



# **Environmental Protection Agency**

## **Ohio's Exceptional Events Demonstration for 2023 Wildfire- Related Ozone Episodes in Cuyahoga County and Lake County**

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

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## **1. Introduction**

### ***1.1. Background***

Ground-level ozone is formed via a chain of photochemical reactions that begins with the photolysis of nitrogen dioxide (NO<sub>2</sub>). Photolysis of a molecule of NO<sub>2</sub> produces a nitrogen oxide (NO) molecule and a free oxygen radical. The free oxygen radical reacts with oxygen (O<sub>2</sub>) in the air to produce ozone (O<sub>3</sub>). Ozone itself can be photolyzed to produce excited singlet oxygen atoms, which react with water vapor in the air to form hydroxyl radicals. Meanwhile, both volatile organic compounds (VOCs) and carbon monoxide (CO) react with these hydroxyl radicals to form peroxy and other radicals capable of reacting with NO to regenerate NO<sub>2</sub>, which can then undergo photolysis as the cycle of ozone-forming reactions continues. Because NO<sub>2</sub>, CO, and VOCs enhance ground-level ozone formation, they are often collectively referred to as ozone precursors.

The 1990 Clean Air Act (CAA) Amendments require the United States Environmental Protection Agency (U.S. EPA) to set National Ambient Air Quality Standards (NAAQS) for certain pollutants considered harmful to public health and the environment, including ozone. In 2015, U.S. EPA established revisions to the primary and secondary NAAQS for ozone, thereby replacing the 2008 ozone standards. The 2015 ozone NAAQS established a primary and secondary 8-hour ozone standard of 0.070 parts per million (ppm), equivalent to 70 parts per billion (ppb), with an effective date of December 28, 2015 (80 FR 65292).

The CAA defines five ozone nonattainment area classifications based on severity for areas that exceed the NAAQS. The nonattainment area classifications are as follows (in order of increasing severity): marginal, moderate, serious, severe, and extreme. The U.S. EPA “Air Quality Designations for the 2015 Ozone National Ambient Air Quality Standards” and “Additional Air Quality Designations for the 2015 Ozone National Ambient Air Quality Standards” rules designated nonattainment and attainment/unclassifiable areas nationwide effective January 16, 2018 (82 FR 54232), and August 3, 2018 (83 FR 25776), respectively. On March 9, 2018, U.S. EPA published the “Implementation of the 2015 National Ambient Air Quality Standards for Ozone: Nonattainment Area Classifications Approach” rule which established the air quality thresholds for classification categories that are assigned to all areas designated nonattainment for the 2015 ozone NAAQS according to the “percent-above-the-standard” methodology (83 FR 10376).

Effective August 3, 2018, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, and Summit counties in Ohio were grouped into the Cleveland, OH 2015 Ozone Nonattainment Area,

which was designated as marginal nonattainment. As part of the initial designation as marginal nonattainment, the Cleveland, OH 2015 Ozone Nonattainment Area was required to attain the 2015 ozone NAAQS by the applicable attainment date of August 3, 2021. However, the Cleveland, OH 2015 Ozone Nonattainment Area did not attain the 2015 ozone NAAQS by this date and was reclassified to moderate nonattainment with an effective date of November 7, 2022, along with a newly applicable attainment date of August 3, 2024 (87 FR 60897). The Cleveland, OH 2015 Ozone Nonattainment Area did not attain the 2015 ozone NAAQS by this attainment date and was reclassified to serious nonattainment with an effective date of January 16, 2025, along with a newly applicable attainment date of August 3, 2027 (89 FR 101901).

The air quality in Cuyahoga County, OH and Lake County, OH was impacted from June to August 2023 by smoke and ozone precursors 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 ozone precursors from these fires resulted in ozone pollution episodes across the region that had significant health and regulatory implications. One of the regulatory impacts of these wildfire-related pollutants was the effect on air quality design values for areas in the Great Lakes region, including the Cleveland, OH 2015 Ozone Nonattainment Area. This exceptional events demonstration focuses on four ozone monitoring sites in the Cleveland, OH 2015 Ozone Nonattainment Area that were impacted by these regulatorily significant wildfire-related ozone episodes: the District 6 (39-035-0034) monitoring site in Cuyahoga County, the Eastlake (39-085-0003) monitoring site in Lake County, the GT Craig NCore PAMS (39-035-0060) monitoring site in Cuyahoga County, and the Painesville (39-085-0007) monitoring site in Lake County.

### ***1.2. Demonstration of Regulatory Significance of Exceptional Events***

Table 1 shows the three dates in 2023 affected by regulatorily significant wildfire-related ozone episodes that, if excluded from the three-year (2023-2025) ozone design value calculation, would result in a design value for the District 6 (39-035-0034) monitoring site in Cuyahoga County that attains the 2015 ozone NAAQS. All three dates have been tentatively treated as Tier 3 category days after preliminary discussions with U.S. EPA, and the three daily maximum 8-hour average (MDA8) ozone concentrations rank as the 2<sup>nd</sup>, 6<sup>th</sup>, and 8<sup>th</sup> highest observed concentration days at this monitoring site in the 2020-2024 period. These three days in 2023 were affected by two regulatorily significant wildfire-related ozone episodes on June 1-2 and June 29, respectively. Figure 1 shows the MDA8 ozone concentrations from

2020-2024 measured at the District 6 (39-035-0034) monitoring site in Cuyahoga County and identifies the values observed on the three dates in 2023 (June 1, June 2, and June 29) affected by regulatorily significant wildfire-related ozone episodes.

**Table 1. Data from the District 6 (39-035-0034) monitoring site being requested for exclusion due to regulatorily significant wildfire-related ozone episodes.**

Date of Event	Daily Maximum 8-Hour Average Ozone Concentration (ppb)	5-Year Percentile	5-Year Rank
June 1, 2023	75	99.32	8
June 2, 2023	79	99.49	6
June 29, 2023	87	99.92	2

**Figure 1. Time series plot of MDA8 ozone concentration data for the District 6 (39-035-0034) monitoring site in Cuyahoga County from 2020-2024, with the data points requested for exclusion that were affected by the June 1-2 and June 29 regulatorily significant wildfire-related ozone episodes in 2023 labeled.**

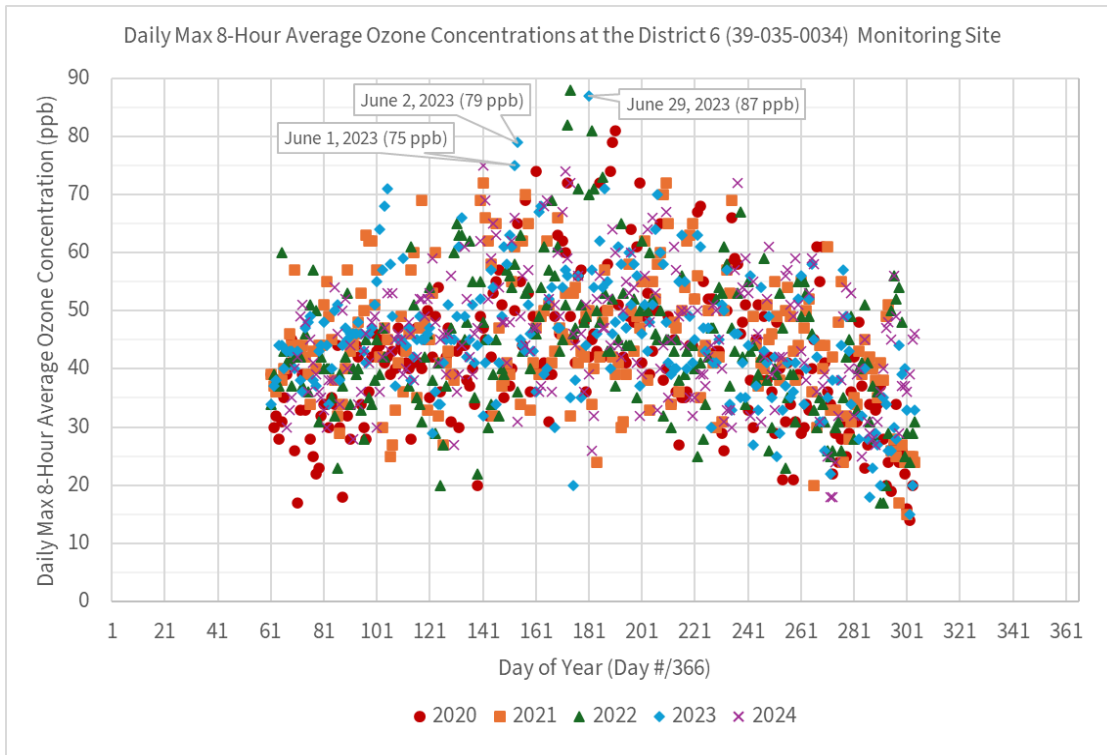


Table 2 shows the two dates in 2023 affected by regulatorily significant wildfire-related ozone episodes that, if excluded from the three-year (2023-2025) ozone design value calculation, would result in a design value for the Eastlake (39-085-0003) monitoring site in Lake County that attains the 2015 ozone NAAQS. Both dates have been tentatively treated as Tier 3 category days after preliminary discussions with U.S. EPA, and the two MDA8 ozone concentrations rank as the 2<sup>nd</sup> and 3<sup>rd</sup> highest observed concentration days at this monitoring site in the 2020-2024 period. These two days were affected by a regulatorily significant wildfire-related ozone episode, lasting from June 1-2, 2023. Figure 2 shows the MDA8 ozone concentrations from 2020-2024 measured at the Eastlake (39-085-0003) monitoring site in Lake County and identifies the values observed on the two dates in 2023 (June 1 and June 2) affected by a regulatorily significant wildfire-related ozone episode.

**Table 2. Data from the Eastlake (39-085-0003) monitoring site being requested for exclusion due to a regulatorily significant wildfire-related ozone episode.**

<b>Date of Event</b>	<b>Daily Maximum 8-Hour Average Ozone Concentration (ppb)</b>	<b>5-Year Percentile</b>	<b>5-Year Rank</b>
June 1, 2023	82	99.83	3
June 2, 2023	84	99.92	2

**Figure 2. Time series plot of MDA8 ozone concentration data for the Eastlake (39-085-0003) monitoring site in Lake County from 2020-2024, with the data points requested for exclusion that were affected by the June 1-2 regulatorily significant wildfire-related ozone episode in 2023 labeled.**

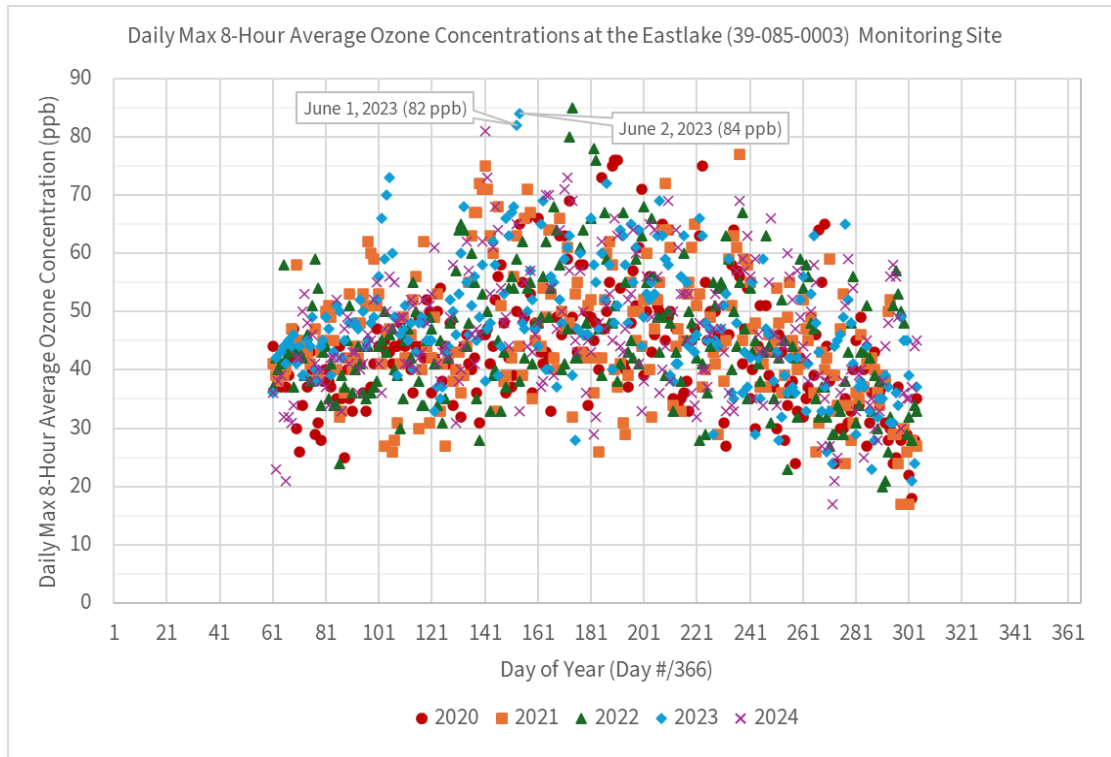


Table 3 shows the fourth highest MDA8 ozone concentrations measured in calendar years 2023, 2024, and 2025, as well as the valid 2023-2025 8-hour ozone design values for each ozone monitoring site operating within the Cleveland, OH 2015 Ozone Nonattainment Area. While the District 6 (39-035-0034) and Eastlake (39-085-0003) monitoring sites each show 2023-2025 8-hour ozone design values above the 2015 ozone NAAQS level of 70 ppb, all other sites show design values at or below 70 ppb, representing attainment of the 2015 ozone NAAQS.

**Table 3. 2023-2025 annual fourth highest MDA8 ozone concentrations and design values for ozone monitoring sites operating within the Cleveland, OH 2015 Ozone Nonattainment Area.**

Site Name	Site ID	County	2023 Fourth Highest MDA8 Ozone Value (ppb)	2024 Fourth Highest MDA8 Ozone Value (ppb)	2025 Fourth Highest MDA8 Ozone Value (ppb)	2023-2025 8-Hour Ozone Design Value (ppb)
District 6	39-035-0034	Cuyahoga	71	72	70	71
GT Craig NCore PAMS	39-035-0060		65	65	68	66
Berea BOE	39-035-0064		75	65	68	69
Mayfield	39-035-5002		73	70	N/A	N/A
Notre Dame	39-055-0004	Geauga	66	66	69	67
Eastlake	39-085-0003	Lake	72	71	71	71
Painesville	39-085-0007		73	69	70	70
Sheffield	39-093-0018	Lorain	64	61	66	63
Chippewa	39-103-0004	Medina	72	65	68	68
Lake Rockwell	39-133-1001	Portage	70	67	70	69
North HS	39-153-0026	Summit	71	69	66	68

Note: The Mayfield (39-035-5002) monitoring site was discontinued due to unforeseen circumstances on April 22, 2025. As such, both the 2025 fourth highest MDA8 ozone value of 56 ppb and the 2023-2025 8-hour ozone design value of 66 ppb are invalid due to data incompleteness for the Mayfield monitoring site.

The Ohio Environmental Protection Agency (Ohio EPA) requests that U.S. EPA exclude the monitored ozone concentration data at the District 6 (39-035-0034) monitoring site in Cuyahoga County on June 1, June 2, and June 29, 2023, from regulatory determinations, including calculations of 8-hour ozone design values, due to the influence of ozone precursors from Canadian wildfires on the monitored ozone concentrations during those dates. The District 6 monitoring site measured fourth highest MDA8 ozone concentrations of 71, 72, and 70 ppb in calendar years 2023, 2024, and 2025, respectively. Averaging these three monitored fourth highest MDA8 ozone concentrations gives a valid 2023-2025 8-hour ozone design value of 71 ppb, violating the 2015 ozone NAAQS. However, if the monitored ozone

concentration data from the three identified dates were excluded, the fourth highest MDA8 ozone concentration in 2023 at the District 6 monitoring site would be 68 ppb, resulting in a recalculated valid 2023-2025 8-hour ozone design value of 70 ppb, which represents attainment of the 2015 ozone NAAQS.

Ohio EPA also requests that U.S. EPA exclude the monitored ozone concentration data at the Eastlake (39-085-0003) monitoring site in Lake County on June 1 and June 2, 2023, from regulatory determinations, including calculations of 8-hour ozone design values, due to the influence of ozone precursors from Canadian wildfires on the monitored ozone concentrations during those dates. The Eastlake monitoring site measured fourth highest MDA8 ozone concentrations of 72, 71, and 71 ppb in calendar years 2023, 2024, and 2025, respectively. Averaging these three monitored fourth highest MDA8 ozone concentrations gives a valid 2023-2025 8-hour ozone design value of 71 ppb, violating the 2015 ozone NAAQS. However, if the monitored ozone concentration data from the three identified dates were excluded, the fourth highest MDA8 ozone concentration in 2023 at the Eastlake monitoring site would be 69 ppb, resulting in a recalculated valid 2023-2025 8-hour ozone design value of 70 ppb, which represents attainment of the 2015 ozone NAAQS.

Excluding the observed ozone concentration data from June 1, June 2, and June 29, 2023, at the District 6 (39-035-0034) monitoring site in Cuyahoga County and excluding the observed ozone concentration data from June 1 and June 2, 2023, at the Eastlake (39-085-0003) monitoring site in Lake County would reduce the 2023-2025 8-hour ozone design values for the District 6 and Eastlake monitoring sites to values that are at or below the 2015 ozone NAAQS value of 70 ppb. As all valid 2023-2025 8-hour ozone design values for monitoring sites within the Cleveland, OH 2015 Ozone Nonattainment Area would, upon approval of the requests for data exclusion, be at or below the 2015 ozone NAAQS value of 70 ppb, the Cleveland, OH 2015 Ozone Nonattainment Area would demonstrate attainment of the 2015 ozone NAAQS prior to the specified attainment deadline of August 3, 2027. Thus, the exceptional events are regulatorily significant in accordance with 40 CFR 50.14(a)(1)(i)(C), as a “determination regarding whether a nonattainment area has attained the level of the appropriate national ambient air quality standard by its specified deadline” would be directly influenced by the exclusion of data impacted by these exceptional events.

### ***1.3. Impact of Regulatorily Significant Exceptional Events at Other Nearby Monitoring Sites***

It should also be noted that two additional ozone monitoring sites, GT Craig NCore PAMS (39-035-0060) in Cuyahoga County and Painesville (39-085-0007) in Lake County, were also

similarly affected by the regulatorily significant wildfire-related ozone episode on June 1-2, 2023. Additionally, the GT Craig NCore PAMS monitoring site was impacted by the regulatorily significant wildfire-related ozone episode on June 29, 2023. Although additional nearby ozone monitoring sites beyond District 6, Eastlake, GT Craig NCore PAMS, and Painesville may have been impacted by these regulatorily significant wildfire-related ozone episodes, these four sites were chosen as the focus of this exceptional events demonstration because they were the most significantly impacted sites during these regulatorily significant wildfire-related ozone episodes. The District 6, Eastlake, GT Craig NCore PAMS, and Painesville monitoring sites are respectively 1.9 km, 1.1 km, 2.2 km, and 3.8 km from the Lake Erie shoreline, aligned roughly linearly along the southwest-northeast direction. The exclusion of other dates/ozone monitoring sites in the Cleveland, OH 2015 Ozone Nonattainment Area from this exceptional events demonstration should not be construed as an implication that no other dates or monitoring sites were affected by these or other regulatorily significant wildfire-related exceptional events.

Table 4 shows the three dates in 2023 on which the GT Craig NCore PAMS (39-035-0060) monitoring site was impacted by regulatorily significant wildfire-related ozone episodes. All three dates have been tentatively treated as Tier 3 category days after preliminary discussions with U.S. EPA, and the three daily maximum 8-hour average (MDA8) ozone concentrations rank as the 2<sup>nd</sup>, 6<sup>th</sup>, and 8<sup>th</sup> highest observed concentration days at this monitoring site in the 2020-2024 period. These three days were affected by two regulatorily significant wildfire-related ozone episodes, lasting from June 1-2 and June 29, respectively. Figure 3 shows the MDA8 ozone concentrations from 2020-2024 measured at the GT Craig NCore PAMS (39-035-0060) monitoring site in Cuyahoga County and identifies the values observed on the three dates in 2023 (June 1, June 2, and June 29) affected by regulatorily significant wildfire-related ozone episodes.

**Table 4. Data from the GT Craig NCore PAMS (39-035-0060) monitoring site being requested for exclusion due to regulatorily significant wildfire-related ozone episodes.**

Date of Event	Daily Maximum 8-Hour Average Ozone Concentration (ppb)	5-Year Percentile	5-Year Rank
June 1, 2023	71	99.72	6
June 2, 2023	76	99.94	2
June 29, 2023	78	100.00	1

**Figure 3. Time series plot of MDA8 ozone concentration data for the GT Craig NCore PAMS (39-035-0060) monitoring site in Cuyahoga County from 2020-2024, with the data points requested for exclusion that were affected by the June 1-2 and June 29 regulatorily significant wildfire-related ozone episodes in 2023 labeled.**

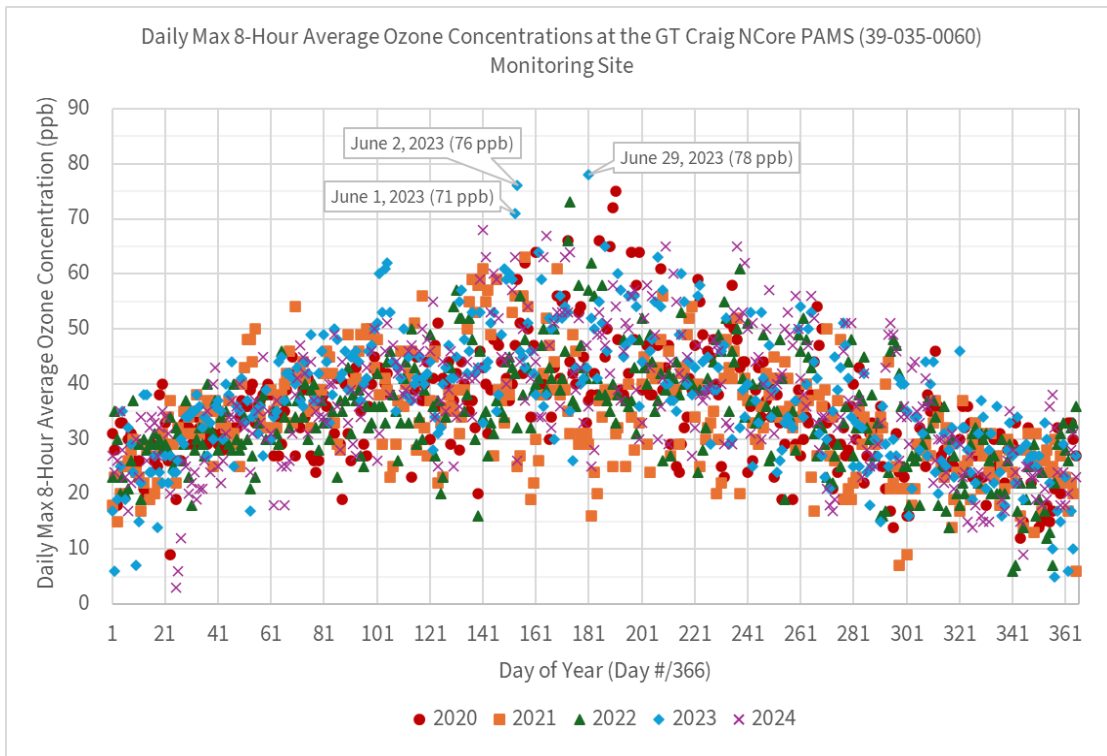


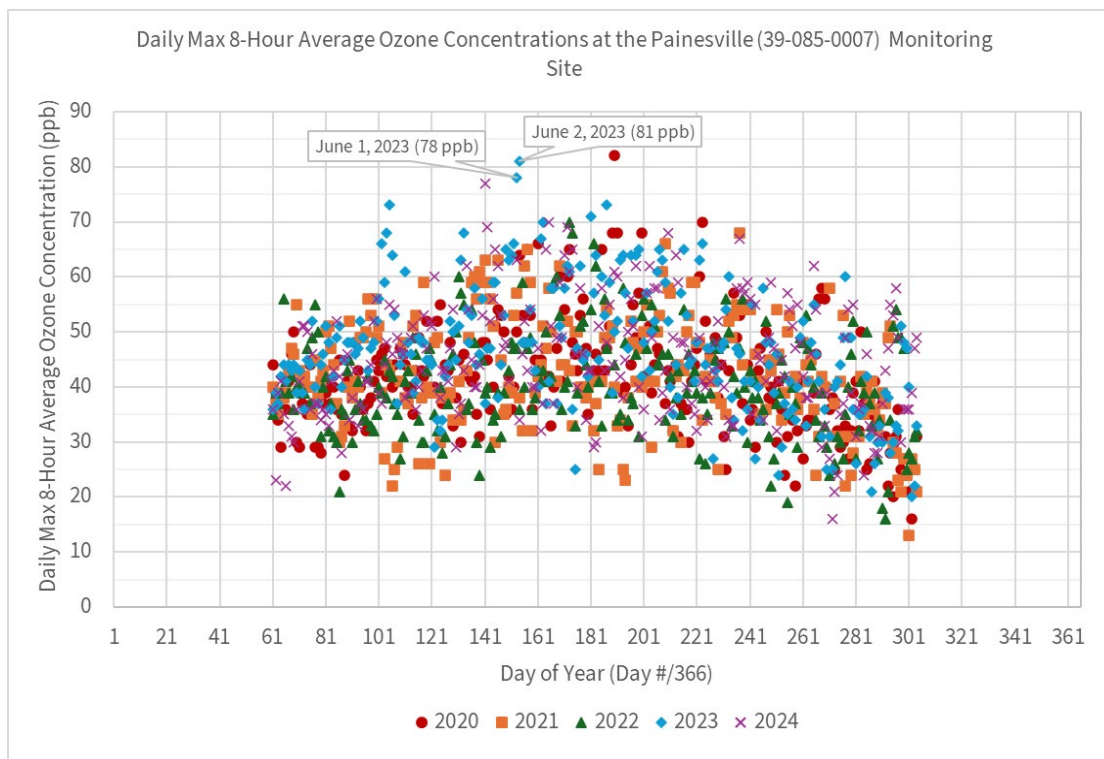
Table 5 shows the two dates in 2023 on which the Painesville (39-085-0007) monitoring site was impacted by a regulatorily significant wildfire-related ozone episode. Both dates have been tentatively treated as Tier 3 category days after preliminary discussions with U.S. EPA, and the two MDA8 ozone concentrations rank as the 2<sup>nd</sup> and 3<sup>rd</sup> highest observed

concentration days at this monitoring site in the 2020-2024 period. These two days were affected by a regulatorily significant wildfire-related ozone episode, lasting from June 1-2, 2023. Figure 4 shows the MDA8 ozone concentrations from 2020-2024 measured at the Painesville (39-085-0007) monitoring site in Lake County and identifies the values observed on the two dates in 2023 (June 1 and June 2) affected by a regulatorily significant wildfire-related ozone episode.

**Table 5. Data from the Painesville (39-085-0007) monitoring site being requested for exclusion due to a regulatorily significant wildfire-related ozone episode.**

Date of Event	Daily Maximum 8-Hour Average Ozone Concentration (ppb)	5-Year Percentile	5-Year Rank
June 1, 2023	78	99.83	3
June 2, 2023	81	99.92	2

**Figure 4. Time series plot of MDA8 ozone concentration data for the Painesville (39-085-0007) monitoring site in Lake County from 2020-2024, with the data points requested for exclusion that were affected by the June 1-2 regulatorily significant wildfire-related ozone episode in 2023 labeled.**



The GT Craig NCore PAMS monitoring site measured fourth highest MDA8 ozone concentrations of 65, 65, and 68 ppb in calendar years 2023, 2024, and 2025, respectively. Averaging these three monitored fourth highest MDA8 ozone concentrations gives a valid 2023-2025 8-hour ozone design value of 66 ppb, below the 2015 ozone NAAQS level of 70 ppb. If the monitored ozone concentration data from the three identified dates in 2023 (June 1, June 2, and June 29) impacted by regulatorily significant exceptional events were excluded, the fourth highest MDA8 ozone concentration in 2023 at the GT Craig NCore PAMS monitoring site would be 62 ppb, resulting in a recalculated valid 2023-2025 8-hour ozone design value of 65 ppb, which would still represent attainment of the 2015 ozone NAAQS. Ohio EPA requests that U.S. EPA exclude the monitored ozone concentration data at the GT Craig NCore PAMS (39-035-0060) monitoring site in Cuyahoga County on June 1, June 2, and June 29, 2023, from regulatory determinations, including calculations of 8-hour ozone design values, due to the influence of regulatorily significant exceptional events involving ozone precursors from Canadian wildfires on the monitored ozone concentrations during those dates.

The Painesville monitoring site measured fourth highest MDA8 ozone concentrations of 73, 69, and 70 ppb in calendar years 2023, 2024, and 2025, respectively. Averaging these three monitored fourth highest MDA8 ozone concentrations gives a valid 2023-2025 8-hour ozone design value of 70 ppb, representing attainment of the 2015 ozone NAAQS. If the monitored ozone concentration data from the two identified dates in 2023 (June 1 and June 2) impacted by a regulatorily significant exceptional event were excluded, the fourth highest MDA8 ozone concentration in 2023 at the Painesville monitoring site would be 70 ppb, resulting in a recalculated valid 2023-2025 8-hour ozone design value of 69 ppb, which would still represent attainment of the 2015 ozone NAAQS. Ohio EPA requests that U.S. EPA exclude the monitored ozone concentration data at the Painesville (39-085-0007) monitoring site in Lake County on June 1 and June 2, 2023, from regulatory determinations, including calculations of 8-hour ozone design values, due to the influence of a regulatorily significant exceptional event involving ozone precursors from Canadian wildfires on the monitored ozone concentrations during those dates.

#### **1.4. 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 and any additional weight of evidence analyses, 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**

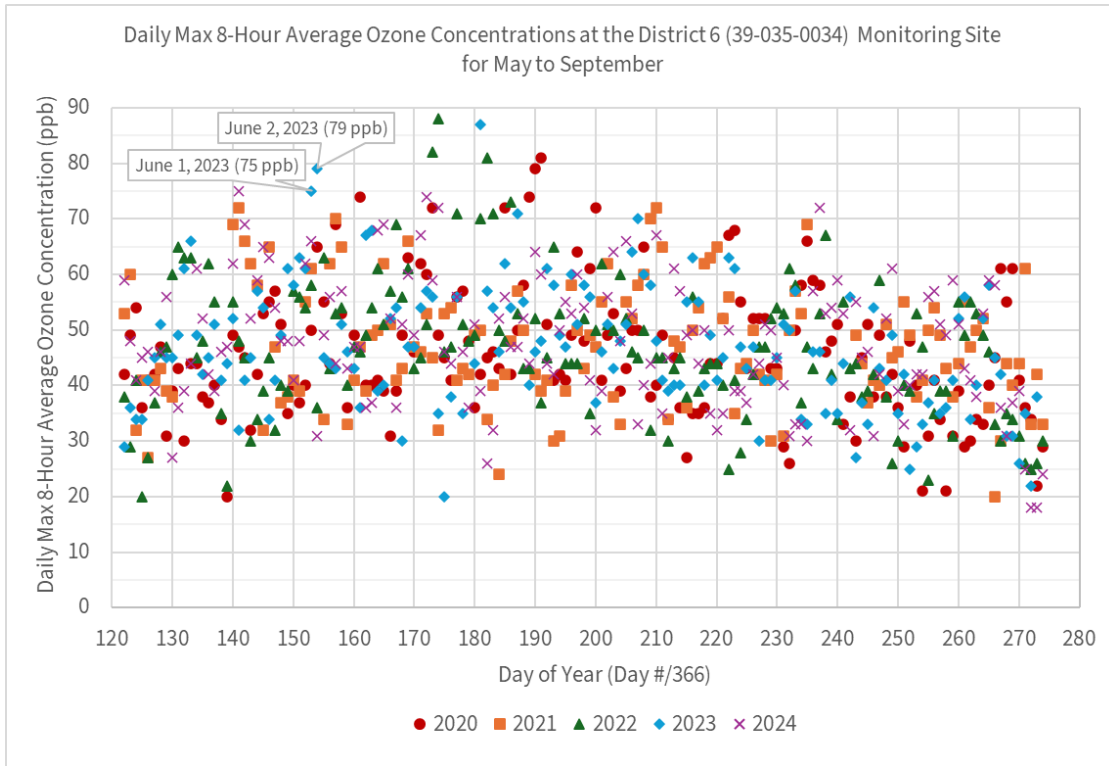
The narrative conceptual models for the regulatorily significant wildfire-related ozone episodes on June 1-2, 2023, and June 29, 2023, are presented in this section. Narrative conceptual models are presented separately for each episode.

### ***2.1. Wildfire-Related Ozone Episode on June 1-2, 2023***

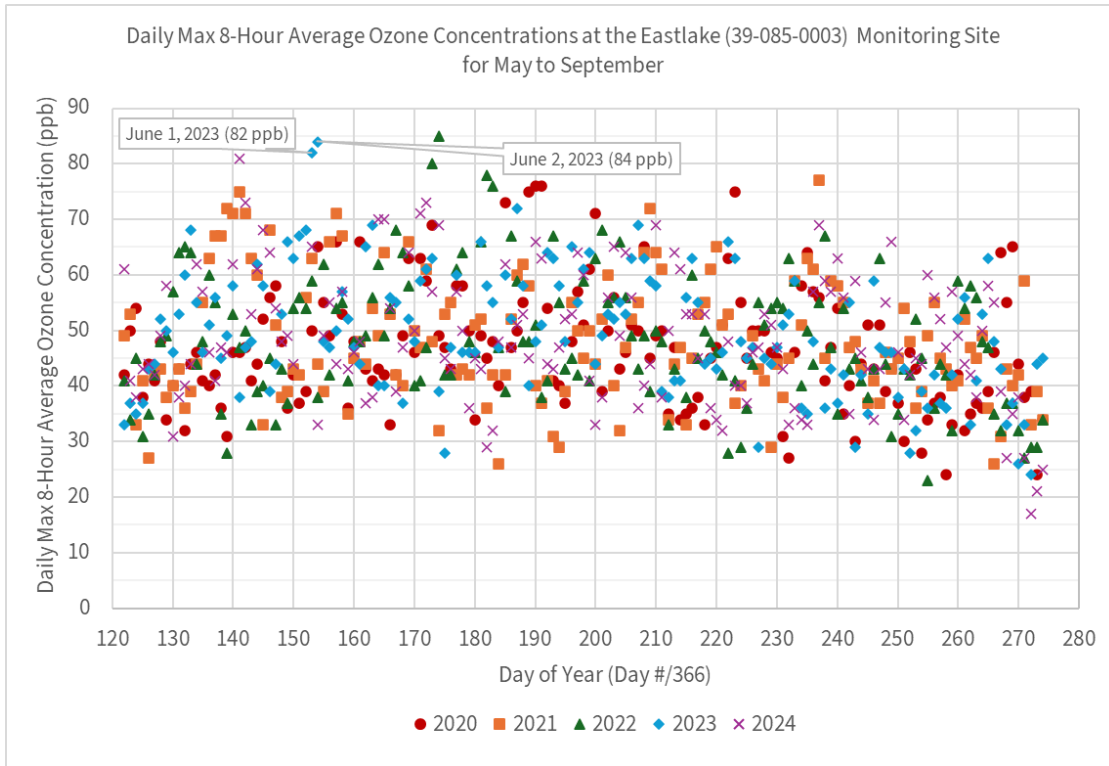
#### **2.1.1. Episode Description**

Air quality in Cuyahoga County and Lake County was impacted on June 1-2, 2023, by smoke and ozone precursors entering the region from wildfires burning southwest of Shelburne, Nova Scotia, Canada. The smoke plumes containing ozone precursors from the wildfires burning in Nova Scotia enhanced ground-level ozone formation in Northeastern Ohio, resulting in significantly increased monitored ozone concentrations at sites in Cuyahoga and Lake counties. Figures 5, 6, 7, and 8 show the MDA8 ozone concentrations for the years 2020-2024 across the typical high-ozone months of May to September at the District 6, Eastlake, GT Craig NCore PAMS, and Painesville monitoring sites. These figures illustrate the severity of the wildfire-related ozone episode on June 1-2, 2023, compared to other typical high-ozone months and compared to the same period in the past five years. The monitored MDA8 ozone concentrations from the wildfire-related ozone episode on June 1-2, 2023, are labeled in each figure.

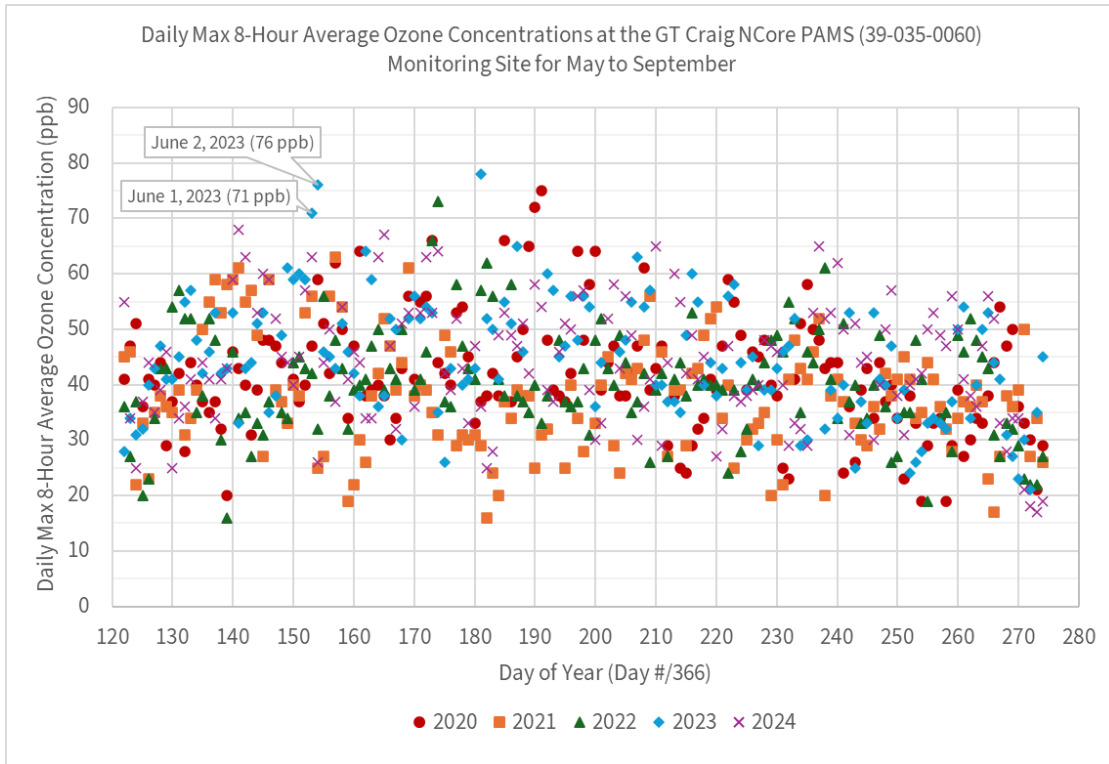
**Figure 5. 2020-2024 MDA8 ozone concentrations across the typical high-ozone months of May to September at the District 6 (39-035-0034) monitoring site in Cuyahoga County, with data from the wildfire-related ozone episode on June 1-2, 2023, labeled.**



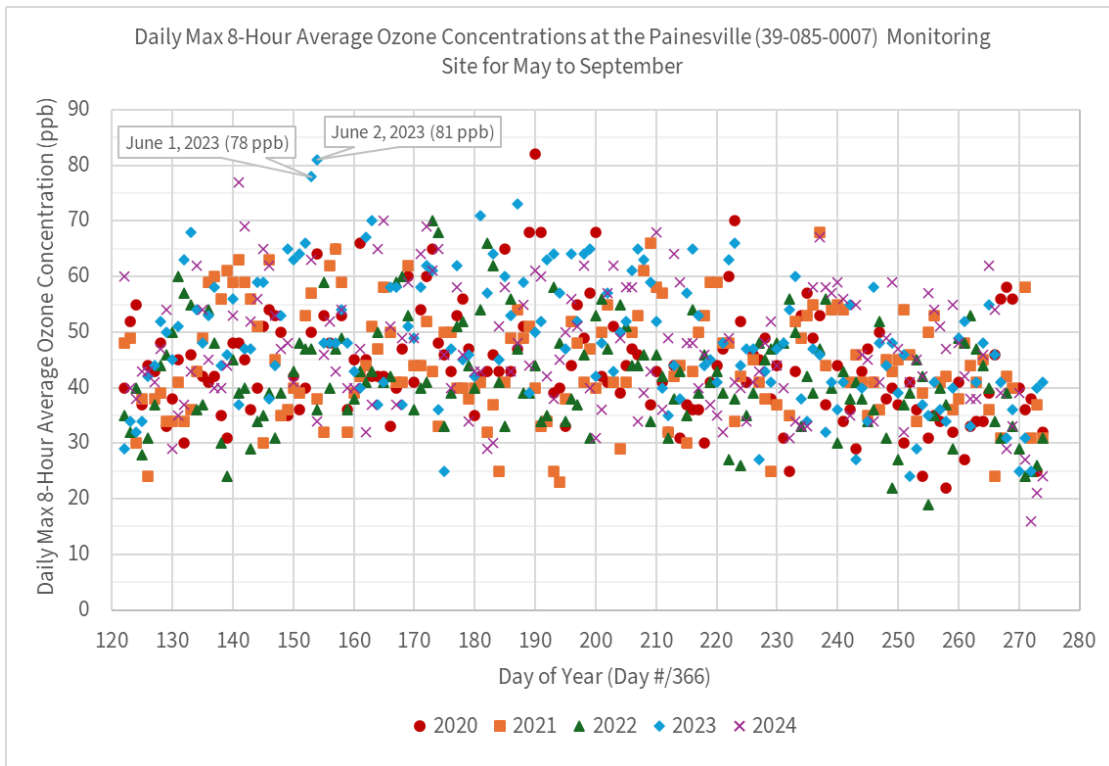
**Figure 6. 2020-2024 MDA8 ozone concentrations across the typical high-ozone months of May to September at the Eastlake (39-085-0003) monitoring site in Lake County, with data from the wildfire-related ozone episode on June 1-2, 2023, labeled.**



**Figure 7. 2020-2024 MDA8 ozone concentrations across the typical high-ozone months of May to September at the GT Craig NCore PAMS (39-035-0060) monitoring site in Cuyahoga County, with data from the wildfire-related ozone episode on June 1-2, 2023, labeled.**



**Figure 8. 2020-2024 MDA8 ozone concentrations across the typical high-ozone months of May to September at the Painesville (39-085-0007) monitoring site in Lake County, with data from the wildfire-related ozone episode on June 1-2, 2023, labeled.**

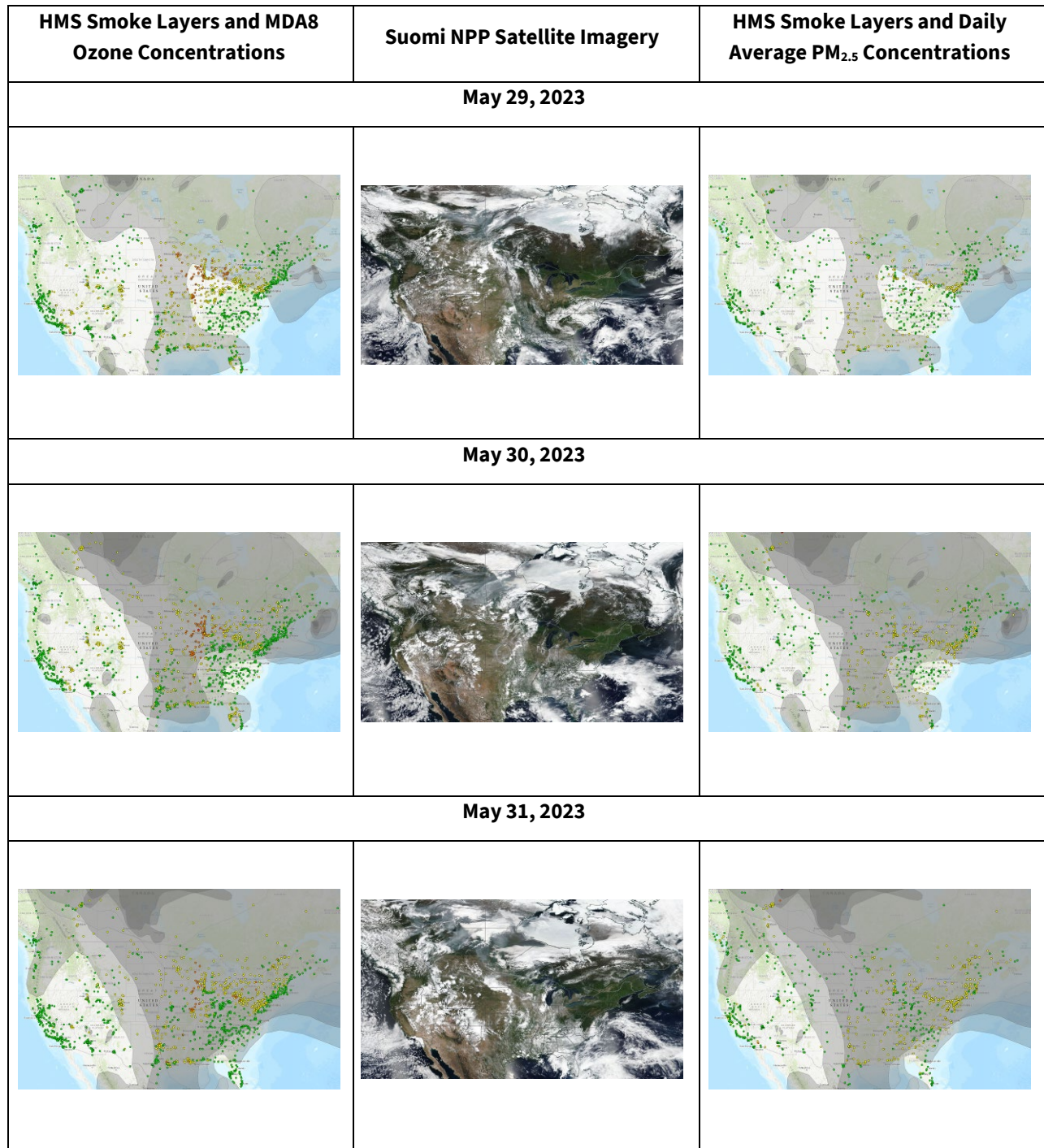


### 2.1.2. Meteorology

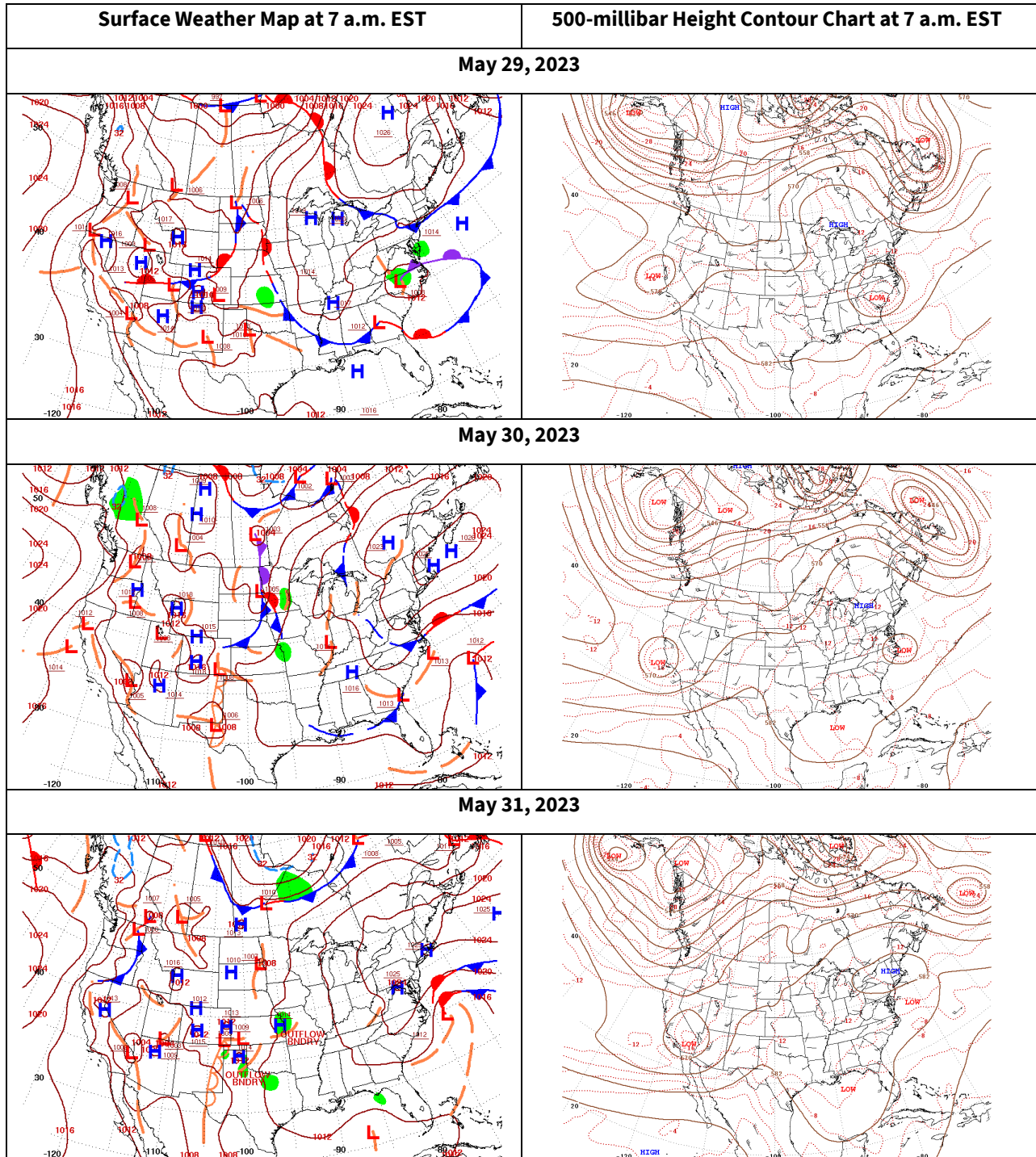
On May 28, 2023, a large high-pressure system formed over James Bay and began moving southeast toward Nova Scotia, where wildfires had recently begun creating large plumes of smoke and ozone precursors. By May 29, this high-pressure system had centered over Nova Scotia, allowing the smoke and ozone precursors from these wildfires to accumulate within the airmass. The high-pressure system slowly crept south over the next few days, moving at a slow enough pace to continually allow built-up smoke and ozone precursors from the wildfires in southern Nova Scotia to push west through New England and the Mid-Atlantic region toward the Eastern Great Lakes region, following the strong westward wind transport along the southern edge of the high-pressure from the anticyclonic rotation. The slow-moving high-pressure system continued to cause this westward transport of the wildfire-related pollutants until the high-pressure system was finally pushed out by a cold front in the early

morning of June 3. Figure 9 shows Hazard Mapping System (HMS) smoke layers with MDA8 ozone concentrations, Suomi NPP satellite imagery, and HMS smoke layers with daily average PM<sub>2.5</sub> concentrations for May 29-31, 2023. Figure 10 shows the surface weather maps at 7 a.m. Eastern Standard Time (EST) and the 500-millibar height contour charts at 7 a.m. EST for May 29-31, 2023. Figure 11 shows HMS smoke layers with MDA8 ozone concentrations, Suomi NPP satellite imagery, and HMS smoke layers with daily average PM<sub>2.5</sub> concentrations for June 1-3, 2023. Figure 12 shows the surface weather maps at 7 a.m. EST and the 500-millibar height contour charts at 7 a.m. EST for June 1-3, 2023. For ease of access and clarity, Appendix A includes larger versions of all images shown in Figures 9, 10, 11, and 12.

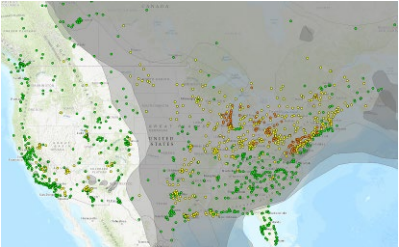

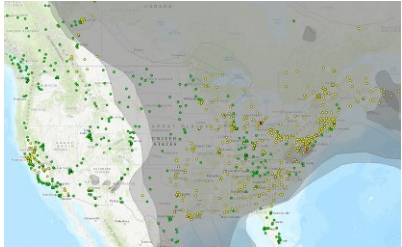
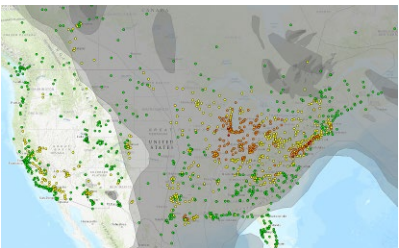

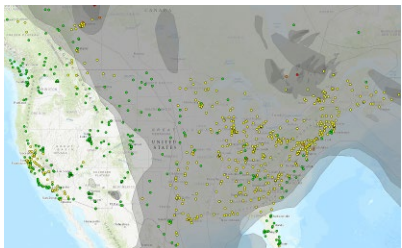
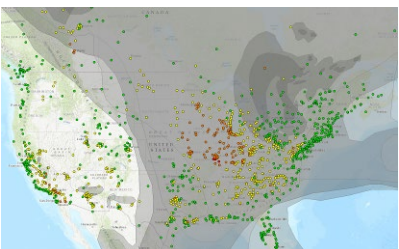
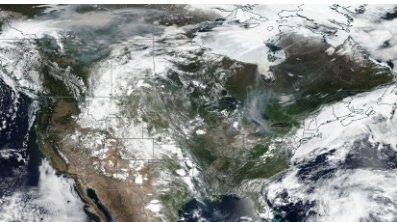
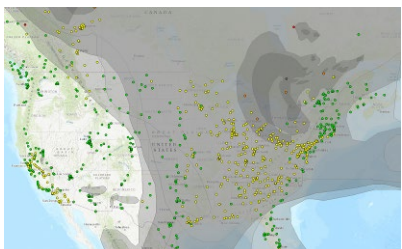
**Figure 9. MDA8 ozone concentrations overlapped with NOAA’s Hazard Mapping System (HMS) smoke layers (left), daily snapshot of the Suomi NPP satellite imagery of cloud cover (middle), and daily average PM<sub>2.5</sub> concentrations overlapped with HMS smoke layers (right) for May 29-31, 2023.**



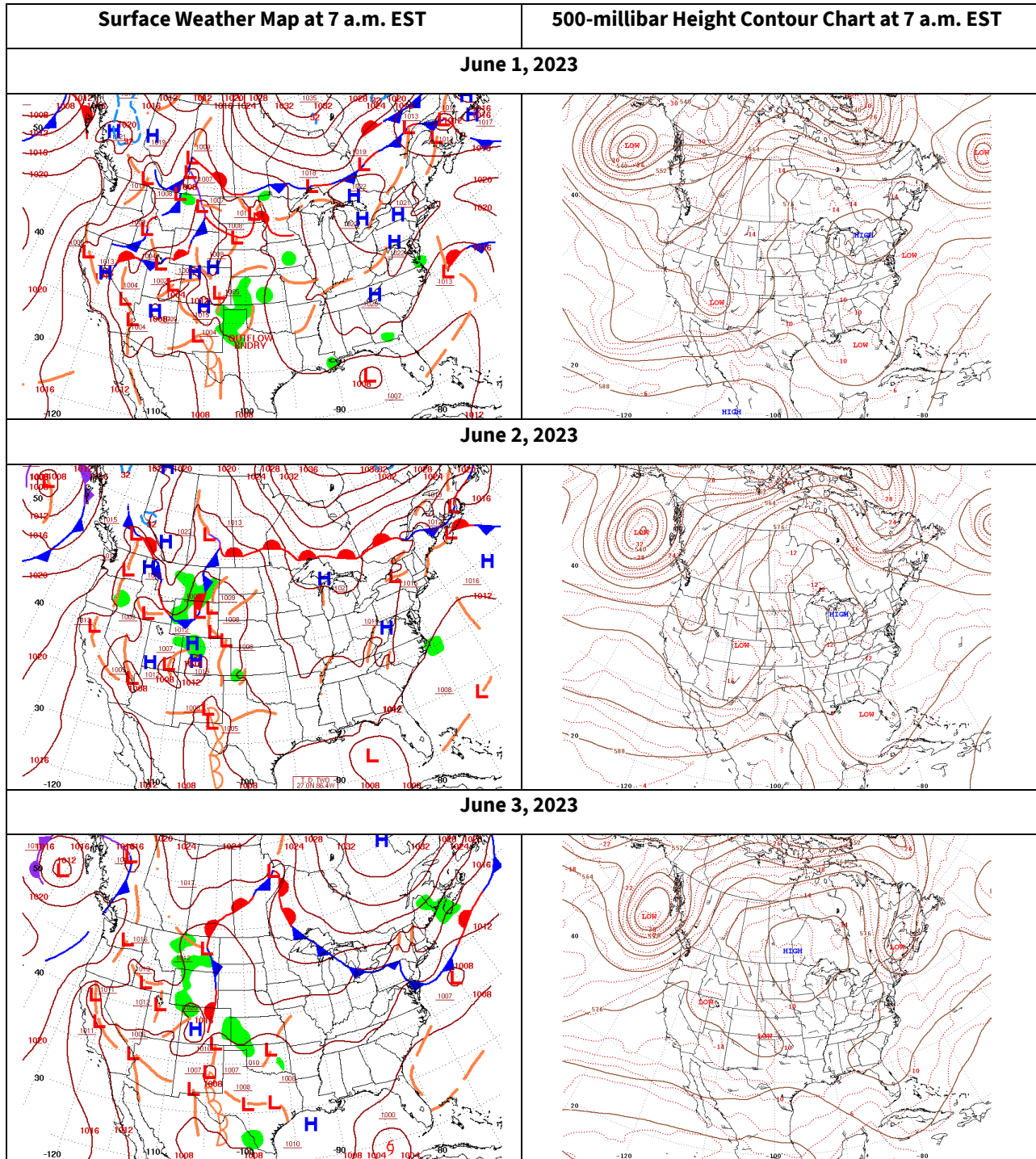
**Figure 10. Surface weather maps at 7 a.m. EST (left) and 500-millibar height contour charts at 7 a.m. EST (right) for May 29-31, 2023.**



**Figure 11. MDA8 ozone concentrations overlapped with NOAA’s Hazard Mapping System (HMS) smoke layers (left), daily snapshot of the Suomi NPP satellite imagery of cloud cover (middle), and daily average PM<sub>2.5</sub> concentrations overlapped with HMS smoke layers (right) for June 1-3, 2023.**

HMS Smoke Layers and MDA8 Ozone Concentrations	Suomi NPP Satellite Imagery	HMS Smoke Layers and Daily Average PM <sub>2.5</sub> Concentrations
<b>June 1, 2023</b>		
		
<b>June 2, 2023</b>		
		
<b>June 3, 2023</b>		
		

**Figure 12. Surface weather maps at 7 a.m. EST (left) and 500-millibar height contour charts at 7 a.m. EST (right) for June 1-3, 2023.**



### **2.1.3. Canadian Wildfires**

Starting on May 27, 2023, the Canadian Wildland Fire Information System (CWFIS)<sup>1</sup> began to report high fire danger conditions across central and southern Nova Scotia, with a few recent fire hotspots having appeared in southern Nova Scotia southwest of Shelburne. On May 28, the Nova Scotia provincial fire-management authority, the Nova Scotia Department of Natural Resources and Renewables (NSDNRR<sup>2</sup>), reported to the Canadian Interagency Forest Fire Centre (CIFFC) a fire preparedness level 4 for the province, which is the second highest alert level in Canada for mobilizing resources to fight wildfires and protect life and structures<sup>3</sup>. CWFIS reported high and extreme fire danger conditions across central and southern Nova Scotia for May 28. NSDNRR reported to CIFFC that seven new natural wildland fires had begun burning across the province on May 28, with three of those fires burning out of control<sup>4</sup>. The province remained at a fire preparedness level 4 until it was raised to level 5 on June 2<sup>5</sup>.

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<sup>1</sup> <https://cwfis.cfs.nrcan.gc.ca/home>

<sup>2</sup> <https://novascotia.ca/natr/forestprotection/wildfire>

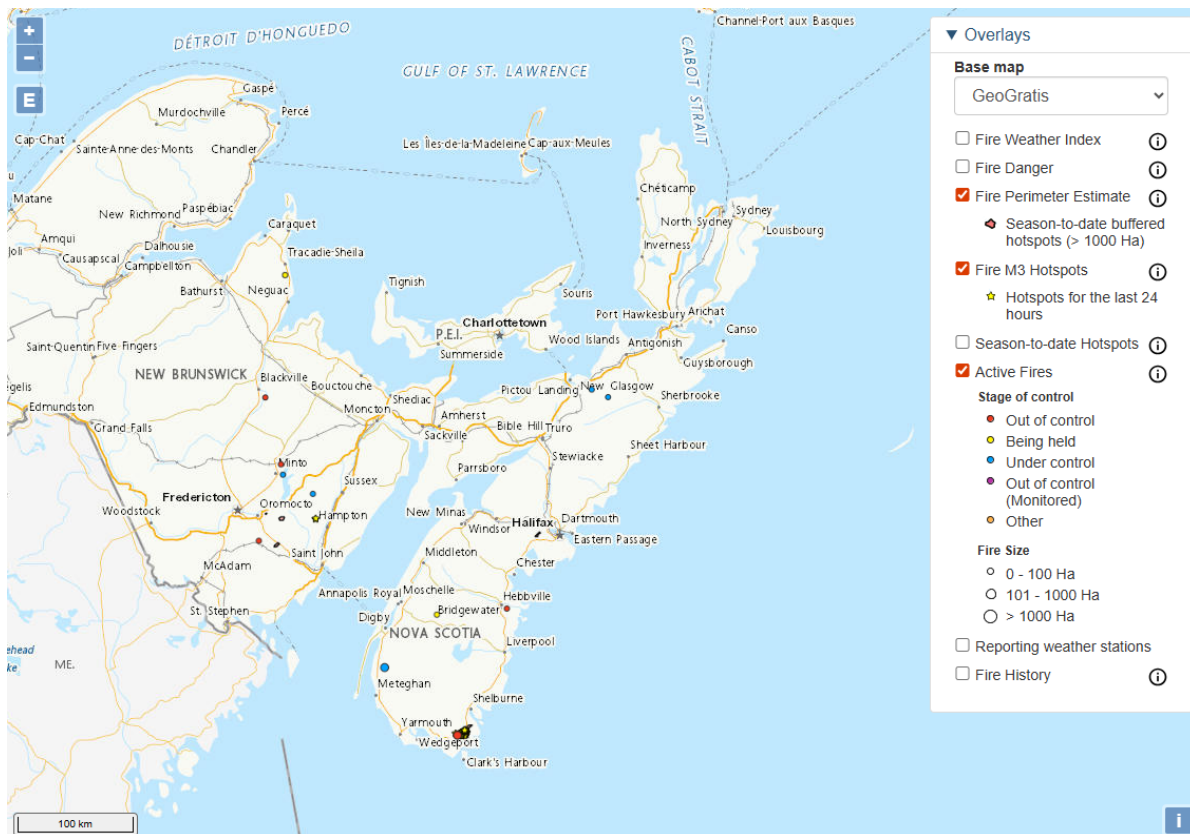
<sup>3</sup> <https://ciffc.net/situation/2023-05-28>

<sup>4</sup> <https://ciffc.net/situation/2023-05-29>

<sup>5</sup> <https://ciffc.net/situation/2023-06-02>

Figure 13 is a CWFIS map showing the active fires and fire hotspots in Nova Scotia on May 28, 2023. On May 28 there were seven active fires burning 813 acres in the province<sup>6</sup>. Most of these fires and recent hotspots were clustered in a complex located in southern Nova Scotia, southwest of Shelburne and east of Yarmouth. The smoke plumes arising from the fires and recent hotspots southwest of Shelburne and east of Yarmouth were located in the source region intersected by the HYSPLIT back and forward trajectory plots for the wildfire-related ozone episode on June 1-2, 2023, shown in Section 3 of this document.

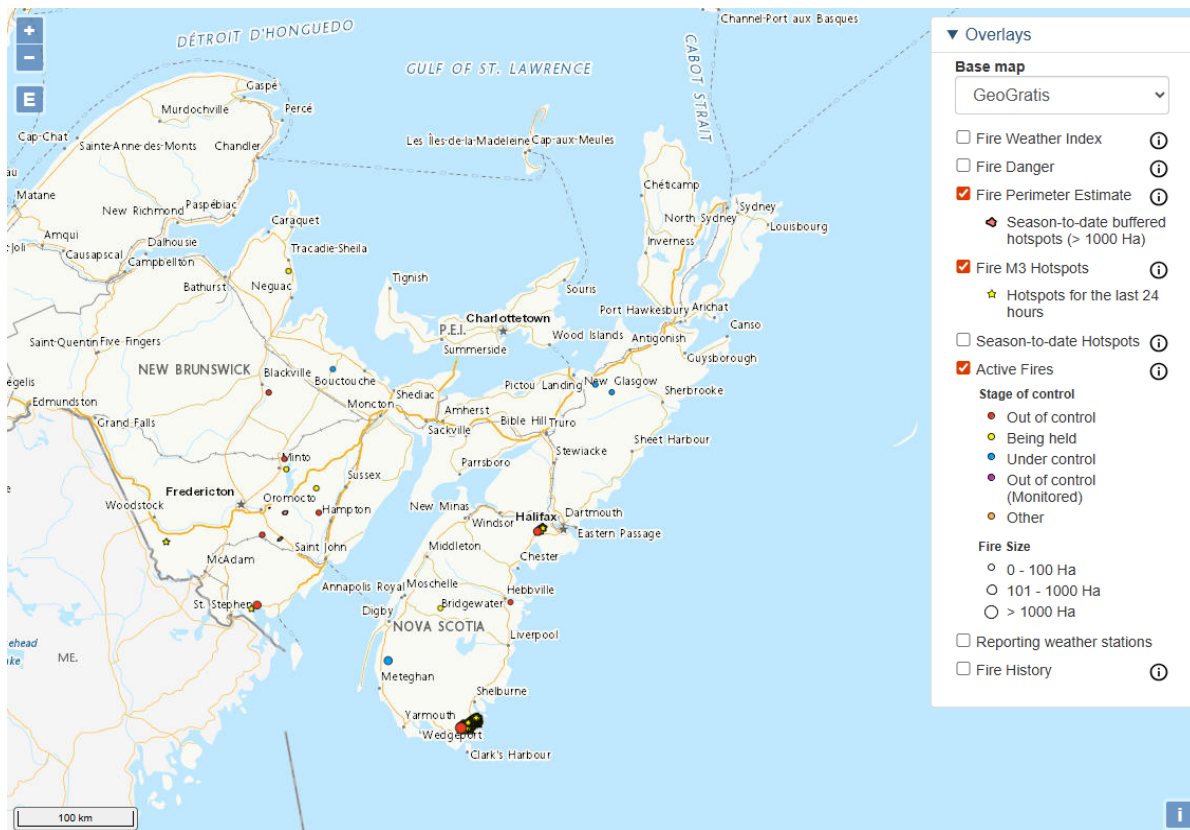
**Figure 13. Map from CWFIS of active fires and recent hotspots in Nova Scotia on May 28, 2023.**



<sup>6</sup> <https://ciffc.net/situation/2023-05-28>

Figure 14 is a CWFIS map showing the active fires and fire hotspots in Nova Scotia on May 29, 2023. On May 29 the seven active fires rapidly expanded and were now burning 25,878 acres in the province<sup>7</sup>. Most of these fires and recent hotspots were clustered in a complex located in southern Nova Scotia, southwest of Shelburne and east of Yarmouth. The smoke plumes arising from the fires and recent hotspots southwest of Shelburne and east of Yarmouth were located in the source region intersected by the HYSPLIT back and forward trajectory plots for the wildfire-related ozone episode on June 1-2, 2023, shown in Section 3 of this document.

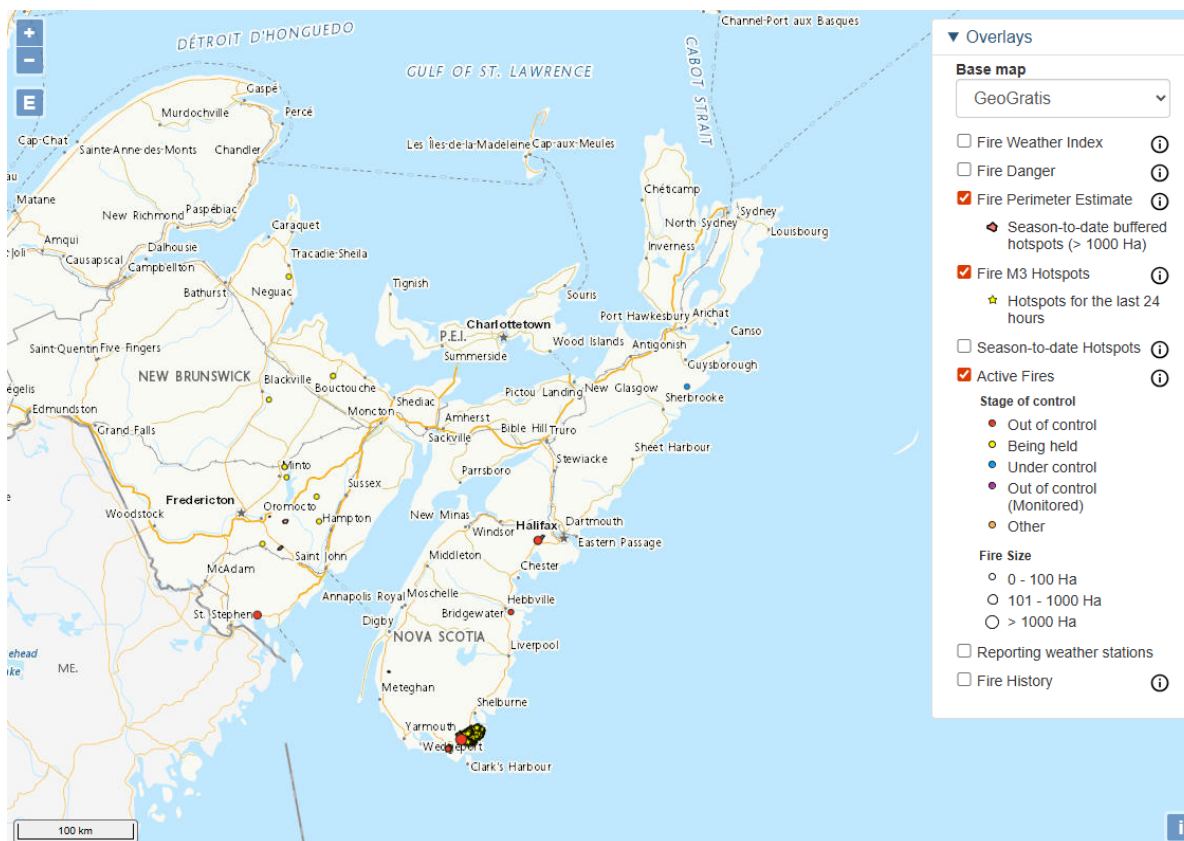
**Figure 14. Map from CWFIS of active fires and recent hotspots in Nova Scotia on May 29, 2023.**



<sup>7</sup> <https://ciffc.net/situation/2023-05-29>

Figure 15 is a CWFIS map showing the active fires and fire hotspots in Nova Scotia on May 30, 2023. On May 30 there were 10 active fires burning 49,280 acres in the province<sup>8</sup>. Most of these fires and recent hotspots were clustered in a complex located in southern Nova Scotia, southwest of Shelburne and east of Yarmouth. The smoke plumes arising from the fires and recent hotspots southwest of Shelburne and east of Yarmouth were located in the source region intersected by the HYSPLIT back and forward trajectory plots for the wildfire-related ozone episode on June 1-2, 2023, shown in Section 3 of this document.

**Figure 15. Map from CWFIS of active fires and recent hotspots in Nova Scotia on May 30, 2023.**



#### 2.1.4. Media Coverage

News media across the country reported on the impacts of the plumes of wildfire smoke and ozone precursors from the wildfires burning in southern Nova Scotia in late May and early June 2023. The coverage of the wildfire smoke plumes, particularly by media outlets that

<sup>8</sup> <https://ciffc.net/situation/2023-05-30>

typically only report on extreme weather and air quality events, indicated the historic nature of the wildfire impacts in the Mid-Atlantic and Eastern Great Lakes regions, including Cuyahoga and Lake counties in Ohio. While the list of news stories in Table 6 is not exhaustive, it illustrates the severe nature of the wildfire-related ozone episode on June 1-2, 2023, in the Eastern Great Lakes region, and serves as further evidence that the wildfire-related ozone episode on June 1-2, 2023, was not local in nature but driven by transported ozone precursors from wildfires burning in Nova Scotia that enhanced ground-level ozone formation in the Mid-Atlantic and Eastern Great Lakes regions.

**Table 6. News media reporting on the impact of the Nova Scotian wildfires on air quality in the Mid-Atlantic and Eastern Great Lakes regions.**

<b>Date</b>	<b>Source</b>	<b>Headline</b>
May 30, 2023	WMAR	Eastern Canadian wildfire smoke moves into the Mid-Atlantic <sup>9</sup>
May 31, 2023	Reuters	Eastern Canada struggles to bring wildfires under control <sup>10</sup>
May 31, 2023	CNN	Canadian wildfire smoke impacting air quality in US Northeast for second day <sup>11</sup>
June 1, 2023	AOL/Yahoo! News	Smoke from Canada wildfires is impacting air quality across the Northeast <sup>12</sup>
June 1, 2023	AP	Nova Scotia wildfires grow, prompt air quality warnings as far south as Virginia <sup>13</sup>

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<sup>9</sup> <https://www.wmar2news.com/weather/weather-blogs/eastern-canadian-wildfire-smoke-moves-into-the-mid-atlantic>

<sup>10</sup> <https://www.reuters.com/business/environment/wildfire-canadas-halifax-stoked-by-wind-gusts-low-humidity-2023-05-31>

<sup>11</sup> <https://www.cnn.com/2023/05/30/weather/nova-scotia-wildfires-smoke-spreads-to-northeast>

<sup>12</sup> <https://www.aol.com/news/smoke-canada-wildfires-impacting-air-181925295.html>

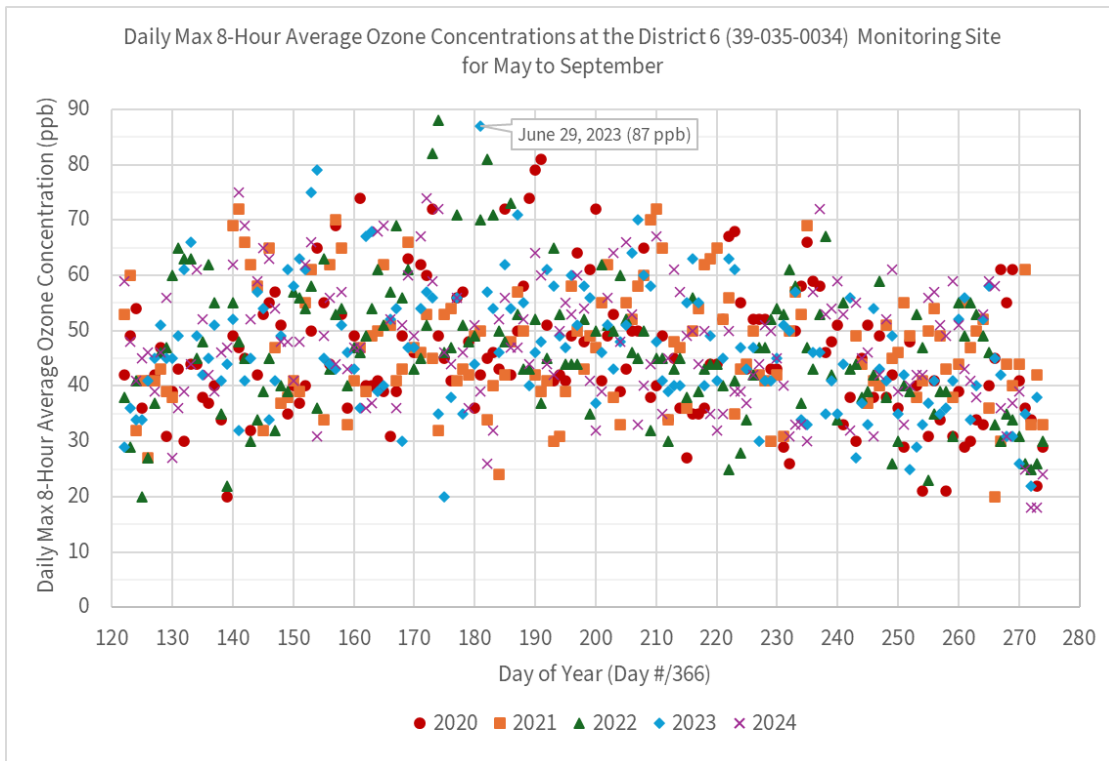
<sup>13</sup> <https://apnews.com/article/canada-wildfires-halifax-firefighters-us-south-africa-20f340036282d892aaa5528f1e48e618>

## 2.2. Wildfire-Related Ozone Episode on June 29, 2023

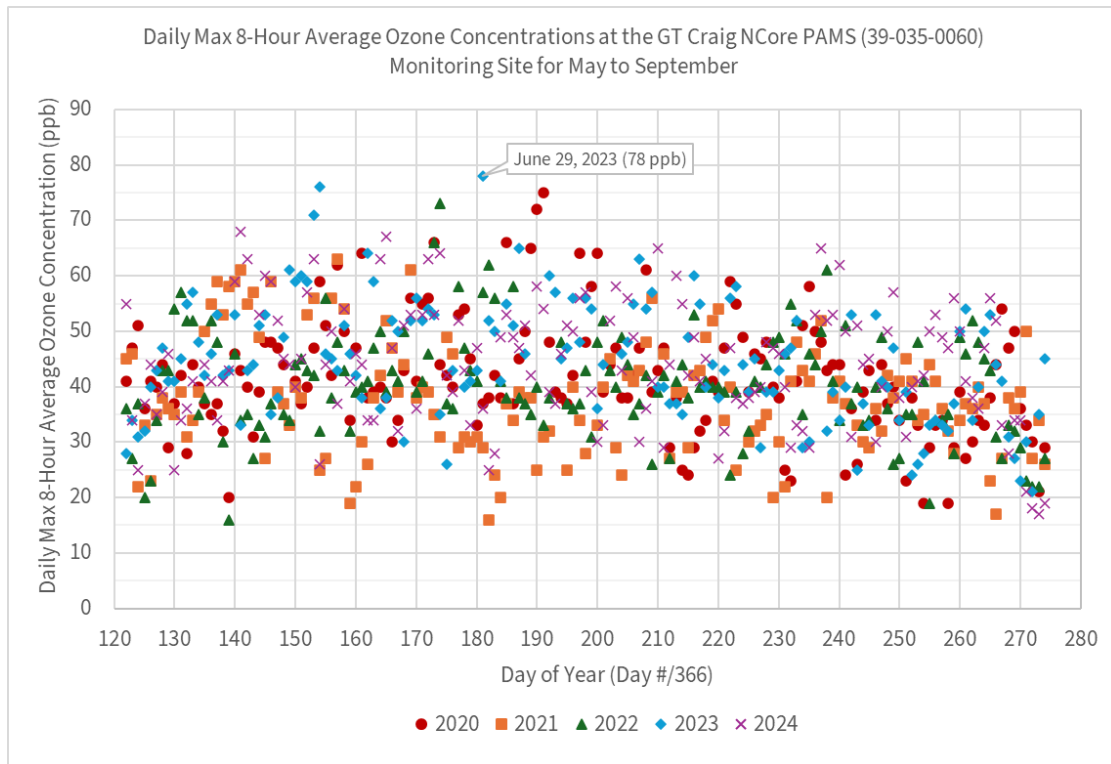
### 2.2.1. Episode Description

Ozone concentrations in Cuyahoga County were impacted on June 29, 2023, by ozone precursors entering the region from wildfires burning northeast of Chisasibi, Quebec, Canada. The ozone precursors from the wildfires burning in Quebec enhanced ground-level ozone formation across the Great Lakes region, resulting in significantly increased monitored ozone concentrations at sites in Cuyahoga County. Figures 16 and 17 show the MDA8 ozone concentrations for the years 2020-2024 across the typical high-ozone months of May to September at the District 6 and GT Craig NCore PAMS monitoring sites. These figures illustrate the severity of the wildfire-related ozone episode on June 29, 2023, compared to other typical high-ozone months and to the same period in the past five years. The monitored MDA8 ozone concentrations from the wildfire-related ozone episode on June 29, 2023, are labeled in each figure.

**Figure 16. 2020-2024 MDA8 ozone concentrations across the typical high-ozone months of May to September at the District 6 (39-035-0034) monitoring site in Cuyahoga County, with data from the wildfire-related ozone episode on June 29, 2023, labeled.**



**Figure 17. 2020-2024 MDA8 ozone concentrations across the typical high-ozone months of May to September at the GT Craig NCore PAMS (39-035-0060) monitoring site in Cuyahoga County, with data from the wildfire-related ozone episode on June 29, 2023, labeled.**

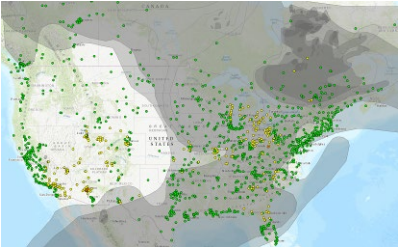

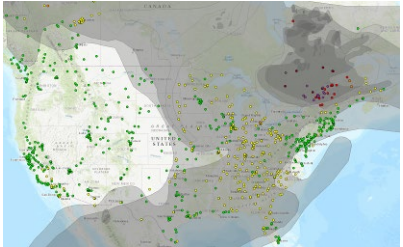
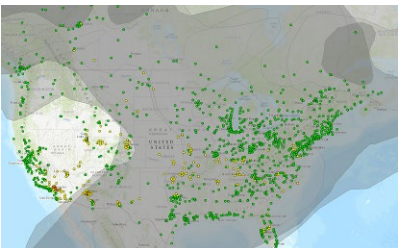
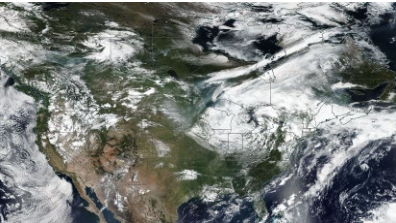
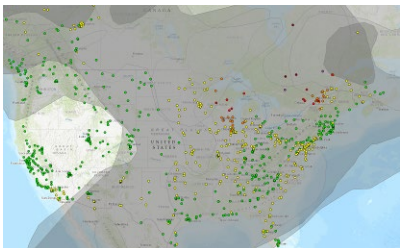
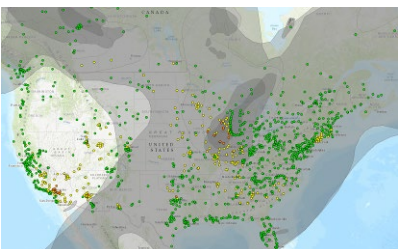

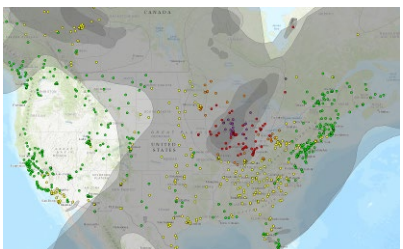


### 2.2.2. Meteorology

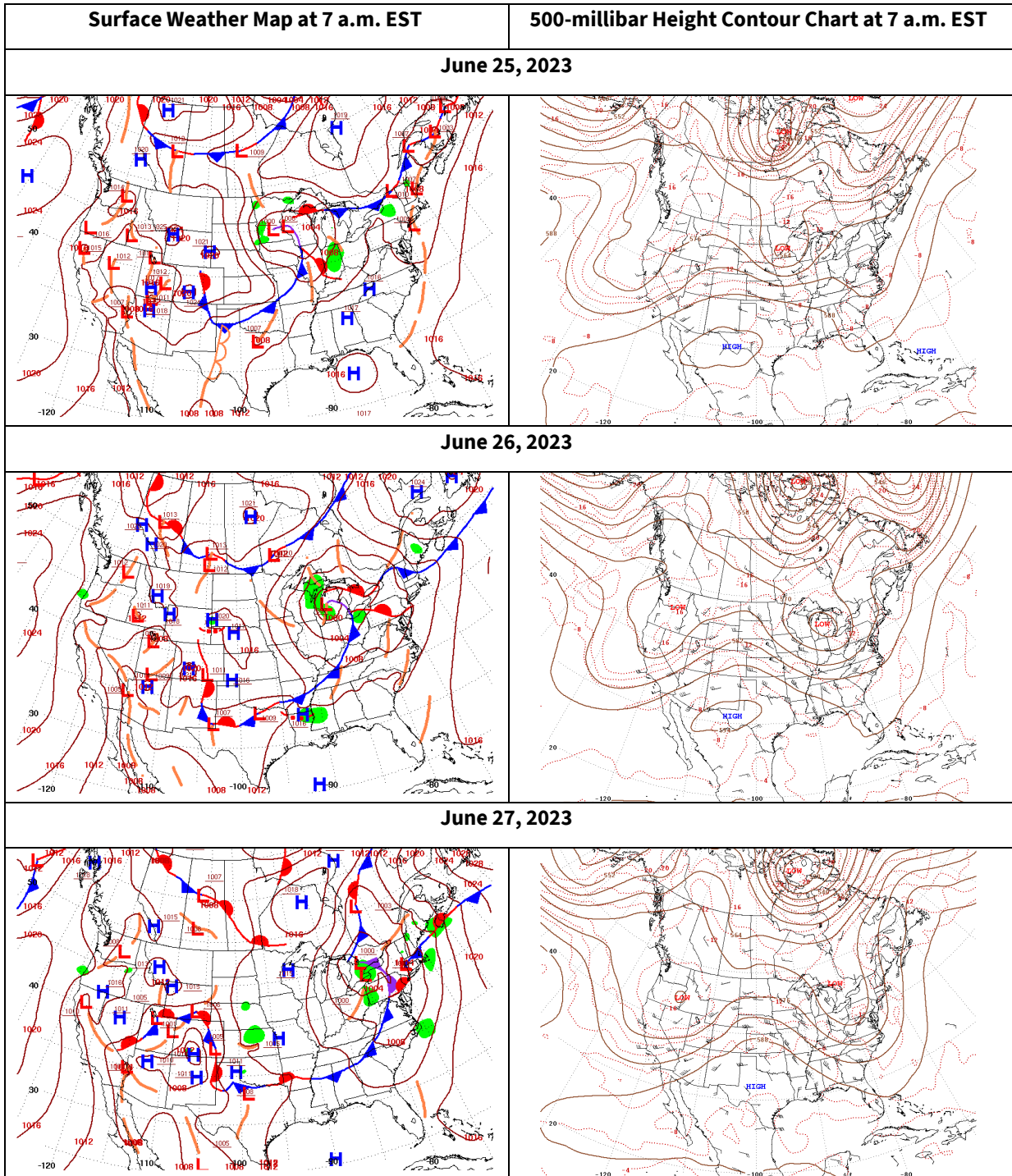
From June 25 through June 30, 2023, distinct airmass transport patterns connected the upper Midwest with Canada and brought smoke and ozone precursors from wildfires into the Great Lakes Basin. During June 25-27, a cyclonic (e.g., counterclockwise) circulation around a large low-pressure system centered on the Great Lakes carried smoke and ozone precursors into the upper Midwest from source regions in Quebec, Canada. A plume of thick smoke and ozone precursors from the Canadian wildfires was transported along the trailing edge of the low-pressure system as it moved east through the Great Lakes region. Figure 18 shows HMS smoke layers with MDA8 ozone concentrations, Suomi NPP satellite imagery, and HMS smoke layers with daily average PM<sub>2.5</sub> concentrations for May 29-31, 2023. Figure 19 shows the surface weather maps at 7 a.m. EST and the 500-millibar height contour charts at 7 a.m. EST for May 29-31, 2023. Figure 20 shows HMS smoke layers with MDA8 ozone concentrations, Suomi NPP satellite imagery, and HMS smoke layers with daily average PM<sub>2.5</sub> concentrations

for June 1-3, 2023. Figure 21 shows the surface weather maps at 7 a.m. EST and the 500-millibar height contour charts at 7 a.m. EST for June 1-3, 2023. For ease of access and clarity, Appendix A includes larger versions of all images shown in Figures 18, 19, 20, and 21.

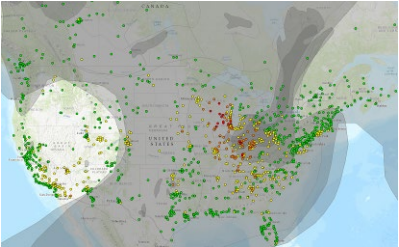

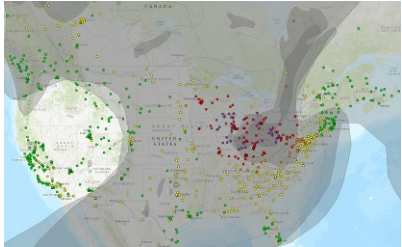
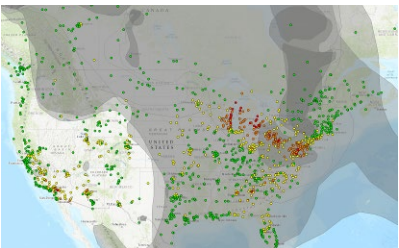

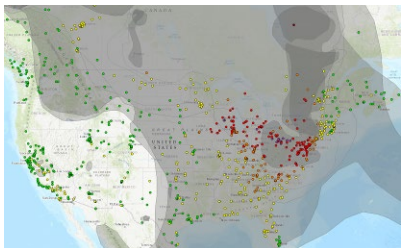
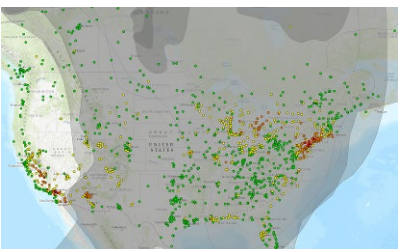

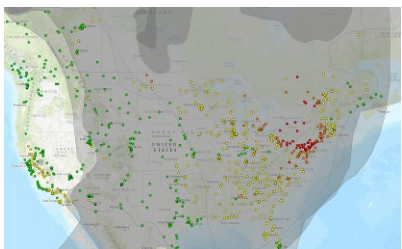
**Figure 18. MDA8 ozone concentrations overlapped with NOAA’s Hazard Mapping System (HMS) smoke layers (left), daily snapshot of the Suomi NPP satellite imagery of cloud cover (middle), and daily average PM<sub>2.5</sub> concentrations overlapped with HMS smoke layers (right) for June 25-27, 2023.**

HMS Smoke Layers and MDA8 Ozone Concentrations	Suomi NPP Satellite Imagery	HMS Smoke Layers and Daily Average PM <sub>2.5</sub> Concentrations
<b>June 25, 2023</b>		
		
<b>June 26, 2023</b>		
		
<b>June 27, 2023</b>		
		

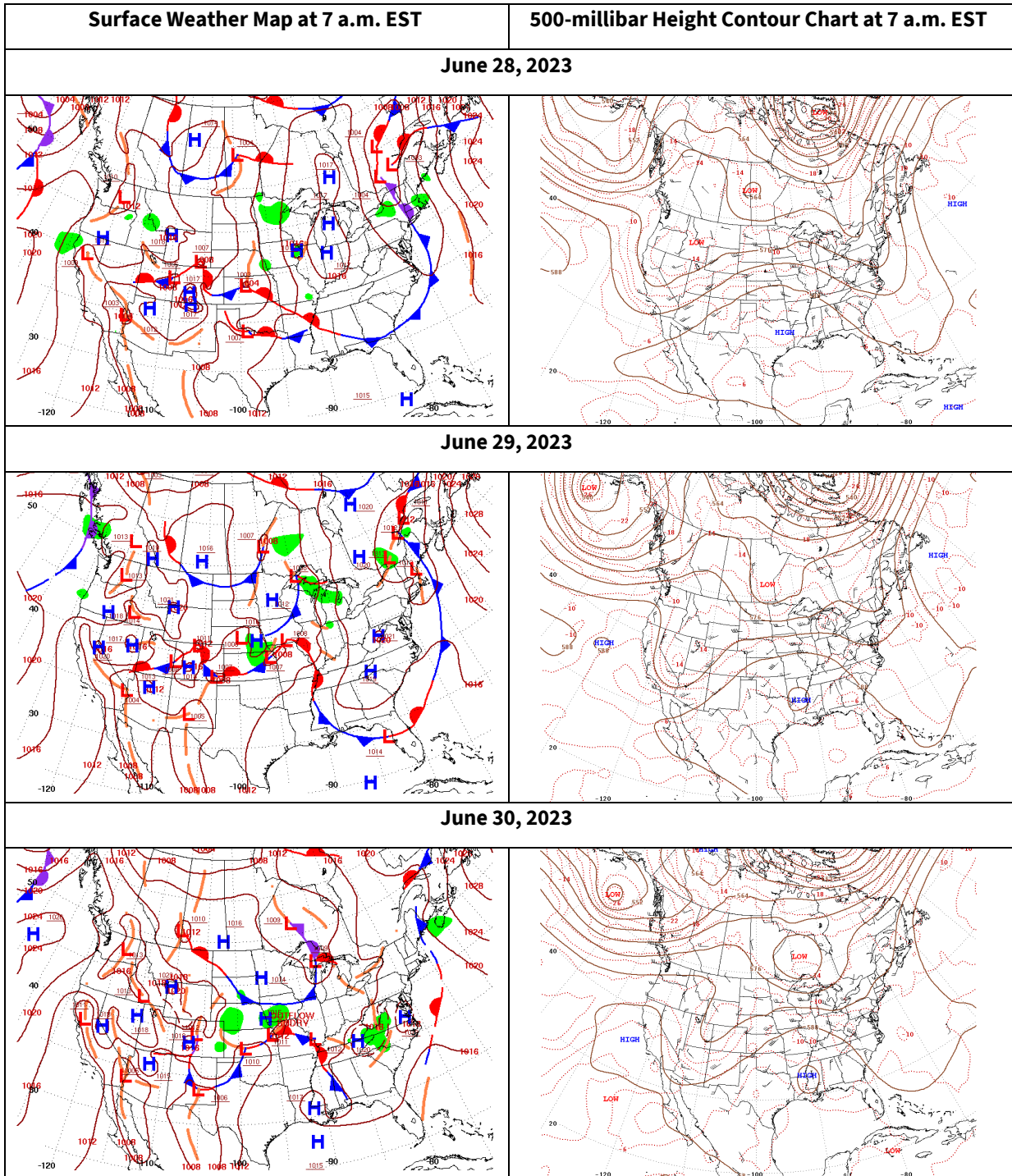
**Figure 19. Surface weather maps at 7 a.m. EST (left) and 500-millibar height contour charts at 7 a.m. EST (right) for June 25-27, 2023.**



**Figure 20. MDA8 ozone concentrations overlapped with NOAA’s Hazard Mapping System (HMS) smoke layers (left), daily snapshot of the Suomi NPP satellite imagery of cloud cover (middle), and daily average PM<sub>2.5</sub> concentrations overlapped with HMS smoke layers (right) for June 28-30, 2023.**

HMS Smoke Layers and MDA8 Ozone Concentrations	Suomi NPP Satellite Imagery	HMS Smoke Layers and Daily Average PM <sub>2.5</sub> Concentrations
<b>June 28, 2023</b>		
		
<b>June 29, 2023</b>		
		
<b>June 30, 2023</b>		
		

**Figure 21. Surface weather maps at 7 a.m. EST (left) and 500-millibar height contour charts at 7 a.m. EST (right) for 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 and ozone precursors from wildfires burning in Quebec to transport into the Great Lakes 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 and ozone precursors from the Canadian wildfires 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 wind transport corridor formed across the central Great Lakes Basin that brought smoke and ozone precursors from wildfires burning in Quebec along with a smoke-enriched air mass from the central Canadian provinces into the region. This corridor persisted until June 30 when the smoke and ozone precursors started to clear out of the region to the east.

### 2.2.3. Canadian Wildfires

Starting on May 27, 2023, CWFIS began to report high, very high, and extreme fire danger conditions across most of Quebec. The areas of Quebec southeast and east of James Bay remained almost continuously under high to extreme fire danger conditions through most of the month of June. On June 2, the Quebec provincial fire-management authority, Société de Protection des Forêts Contre le Feu (SOPFEU<sup>14</sup>), reported to 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. The province remained at fire preparedness level 5 continuously until it was lowered to level 4 on July 17.

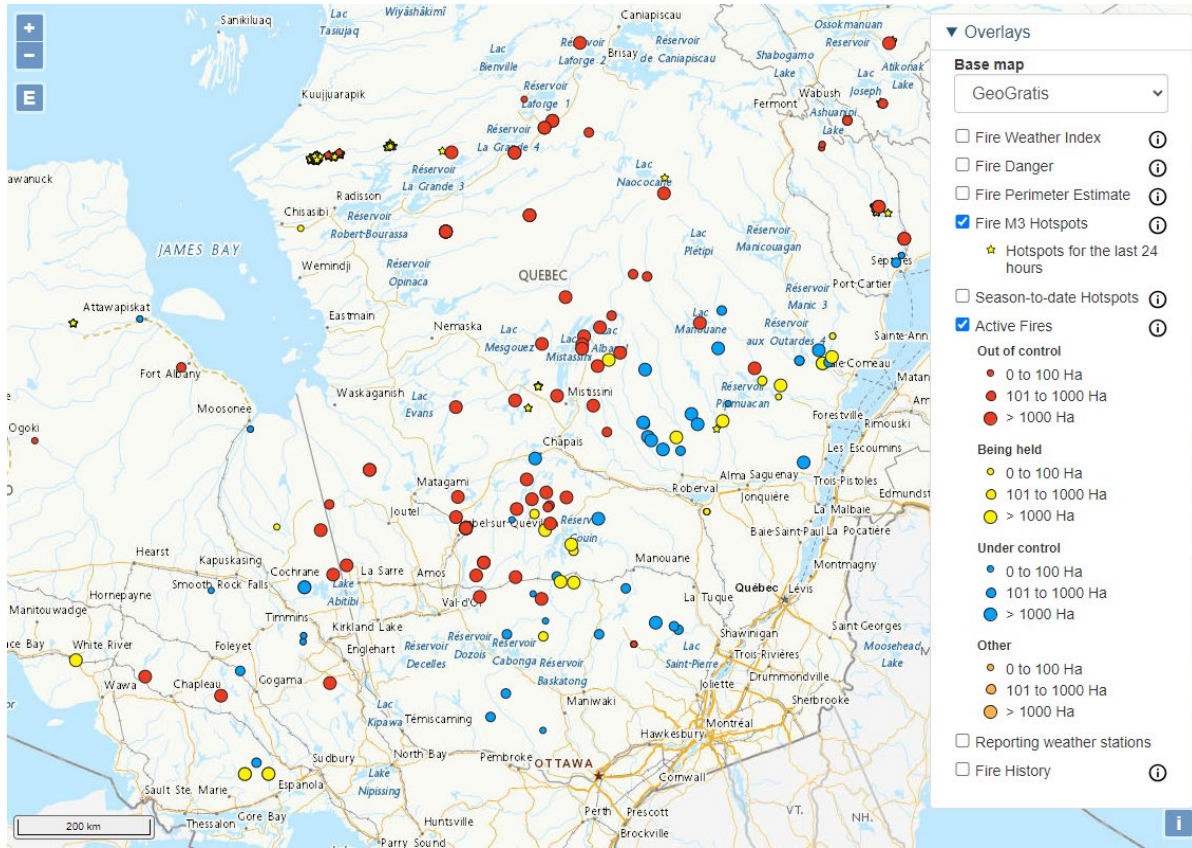
Figure 22 is a CWFIS map showing the active fires and fire hotspots in Quebec on June 27, 2023. On June 27 there were 80 active fires burning 3,200,677 acres in the province<sup>15</sup>. The plumes containing smoke and ozone precursors arising from the wildfires and recent hotspots northeast of Chisasibi were located in the source region intersected by the HYSPLIT back and forward trajectory plots for the wildfire-related ozone episode on June 29, 2023, shown in Section 3 of this document.

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<sup>14</sup> <https://sopfeu.qc.ca/>

<sup>15</sup> <https://ciffc.net/situation/2023-06-27>

Figure 22. Map from CWFIS of active fires and recent hotspots in Quebec on June 27, 2023.



#### 2.1.4. Media Coverage

Similar to the media and messaging coverage shown for the wildfire-related ozone episode on June 1-2, 2023, Table 7 illustrates the severe nature of the wildfire-related pollution episode in the Great Lakes region and Cuyahoga County in particular, and serves as further evidence that the wildfire-related ozone episode on June 29, 2023, was not local in nature but driven by transported wildfire smoke and ozone precursors from Quebec that blanketed the Great Lakes region.

**Table 7. News media reporting on the impact of the Quebec wildfires on air quality in the Great Lakes region.**

Date	Source	Headline
June 28, 2023	The New York Times	Wildfire smoke from Canadian fires blankets Great Lakes region <sup>16</sup>
June 28, 2023	Akron Beacon Journal	Canadian wildfire haze drifts into Ohio causing unhealthy air. See the photos <sup>17</sup>
June 29, 2023	Reuters	Canadian wildfire smoke spreads, 100 million Americans under air-quality alerts <sup>18</sup>
June 29, 2023	Mahoning Matters	Mahoning Valley air quality back to 'very unhealthy' levels <sup>19</sup>
June 29, 2023	Newsweek	Before and After Photos Show Cleveland 'Disappear' Into Wildfire Smoke <sup>20</sup>
June 30, 2023	Cleveland.com	Cleveland area starts another day with smoky air, but relief might arrive during afternoon <sup>21</sup>

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<sup>16</sup> <https://www.nytimes.com/live/2023/06/28/us/canada-wildfires-air-quality-smoke>

<sup>17</sup> <https://www.beaconjournal.com/picture-gallery/news/2023/06/28/canadian-wildfire-smoke-covers-ohio-haze-see-photos/12177568002/>

<sup>18</sup> <https://www.reuters.com/world/us/smoke-canadian-wildfires-settles-over-us-midwest-east-2023-06-29>

<sup>19</sup> <https://www.mahoningmatters.com/news/local/article276862193.html>

<sup>20</sup> <https://www.newsweek.com/before-after-photos-cleveland-ohio-disappear-wildfire-smoke-1809836>

<sup>21</sup> <https://www.cleveland.com/metro/2023/06/cleveland-area-starts-another-day-with-smoky-air-but-relief-might-arrive-during-afternoon.html>

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

While the regional wildfire smoke episodes spanned multiple days in the summer of 2023, Cuyahoga and Lake counties experienced greatly enhanced ground-level ozone formation during the wildfire-related ozone episode on June 1-2, 2023. Cuyahoga County also saw substantially enhanced ground-level ozone formation during the wildfire-related ozone episode on June 29, 2023. The impacts of both wildfire-related ozone episodes are clearly seen in satellite imagery, remote sensing products, and surface monitors. The figures in this section that are used to establish the clear and causal relationship between the Canadian wildfires and the ozone episodes in Cuyahoga and Lake counties show data from AirNowTech.gov and include the following information:

- Hazard Mapping System (HMS) fire locations and smoke layers
- Air Quality System (AQS) daily average PM<sub>2.5</sub> concentrations
- HYSPLIT 72-hour back trajectories from June 1, 2023, released at 100, 250, and 500 meters
- HYSPLIT 72-hour forward trajectories from May 29, 2023, released at heights corresponding to those back trajectories
- HYSPLIT 72-hour back trajectories from June 2, 2023, released at 100, 250, and 500 meters
- HYSPLIT 48-hour forward trajectories from June 1, 2023, released at heights corresponding to the intersecting points of those back trajectories
- HYSPLIT 60-hour back trajectories from June 29, 2023, released at 100, 250, and 500 meters
- HYSPLIT 60-hour forward trajectories from June 27, 2023, released at heights corresponding to those back trajectories

NASA Worldview<sup>22</sup> data are also used in this section, and include the following information:

- Aerosol optical depth (AOD) from the Moderate Resolution Imaging Spectroradiometer (MODIS) combined Terra and Aqua Multi-Angle Implementation of Atmospheric Correction (MAIAC) Land Aerosol Optical Depth level 2 product overlaid on Terra MODIS corrected reflectance (true color) satellite imagery

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<sup>22</sup> <https://worldview.earthdata.nasa.gov>

- Suomi NPP corrected reflectance (true color) satellite imagery 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

Additional weight of evidence analyses are also presented in this section, and include the following information:

- Results and residual estimates of wildfire-related MDA8 ozone concentration impacts from the generalized additive model (GAM) developed by Dan Jaffe and Haebum Lee of the University of Washington (UW)<sup>23</sup>
- Fire impact estimates of wildfire-related MDA8 ozone concentration impacts from U.S. EPA’s Expedited Modeling of Burn Events Results (EMBER) dataset tool<sup>24</sup>
- Results and residual estimates of wildfire-related MDA8 ozone concentration impacts from U.S. EPA’s Meteorology-Adjusted Ozone Trends (MAOT) dataset<sup>25</sup>
- Analysis of hourly average PM<sub>2.5</sub> concentrations measured during the wildfire-related ozone episodes and comparison to historical average values during the month of June
- Analysis of hourly average NO<sub>2</sub> concentrations measured during the wildfire-related ozone episodes and comparison to historical average values during the month of June
- Analysis of hourly average CO concentrations measured during the wildfire-related ozone episodes and comparison to historical average values during the month of June

The clear causal relationships between the Canadian wildfires and MDA8 ozone concentrations in Cuyahoga and Lake counties during the wildfire-related ozone episode on June 1-2, 2023, and in Cuyahoga County during the wildfire-related ozone episode on June 29, 2023, are presented in this section. Clear causal relationship descriptions are presented separately for each episode.

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<sup>23</sup> <https://westar.shinyapps.io/PMO3smokeTool>

<sup>24</sup> <https://www.epa.gov/air-quality-analysis/expedited-modeling-burn-events-results-ember>

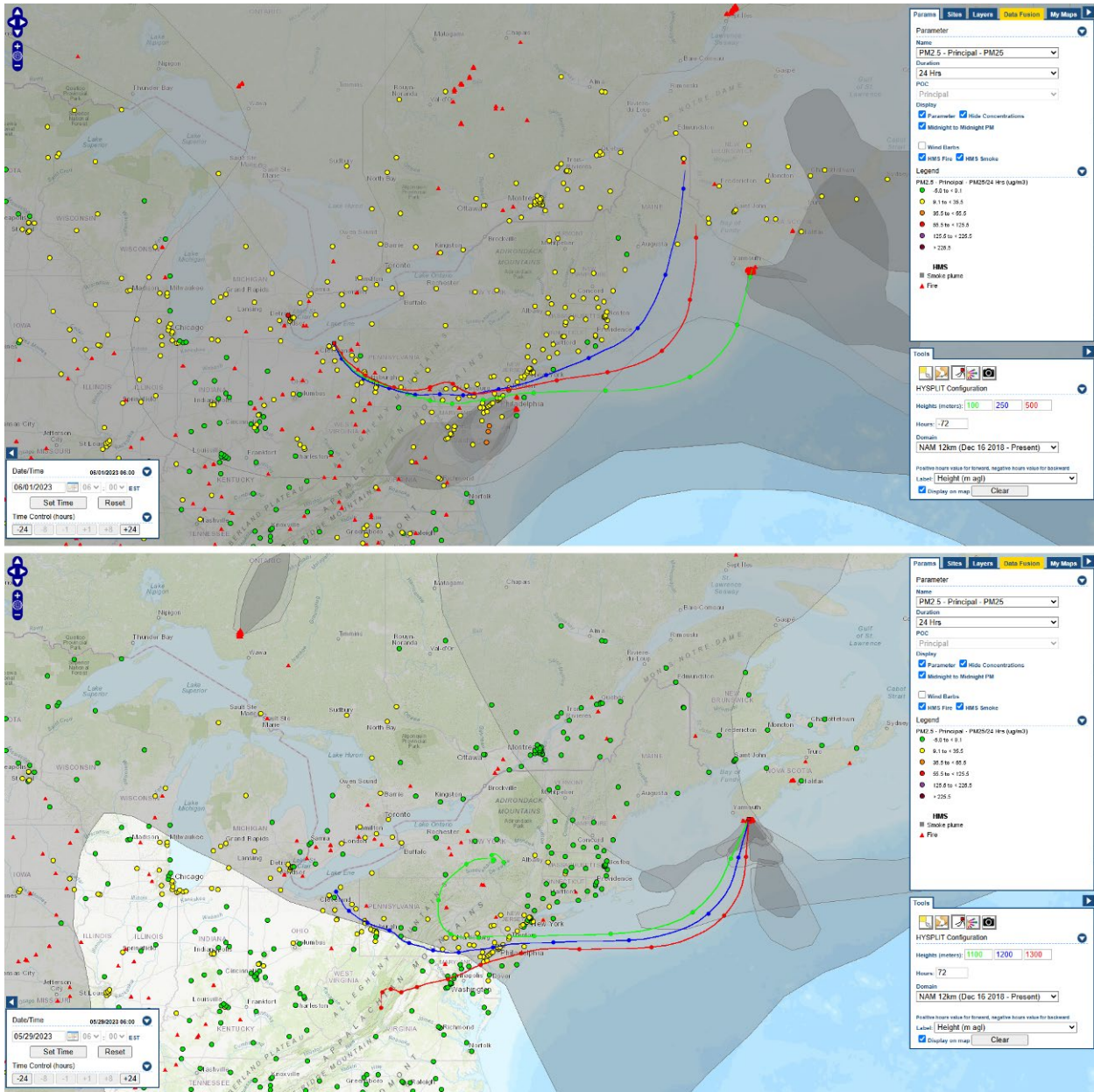
<sup>25</sup> <https://www.epa.gov/air-trends/trends-ozone-adjusted-weather-conditions>

### **3.1. Wildfire-Related Ozone Episode on June 1-2, 2023**

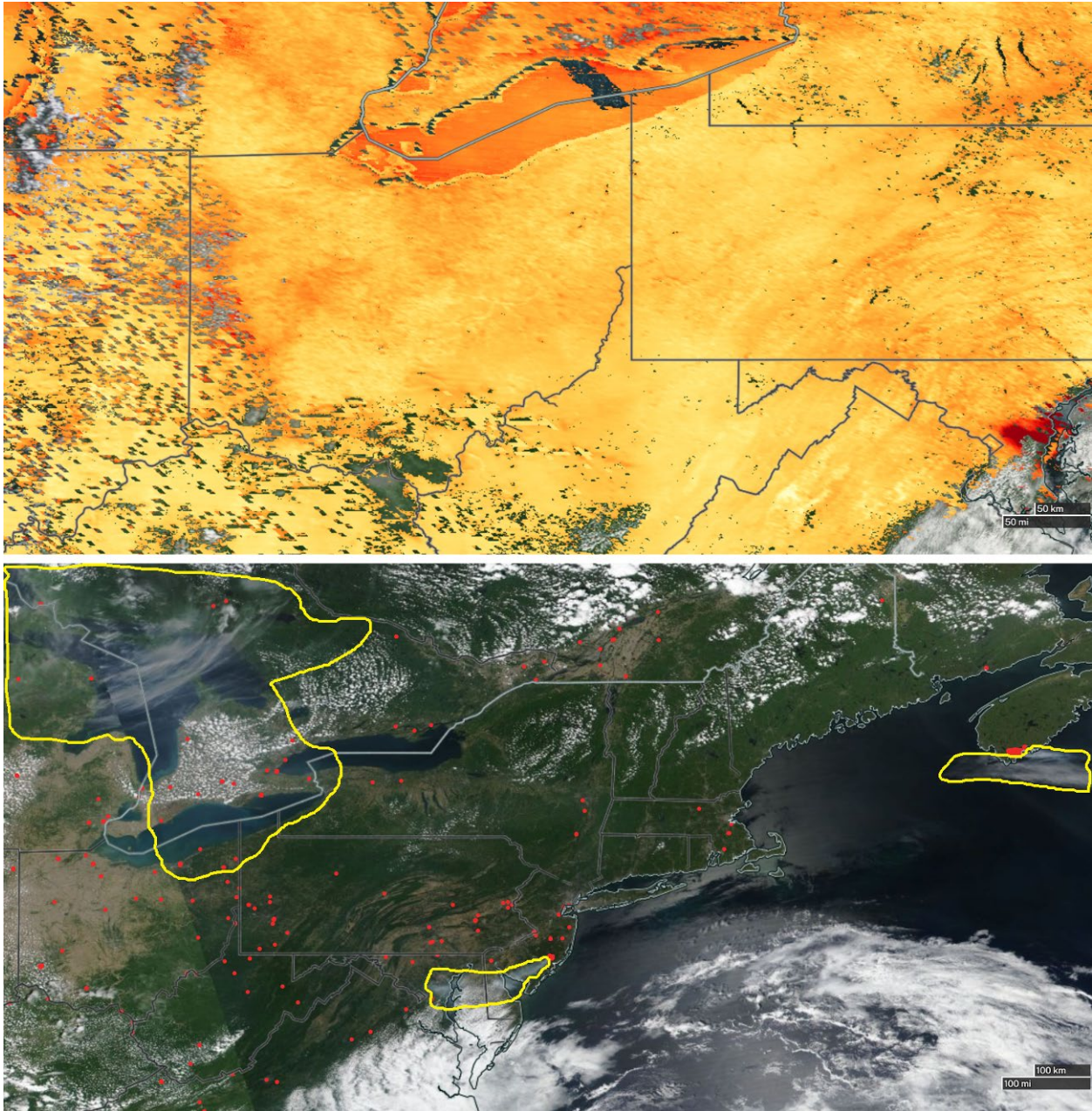
#### **3.1.1. Ozone Precursor Transport Analysis for June 1, 2023**

The HYSPLIT 72-hour back and forward trajectory plots show the origin and transport of the wildfire smoke plumes carrying ozone precursors that greatly enhanced ground-level ozone formation and contributed to the high monitored MDA8 ozone concentrations in Cuyahoga and Lake counties on June 1, 2023. Figure 23 shows the HYSPLIT 72-hour back trajectory plot from June 1, overlaid on a map of fire locations, monitored MDA8 ozone concentrations, and HMS smoke layers for June 1, as well as the HYSPLIT 72-hour forward trajectory plot from May 29 overlaid on a map of fire locations, monitored daily average PM<sub>2.5</sub> concentrations, and HMS smoke layers for May 29. The wildfire locations in and near the Bowers Meadows Wilderness Area, about 15 km (9 mi) southwest of Shelburne, Nova Scotia, coincide with the endpoint (at 1158 meters above ground level, AGL) of the 100-meter release height back trajectory from Cuyahoga and Lake counties, and the area of Cuyahoga and Lake counties is the endpoint (at 89 meters AGL) of the 1200-meter release height forward trajectory from those wildfires. The coincidence of the 72-hour back and forward trajectories between the wildfire locations and Cuyahoga and Lake counties serves as clear evidence that the smoke plumes carrying ozone precursors from these wildfires caused the high ozone concentrations in Cuyahoga and Lake counties on June 1, 2023. The accompanying AOD map (darker orange/red denotes higher AOD values) and satellite imagery for June 1 presented in Figure 24 provide further evidence that smoke and ozone precursors from these wildfires were present in Cuyahoga and Lake counties on June 1, 2023, and that these wildfire-related ozone precursors caused the high ozone concentrations at the impacted monitoring sites. For ease of access and clarity, Appendix A includes larger versions of both images shown in Figure 23.

**Figure 23. HYSPLIT 72-hour back trajectory plot from June 1, 2023, with fire locations, monitored daily average PM<sub>2.5</sub> concentrations, and HMS smoke layers for June 1, 2023 (top), and HYSPLIT 72-hour forward trajectory plot from May 29, 2023, with fire locations, monitored daily average PM<sub>2.5</sub> concentrations, and HMS smoke layers for May 29, 2023 (bottom).**



**Figure 24. MAIAC AOD imagery (top) and Suomi NPP satellite true color imagery with visible smoke and haze outlined in yellow (bottom) for June 1, 2023.**



### **3.1.2. Modeled Ozone Values and Residuals Analysis for June 1, 2023**

Further evidence that these wildfires impacted ozone concentrations in Cuyahoga and Lake counties on June 1, 2023, comes from an analysis of predicted MDA8 ozone values on this date and associated residuals/estimated fire impacts at each of the four impacted monitoring sites. A larger residual, which is the difference between the monitored MDA8 ozone value and the predicted MDA8 ozone value, indicates that the model has underpredicted the monitored MDA8 ozone value, which may mean that there were additional impacts increasing ozone concentrations that were not accounted for in the modeling, such as an influx of ozone precursors transported from wildfires. Thus, multiple models showing rather large residuals for ozone predictions at the four monitoring sites on this date would serve as additional evidence that monitored ozone concentrations at these sites on this date were impacted by other factors unaccounted for in the models, such as smoke and ozone precursors from wildfires.

The predicted values and residuals from two statistical modeling analyses (the UW GAM modeling analysis and the U.S. EPA MAOT modeling analysis) were assessed, as well as the estimated fire impacts and model biases based on the U.S. EPA EMBER photochemical modeling simulations dataset, including the U.S. EPA EMBER base scenario modeling analysis and the U.S. EPA EMBER no Canadian wildfires (NCW) scenario modeling analysis. The EMBER, GAM, and MAOT models all reported the presence of smoke at all four monitoring sites on June 1, 2023. Table 8 shows the predicted values and residuals/estimated fire impacts for each modeling analysis for each of the four monitoring sites on June 1, 2023. It should be noted that the estimated fire impact for the U.S. EPA EMBER modeling analysis was calculated as the direct modeled impact of Canadian wildfires on MDA8 ozone concentrations by taking the difference in predicted values between the base scenario and the NCW scenario. The model bias for the U.S. EPA EMBER modeling analysis was calculated by taking the difference between the monitored MDA8 ozone value and the EMBER predicted MDA8 ozone value for the base scenario, and a larger model bias would suggest that the model is not accounting for certain ozone sources or formation processes relevant to the date in question. While photochemical modeling explicitly simulates the impacts of wildfires on ozone concentrations within the modeling domain, statistical modeling predicts ozone concentrations as a function of several meteorological and other variables. However, these statistical models do not explicitly include wildfire indicators as dependent variables. Thus, the residuals for the statistical model predicted MDA8 ozone values can be interpreted as the

upper bound for ozone impacts caused by factors unaccounted for in the model, such as smoke and ozone precursors from wildfires. The EMBER estimated Canadian wildfire impacts were 2 ppb for all four sites on June 1, 2023. However, the EMBER model biases ranged from -8 to -16 ppb, suggesting that these fire impacts could be considered low confidence estimates. The GAM residuals ranged from 15.0 to 25.6 ppb and the MAOT residuals ranged from 4.3 to 13.5 ppb, suggesting that an external factor unaccounted for in the modeling, such as smoke and ozone precursors from wildfires, played a significant role in enhancing ozone formation at these monitoring sites on June 1, 2023. These large residual ozone impacts are likely attributable to the presence of ozone precursors transported from the wildfires in southern Nova Scotia.

**Table 8. Predicted MDA8 ozone values and associated residuals/estimated fire impacts at each monitoring site on June 1, 2023.**

<b>Monitoring Site Name</b>	District 6	Eastlake	GT Craig NCore PAMS	Painesville
<b>Monitored MDA8 Ozone Value (ppb)</b>	75	82	71	78
<b>EMBER Base Predicted Value (ppb)</b>	63	66	63	66
<b>EMBER NCW Predicted Value (ppb)</b>	61	64	61	64
<b>EMBER Canadian Wildfire Impact (ppb)</b>	2	2	2	2
<b>UW GAM Predicted Value (ppb)</b>	58.3*	58.7	56.0	52.4
<b>UW GAM Residual (ppb)</b>	16.7*	23.3	15.0	25.6
<b>MAOT Predicted Value (ppb)</b>	71.1	69.3	65.2	68.3
<b>MAOT Residual (ppb)</b>	4.3	13.5	5.8	10.5

Note: An asterisk denotes that results were obtained from the UW GAMv1 modeling analysis as it was the only version with results available. All other UW GAM results were obtained from the UW GAMv2 modeling analysis.

### 3.1.3. Other Wildfire-Related Pollutants Analysis for June 1, 2023

The plumes from the wildfires burning in southern Nova Scotia also directly transported PM<sub>2.5</sub>, NO<sub>2</sub>, and CO to Cuyahoga and Lake counties on June 1, 2023. While PM<sub>2.5</sub> and CO are directly emitted from wildfires, wildfire-related NO<sub>2</sub> is typically formed later via photochemical reactions involving the NO that is directly emitted from wildfires. Although

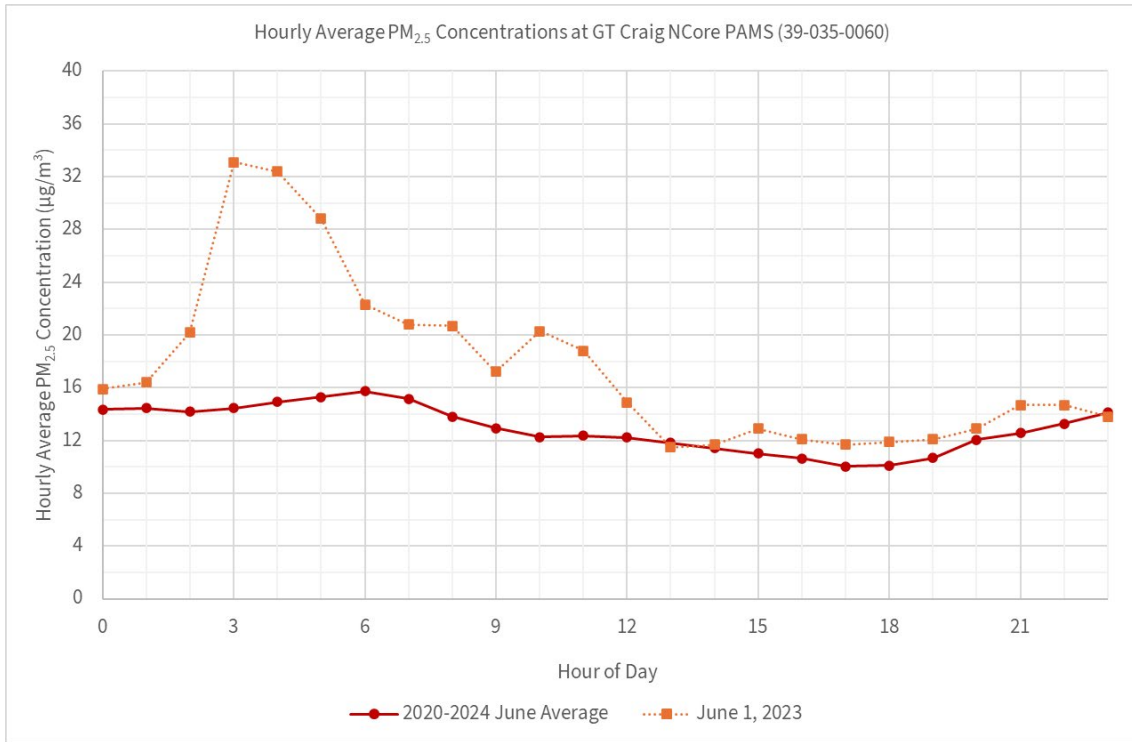
spikes in monitored concentrations of these pollutants may be expected at certain hours of the day due to typically urban area traffic patterns, elevated concentrations of these pollutants that persist throughout the day-night cycle would suggest the existence of an external source transporting these pollutants into the area, such as plumes of smoke and ozone precursors from wildfires. Comparisons of the mean hourly average concentrations at representative monitoring sites from June days across 2020-2024 to the hourly average concentrations on June 1, 2023, were performed to provide additional evidence that the plumes transported smoke and ozone precursors from the wildfires burning in southern Nova Scotia to the monitoring sites in Cuyahoga and Lake counties. Table 9 and Figure 25 show the hourly average PM<sub>2.5</sub> concentrations at the GT Craig NCore PAMS site on June 1, 2023, as well as the June 2020-2024 mean hourly average PM<sub>2.5</sub> concentrations at the site. Table 10 and Figure 26 show the hourly average NO<sub>2</sub> concentrations at the GT Craig NCore PAMS site on June 1, 2023, as well as the June 2020-2024 mean hourly average NO<sub>2</sub> concentrations at the site. Table 11 and Figure 27 show the hourly average CO concentrations at the GT Craig NCore PAMS site on June 1, 2023, as well as the June 2020-2024 mean hourly average CO concentrations at the site. Hourly average PM<sub>2.5</sub> concentrations at the GT Craig NCore PAMS site were significantly elevated across a 10-hour span on June 1, 2023, even when accounting for the typical morning spikes due to urban area traffic patterns, suggesting a prolonged influx of PM<sub>2.5</sub> into the Cleveland area from some external source, such as wildfires. Hourly average NO<sub>2</sub> concentrations were significantly elevated across 23 hours on June 1, 2023, suggesting an external source of NO<sub>2</sub>, such as plumes from wildfires that have already been subjected to photochemical reactions that convert NO to NO<sub>2</sub>. Hourly average CO concentrations were significantly elevated across 20 hours on June 1, 2023, outside of the typical window for morning urban traffic emissions, suggesting an external combustion source beyond motor vehicle exhaust that brought an influx of CO to the Cleveland area. The statistically significantly ( $p < 0.05$ ) elevated hourly average concentrations of all three wildfire-related pollutants at the GT Craig NCore PAMS site on June 1, 2023, serve as additional evidence of the wildfire impacts on monitored ozone concentrations in Cuyahoga and Lake counties on June 1, 2023.

**Table 9. Hourly average PM<sub>2.5</sub> concentrations at the GT Craig NCore PAMS (39-035-0060) monitoring site.**

Hour	2020-2024 June Mean Hourly PM <sub>2.5</sub> (µg/m <sup>3</sup> )	Hourly PM <sub>2.5</sub> on June 1, 2023 (µg/m <sup>3</sup> )
0	14.3	15.9
1	14.5	16.4
2	14.2	20.2
3	14.5	33.1
4	14.9	32.4
5	15.3	28.8
6	15.7	22.3
7	15.2	20.8
8	13.8	20.7
9	12.9	17.2
10	12.3	20.3
11	12.4	18.8
12	12.2	14.9
13	11.8	11.5
14	11.4	11.7
15	11.0	12.9
16	10.7	12.1
17	10.0	11.7
18	10.1	11.9
19	10.7	12.1
20	12.0	12.9
21	12.6	14.7
22	13.3	14.7
23	14.1	13.8

Note: Yellow highlighting denotes that the hourly concentration is statistically significantly greater than the 2020-2024 June hourly average ( $p < 0.05$ ).

**Figure 25. Hourly average PM<sub>2.5</sub> concentrations at the GT Craig NCore PAMS monitoring site in Cuyahoga County.**

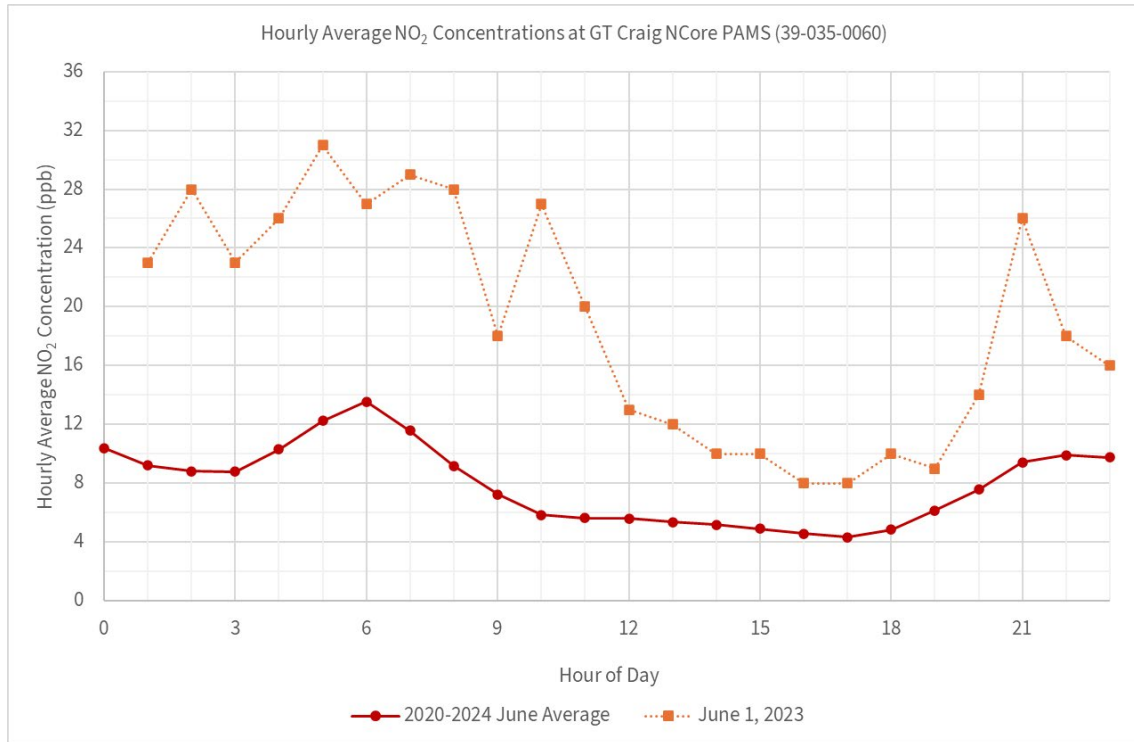


**Table 10. Hourly average NO<sub>2</sub> concentrations at the GT Craig NCore PAMS (39-035-0060) monitoring site.**

Hour	2020-2024 June Mean Hourly NO <sub>2</sub> (ppb)	Hourly NO <sub>2</sub> on June 1, 2023 (ppb)
0	10.4	N/A
1	9.2	23
2	8.8	28
3	8.8	23
4	10.3	26
5	12.2	31
6	13.5	27
7	11.6	29
8	9.2	28
9	7.2	18
10	5.8	27
11	5.6	20
12	5.6	13
13	5.3	12
14	5.2	10
15	4.9	10
16	4.6	8
17	4.3	8
18	4.8	10
19	6.1	9
20	7.6	14
21	9.4	26
22	9.9	18
23	9.8	16

Note: Yellow highlighting denotes that the hourly concentration is statistically significantly greater than the 2020-2024 June hourly average ( $p < 0.05$ ).

**Figure 26. Hourly average NO<sub>2</sub> concentrations at the GT Craig NCore PAMS monitoring site in Cuyahoga County.**

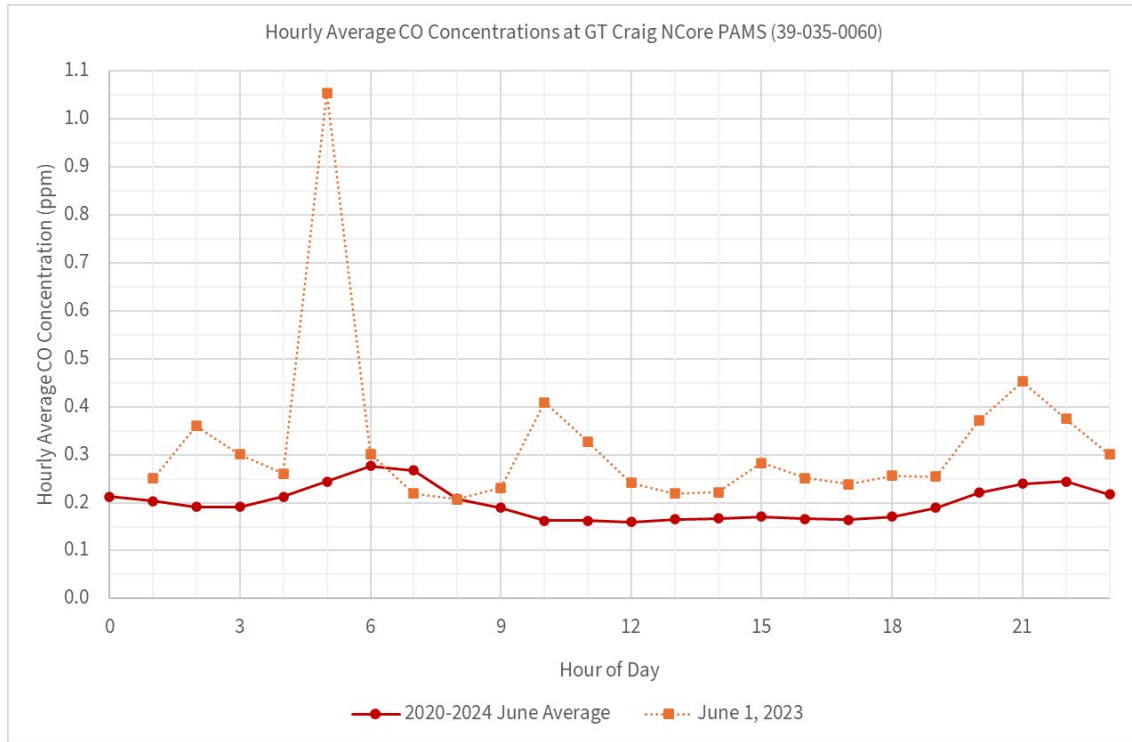


**Table 11. Hourly average CO concentrations at the GT Craig NCore PAMS (39-035-0060) monitoring site.**

Hour	2020-2024 June Mean Hourly CO (ppm)	Hourly CO on June 1, 2023 (ppm)
0	0.213	N/A
1	0.204	0.251
2	0.191	0.360
3	0.191	0.301
4	0.213	0.261
5	0.245	1.055
6	0.277	0.302
7	0.267	0.219
8	0.208	0.207
9	0.190	0.231
10	0.163	0.409
11	0.162	0.328
12	0.159	0.241
13	0.165	0.219
14	0.167	0.222
15	0.171	0.283
16	0.166	0.252
17	0.164	0.239
18	0.171	0.256
19	0.190	0.254
20	0.221	0.371
21	0.240	0.453
22	0.244	0.375
23	0.217	0.301

Note: Yellow highlighting denotes that the hourly concentration is statistically significantly greater than the 2020-2024 June hourly average ( $p < 0.05$ ).

**Figure 27. Hourly average CO concentrations at the GT Craig NCore PAMS monitoring site in Cuyahoga County.**

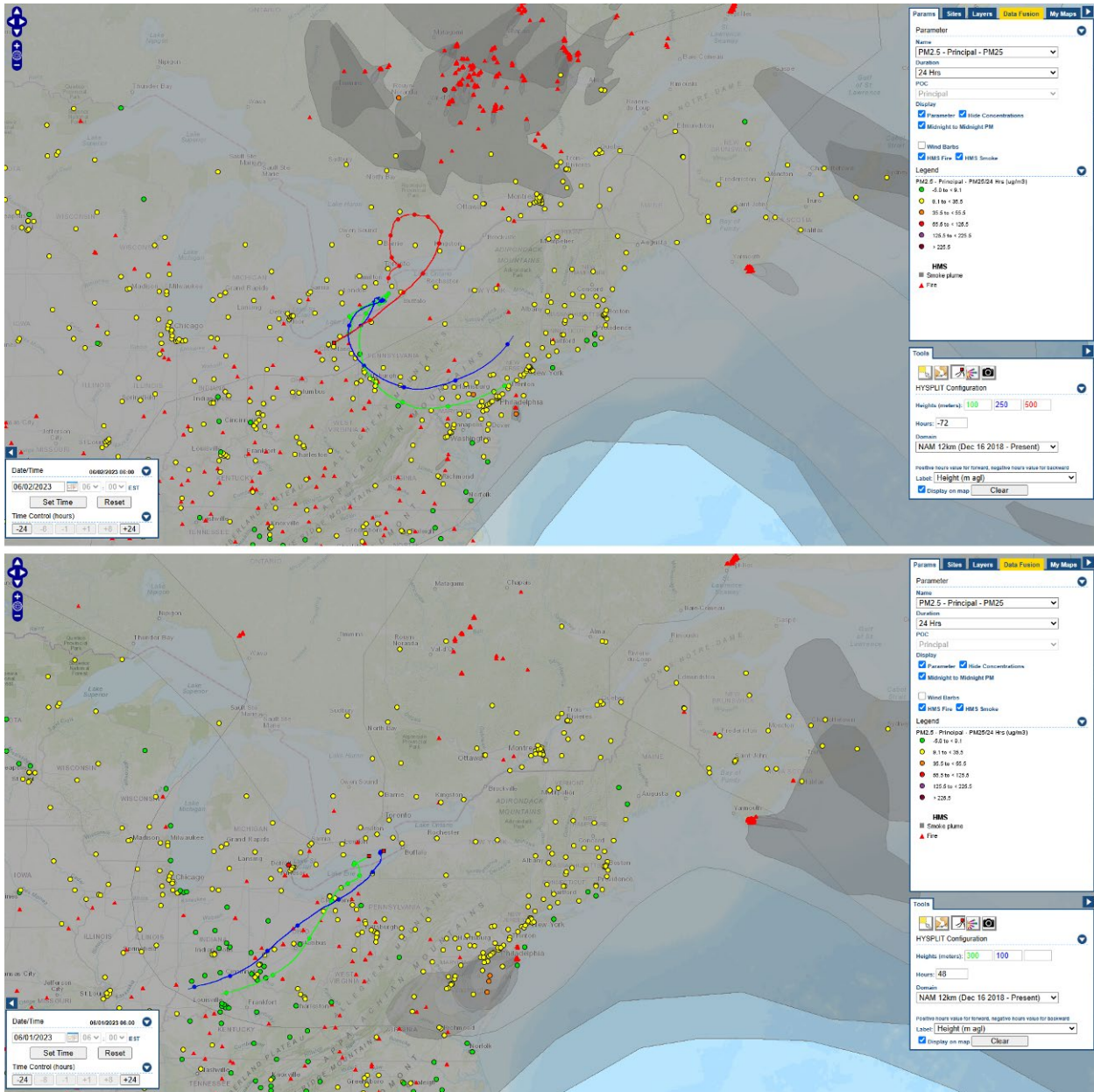


### 3.1.4. Ozone Precursor Transport Analysis for June 2, 2023

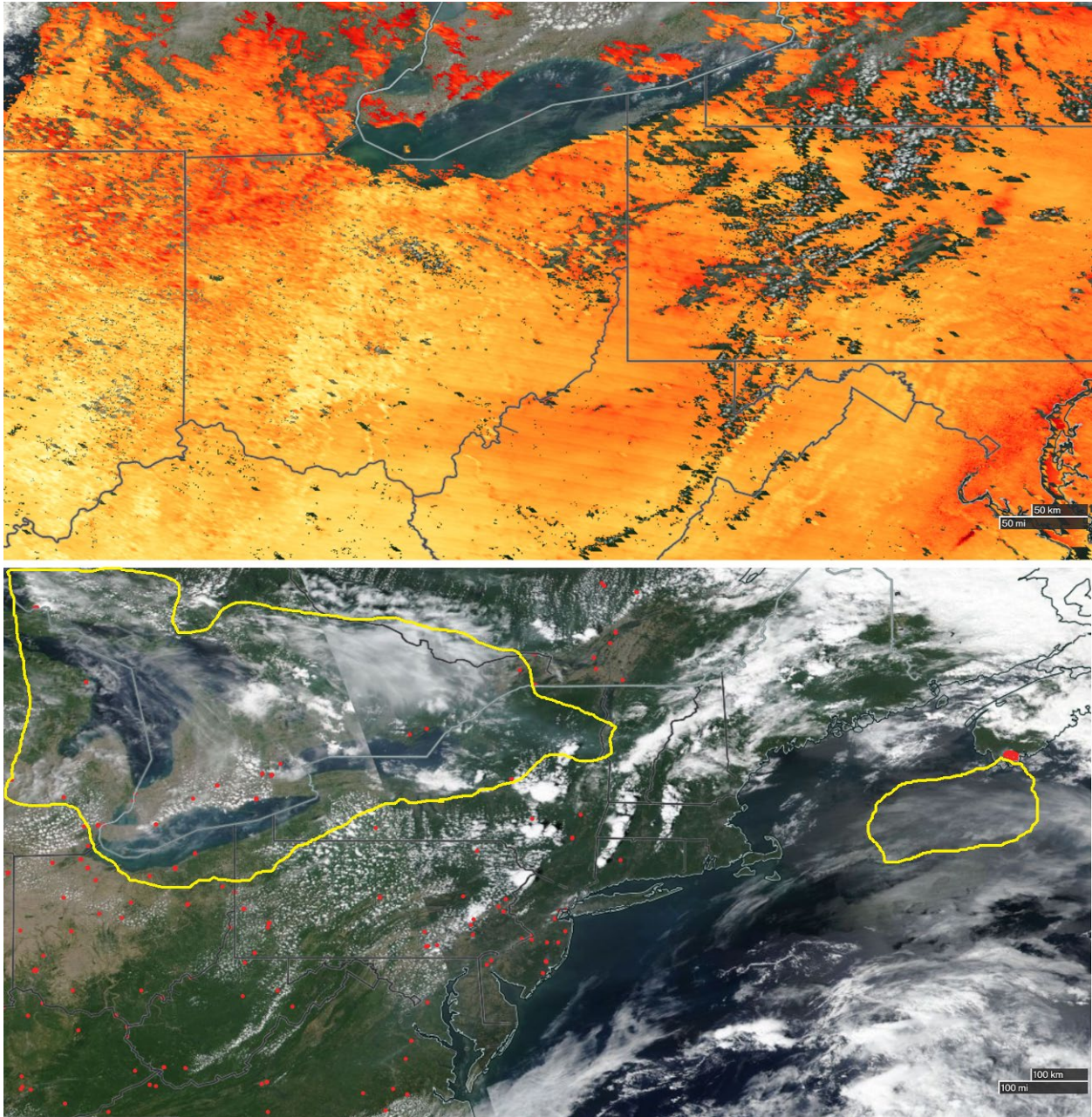
The HYSPLIT 24-hour back and forward trajectory plots show the continued transport of the wildfire smoke plumes carrying ozone precursors that greatly enhanced ground-level ozone formation and contributed to the high monitored MDA8 ozone concentrations in Cuyahoga and Lake counties on June 2, 2023. As shown in Section 3.1.1, the wildfire smoke plumes carrying ozone precursors from the wildfires burning in southern Nova Scotia had already begun impacting Cuyahoga and Lake counties, as well as the surrounding areas near the central and eastern portions of Lake Erie, on June 1, 2023. The air mass containing the wildfire smoke and ozone precursors stalled within the high-pressure system over Lake Erie, barely moving westward while continuing to contribute to excess ground-level ozone formation in Cuyahoga and Lake counties on June 2, 2023. Figure 28 shows the HYSPLIT 72-hour back trajectory plot from June 2, overlaid on a map of fire locations, monitored daily average PM<sub>2.5</sub> concentrations, and HMS smoke layers for June 2, as well as the HYSPLIT 24-hour forward trajectory plot from June 1 overlaid on a map of fire locations, monitored daily average PM<sub>2.5</sub> concentrations, and HMS smoke layers for June 1. 24 hours along the 72-hour back

trajectories released from the Cleveland area at heights of 100 m AGL and 250 m AGL, these air parcels were located at points over eastern Lake Erie at respective heights of 302 m AGL and 53 m AGL. Parcels were released at these points at respective heights of 300 m AGL and 100 m AGL on June 1, following along a 48-hour forward trajectory. These parcels intersected the Cleveland area on June 2 at respective heights of 124 m AGL and 338 m AGL. The back and forward trajectories illustrate the extremely slow-moving nature of the airmass caught in the high-pressure system over eastern Lake Erie. This airmass was previously shown in Section 3.1.1 to contain smoke and ozone precursors from the wildfires burning in southern Nova Scotia, which clearly were still impacting Cuyahoga and Lake counties on June 2, 2023. The accompanying AOD map (darker orange/red denotes higher AOD values) and satellite imagery for June 2 presented in Figure 29 provide further evidence that smoke and ozone precursors from these wildfires were still present in Cuyahoga and Lake counties on June 2, 2023, and that these wildfire-related ozone precursors caused the high ozone concentrations at the impacted monitoring sites. For ease of access and clarity, Appendix A includes larger versions of both images shown in Figure 28.

**Figure 28. HYSPLIT 72-hour back trajectory plot from June 2, 2023, with fire locations, monitored daily average PM<sub>2.5</sub> concentrations, and HMS smoke layers for June 2, 2023 (top), and HYSPLIT 48-hour forward trajectory plot from June 1, 2023, with fire locations, monitored daily average PM<sub>2.5</sub> concentrations, and HMS smoke layers for June 1, 2023 (bottom).**



**Figure 29. MAIAC AOD imagery (top) and Suomi NPP satellite true color imagery with visible smoke and haze outlined in yellow (bottom) for June 2, 2023.**



### **3.1.5. Modeled Ozone Values and Residuals Analysis for June 2, 2023**

Further evidence that these wildfires impacted ozone concentrations in Cuyahoga and Lake counties on June 2, 2023, comes from an analysis of predicted MDA8 ozone values on this date and associated residuals/estimated fire impacts at each of the four impacted monitoring sites. A larger residual, which is the difference between the monitored MDA8 ozone value and the predicted MDA8 ozone value, indicates that the model has underpredicted the monitored MDA8 ozone value, which may mean that there were additional impacts increasing ozone concentrations that were not accounted for in the modeling, such as an influx of ozone precursors transported from wildfires. Thus, multiple models showing rather large residuals for ozone predictions at the four monitoring sites on this date would serve as additional evidence that monitored ozone concentrations at these sites on this date were impacted by other factors unaccounted for in the models, such as smoke and ozone precursors from wildfires.

The predicted values and residuals from two statistical modeling analyses (the UW GAM modeling analysis and the U.S. EPA MAOT modeling analysis) were assessed, as well as the estimated fire impacts and model biases based on the U.S. EPA EMBER photochemical modeling simulations dataset, including the U.S. EPA EMBER base scenario modeling analysis and the U.S. EPA EMBER NCW scenario modeling analysis. The EMBER, GAM, and MAOT models all reported the presence of smoke at all four monitoring sites on June 2, 2023. Table 12 shows the predicted values and residuals/estimated fire impacts for each modeling analysis for each of the four monitoring sites on June 2, 2023. It should be noted that the estimated fire impact for the U.S. EPA EMBER modeling analysis was calculated as the direct modeled impact of Canadian wildfires on MDA8 ozone concentrations by taking the difference in predicted values between the base scenario and the NCW scenario. The model bias for the U.S. EPA EMBER modeling analysis was calculated by taking the difference between the monitored MDA8 ozone value and the EMBER predicted MDA8 ozone value for the base scenario, and a larger model bias would suggest that the model is not accounting for certain ozone sources or formation processes relevant to the date in question. While photochemical modeling explicitly simulates the impacts of wildfires on ozone concentrations within the modeling domain, statistical modeling predicts ozone concentrations as a function of several meteorological and other variables. However, these statistical models do not explicitly include wildfire indicators as dependent variables. Thus, the residuals for the statistical model predicted MDA8 ozone values can be interpreted as the

upper bound for ozone impacts caused by factors unaccounted for in the model, such as smoke and ozone precursors from wildfires. The EMBER estimated Canadian wildfire impacts were 1 ppb for all four sites on June 2, 2023. However, the EMBER model biases ranged from -6 to -22 ppb, suggesting that these fire impacts could be considered low confidence estimates. The GAM residuals ranged from 26.6 to 32.0 ppb and the MAOT residuals ranged from 12.0 to 17.4 ppb, suggesting that an external factor unaccounted for in the modeling, such as smoke and ozone precursors from wildfires, played a significant role in enhancing ozone formation at these monitoring sites on June 2, 2023. These large residual ozone impacts are likely attributable to the continued presence of ozone precursors transported from the wildfires in southern Nova Scotia.

**Table 12. Predicted MDA8 ozone values and associated residuals/estimated fire impacts at each monitoring site on June 2, 2023.**

<b>Monitoring Site Name</b>	District 6	Eastlake	GT Craig NCore PAMS	Painesville
<b>Monitored MDA8 Ozone Value (ppb)</b>	79	84	76	81
<b>EMBER Base Predicted Value (ppb)</b>	57	75	57	75
<b>EMBER NCW Predicted Value (ppb)</b>	56	74	56	74
<b>EMBER Canadian Wildfire Impact (ppb)</b>	1	1	1	1
<b>UW GAM Predicted Value (ppb)</b>	52.4*	56.1	48.5	49.0
<b>UW GAM Residual (ppb)</b>	26.6*	27.9	27.5	32.0
<b>MAOT Predicted Value (ppb)</b>	62.8	66.6	62.6	69.0
<b>MAOT Residual (ppb)</b>	16.8	17.4	14.1	12.0

Note: An asterisk denotes that results were obtained from the UW GAMv1 modeling analysis as it was the only version with results available. All other UW GAM results were obtained from the UW GAMv2 modeling analysis.

### 3.1.6. Other Wildfire-Related Pollutants Analysis for June 2, 2023

The plumes from the wildfires burning in southern Nova Scotia also directly transported PM<sub>2.5</sub>, NO<sub>2</sub>, and CO to Cuyahoga and Lake counties, which continued to impact monitored ozone concentrations on June 2, 2023. While PM<sub>2.5</sub> and CO are directly emitted from wildfires, wildfire-related NO<sub>2</sub> is typically formed later via photochemical reactions involving the NO

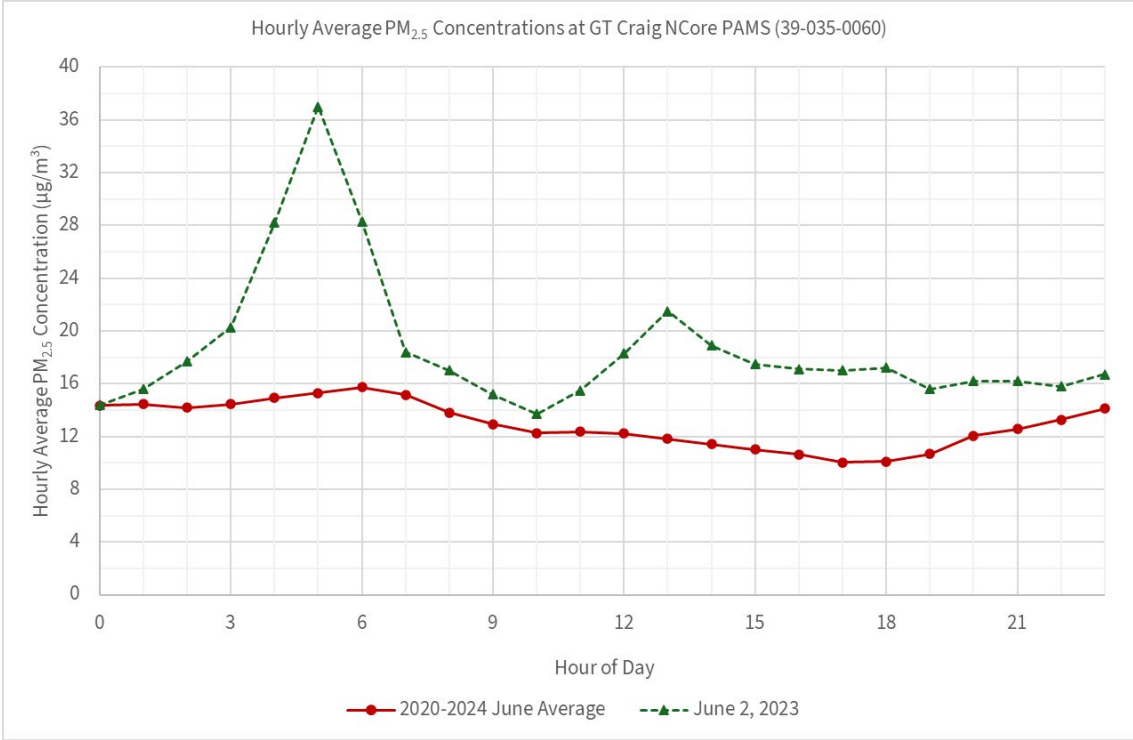
that is directly emitted from wildfires. Although spikes in monitored concentrations of these pollutants may be expected at certain hours of the day due to typically urban area traffic patterns, elevated concentrations of these pollutants that persist throughout the day-night cycle would suggest the existence of an external source transporting these pollutants into the area, such as plumes of smoke and ozone precursors from wildfires. Comparisons of the mean hourly average concentrations at representative monitoring sites from June days across 2020-2024 to the hourly average concentrations on June 2, 2023, were performed to provide additional evidence that the plumes transported smoke and ozone precursors from the wildfires burning in southern Nova Scotia to the monitoring sites in Cuyahoga and Lake counties. Table 13 and Figure 30 show the hourly average PM<sub>2.5</sub> concentrations at the GT Craig NCore PAMS site on June 2, 2023, as well as the June 2020-2024 mean hourly average PM<sub>2.5</sub> concentrations at the site. Table 14 and Figure 31 show the hourly average NO<sub>2</sub> concentrations at the GT Craig NCore PAMS site on June 2, 2023, as well as the June 2020-2024 mean hourly average NO<sub>2</sub> concentrations at the site. Table 15 and Figure 32 show the hourly average CO concentrations at the GT Craig NCore PAMS site on June 2, 2023, as well as the June 2020-2024 mean hourly average CO concentrations at the site. Hourly average PM<sub>2.5</sub> concentrations at the GT Craig NCore PAMS site were significantly elevated across 17 hours on June 2, 2023, even when accounting for the typical morning spikes due to urban area traffic patterns, suggesting a prolonged influx of PM<sub>2.5</sub> into the Cleveland area from some external source, such as wildfires. Hourly average NO<sub>2</sub> concentrations were significantly elevated across 23 hours on June 2, 2023, suggesting an external source of NO<sub>2</sub>, such as plumes from wildfires that have already been subjected to photochemical reactions that convert NO to NO<sub>2</sub>. Hourly average CO concentrations were significantly elevated across 21 hours on June 2, 2023, suggesting an external combustion source beyond motor vehicle exhaust that brought an influx of CO to the Cleveland area. The statistically significantly ( $p < 0.05$ ) elevated hourly average concentrations of all three wildfire-related pollutants at the GT Craig NCore PAMS site on June 2, 2023, serve as additional evidence of the continued wildfire impacts on monitored ozone concentrations in Cuyahoga and Lake counties on June 2, 2023.

**Table 13. Hourly average PM<sub>2.5</sub> concentrations at the GT Craig NCore PAMS (39-035-0060) monitoring site.**

Hour	2020-2024 June Mean Hourly PM <sub>2.5</sub> (µg/m <sup>3</sup> )	Hourly PM <sub>2.5</sub> on June 2, 2023 (µg/m <sup>3</sup> )
0	14.3	14.4
1	14.5	15.6
2	14.2	17.7
3	14.5	20.3
4	14.9	28.2
5	15.3	37.0
6	15.7	28.3
7	15.2	18.4
8	13.8	17.0
9	12.9	15.2
10	12.3	13.7
11	12.4	15.5
12	12.2	18.3
13	11.8	21.5
14	11.4	18.9
15	11.0	17.5
16	10.7	17.1
17	10.0	17.0
18	10.1	17.2
19	10.7	15.6
20	12.0	16.2
21	12.6	16.2
22	13.3	15.8
23	14.1	16.7

Note: Yellow highlighting denotes that the hourly concentration is statistically significantly greater than the 2020-2024 June hourly average ( $p < 0.05$ ).

**Figure 30. Hourly average PM<sub>2.5</sub> concentrations at the GT Craig NCore PAMS monitoring site in Cuyahoga County.**

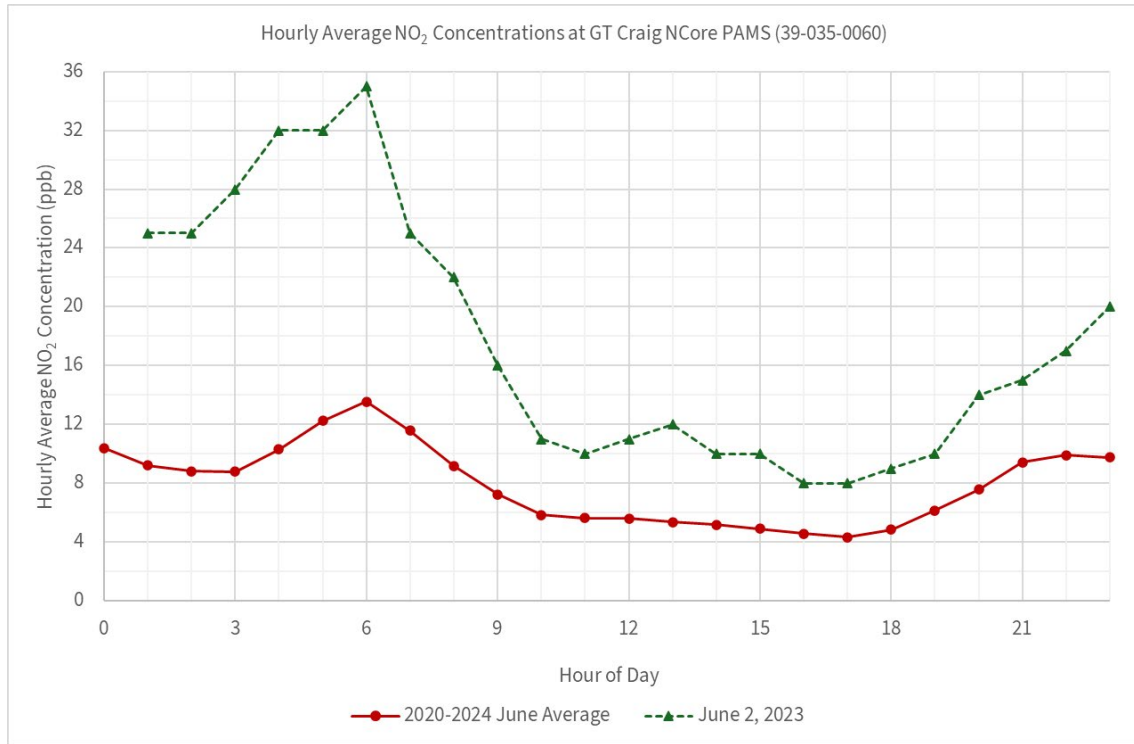


**Table 14. Hourly average NO<sub>2</sub> concentrations at the GT Craig NCore PAMS (39-035-0060) monitoring site.**

Hour	2020-2024 June Mean Hourly NO <sub>2</sub> (ppb)	Hourly NO <sub>2</sub> on June 2, 2023 (ppb)
0	10.4	N/A
1	9.2	25
2	8.8	25
3	8.8	28
4	10.3	32
5	12.2	32
6	13.5	35
7	11.6	25
8	9.2	22
9	7.2	16
10	5.8	11
11	5.6	10
12	5.6	11
13	5.3	12
14	5.2	10
15	4.9	10
16	4.6	8
17	4.3	8
18	4.8	9
19	6.1	10
20	7.6	14
21	9.4	15
22	9.9	17
23	9.8	20

Note: Yellow highlighting denotes that the hourly concentration is statistically significantly greater than the 2020-2024 June hourly average ( $p < 0.05$ ).

**Figure 31. Hourly average NO<sub>2</sub> concentrations at the GT Craig NCore PAMS monitoring site in Cuyahoga County.**

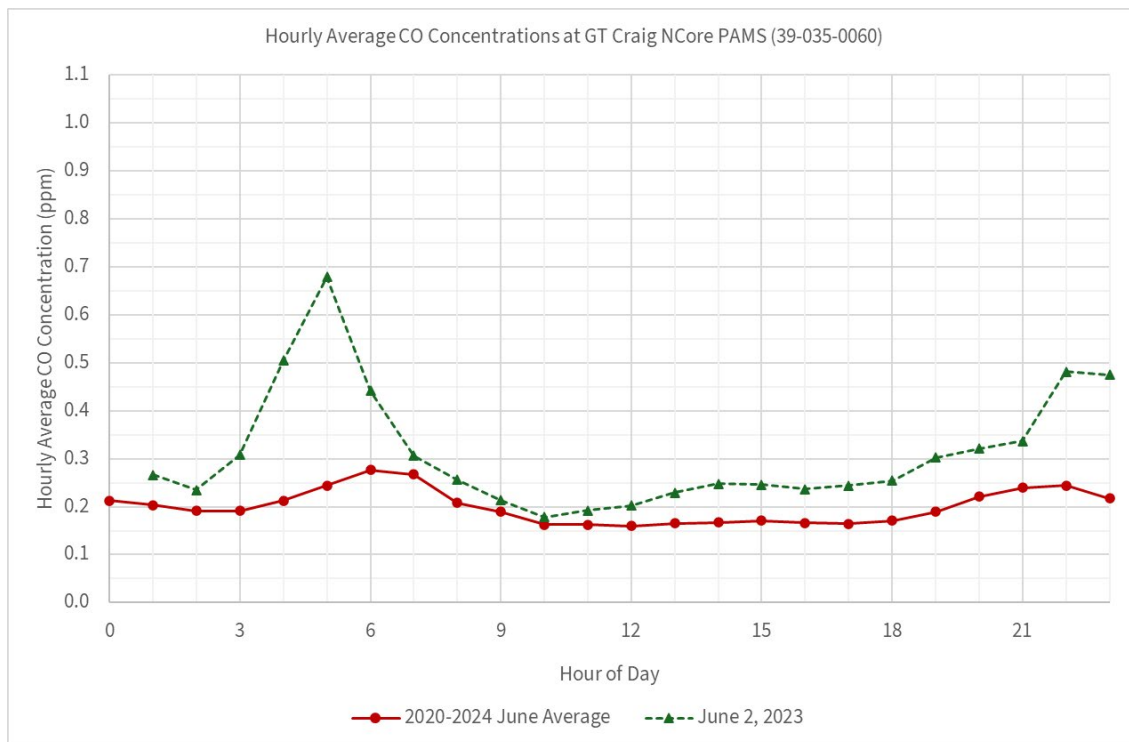


**Table 15. Hourly average CO concentrations at the GT Craig NCore PAMS (39-035-0060) monitoring site.**

Hour	2020-2024 June Mean Hourly CO (ppm)	Hourly CO on June 2, 2023 (ppm)
0	0.213	N/A
1	0.204	0.266
2	0.191	0.235
3	0.191	0.308
4	0.213	0.505
5	0.245	0.679
6	0.277	0.442
7	0.267	0.306
8	0.208	0.256
9	0.190	0.214
10	0.163	0.178
11	0.162	0.192
12	0.159	0.202
13	0.165	0.229
14	0.167	0.248
15	0.171	0.246
16	0.166	0.237
17	0.164	0.244
18	0.171	0.254
19	0.190	0.303
20	0.221	0.321
21	0.240	0.337
22	0.244	0.482
23	0.217	0.475

Note: Yellow highlighting denotes that the hourly concentration is statistically significantly greater than the 2020-2024 June hourly average ( $p < 0.05$ ).

**Figure 32. Hourly average CO concentrations at the GT Craig NCore PAMS monitoring site in Cuyahoga County.**

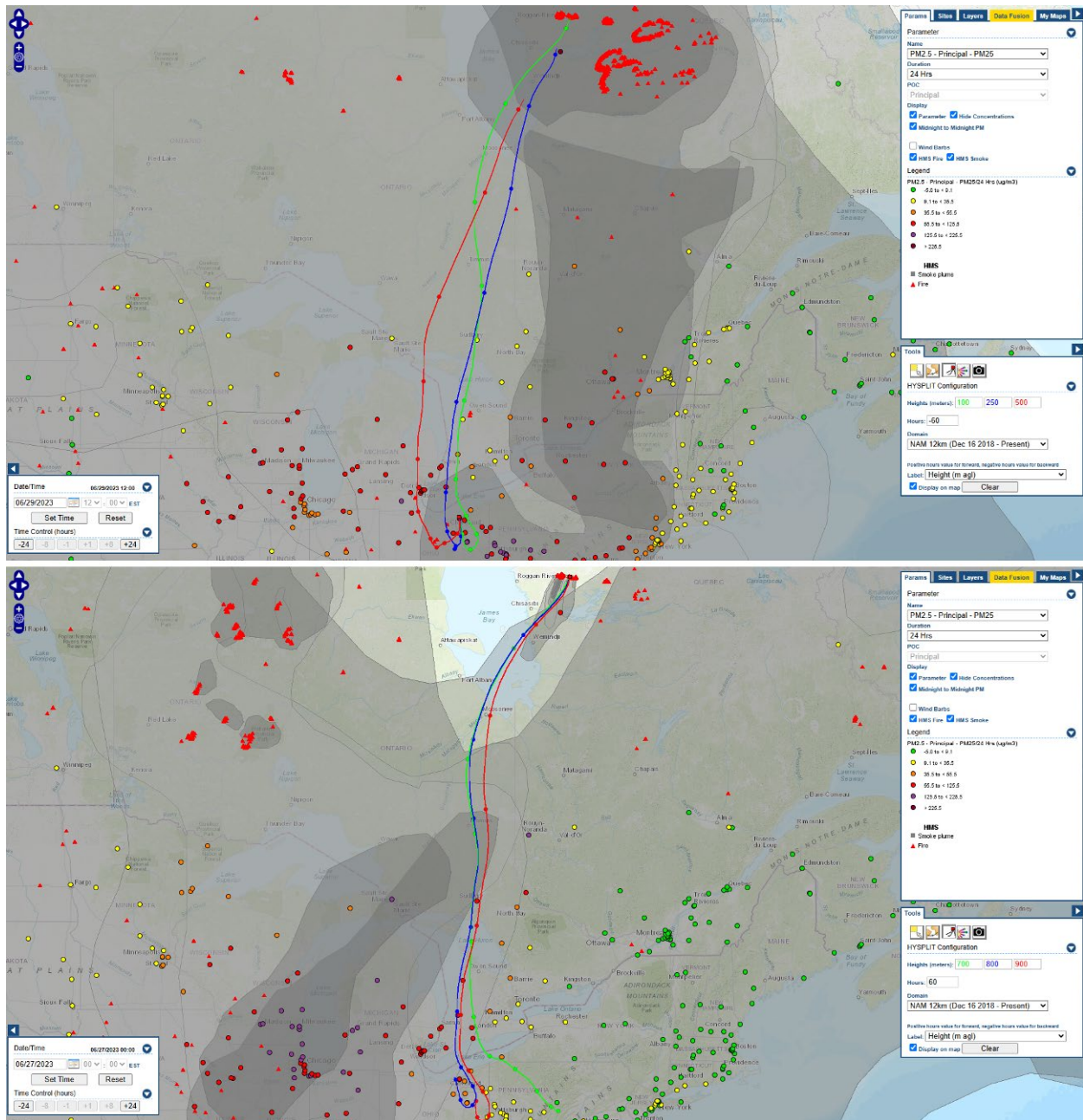


## **3.2. Wildfire-Related Ozone Episode on June 29, 2023**

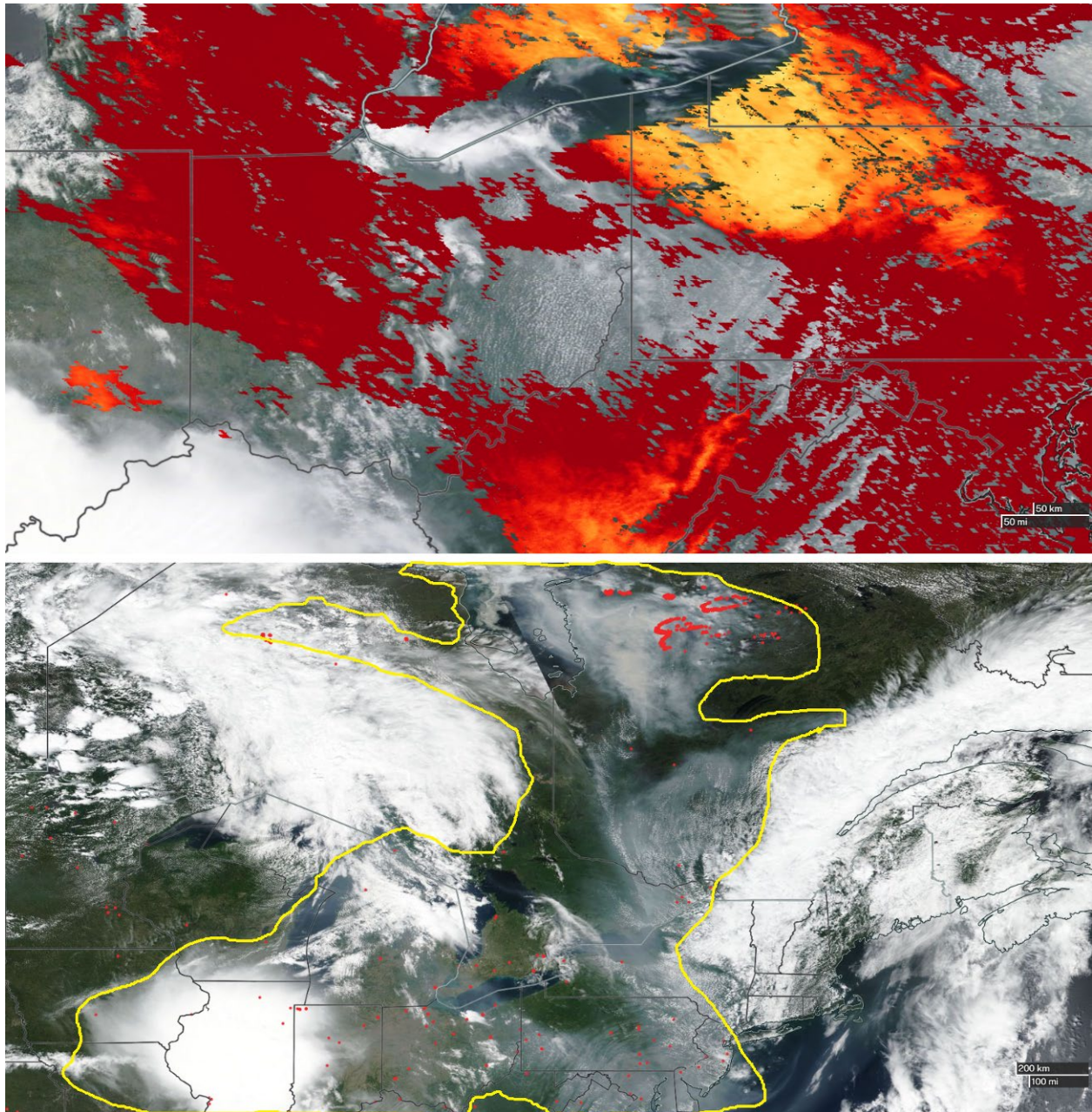
### **3.1.1. Ozone Precursor Transport Analysis for June 29, 2023**

The HYSPLIT 60-hour back and forward trajectory plots show the origin and transport of the plumes containing wildfire smoke and ozone precursors that caused the high MDA8 ozone concentrations in Cuyahoga County on June 29, 2023. Figure 33 shows the HYSPLIT 60-hour back trajectory plot for June 29, overlaid on a map of fire locations, monitored daily average PM<sub>2.5</sub> concentrations, and HMS smoke layers for June 29, as well as the HYSPLIT 60-hour forward trajectory plot for June 27, overlaid on a map of fire locations, monitored daily average PM<sub>2.5</sub> concentrations, and HMS smoke layers for June 27. The wildfire and smoke locations 120 km (75 mi) northeast of Chisasibi, Quebec coincide with the endpoint (at 802 meters AGL) of the 100-meter release height back trajectory from Cuyahoga County and Cuyahoga County is the endpoint (at 62 meters AGL) of the 800-meter release height forward trajectory from those wildfires. The coincidence of the 60-hour back and forward trajectories between the wildfire locations and Cuyahoga County serves as clear evidence that the smoke and ozone precursors from the wildfires in Quebec caused the high MDA8 ozone concentrations in Cuyahoga County on June 29, 2023. The accompanying AOD map (darker orange/red denotes higher AOD values) and satellite imagery for June 29 presented in Figure 34, which show high AOD values as well as visible smoke and haze over most of Ohio, provide further evidence that dense smoke and ozone precursors from the wildfires were present in Cuyahoga County on June 29, 2023, and that the ozone precursors from the wildfires caused the high MDA8 ozone concentrations at the District 6 and GT Craig NCore PAMS monitoring sites. For ease of access and clarity, Appendix A includes larger versions of both images shown in Figure 33.

**Figure 33. HYSPLIT 60-hour back trajectory plot from June 29, 2023, with fire locations, monitored daily average PM<sub>2.5</sub> concentrations, and HMS smoke layers for June 29, 2023 (top), and HYSPLIT 60-hour forward trajectory plot from June 27, 2023, with fire locations, monitored daily average PM<sub>2.5</sub> concentrations, and HMS smoke layers for June 27, 2023 (bottom).**



**Figure 34. MAIAC AOD imagery (top) and Suomi NPP satellite true color imagery with visible smoke and haze outlined in yellow (bottom) for June 29, 2023.**



### **3.1.2. Modeled Ozone Values and Residuals Analysis for June 29, 2023**

Further evidence that these wildfires impacted ozone concentrations in Cuyahoga and Lake counties on June 2, 2023, comes from an analysis of predicted MDA8 ozone values on this date and associated residuals/estimated fire impacts at each of the four impacted monitoring sites. A larger residual, which is the difference between the monitored MDA8 ozone value and the predicted MDA8 ozone value, indicates that the model has underpredicted the monitored MDA8 ozone value, which may mean that there were additional impacts increasing ozone concentrations that were not accounted for in the modeling, such as an influx of ozone precursors transported from wildfires. Thus, multiple models showing rather large residuals for ozone predictions at the four monitoring sites on this date would serve as additional evidence that monitored ozone concentrations at these sites on this date were impacted by other factors unaccounted for in the models, such as smoke and ozone precursors from wildfires.

The predicted values and residuals from two statistical modeling analyses (the UW GAM modeling analysis and the U.S. EPA MAOT modeling analysis) were assessed, as well as the estimated fire impacts and model biases based on the U.S. EPA EMBER photochemical modeling simulations dataset, including the U.S. EPA EMBER base scenario modeling analysis and the U.S. EPA EMBER NCW scenario modeling analysis. The EMBER, GAM, and MAOT models all reported the presence of smoke at both the District 6 and GT Craig NCore PAMS monitoring sites on June 29, 2023. Table 16 shows the predicted values and residuals/estimated fire impacts for each modeling analysis for both monitoring sites on June 29, 2023. It should be noted that the estimated fire impact for the U.S. EPA EMBER modeling analysis was calculated as the direct modeled impact of Canadian wildfires on MDA8 ozone concentrations by taking the difference in predicted values between the base scenario and the NCW scenario. The model bias for the U.S. EPA EMBER modeling analysis was calculated by taking the difference between the monitored MDA8 ozone value and the EMBER predicted MDA8 ozone value for the base scenario, and a larger model bias would suggest that the model is not accounting for certain ozone sources or formation processes relevant to the date in question. While photochemical modeling explicitly simulates the impacts of wildfires on ozone concentrations within the modeling domain, statistical modeling predicts ozone concentrations as a function of several meteorological and other variables. However, these statistical models do not explicitly include wildfire indicators as dependent variables. Thus, the residuals for the statistical model predicted MDA8 ozone values can be interpreted as the

upper bound for ozone impacts caused by factors unaccounted for in the model, such as smoke and ozone precursors from wildfires. The EMBER estimated Canadian wildfire impacts were 26 ppb for both sites on June 29, 2023. However, the EMBER model biases were -5 for District 6 and 4 for GT Craig NCore PAMS, suggesting that these fire impacts could be considered medium confidence estimates. For District 6, the GAM residual was 30.2 ppb and the MAOT residual was 17.8 ppb. For GT Craig NCore PAMS, the GAM residual was 26.3 ppb and the MAOT residual was 17.5 ppb. These large residuals suggest that an external factor unaccounted for in the modeling, such as smoke and ozone precursors from wildfires, played a significant role in enhancing ozone formation at these monitoring sites on June 29, 2023. These large residual ozone impacts are likely attributable to the influx of ozone precursors transported from the wildfires in Quebec.

**Table 16. Predicted MDA8 ozone values and associated residuals at each monitoring site on June 29, 2023.**

<b>Monitoring Site Name</b>	District 6	GT Craig NCore PAMS
<b>Monitored MDA8 Ozone Value (ppb)</b>	87	78
<b>EMBER Base Predicted Value (ppb)</b>	82	82
<b>EMBER NCW Predicted Value (ppb)</b>	56	56
<b>EMBER Canadian Wildfire Impact (ppb)</b>	26	26
<b>UW GAM Predicted Value (ppb)</b>	56.8*	51.7
<b>UW GAM Residual (ppb)</b>	30.2*	26.3
<b>MAOT Predicted Value (ppb)</b>	69.2	60.9
<b>MAOT Residual (ppb)</b>	17.8	17.5

Note: An asterisk denotes that results were obtained from the UW GAMv1 modeling analysis as it was the only version with results available. All other UW GAM results were obtained from the UW GAMv2 modeling analysis.

### **3.1.3. Other Wildfire-Related Pollutants Analysis for June 29, 2023**

The plumes from the wildfires burning in Quebec also directly transported PM<sub>2.5</sub>, NO<sub>2</sub>, and CO to Cuyahoga County on June 29, 2023. While PM<sub>2.5</sub> and CO are directly emitted from wildfires, wildfire-related NO<sub>2</sub> is typically formed later via photochemical reactions involving the NO that is directly emitted from wildfires. Although spikes in monitored concentrations of these

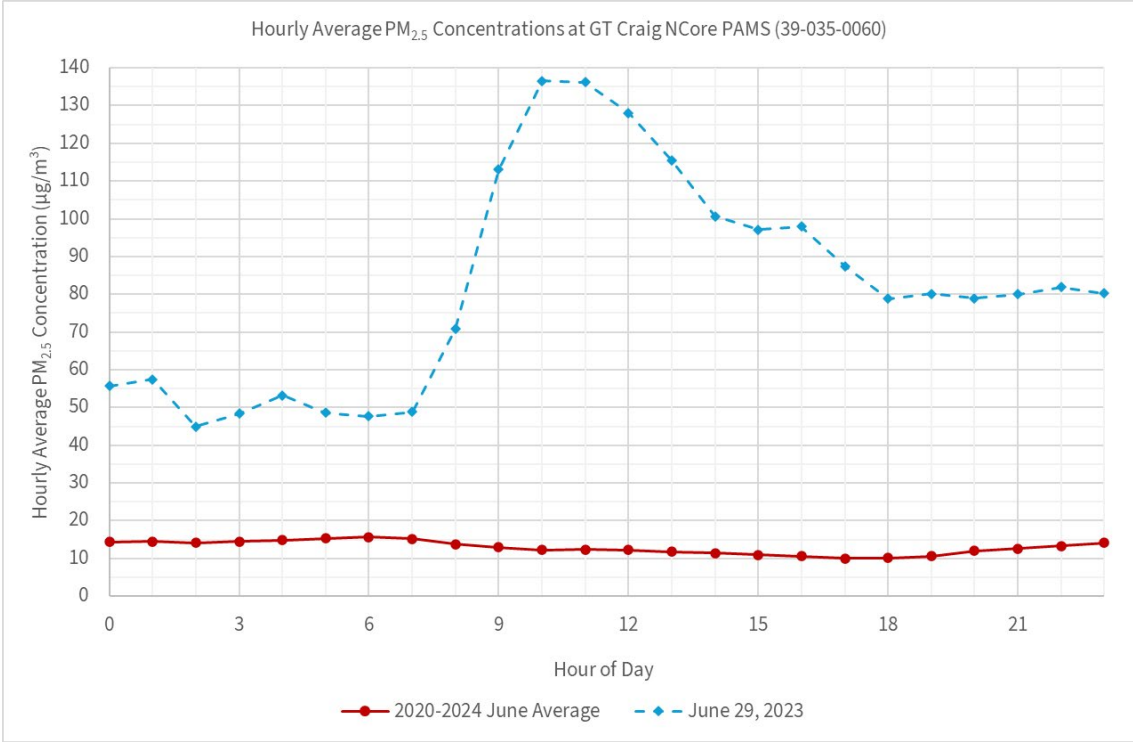
pollutants may be expected at certain hours of the day due to typically urban area traffic patterns, elevated concentrations of these pollutants that persist throughout the day-night cycle would suggest the existence of an external source transporting these pollutants into the area, such as plumes of smoke and ozone precursors from wildfires. Comparisons of the mean hourly average concentrations at representative monitoring sites from June days across 2020-2024 to the hourly average concentrations on June 29, 2023, were performed to provide additional evidence that the plumes transported smoke and ozone precursors from the wildfires burning in Quebec to the monitoring sites in Cuyahoga County. Table 17 and Figure 35 show the hourly average PM<sub>2.5</sub> concentrations at the GT Craig NCore PAMS site on June 29, 2023, as well as the June 2020-2024 mean hourly average PM<sub>2.5</sub> concentrations at the site. Table 18 and Figure 36 show the hourly average NO<sub>2</sub> concentrations at the GT Craig NCore PAMS site on June 29, 2023, as well as the June 2020-2024 mean hourly average NO<sub>2</sub> concentrations at the site. Table 19 and Figure 37 show the hourly average CO concentrations at the nearby Galleria (39-035-0051) site on June 29, 2023, as well as the June 2020-2024 mean hourly average CO concentrations at the site. Hourly average CO concentrations on June 29, 2023, were not available for the GT Craig NCore PAMS site, but the Galleria site did have data available and is located 1.7 km (1.1 mi) northwest of the GT Craig NCore PAMS site. Hourly average PM<sub>2.5</sub> concentrations at the GT Craig NCore PAMS site were extremely high across all 24 hours on June 29, 2023, ranging from 45.0 to 136.5 µg/m<sup>3</sup>, suggesting a prolonged influx of PM<sub>2.5</sub> into the Cleveland area from a large source, such as a plume of wildfire smoke. Hourly average NO<sub>2</sub> concentrations were significantly elevated across 14 hours on June 29, 2023, suggesting an external source of NO<sub>2</sub>, such as plumes from wildfires that have already been subjected to photochemical reactions that convert NO to NO<sub>2</sub>. Hourly average CO concentrations were significantly elevated across 14 hours on June 29, 2023, outside of the typical window for morning urban traffic emissions, suggesting an external combustion source beyond motor vehicle exhaust that brought an influx of CO to the Cleveland area. The statistically significantly ( $p < 0.05$ ) elevated hourly average concentrations of PM<sub>2.5</sub> and NO<sub>2</sub> at the GT Craig NCore PAMS site and CO at the Galleria site on June 29, 2023, serve as additional evidence of the wildfire impacts on monitored ozone concentrations in Cuyahoga County on June 29, 2023.

**Table 17. Hourly average PM<sub>2.5</sub> concentrations at the GT Craig NCore PAMS (39-035-0060) monitoring site.**

Hour	2020-2024 June Mean Hourly PM <sub>2.5</sub> (µg/m <sup>3</sup> )	Hourly PM <sub>2.5</sub> on June 29, 2023 (µg/m <sup>3</sup> )
0	14.3	55.7
1	14.5	57.5
2	14.2	45.0
3	14.5	48.4
4	14.9	53.2
5	15.3	48.6
6	15.7	47.7
7	15.2	48.9
8	13.8	70.8
9	12.9	113.1
10	12.3	136.5
11	12.4	136.2
12	12.2	128.0
13	11.8	115.5
14	11.4	100.7
15	11.0	97.1
16	10.7	97.9
17	10.0	87.4
18	10.1	78.8
19	10.7	80.1
20	12.0	79.0
21	12.6	80.0
22	13.3	81.9
23	14.1	80.2

Note: Yellow highlighting denotes that the hourly concentration is statistically significantly greater than the 2020-2024 June hourly average ( $p < 0.05$ ).

**Figure 35. Hourly average PM<sub>2.5</sub> concentrations at the GT Craig NCore PAMS monitoring site in Cuyahoga County.**

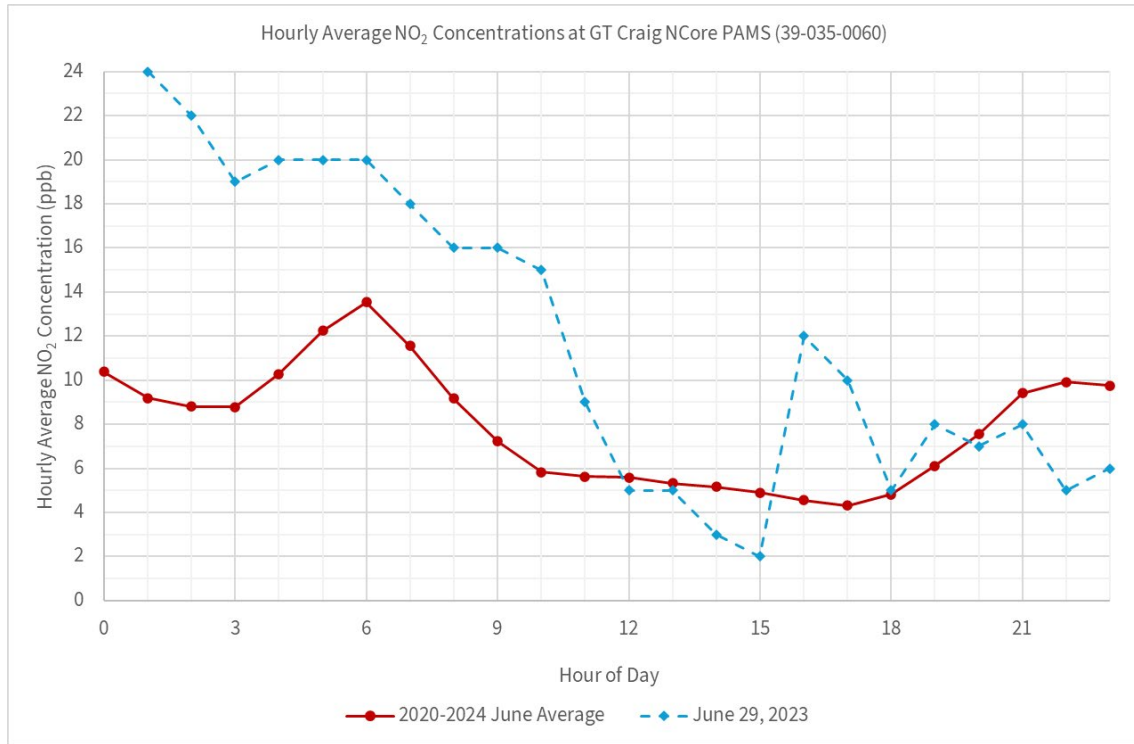


**Table 18. Hourly average NO<sub>2</sub> concentrations at the GT Craig NCore PAMS (39-035-0060) monitoring site.**

Hour	2020-2024 June Mean Hourly NO <sub>2</sub> (ppb)	Hourly NO <sub>2</sub> on June 29, 2023 (ppb)
0	10.4	N/A
1	9.2	24
2	8.8	22
3	8.8	19
4	10.3	20
5	12.2	20
6	13.5	20
7	11.6	18
8	9.2	16
9	7.2	16
10	5.8	15
11	5.6	9
12	5.6	5
13	5.3	5
14	5.2	3
15	4.9	2
16	4.6	12
17	4.3	10
18	4.8	5
19	6.1	8
20	7.6	7
21	9.4	8
22	9.9	5
23	9.8	6

Note: Yellow highlighting denotes that the hourly concentration is statistically significantly greater than the 2020-2024 June hourly average ( $p < 0.05$ ).

**Figure 36. Hourly average NO<sub>2</sub> concentrations at the GT Craig NCore PAMS monitoring site in Cuyahoga County.**

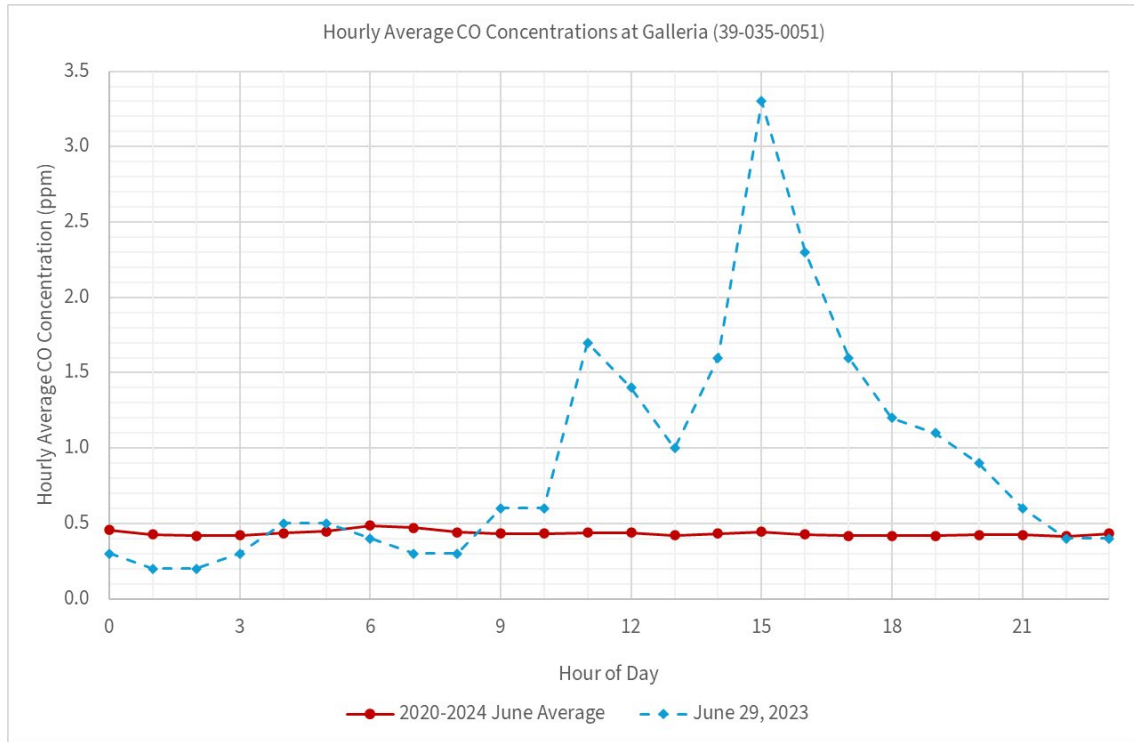


**Table 19. Hourly average CO concentrations at the Galleria (39-035-0051) monitoring site.**

Hour	2020-2024 June Mean Hourly CO (ppm)	Hourly CO on June 29, 2023 (ppm)
0	0.457	0.3
1	0.427	0.2
2	0.418	0.2
3	0.421	0.3
4	0.437	0.5
5	0.449	0.5
6	0.486	0.4
7	0.471	0.3
8	0.443	0.3
9	0.435	0.6
10	0.434	0.6
11	0.440	1.7
12	0.438	1.4
13	0.423	1.0
14	0.434	1.6
15	0.446	3.3
16	0.427	2.3
17	0.418	1.6
18	0.419	1.2
19	0.418	1.1
20	0.425	0.9
21	0.423	0.6
22	0.417	0.4
23	0.434	0.4

Note: Yellow highlighting denotes that the hourly concentration is statistically significantly greater than the 2020-2024 June hourly average ( $p < 0.05$ ).

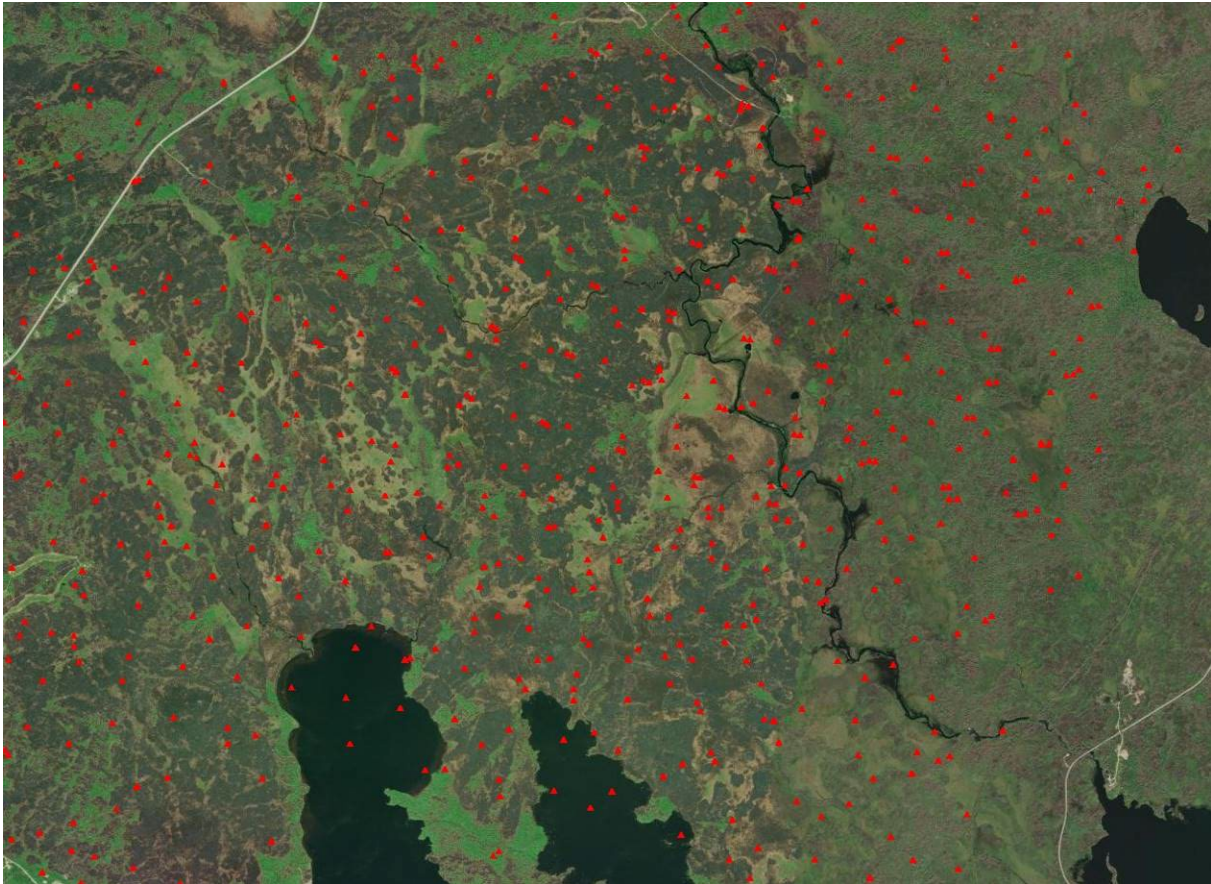
**Figure 37. Hourly average CO concentrations at the Galleria monitoring site in Cuyahoga County.**



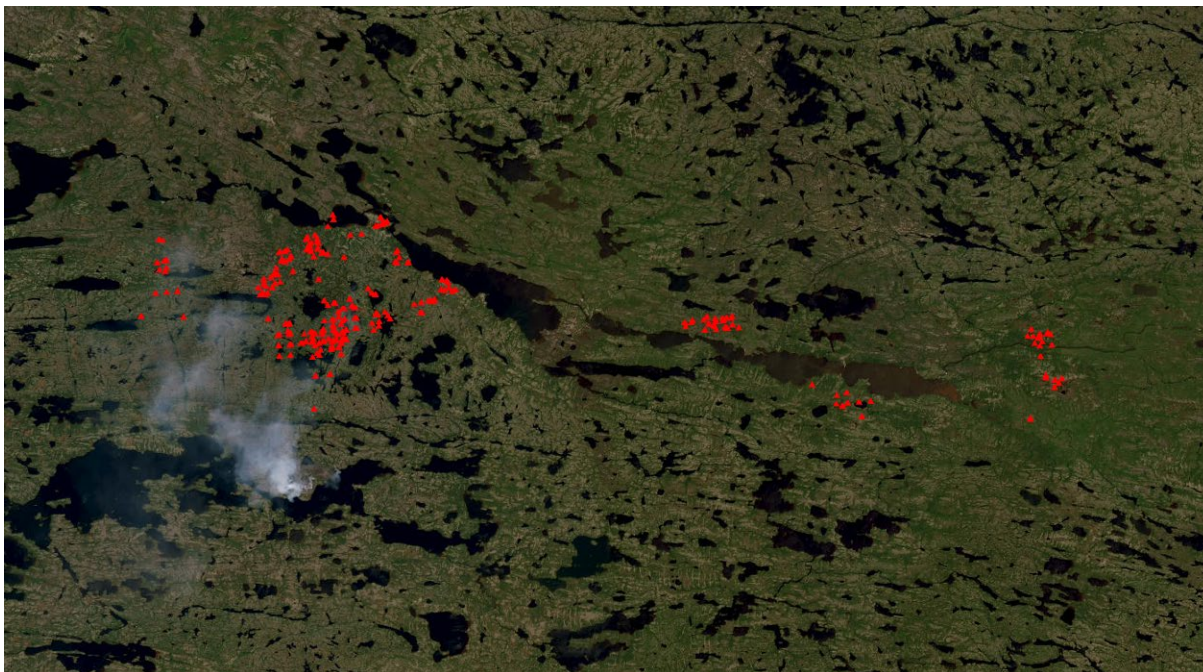
#### **4. Not Reasonably Controllable or Not Reasonably Preventable**

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 Figure 38, the area of southern Nova Scotia, in and near the Bowers Meadows Wilderness Area, in which the wildfires produced plumes of smoke and ozone precursors that affected Cuyahoga and Lake counties on June 1-2, 2023, is wildland. Additionally, Figure 39 shows that the area of northern Quebec in which the wildfires produced plumes of smoke and ozone precursors that affected Cuyahoga County on June 29, 2023, is also wildland.

**Figure 38. Satellite imagery of the wildland area 15 km (9 mi) southwest of Shelburne, Nova Scotia, where wildfires burning on May 29, 2023, shown as red triangles, produced plumes of smoke and ozone precursors that affected Cuyahoga and Lake counties on June 1-2, 2023.**



**Figure 39. Satellite imagery of the wildland area 120 km (75 mi) northeast of Chisasibi, Quebec, where wildfires burning on June 27, 2023, shown as red triangles, produced plumes of smoke and ozone precursors that affected Cuyahoga County on June 29, 2023.**



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>26</sup>. SOPFEU and CIFCC reported that the 2023 fire season in Quebec was devastating and record-setting, with fires burning a total of 45,000 km<sup>2</sup> (17,375 mi<sup>2</sup>) across Quebec, with an estimated 99.9% of this area burned by wildfires started by lightning<sup>27</sup>. NSDNRR reported to CIFCC that seven new natural wildland fires had begun burning across Nova Scotia on May 28, 2023, most likely started by lightning strikes<sup>28</sup>. As these 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

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<sup>26</sup> <https://natural-resources.canada.ca/our-natural-resources/forests/wildland-fires-insects-disturbances/forest-fires/fire-behaviour/13145>

<sup>27</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)

<sup>28</sup> <https://cifcc.net/situation/2023-05-29>

Rule. These wildfires could not have been prevented and could not have been controlled by state or federal natural resources managers in the U.S. The plumes of smoke and ozone precursors emitted by these wildfires that caused the regulatorily significant wildfire-related ozone episode in Cuyahoga and Lake counties on June 1-2, 2023, and the regulatorily significant wildfire-related ozone episode in Cuyahoga County on June 29, 2023, were 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 wildfires that created plumes of smoke and ozone precursors affecting Cuyahoga and Lake counties in the wildfire-related ozone episode on June 1-2, 2023, occurred on wildlands in and near the Bowers Meadows Wilderness Area, located about 15 km (9 mi) southwest of Shelburne, Nova Scotia. Additionally, as described in this document, the origin and evolution of the wildfires that created plumes of smoke and ozone precursors affecting Cuyahoga County in the wildfire-related ozone episode on June 29, 2023, occurred on wildlands located about 120 km (75 mi) northeast of Chisasibi, Quebec.

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

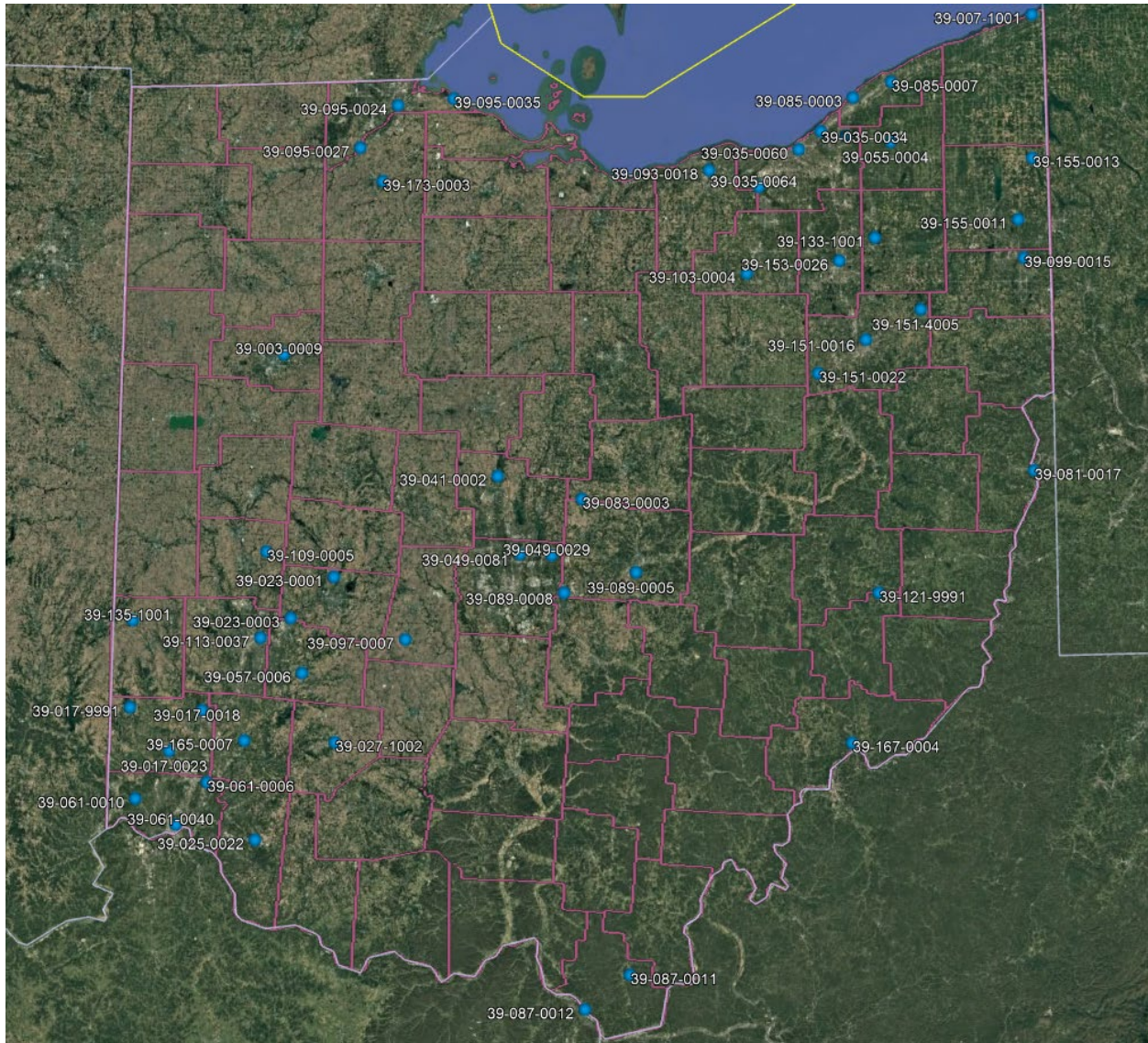
## **6. Public Notification**

Ohio EPA maintains a public alert system as well as publicly available information via the Ohio EPA website<sup>29</sup> to keep residents informed of potential air quality impacts from wildfires. 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 40 and 41 show the locations of active ozone monitoring sites in the state of Ohio and in the Cleveland, OH 2015 Ozone Nonattainment Area, respectively. Figure 42 shows the locations of the District 6 (39-035-0034), Eastlake (39-085-0003), GT Craig NCore PAMS (39-035-0060), and Painesville (39-085-0007) monitoring sites in Cuyahoga and Lake counties.

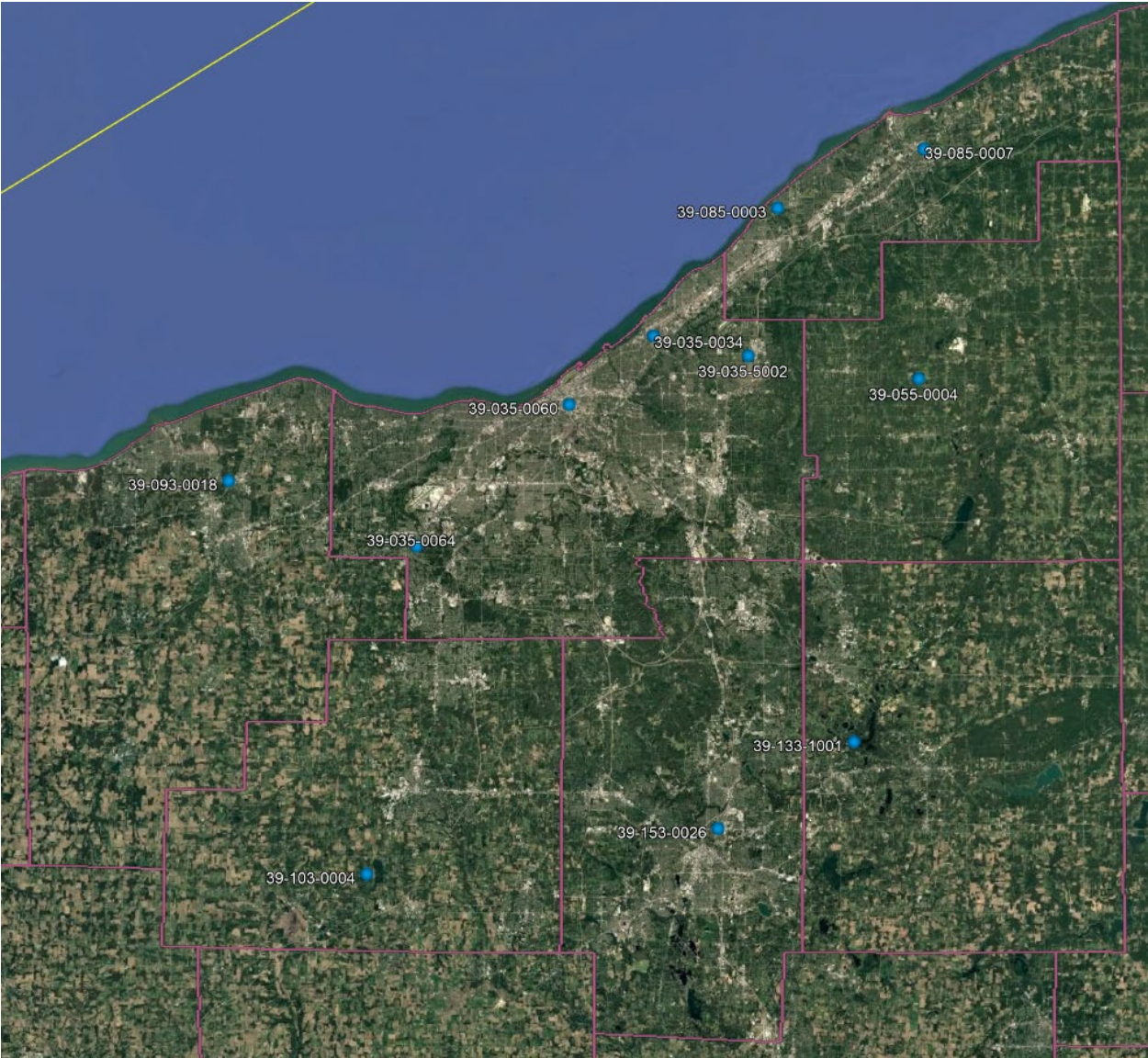
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<sup>29</sup> <https://epa.ohio.gov>

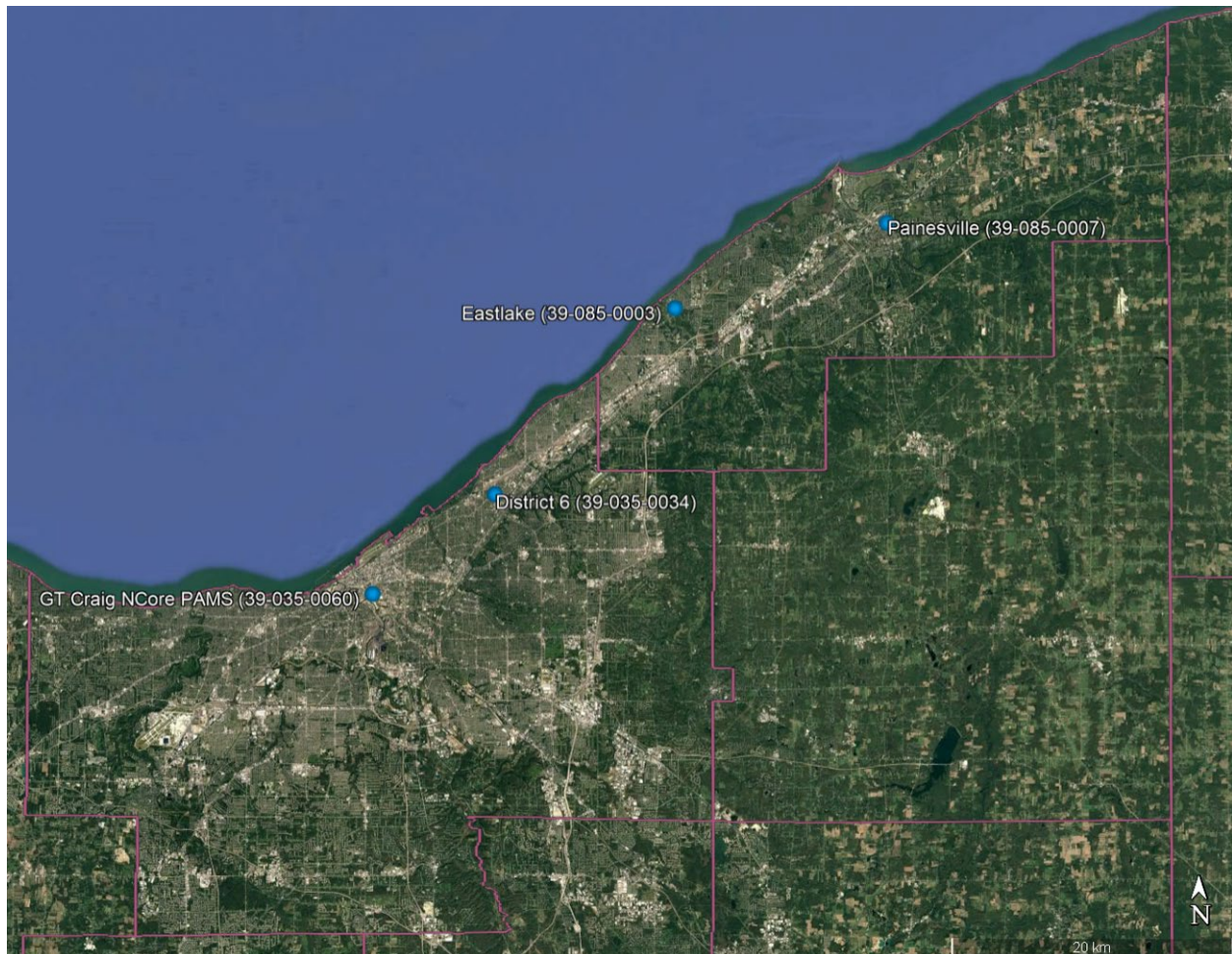
**Figure 40. Map of active ozone monitoring sites in the state of Ohio.**



**Figure 41. Map of active ozone monitoring sites in the Cleveland, OH 2015 Ozone Nonattainment Area.**



**Figure 42. Map of the District 6, Eastlake, GT Craig NCore PAMS, and Painesville ozone monitoring sites in Cuyahoga and Lake counties.**



The District 6, Eastlake, GT Craig NCore PAMS, and Painesville monitoring sites in Cuyahoga and Lake counties were all operational and collected ambient ozone concentration measurements throughout the 2023 ozone season, including during the wildfire-related ozone episodes on June 1-2 and June 29, 2023. Ohio EPA reported these data in real time to U.S. EPA for inclusion in the AirNow system. The ambient ozone data from the District 6, Eastlake, GT Craig NCore PAMS, and Painesville monitoring sites were also publicly accessible through the Ohio EPA Division of Air Pollution Control website<sup>30</sup>. Data collected from the network of monitoring sites are used by Ohio EPA and partner agencies, such as public health

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<sup>30</sup> <https://epa.ohio.gov/divisions-and-offices/air-pollution-control/reports-and-data/air ohio-air-monitoring-data>

departments, local air pollution control agencies, and metropolitan planning organizations, such as the Northeast Ohio Areawide Coordinating Agency (NOACA), to notify the public when air pollution may reach levels that are potentially harmful to public health. Table 20 lists the public notices issued by Ohio EPA and other agencies regarding the wildfire-related ozone episode on June 1-2, 2023. Table 21 lists the public notices, including statewide air quality advisories explicitly related to Canadiana wildfire smoke episodes, issued by Ohio EPA and other agencies regarding the wildfire-related ozone and PM<sub>2.5</sub> episode on June 29, 2023.

**Table 20. Public notices issued regarding the wildfire-related ozone episode impacting Cuyahoga and Lake counties on June 1-2, 2023.**

<b>Date Issued</b>	<b>Date(s) Covered</b>	<b>Issued By</b>	<b>Counties Covered</b>	<b>Type of Notice</b>
May 30, 2023	May 31, 2023	NOACA	Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, Summit	Air Quality Advisory (Ozone) <sup>31</sup>
May 31, 2023	June 1, 2023	NOACA	Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, Summit	Air Quality Advisory (Ozone) <sup>32</sup>
June 1, 2023	June 2, 2023	NOACA	Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, Summit	Air Quality Advisory (Ozone) <sup>33</sup>
June 2, 2023	June 3, 2023	NOACA	Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, Summit	Air Quality Advisory (Ozone) <sup>34</sup>

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<sup>31</sup> <https://myemail.constantcontact.com/Air-Quality-Advisory-May-31--2023.html?soid=1105576147256&aid=lr9Q8Obx6vw>

<sup>32</sup> <https://myemail.constantcontact.com/Air-Quality-Advisory-June-1--2023.html?soid=1105576147256&aid=n2U-wGZpKhY>

<sup>33</sup> [https://myemail.constantcontact.com/Air-Quality-Advisory-June-2--2023.html?soid=1105576147256&aid=9RvMZ\\_hVrVw](https://myemail.constantcontact.com/Air-Quality-Advisory-June-2--2023.html?soid=1105576147256&aid=9RvMZ_hVrVw)

<sup>34</sup> <https://myemail.constantcontact.com/Air-Quality-Advisory-June-3--2023.html?soid=1105576147256&aid=qHOrmikFUWw>

**Table 21. Public notices issued regarding the wildfire-related smoke and ozone episode impacting Cuyahoga County on June 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 28, 2023	NOACA	Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, Summit	Air Quality Advisory (PM <sub>2.5</sub> ) <sup>35</sup>
June 28, 2023	June 28, 2023	Ohio EPA	ALL (Statewide)	Statewide Air Quality Advisory <sup>36</sup>
June 28, 2023	June 29, 2023	NOACA	Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, Summit	Air Quality Advisory (PM <sub>2.5</sub> ) <sup>37</sup>
June 29, 2023	June 29, 2023	Ohio EPA	ALL (Statewide)	Statewide Air Quality Advisory <sup>38</sup>
June 29, 2023	June 30, 2023	NOACA	Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, Summit	Air Quality Advisory (PM <sub>2.5</sub> and Ozone) <sup>39</sup>

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<sup>35</sup> <https://myemail.constantcontact.com/Air-Quality-Advisory-June-28--2023.html?soid=1105576147256&aid=j3tENpRGT94>

<sup>36</sup> <https://epa.ohio.gov/about/media-center/news/statewide-air-quality-advisory-june-28>

<sup>37</sup> <https://myemail-api.constantcontact.com/Air-Quality-Advisory-June-29--2023.html?soid=1105576147256&aid=1yfle3EBprg>

<sup>38</sup> <https://epa.ohio.gov/about/media-center/news/statewide-air-quality-advisory-june-29>

<sup>39</sup> <https://myemail-api.constantcontact.com/Air-Quality-Advisory-June-30--2023.html?soid=1105576147256&aid=plkiOuq7GgY>

## **7. Public Participation**

In accordance with the requirements of 40 CFR 50.14(c)(2)(i), on September 22, 2025, 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 Cuyahoga County and Lake County is included as Appendix B. Ohio published solicitation for public comment concerning the draft Exceptional Events Demonstration for 2023 Wildfire-Related Ozone Episodes in Cuyahoga County and Lake County on November 3, 2025. The public comment period closed on December 4, 2025. Ohio received public comments in support of this exceptional events demonstration during the public comment period, but no response to these comments is warranted. Appendix C includes a copy of the public notice and a copy of the public comments received.

## **8. Summary**

This exceptional events demonstration shows that wildfires in Canada adversely affected monitored ozone concentrations measured by monitoring sites in Cuyahoga and Lake counties on June 1 and June 2, 2023, and in Cuyahoga County on June 29, 2023. The MDA8 ozone concentrations measured by the District 6 (39-035-0034) monitoring site in Cuyahoga County on June 1, June 2, and June 29, 2023, have been shown to have contributed to a monitored violation of the 2015 ozone NAAQS, and it has been demonstrated that the exclusion of the MDA8 ozone concentrations measured by the District 6 monitoring site on these dates would result in a valid 2023-2025 8-hour ozone design value that is at or below the 2015 ozone NAAQS value of 70 ppb, representing attainment of the 2015 ozone NAAQS. The MDA8 ozone concentrations measured by the Eastlake (39-085-0003) monitoring site in Lake County on June 1 and June 2, 2023, have been shown to have contributed to a monitored violation of the 2015 ozone NAAQS, and it has been demonstrated that the exclusion of the MDA8 ozone concentrations measured by the Eastlake monitoring site on these dates would result in a valid 2023-2025 8-hour ozone design value that is at or below the 2015 ozone NAAQS value of 70 ppb, representing attainment of the 2015 ozone NAAQS. If these requests for exclusion due to exceptional events were to be approved, all active ozone monitoring sites within the Cleveland, OH 2015 Ozone Nonattainment Area would have valid 2023-2025 8-hour ozone design values that attain the 2015 ozone NAAQS, allowing for a determination that this nonattainment area has attained the relevant NAAQS by the specified deadline, proving the regulatory significance of these exceptional events. Ohio EPA therefore requests the exclusion of the monitored ozone concentrations measured at the District 6 (39-035-0034) monitoring site on June 1, June 2, and June 29, 2023, from regulatory determinations, including calculations of 8-hour ozone design values. Ohio EPA also requests the exclusion of the monitored ozone concentrations measured at the Eastlake (39-085-0003) monitoring site on June 1 and June 2, 2023, from regulatory determinations, including calculations of 8-hour ozone design values.

Additionally, the plumes of smoke and ozone precursors from these regulatorily significant wildfire exceptional events were shown to have impacted monitored ozone concentrations measured at the GT Craig NCore PAMS (39-035-0060) monitoring site on three dates (June 1, June 2, and June 29, 2023), and at the Painesville (39-085-0007) monitoring site on two dates (June 1 and June 2, 2023). Ohio EPA is requesting the exclusion of the monitored ozone concentrations measured at the GT Craig NCore PAMS (39-035-0060) monitoring site on June 1, June 2, and June 29, 2023, from regulatory determinations, including calculations of 8-hour

ozone design values. Ohio EPA is also requesting the exclusion of the monitored ozone concentrations measured at the Painesville (39-085-0007) monitoring site on June 1 and June 2, 2023, from regulatory determinations, including calculations of 8-hour ozone design values.

This exceptional events demonstration includes all the required elements of wildfire-related ozone 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 plumes of smoke and ozone precursors from wildfires burning in Canada had unprecedented impacts on monitored MDA8 ozone concentrations in Cuyahoga and Lake counties on June 1-2, 2023, as well as in Cuyahoga County on June 29, 2023.