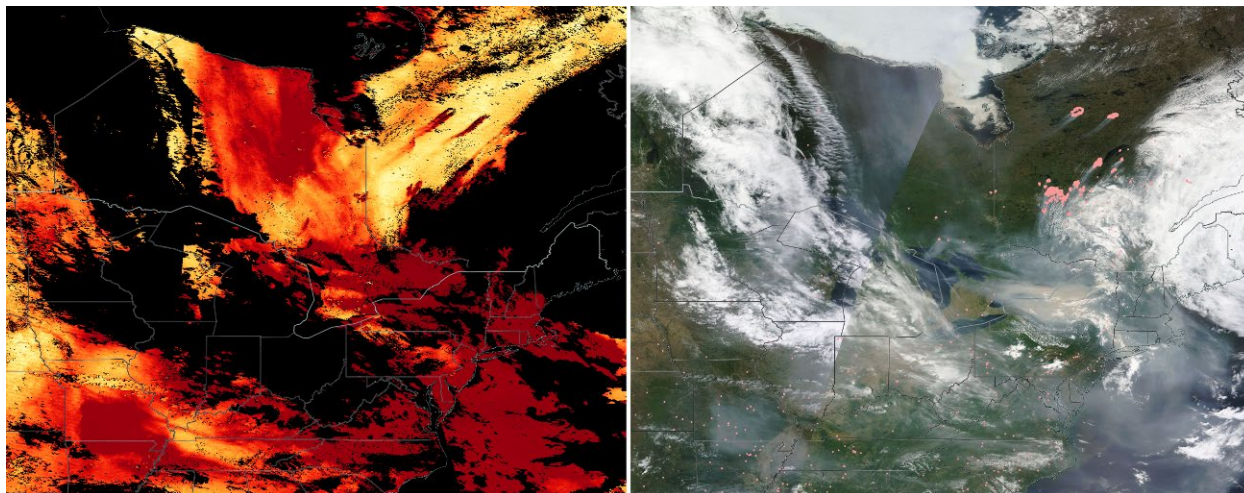
on a map of fire locations, monitored 24-hour average surface  $PM_{2.5}$  concentrations, and HMS smoke polygons for June 6, as well as the HYSPLIT 48-hour forward trajectory plot from June 4 overlaid on a map of fire locations, monitored 24-hour average surface  $PM_{2.5}$  concentrations, and HMS smoke polygons for June 4. The wildfire and smoke locations 120 km (75 mi) northwest of Trois-Rivières, Quebec coincide with the endpoint (at 1317 meters above ground level, AGL) of the 50-meter release height back trajectory from Columbus and the Columbus area is the endpoint (at 111 meters AGL) of the 1500-meter release height forward trajectory from those wildfires. The wildfire and smoke locations 180 km (112 mi) east of Val-d'Or, Quebec coincide with the endpoint (at 2063 meters AGL) of the 250-meter release height back trajectory from Columbus and Columbus is the endpoint (at 244 meters AGL) of the 2000-meter release height forward trajectory from those wildfires. The wildfire and smoke locations 100 km (62 mi) northeast of Val-d'Or, Quebec coincide with the endpoint (at 2018 meters AGL) of the 1000-meter release height back trajectory from Columbus and Columbus is the endpoint (at 1070 meters AGL) of the 2000-meter release height forward trajectory from those wildfires. The coincidence of the 48-hour back and forward trajectories between the wildfire locations and the Columbus area serves as clear evidence that the smoke from these wildfires caused the high  $PM_{2.5}$  concentrations in the Columbus, OH MSA on June 6, 2023. The accompanying AOD and imagery maps for June 6 presented in Figure 25 provide further evidence that dense smoke from the Canadian wildfires was present in the Columbus, OH MSA on June 6, 2023, and that this wildfire smoke was the cause of the high concentrations of  $PM_{2.5}$  at the monitoring sites.

**Figure 24. HYSPLIT 48-hour back trajectory plot from June 6, 2023, with fire locations, monitored surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 6, 2023 (top), and HYSPLIT 48-hour forward trajectory plot from June 4, 2023, with fire locations, monitored surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 4, 2023 (bottom).**





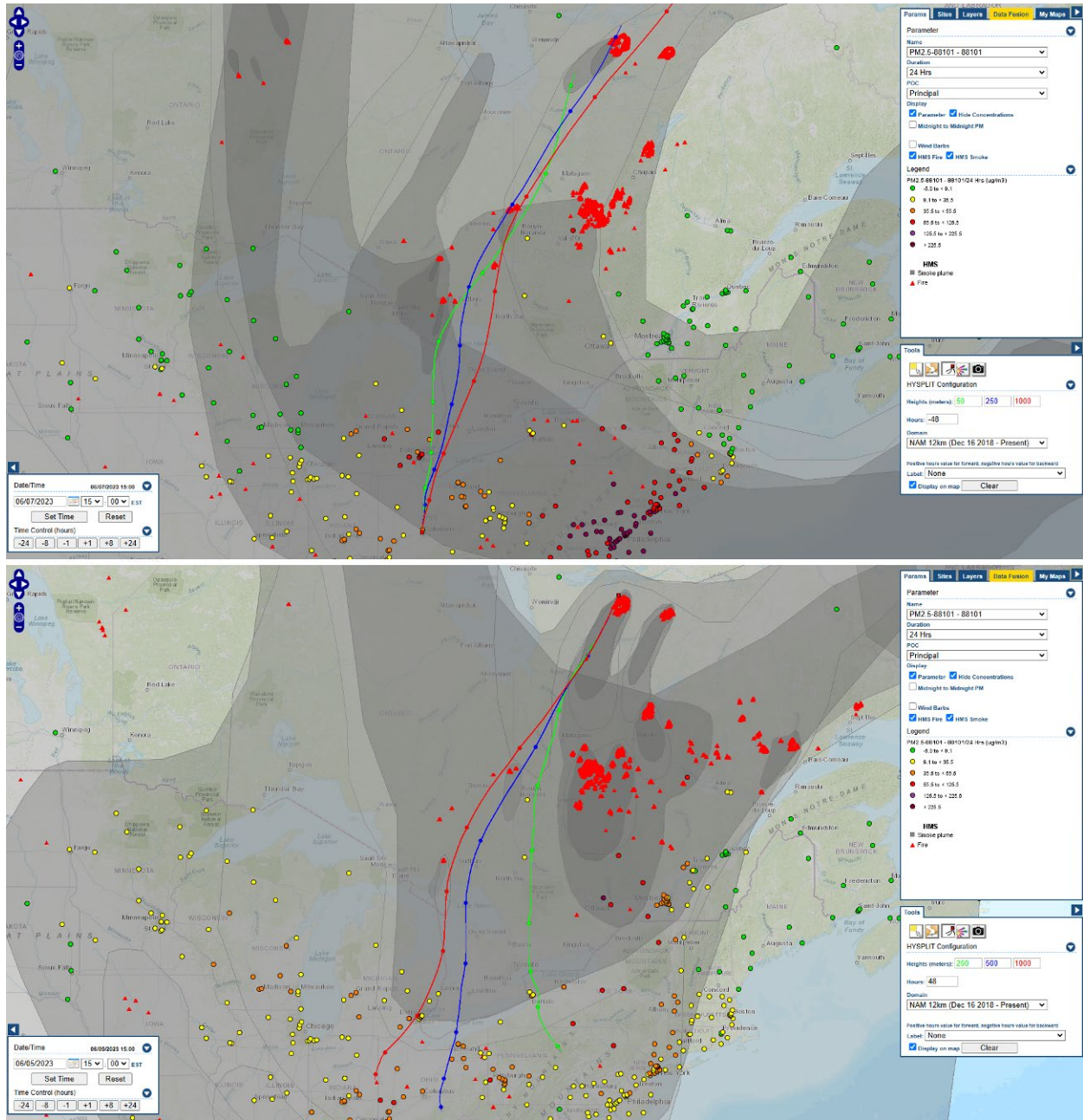
**Figure 25. MAIAC AOD imagery (left) and Terra satellite true color imagery (right) for June 6, 2023.**



### **3.1.2. June 7, 2023**

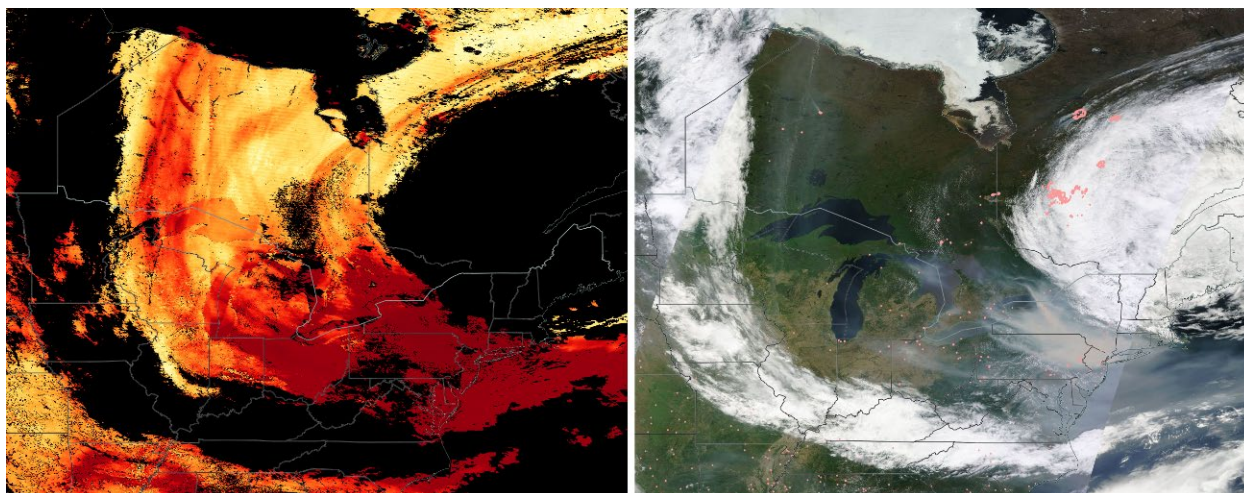
The HYSPLIT 48-hour back and forward trajectory plots show the origin and transport of the smoke plumes that caused the high surface  $PM_{2.5}$  concentrations in the Columbus, OH MSA on June 7, 2023. Figure 26 shows the HYSPLIT 48-hour back trajectory plot from June 7, overlaid on a map of fire locations, monitored 24-hour average surface  $PM_{2.5}$  concentrations, and HMS smoke polygons for June 7, as well as the HYSPLIT 48-hour forward trajectory plot from June 5 overlaid on a map of fire locations, monitored 24-hour average surface  $PM_{2.5}$  concentrations, and HMS smoke polygons for June 5. The wildfire and smoke locations 225 km (140 mi) east of Wemindji, Quebec coincide with the endpoint (at 543 meters AGL) of the 250-meter release height back trajectory from Columbus and the Columbus area is the endpoint (at 183 meters AGL) of the 500-meter release height forward trajectory from those wildfires. The coincidence of the 48-hour back and forward trajectories between the wildfire locations and the Columbus area serves as clear evidence that the smoke from these wildfires caused the high  $PM_{2.5}$  concentrations in the Columbus, OH MSA on June 7, 2023. The accompanying AOD and imagery maps for June 7 presented in Figure 27 provide further evidence that dense smoke from the Canadian wildfires was present in the Columbus, OH MSA on June 7, 2023, and that this wildfire smoke was the cause of the high concentrations of  $PM_{2.5}$  at the monitoring sites.

**Figure 26. HYSPLIT 48-hour back trajectory plot from June 7, 2023, with fire locations, monitored surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 7, 2023 (top), and HYSPLIT 48-hour forward trajectory plot from June 5, 2023, with fire locations, monitored surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 5, 2023 (bottom).**





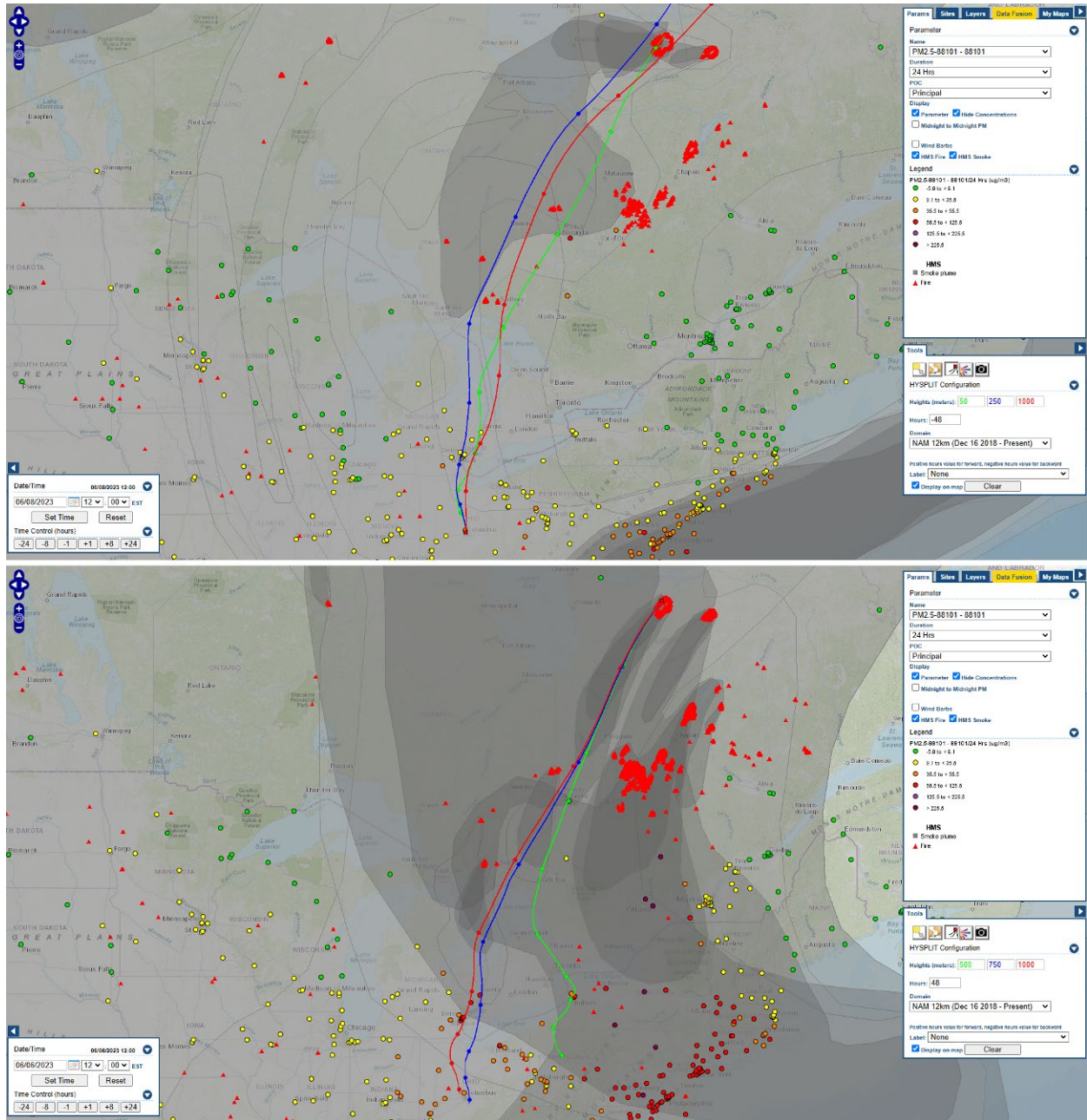
**Figure 27. MAIAC AOD imagery (left) and Terra satellite true color imagery (right) for June 7, 2023.**



### **3.1.3. June 8, 2023**

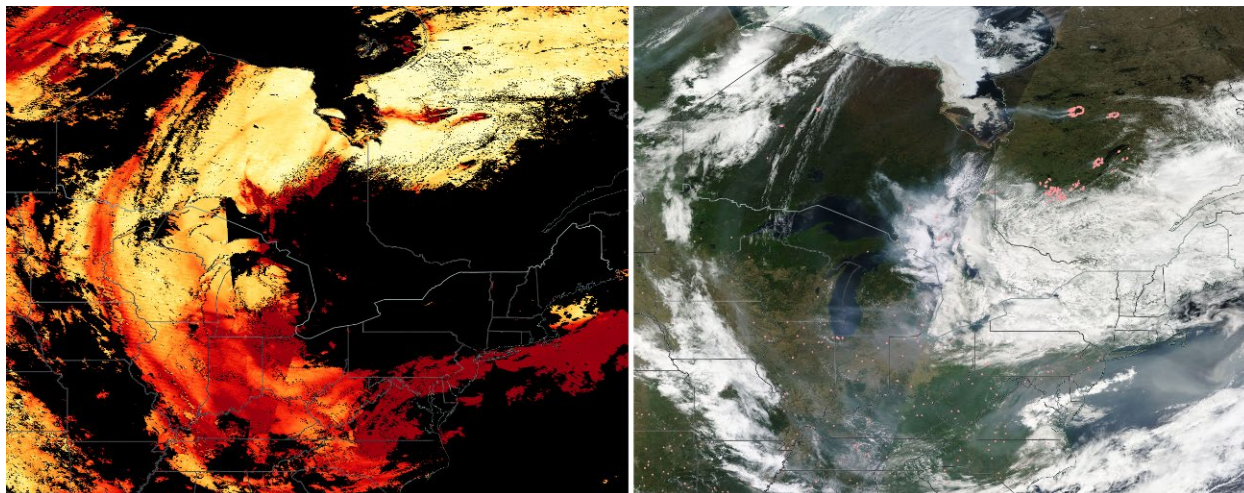
The HYSPLIT 48-hour back and forward trajectory plots show the origin and transport of the smoke plumes that caused the high surface  $PM_{2.5}$  concentrations in the Columbus, OH MSA on June 8, 2023. Figure 28 shows the HYSPLIT 48-hour back trajectory plot from June 8, overlaid on a map of fire locations, monitored 24-hour average surface  $PM_{2.5}$  concentrations, and HMS smoke polygons for June 8, as well as the HYSPLIT 48-hour forward trajectory plot from June 6 overlaid on a map of fire locations, monitored 24-hour average surface  $PM_{2.5}$  concentrations, and HMS smoke polygons for June 6. The wildfire and smoke locations 225 km (140 mi) east of Wemindji, Quebec coincide with the endpoint (at 781 meters AGL) of the 50-meter release height back trajectory from Columbus and Columbus is the endpoint (at 18 meters AGL) of the 750-meter release height forward trajectory and the endpoint (at 136 meters AGL) of the 1000-meter release height forward trajectory from those wildfires. The coincidence of the 48-hour back and forward trajectories between the wildfire locations and the Columbus area serves as clear evidence that the smoke from these wildfires caused the high  $PM_{2.5}$  concentrations in the Columbus, OH MSA on June 8, 2023. The accompanying AOD and imagery maps for June 8 presented in Figure 29 provide further evidence that dense smoke from the Canadian wildfires was present in the Columbus, OH MSA on June 8, 2023, and that this wildfire smoke was the cause of the high concentrations of  $PM_{2.5}$  at the monitoring sites.

**Figure 28. HYSPLIT 48-hour back trajectory plot from June 8, 2023, with fire locations, monitored surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 8, 2023 (top), and HYSPLIT 48-hour forward trajectory plot from June 6, 2023, with fire locations, monitored surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 6, 2023 (bottom).**





**Figure 29. MAIAC AOD imagery (left) and Terra satellite true color imagery (right) for June 8, 2023.**

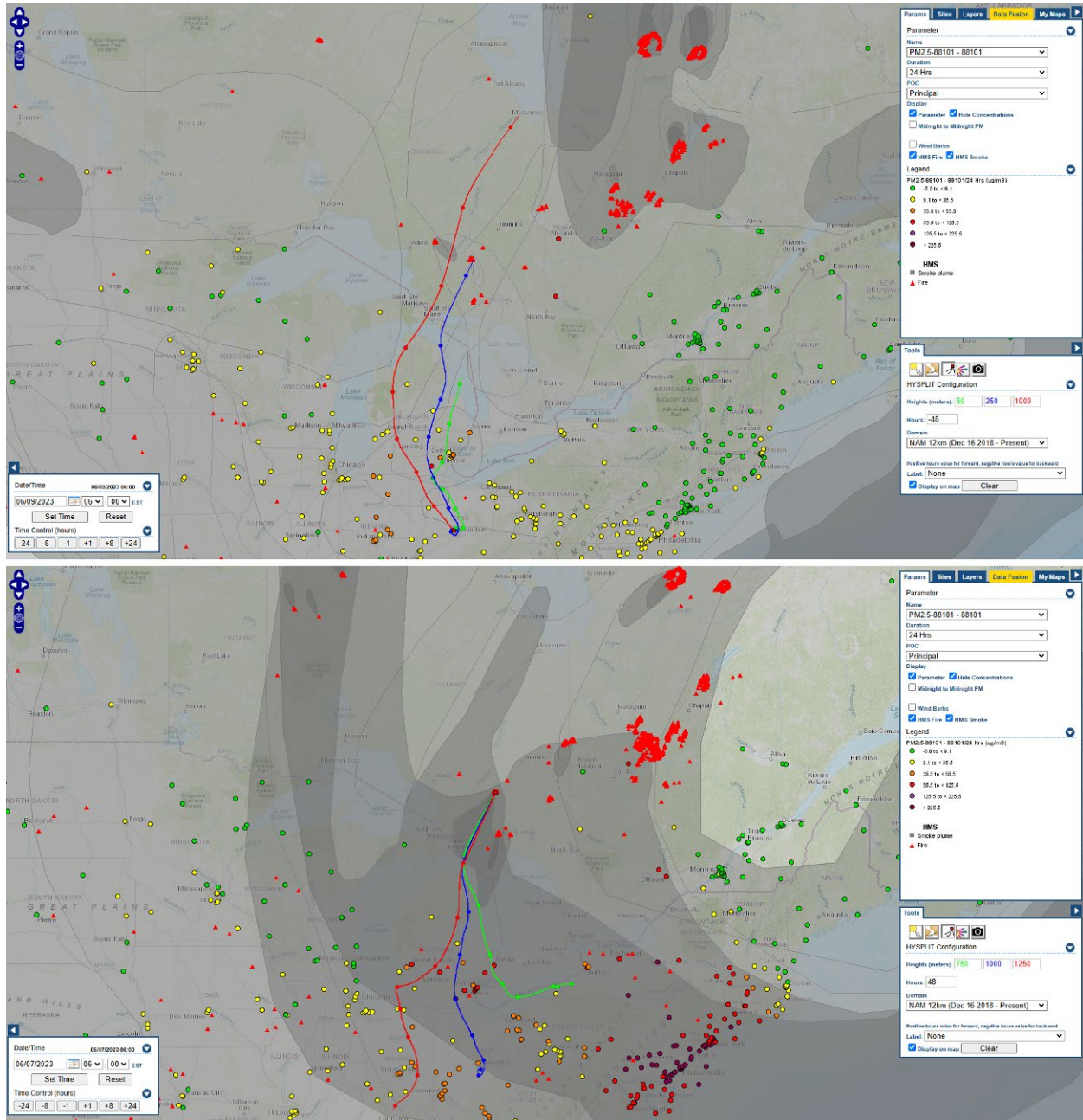


### **3.1.4. June 9, 2023**

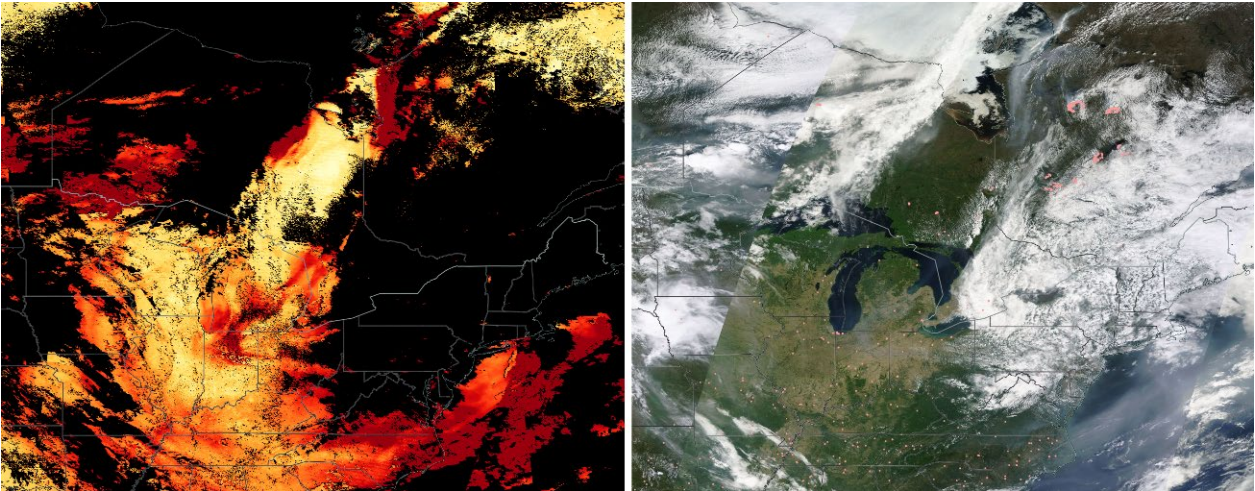
The HYSPLIT 48-hour back and forward trajectory plots show the origin and transport of the smoke plumes that caused the high surface PM<sub>2.5</sub> concentrations in the Columbus, OH MSA on June 9, 2023. Figure 30 shows the HYSPLIT 48-hour back trajectory plot from June 9, overlaid on a map of fire locations, monitored 24-hour average surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 9, as well as the HYSPLIT 48-hour forward trajectory plot from June 7 overlaid on a map of fire locations, monitored 24-hour average surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 7. The wildfire and smoke locations 120 km (75 mi) southwest of Timmins, Ontario coincide with the endpoint (at 1015 meters AGL) of the 250-meter release height back trajectory from Columbus and Columbus is the endpoint (at 227 meters AGL) of the 1000-meter release height forward trajectory from those wildfires. The coincidence of the 48-hour back and forward trajectories between the wildfire locations and the Columbus area serves as clear evidence that the smoke from these wildfires caused the high PM<sub>2.5</sub> concentrations in the Columbus, OH MSA on June 9, 2023. The accompanying AOD and imagery maps for June 9 presented in Figure 31 provide further evidence that dense smoke from the Canadian wildfires was present in the Columbus, OH MSA on June 9, 2023, and that this wildfire smoke was the cause of the high concentrations of PM<sub>2.5</sub> at the monitoring sites.



**Figure 30. HYSPLIT 48-hour back trajectory plot from June 9, 2023, with fire locations, monitored surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 9, 2023 (top), and HYSPLIT 48-hour forward trajectory plot from June 7, 2023, with fire locations, monitored surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 7, 2023 (bottom).**



**Figure 31. MAIAC AOD imagery (left) and Terra satellite true color imagery (right) for June 9, 2023.**



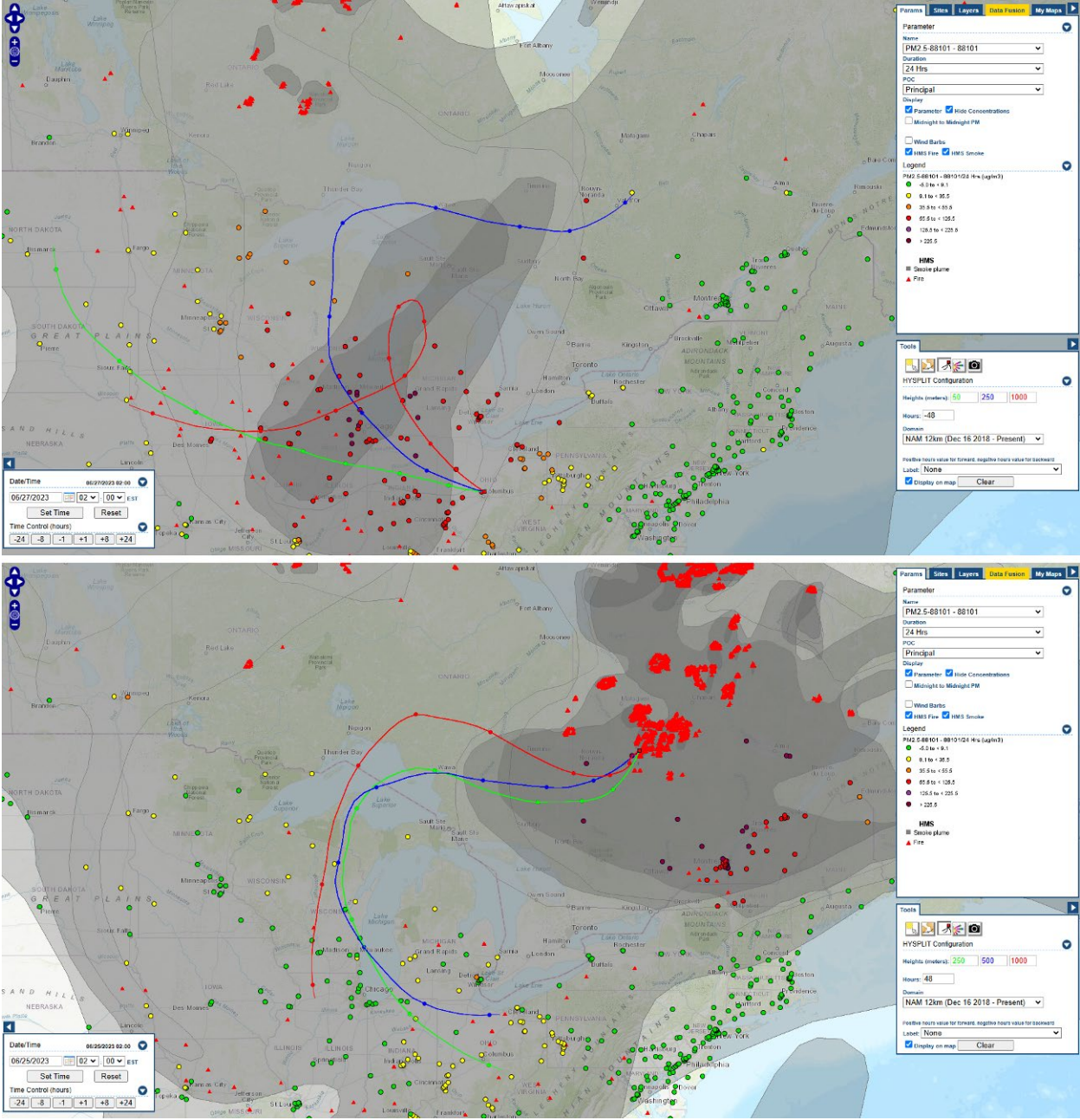
## **3.2. June 27-29, 2023 Wildfire Smoke-Driven PM<sub>2.5</sub> Episode**

### **3.2.1. June 27, 2023**

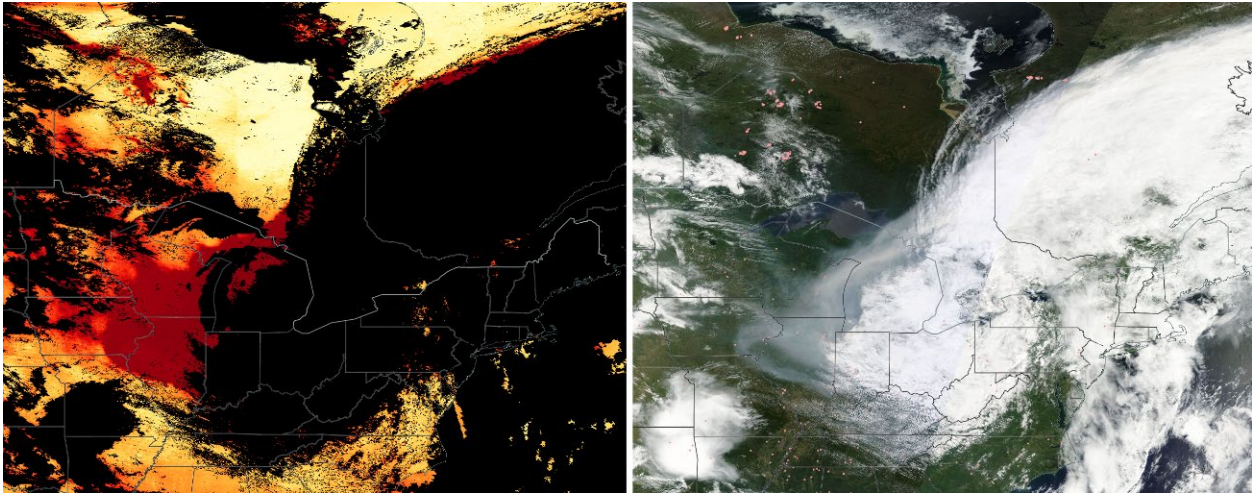
The HYSPLIT 48-hour back and forward trajectory plots show the origin and transport of the smoke plumes that caused the high surface PM<sub>2.5</sub> concentrations in the Columbus, OH MSA on June 27, 2023. Figure 32 shows the HYSPLIT 48-hour back trajectory plot from June 27, overlaid on a map of fire locations, monitored 24-hour average surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 27, as well as the HYSPLIT 48-hour forward trajectory plot from June 25 overlaid on a map of fire locations, monitored 24-hour average surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 25. The wildfire and smoke locations 75 km (47 mi) northeast of Val-d'Or, Quebec coincide with the endpoint (at 361 meters AGL) of the 250-meter release height back trajectory from Columbus and the Columbus area is the endpoint (at 452 meters AGL) of the 250-meter release height forward trajectory from those wildfires. The coincidence of the 48-hour back and forward trajectories between the wildfire locations and the Columbus area serves as clear evidence that the smoke from these wildfires caused the high PM<sub>2.5</sub> concentrations in the Columbus, OH MSA on June 27, 2023. The accompanying AOD and imagery maps for June 27 presented in Figure 33, which show wildfire smoke from Wisconsin to Indiana with heavy cloud cover above the wildfire smoke obscuring Ohio, provide further evidence that dense smoke from the Canadian wildfires was present in the Columbus, OH MSA on June 27, 2023, and that this wildfire smoke was the cause of the high concentrations of PM<sub>2.5</sub> at the monitoring sites.



**Figure 32. HYSPLIT 48-hour back trajectory plot from June 27, 2023, with fire locations, monitored surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 27, 2023 (top), and HYSPLIT 48-hour forward trajectory plot from June 25, 2023, with fire locations, monitored surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 25, 2023 (bottom).**



**Figure 33. MAIAC AOD imagery (left) and Terra satellite true color imagery (right) for June 27, 2023.**

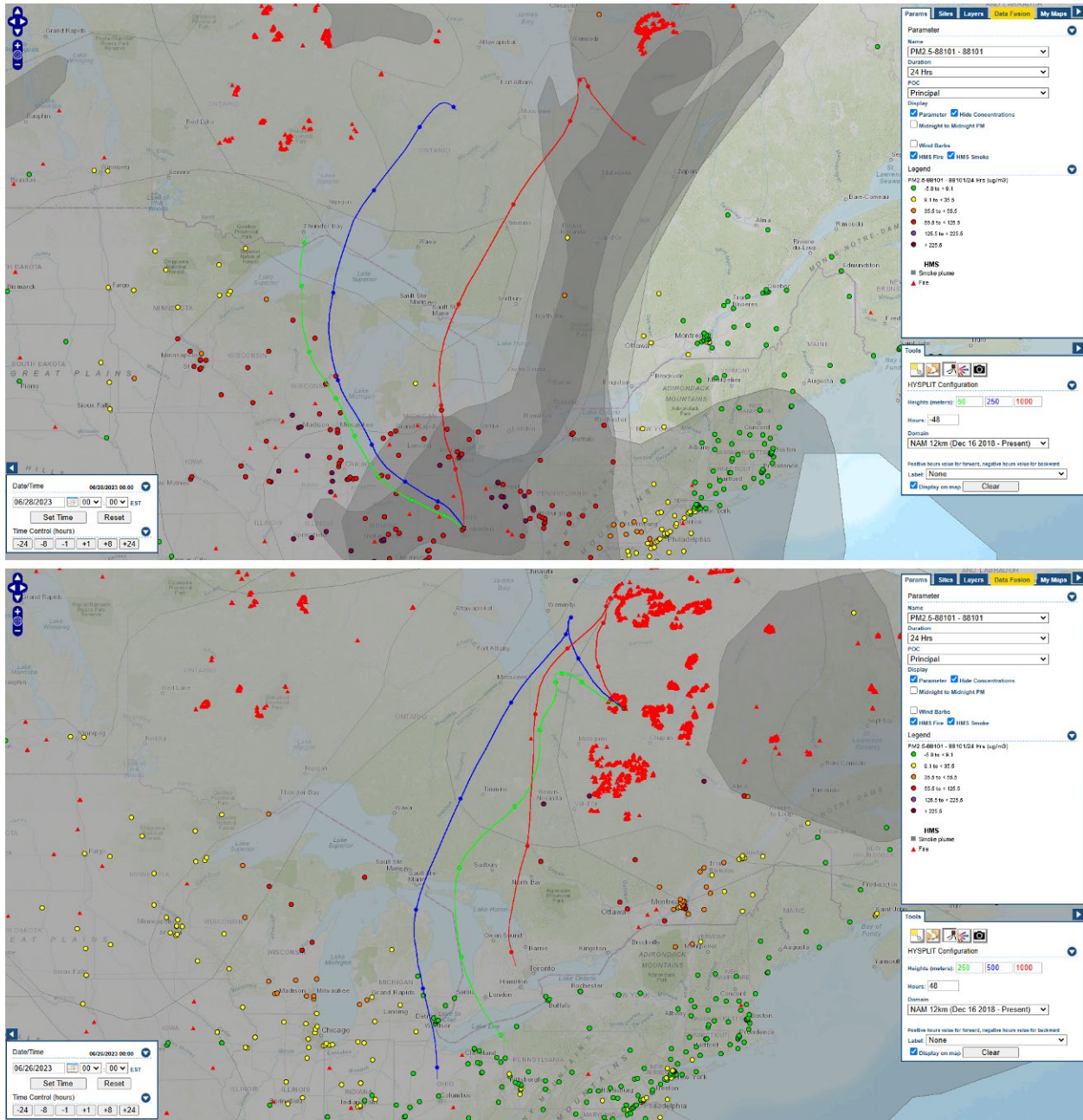


### **3.2.2. June 28, 2023**

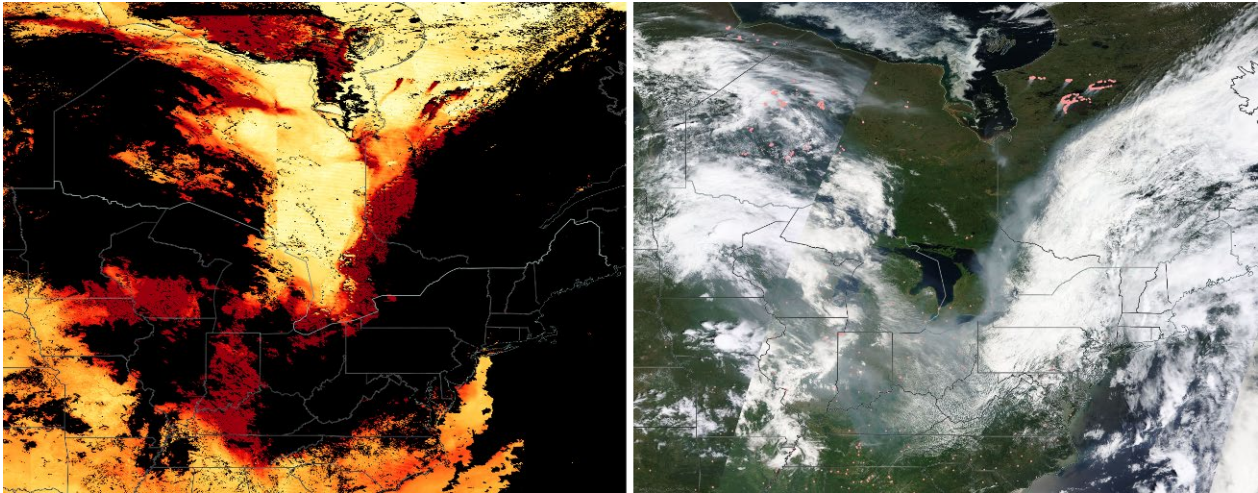
The HYSPLIT 48-hour back and forward trajectory plots show the origin and transport of the smoke plumes that caused the high surface  $PM_{2.5}$  concentrations in the Columbus, OH MSA on June 28, 2023. Figure 34 shows the HYSPLIT 48-hour back trajectory plot from June 28, overlaid on a map of fire locations, monitored 24-hour average surface  $PM_{2.5}$  concentrations, and HMS smoke polygons for June 28, as well as the HYSPLIT 48-hour forward trajectory plot from June 26 overlaid on a map of fire locations, monitored 24-hour average surface  $PM_{2.5}$  concentrations, and HMS smoke polygons for June 26. The wildfire and smoke locations 155 km (96 mi) northeast of Matagami, Quebec coincide with the endpoint (at 366 meters AGL) of the 1000-meter release height back trajectory from Columbus and the Columbus area is the endpoint (at 1113 meters AGL) of the 500-meter release height forward trajectory from those wildfires. The coincidence of the 48-hour back and forward trajectories between the wildfire locations and the Columbus area serves as clear evidence that the smoke from these wildfires caused the high  $PM_{2.5}$  concentrations in the Columbus, OH MSA on June 28, 2023. The accompanying AOD and imagery maps for June 28 presented in Figure 35, although slightly obscured by moderate cloud cover, show high AOD values as well as visible haze and smoke over portions of central and northern Ohio, providing further evidence that dense smoke from the Canadian wildfires was present in the Columbus, OH MSA on June 28, 2023, and that this wildfire smoke was the cause of the high concentrations of  $PM_{2.5}$  at the monitoring sites.



**Figure 34. HYSPLIT 48-hour back trajectory plot from June 28, 2023, with fire locations, monitored surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 28, 2023 (top), and HYSPLIT 48-hour forward trajectory plot from June 26, 2023, with fire locations, monitored surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 26, 2023 (bottom).**



**Figure 35. MAIAC AOD imagery (left) and Terra satellite true color imagery (right) for June 28, 2023.**



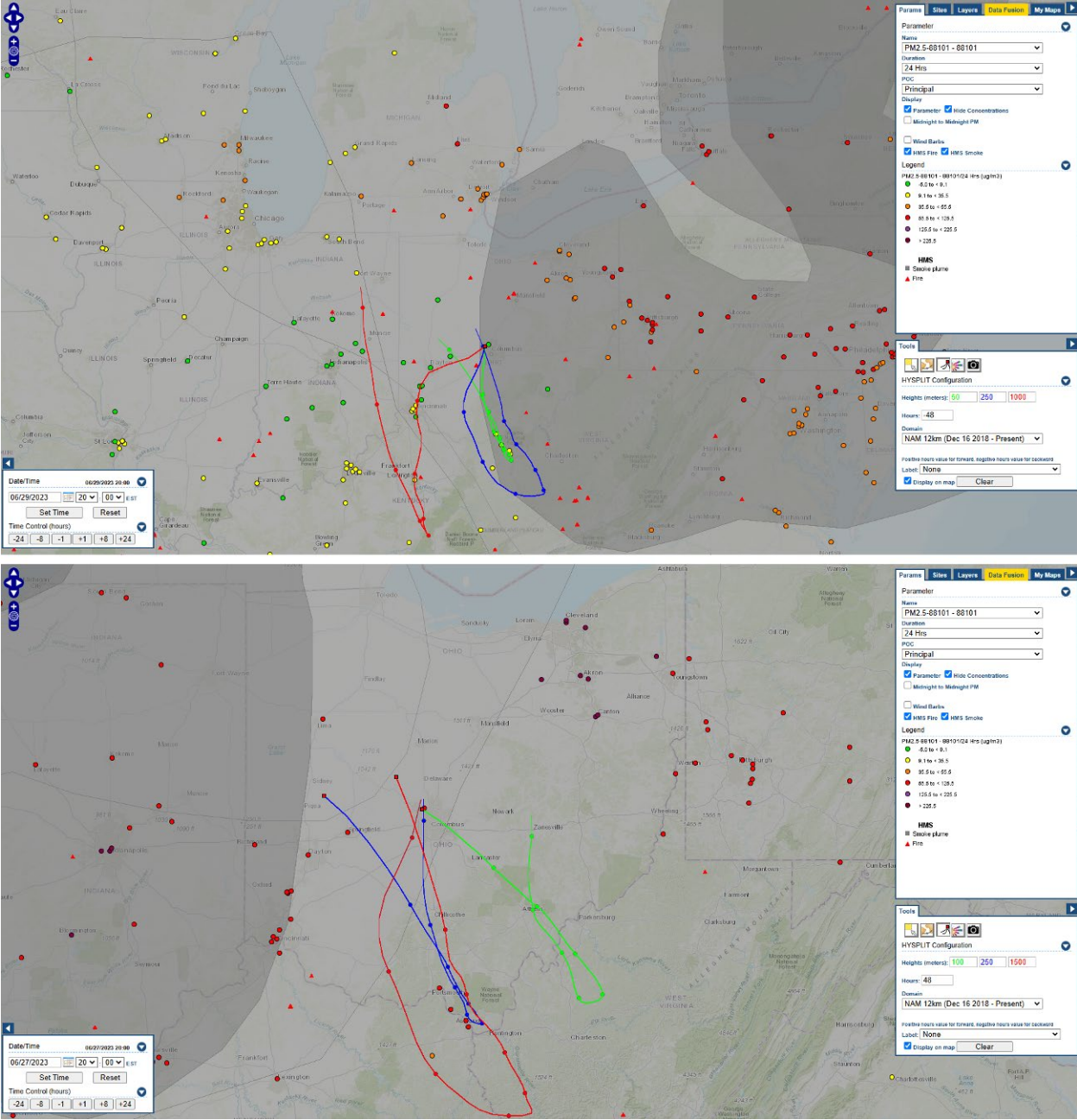
### **3.2.3. June 29, 2023**

The HYSPLIT 48-hour back and forward trajectory plots show the origin and transport of the smoke plumes that caused the high surface  $PM_{2.5}$  concentrations in the Columbus, OH MSA on June 29, 2023. Figure 36 shows the HYSPLIT 48-hour back trajectory plot from June 29, overlaid on a map of fire locations, monitored 24-hour average surface  $PM_{2.5}$  concentrations, and HMS smoke polygons for June 29, as well as the HYSPLIT 48-hour forward trajectory plot from June 27 overlaid on a map of fire locations, monitored 24-hour average surface  $PM_{2.5}$  concentrations, and HMS smoke polygons for June 27. As previously shown, wildfire smoke was already present in central Ohio on June 27, when a stalled air mass over most of Ohio caused the wildfire smoke in central Ohio to slowly circulate southeast toward the Ohio River and return to central Ohio. The 50-meter release height back trajectory from Columbus originated near Piqua at a height of 260 meters AGL, and the 250-meter release height forward trajectory from the location near Piqua affected by wildfire smoke ended in Columbus at a height of 45 meters AGL. The 250-meter release height back trajectory from Columbus originated near Marysville at a height of 1358 meters AGL, and the 1500-meter release height forward trajectory from the location near Marysville affected by wildfire smoke ended in Columbus at a height of 292 meters AGL. Additionally, the 100-meter release height forward trajectory from Columbus ended north of Zanesville on June 29, just 90 km (56 mi) west of the wildfire smoke affecting Columbus on June 27, illustrating the extremely slow-moving nature of the air mass over central Ohio containing the wildfire smoke. The coincidence of the 48-hour back and forward trajectories between the central Ohio locations

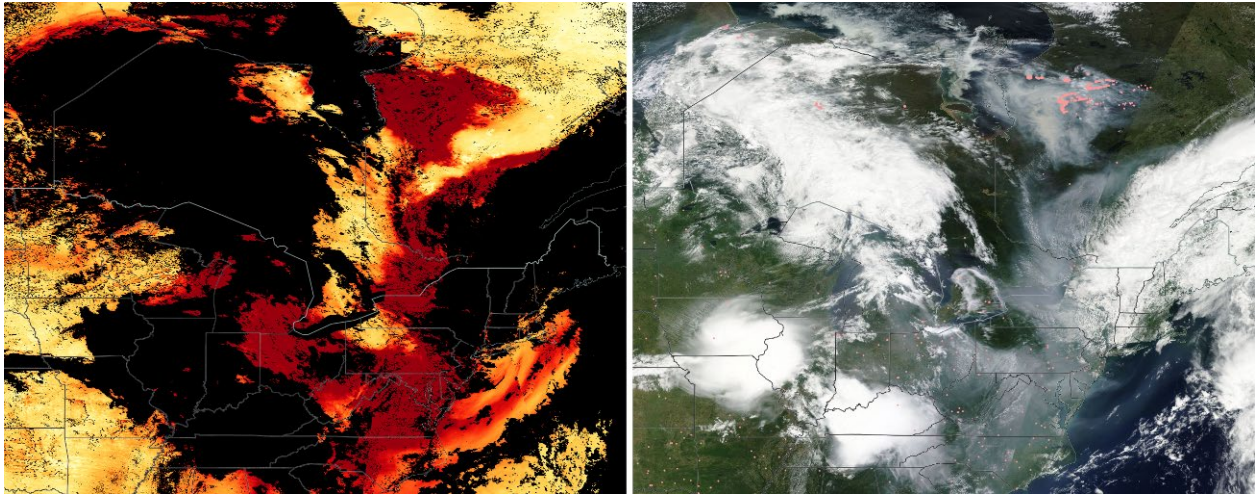
known to be affected by wildfire smoke on June 27 and the Columbus area serves as clear evidence that the smoke from these wildfires caused the high PM<sub>2.5</sub> concentrations in the Columbus, OH MSA on June 29, 2023. The accompanying AOD and imagery maps for June 29 presented in Figure 37, which show high AOD values as well as visible haze and smoke over most of Ohio, provide further evidence that dense smoke from the Canadian wildfires was present in the Columbus, OH MSA on June 29, 2023, and that this wildfire smoke was the cause of the high concentrations of PM<sub>2.5</sub> at the monitoring sites.



**Figure 36. HYSPLIT 48-hour back trajectory plot from June 29, 2023, with fire locations, monitored surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 29, 2023 (top), and HYSPLIT 48-hour forward trajectory plot from June 27, 2023, with fire locations, monitored surface PM<sub>2.5</sub> concentrations, and HMS smoke polygons for June 27, 2023 (bottom).**



**Figure 37. MAIAC AOD imagery (left) and Terra satellite true color imagery (right) for June 29, 2023.**

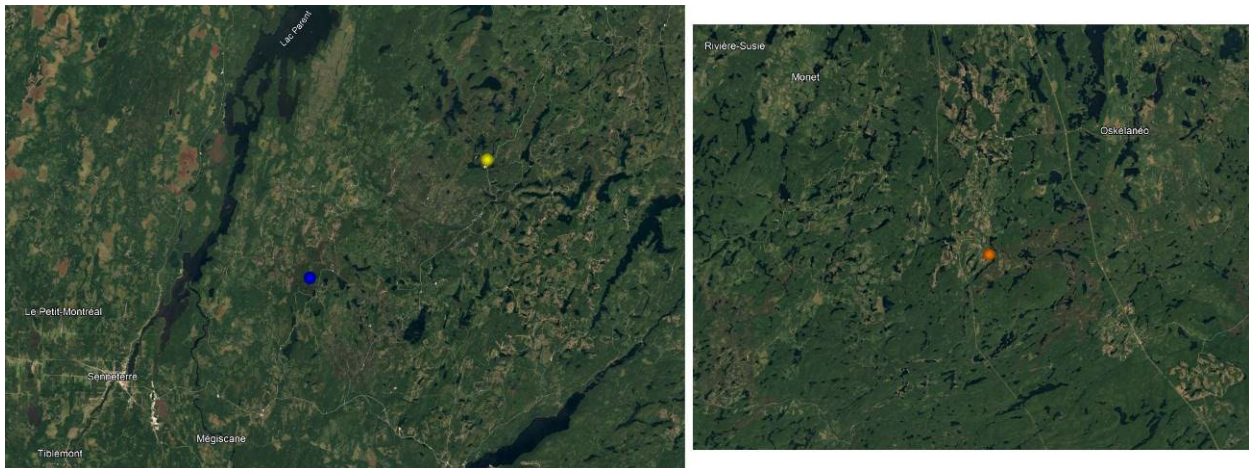




#### **4. Not Reasonably Controllable or Not Reasonably Preventable**

40 CFR 50.14 (c)(3)(iv)(D) requires a demonstration that the event was both not reasonably controllable and not reasonably preventable. For wildfires, it is presumed according to 40 CFR 50.14(b)(4) that wildfires on wildland will satisfy both factors of the not reasonably controllable or not reasonably preventable unless there is evidence that demonstrates otherwise. 40 CFR 50.1(n) defines a wildfire as “any fire started by an unplanned ignition caused by lightning; volcanoes; other acts of nature; unauthorized activity; or accidental, human-caused actions, or a prescribed fire that has developed into a wildfire”. 40 CFR 50.1(o) defines wildland as “an area in which human activity and development are essentially non-existent, except for roads, railroads, power lines, and similar transportation facilities. Structures, if any, are widely scattered”. As seen from the satellite imagery shown in Figures 38, 39, and 40, the areas in which the June 2023 wildfires producing smoke that affected the Columbus, OH MSA occurred are wildlands.

**Figure 38. Satellite imagery of the wildland areas where wildfires producing smoke that affected the Columbus, OH MSA occurred, showing the wildfire locations 75 km (47 mi) northeast of Val-d’Or (left, blue dot), 100 km (62 mi) northeast of Val-d’Or (left, yellow dot), and 180 km (112 mi) east of Val-d’Or (right, orange dot).**



**Figure 39. Satellite imagery of the wildland areas where wildfires producing smoke that affected the Columbus, OH MSA occurred, showing the wildfire locations 120 km (75 mi) southwest of Timmins (left, cyan dot) and 120 km (75 mi) northwest of Trois-Rivières (right, red dot).**



**Figure 40. Satellite imagery of the wildland areas where wildfires producing smoke that affected the Columbus, OH MSA occurred, showing the wildfire locations 225 km (140 mi) east of Wemindji (left, green dot) and 155 km (96 mi) northeast of Matagami (right, purple dot).**



Extensive wildfire activity occurred on wildlands across Canada during the late spring and summer of 2023. The Canadian government estimates that on average 67% of the area burned in Canada from wildfires is due to lightning-caused fires<sup>30</sup>. CIFCC<sup>31</sup> reported that on June 1, 2023, “a major lightning strike hit Quebec, igniting 182 forest fires in a single day”.

<sup>30</sup> <https://natural-resources.canada.ca/our-natural-resources/forests/wildland-fires-insects-disturbances/forest-fires/fire-behaviour/13145>

<sup>31</sup> [https://cifcc.ca/sites/default/files/2024-03/03.07.24\\_CIFCC\\_2023CanadaReport%20%281%29.pdf](https://cifcc.ca/sites/default/files/2024-03/03.07.24_CIFCC_2023CanadaReport%20%281%29.pdf)

As the June 2023 fires in Canada were reported to have been started by unplanned ignitions caused by lightning, they are considered wildfires as defined in 40 CFR 50.1(n). Since these wildfires occurred predominantly on wildlands, they meet the not reasonably controllable and not reasonably preventable criterion in the Exceptional Events Rule. The wildfires burning in June 2023 could not have been prevented and could not have been controlled by state or federal natural resources managers in the U.S. The excessive wildfire smoke emissions that contributed to monitored violations of the 2024 revised annual PM<sub>2.5</sub> NAAQS in the Columbus, OH MSA on June 6-9, 2023, and June 27-29, 2023, were caused by the wildfires and not the result of emissions from anthropogenic sources.

## **5. Human Activity Unlikely to Recur at a Particular Location or Natural Event**

40 CFR 50.14(c)(3)(iv)(E) requires a demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event. 40 CFR 50.1(k) defines a natural event as “an event and its resulting emissions, which may recur at the same location, in which human activity plays little or no direct causal role”, and further states that for purposes of this definition, “anthropogenic sources that are reasonably controlled shall be considered to not play a direct role in causing emissions”. Additionally, 40 CFR 50.1(n) states that a “wildfire that predominantly occurs on wildland is a natural event”. As described in this document, the origin and evolution of the June 2023 wildfires occurred predominantly across wildlands in Quebec and eastern Ontario, Canada.

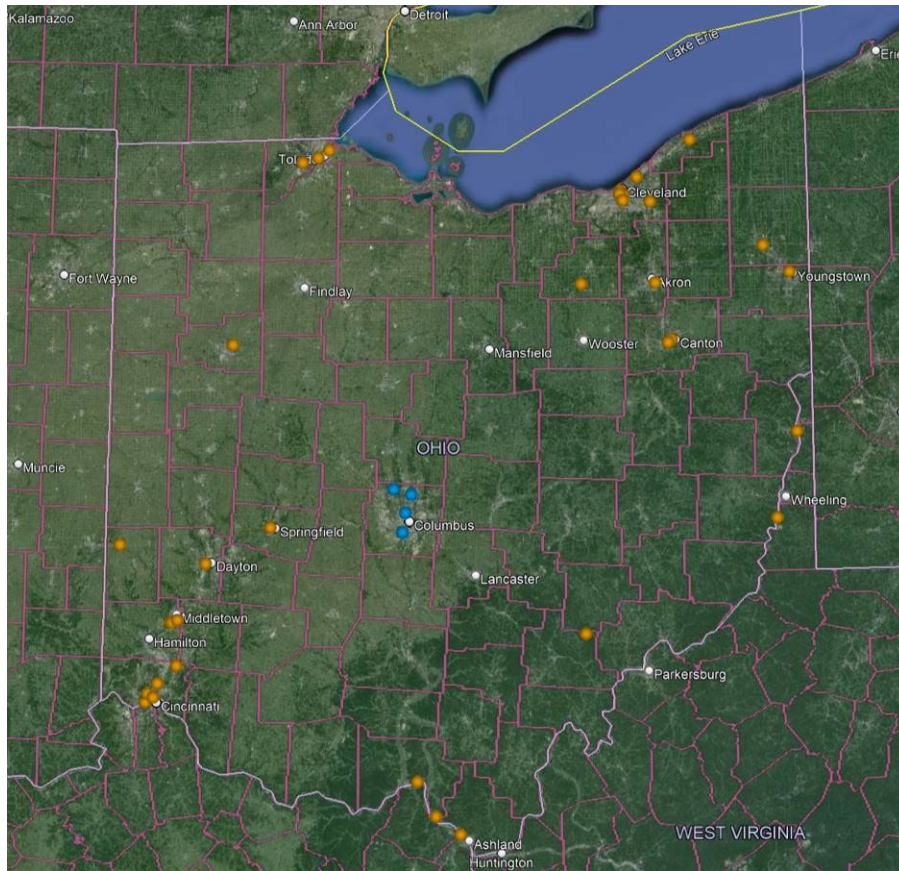
Based on the documentation provided in this demonstration, the June 2023 events qualify as wildfires because lightning most likely caused the unplanned wildfire events. As the wildfire events that are subject of this demonstration occurred on wildlands and were caused by lightning, they were natural and should be considered for treatment as exceptional events.



## 6. Public Notification

Ohio EPA maintains a public alert system as well as publicly available information via the Ohio EPA website<sup>32</sup> to keep residents informed of potential wildfire smoke impacts. As required by 40 CFR Part 58, Appendix D, Ohio EPA and partner public health and air pollution control agencies in the state install, operate, and maintain a network of instruments to measure ambient air quality at monitoring sites across the state. Figures 41, 42, and 43 show the locations of active PM<sub>2.5</sub> monitoring sites in the state of Ohio, in the Columbus, OH MSA, and in the city of Columbus, respectively.

**Figure 41. Map of active PM<sub>2.5</sub> monitoring sites in the state of Ohio.**

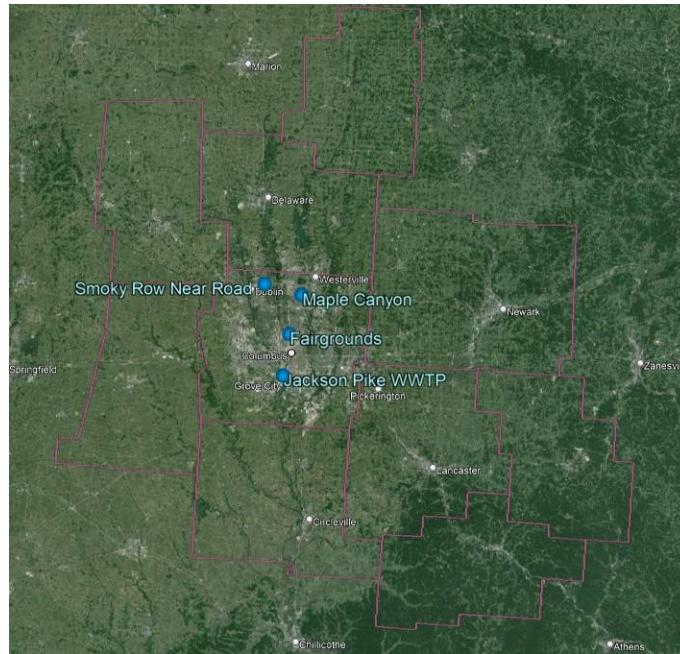


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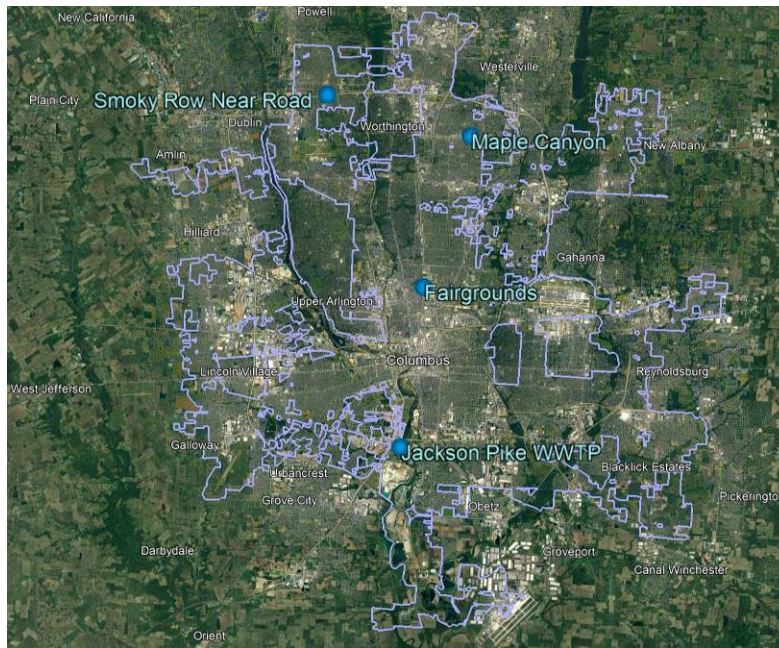
<sup>32</sup> <https://epa.ohio.gov>



**Figure 42. Map of active PM<sub>2.5</sub> monitoring sites in the Columbus, OH MSA.**



**Figure 43. Map of active PM<sub>2.5</sub> monitoring sites in the city of Columbus, OH.**



The Smoky Row Near Road, Fairgrounds, Jackson Pike WWTP, and Maple Canyon monitoring sites in the Columbus, OH MSA were all operational and collected ambient PM<sub>2.5</sub> measurements throughout 2023, including during the June 6-9, 2023 and June 27-29, 2023

wildfire smoke-driven PM<sub>2.5</sub> episodes. Ohio EPA reported these data in real time to U.S. EPA for inclusion in the AirNow system. The ambient PM<sub>2.5</sub> data from the Smoky Row Near Road, Fairgrounds, Jackson Pike WWTP, and Maple Canyon monitoring sites were also publicly accessible through the Ohio EPA Division of Air Pollution Control website<sup>33</sup>.

Data collected from the network of monitoring sites are used by Ohio EPA and partner agencies, such as public health departments, local air pollution control agencies, and metropolitan planning organizations, such as the Mid-Ohio Regional Planning Commission (MORPC) to notify the public when air pollution may reach levels that are potentially harmful to public health. Table 7 lists the public notices issued by Ohio EPA and other agencies regarding the wildfire smoke-driven PM<sub>2.5</sub> episode from June 6-9, 2023. Table 8 lists the public notices issued by Ohio EPA and other agencies regarding the wildfire smoke-driven PM<sub>2.5</sub> episode from June 27-29, 2023.

**Table 7. Public notices issued regarding the wildfire smoke-driven PM<sub>2.5</sub> episodes impacting the Columbus, OH MSA from June 6-9, 2023.**

Date Issued	Date(s) Covered	Issued By	Counties Covered	Type of Notice
June 5, 2023	June 6, 2023	MORPC	Delaware, Fairfield, Franklin, Licking	Air Quality Alert <sup>34</sup>
June 6, 2023	June 7, 2023	MORPC	Delaware, Fairfield, Franklin, Licking	Air Quality Alert <sup>35</sup>
June 7, 2023	June 7, 2023	Ohio EPA	ALL (Statewide)	Statewide Air Quality Advisory <sup>36</sup>
June 7, 2023	June 8, 2023	MORPC	Delaware, Fairfield, Franklin, Licking	Air Quality Alert <sup>37</sup>
June 8, 2023	June 8, 2023	Ohio EPA	ALL (Statewide)	Statewide Air Quality Advisory <sup>38</sup>

<sup>33</sup> <https://epa.ohio.gov/divisions-and-offices/air-pollution-control/reports-and-data/airohio-air-monitoring-data>

<sup>34</sup> <https://web.archive.org/web/20230706133231/https://www.morpc.org/news/air-quality-alert-issued-for-june-6-im>

<sup>35</sup> <https://web.archive.org/web/20230706133147/https://www.morpc.org/news/air-quality-alert-extended-for-june-7-in-central-ohio>

<sup>36</sup> <https://epa.ohio.gov/about/media-center/news/statewide-air-quality-advisory>

<sup>37</sup> [https://mcusercontent.com/2cb2461e42ec60600137325d2/files/38e33cec-4812-bb9f-93f4-5f620b960b6f/6.8.23\\_AQ\\_Alert\\_PM2.5\\_extended\\_press\\_release\\_final.pdf](https://mcusercontent.com/2cb2461e42ec60600137325d2/files/38e33cec-4812-bb9f-93f4-5f620b960b6f/6.8.23_AQ_Alert_PM2.5_extended_press_release_final.pdf)

**Table 8. Public notices issued regarding the wildfire smoke-driven PM<sub>2.5</sub> episodes impacting the Columbus, OH MSA from June 27-29, 2023.**

<b>Date Issued</b>	<b>Date(s) Covered</b>	<b>Issued By</b>	<b>Counties Covered</b>	<b>Type of Notice</b>
June 27, 2023	June 27, 2023 & June 28, 2023	MORPC	Delaware, Fairfield, Franklin, Licking	Air Quality Alert <sup>39</sup>
June 28, 2023	June 28, 2023	Ohio EPA	ALL (Statewide)	Statewide Air Quality Advisory <sup>40</sup>
June 28, 2023	June 29, 2023	MORPC	Delaware, Fairfield, Franklin, Licking	Air Quality Alert <sup>41</sup>
June 29, 2023	June 29, 2023	Ohio EPA	ALL (Statewide)	Statewide Air Quality Advisory <sup>42</sup>
June 29, 2023	June 30, 2023	MORPC	Delaware, Fairfield, Franklin, Licking	Air Quality Alert <sup>43</sup>

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<sup>38</sup> <https://epa.ohio.gov/about/media-center/news/statewide-air-quality-advisory-june-8>

<sup>39</sup> <https://web.archive.org/web/20230706132044/https://www.morpc.org/news/air-quality-alert-issued-for-june-27-and-28-in-central-ohio>

<sup>40</sup> <https://epa.ohio.gov/about/media-center/news/statewide-air-quality-advisory-june-28>

<sup>41</sup> <https://web.archive.org/web/20230706132022/https://www.morpc.org/news/air-quality-alert-extended-for-june-29-in-central-ohio-2>

<sup>42</sup> <https://epa.ohio.gov/about/media-center/news/statewide-air-quality-advisory-june-29>

<sup>43</sup> <https://web.archive.org/web/20230706131955/https://www.morpc.org/news/air-quality-alert-extended-for-june-30-in-central-ohio>

## **7. Public Participation**

In accordance with the requirements of 40 CFR 50.14(c)(2)(i), on September 10, 2024, Ohio formally notified U.S. EPA of its intent to request the exclusion of data due to exceptional events. A copy of the initial notification form submitted to U.S. EPA regarding exceptional events in the Columbus, OH MSA is included as Appendix A. Ohio published solicitation for public comment concerning the draft Exceptional Events Demonstration for 2023 PM<sub>2.5</sub> Episodes in the Columbus, OH Metropolitan Statistical Area on November 15, 2024. The public comment period closed on December 16, 2024. Appendix B includes a copy of the public notice, a copy of the public comments received, and a copy of Ohio's responses to the public comments received.



## **8. Summary**

This exceptional events demonstration shows that wildfires in Canada adversely affected ambient PM<sub>2.5</sub> concentrations measured by monitoring sites in the Columbus, OH MSA from June 6-9 and June 27-29, 2023. The ambient PM<sub>2.5</sub> concentrations measured by the Smoky Row Near Road (39-049-0038) site on June 6, June 7, June 8, June 9, June 27, June 28, and June 29, 2023 have been shown to have contributed to a monitored violation of the 2024 revised annual PM<sub>2.5</sub> NAAQS, and it has been demonstrated that the exclusion of the ambient PM<sub>2.5</sub> concentrations measured by the Smoky Row Near Road monitoring site on these dates would result in a valid 2021-2023 annual PM<sub>2.5</sub> design value that is at or below the 2024 revised annual PM<sub>2.5</sub> NAAQS value of 9.0 µg/m<sup>3</sup>, proving regulatory significance. Ohio EPA therefore requests the exclusion of the ambient PM<sub>2.5</sub> concentrations measured at the Smoky Row Near Road monitoring site on June 6, June 7, June 8, June 9, June 27, June 28, and June 29, 2023 from regulatory determinations, including calculations of annual PM<sub>2.5</sub> design values.

Additionally, the wildfire smoke from these regulatorily significant events was shown to have impacted ambient PM<sub>2.5</sub> concentrations measured at the Fairgrounds (39-049-0034) monitoring site on three dates (June 8, June 9, and June 29, 2023), at the Jackson Pike WWTP (39-049-0040) monitoring site on one date (June 8, 2023), and at the Maple Canyon (39-049-0081) monitoring site on two dates (June 8 and June 29, 2023). Ohio EPA is also requesting the exclusion of these data from regulatory determinations, including calculations of annual PM<sub>2.5</sub> design values for these monitoring sites.

This exceptional events demonstration includes all the required elements of wildfire smoke-driven PM<sub>2.5</sub> exceptional events demonstrations as described in the Exceptional Events Rule. These included elements meet all applicable requirements of the Exceptional Events Rule and clearly demonstrate that wildfire smoke from Canada had unprecedented impacts on ambient PM<sub>2.5</sub> concentrations in the Columbus, OH MSA from June 6-9 and June 27-29, 2023.