The State of New Jersey
Department of Environmental Protection

Exceptional Event Demonstration for PM2.5
June 6, 7, and 8, 2023
June 29 and 30, 2023

November 2024

Table of Contents

List of Tables 3

List of Figures 4

Acronyms and Abbreviations 7

Executive Summary 8

Regulatory Significance of Data Exclusion 9

Exceptional Event Demonstration Analysis for PM2.5 During June 6, 7, 8, 2023 11

I. A Narrative Conceptual Model and a Discussion of the Event that Led to Exceedances at New Jersey Monitors 12

1. Non-Event PM2.5 in New Jersey 12

2. Wildfire Description 13

3. Conceptual Model of PM2.5 Concentrations from Wildfires 16

3.1 Conceptual Model Discussion 16

3.2 Surface Analysis – Transport and Wind Patterns 18

3.3 Upper Air Analysis 29

3.4 Aerosol Optical Depth 34

3.5 Daily PM2.5 AQI Maps 37

II. Clear Causal Relationship Between the Specific Event and the Monitored Concentration .42

Tiering Overview 42

1. Comparison of Candidate Event Data to Tiering Threshold for Tier 1 Analysis 43

Camden Spruce Street Tiering Calculations for June: 43

Elizabeth Lab Tiering Calculations for June: 45

2. Comparison of Event-Related Concentrations to Historical Concentrations 46

3. Evidence that Fire Emissions were Transported to the Monitor 50

3.1 Trajectory Analysis 50

4. Evidence that the Fire Emissions Affected New Jersey Monitors 57

4.1 Visual Photographic Evidence of Ground-level Smoke at the Monitor (HazCam Pictures from Brigantine) 57

III. A Demonstration that the Exceptional Event was Both Not Reasonably Controllable and Not Reasonably Preventable 62

IV. Caused by Human Activity that is Unlikely to Recur at a Particular Location or a Natural Event 63

Exceptional Event Demonstration Analysis for PM2.5 During June 29 & 30, 2023 64

I. A Narrative Conceptual Model and a Discussion of the Event that Led to Exceedances at New Jersey Monitors 65

1. Non-Event PM2.5 in New Jersey 65
2. Wildfire Description 66
3. Conceptual Model of PM2.5 Concentrations from Wildfires 71
3.1 Conceptual Model Discussion 71
3.2 Surface Analysis – Transport and Wind Patterns 73
3.3 Upper Air Analysis 81
3.4 Aerosol Optical Depth 85
3.5 Daily PM2.5 AQI Maps 89
II. Clear Causal Relationship between the Specific Event and the Monitored Concentration 93
Tiering Overview 93
1. Comparison of Candidate Event Data to Tiering Threshold for Tier 1 Analyses 94
Camden Spruce Street Tiering Calculations for June: 94
Elizabeth Lab Tiering Calculations for June: 96
2. Comparison of Event-Related Concentrations to Historical Concentrations 97
3. Evidence that Fire Emissions were Transported to New Jersey Monitors 101
3.1 Trajectory Analysis 101
4. Evidence that Fire Emissions Affected New Jersey Monitors 106
4.1 Light Extinction 106
4.2 Visual Photographic Evidence of Ground-level Smoke at the Monitor (HazeCam Pictures from Brigantine) 107
III. A Demonstration that the Exceptional Event was Both Not Reasonably Controllable and Not Reasonably Preventable 110
IV. Caused by Human Activity that is Unlikely to Recur at a Particular Location or a Natural Event 111
Conclusion 112

List of Tables

Table 1: Adjusted Annual Average for Exceptional Event (EE) Days 10
Table 2: 2021 – 2023 Annual Mean with EPA Concurrence 10
Table 3: Site Level Tiering Thresholds based on 2019 – 2023 5-year Period 43
Table 4: Site Level Tiering Thresholds based on 2019 – 2023 5-year Period 94

List of Figures

Figure 1: North American Snow Cover (Millions km^2) in May 1967 – 2023 14
Figure 2: Accumulated Hectares Burned 2015 - 2024 15
Figure 3: Photo of Wildfire No. 334 near Mistissini, Quebec 15
Figure 4: Smoke Plume Sweeping NY, PA, and NJ Early Morning Hours – June 7, 2023 16
Figure 5: Simplified, Illustrated Conceptual Model of June 6, 7, 8, 2023 Wildfire Event 18
Figure 6: Surface Analysis June 1, 2023 19
Figure 7: Surface Analysis June 2, 2023 20
Figure 8: Surface Analysis June 3, 2023 21
Figure 9: Surface Analysis June 4, 2023 22
Figure 10: Surface Analysis June 5, 2023 23
Figure 11: Surface Analysis June 6, 2023 24
Figure 12: Aerosol Watch Satellite Imagery of Smoke Plume - Early Evening June 6, 2023 25
Figure 13: Surface Analysis June 7, 2023 26
Figure 14: Aerosol Watch Satellite Imagery of Smoke Plume – June 7, 2023 27
Figure 15: Surface Analysis June 8, 2023 28
Figure 16: Aerosol Watch Satellite Imagery – June 8, 2023 29
Figure 17: 850mb Upper Air Analysis, June 5, 2023 30
Figure 18: 850mb Upper Air Analysis, June 6, 2023 31
Figure 19: 850b Upper Air Analysis, June 7, 2023 32
Figure 20: 850mb Upper Air Analysis, June 8, 2023 33
Figure 21: Aerosol Optical Depth, June 5, 2023 35
Figure 22: Aerosol Optical Depth, June 6, 2023 35
Figure 23: Aerosol Optical Depth, June 7, 2023 36
Figure 24: Aerosol Optical Depth June 8, 2023 36
Figure 25: Daily PM2.5 AQI June 2, 2023 38
Figure 26: Daily PM2.5 AQI June 3, 2023 38
Figure 27: Daily PM2.5 AQI June 4, 2023 39
Figure 28: Daily PM2.5 AQI June 5, 2023 39
Figure 29: Daily PM2.5 AQI June 6, 2023 40
Figure 30: Daily PM2.5 AQI June 7, 2023 40
Figure 31: Daily PM2.5 AQI June 8, 2023 41
Figure 32: Camden Tiering Thresholds for June and Daily PM2.5 Concentrations for the Period of January 2018 – December 2023 44
Figure 33: Elizabeth Lab Tiering Thresholds for June and Daily PM2.5 Concentrations for the Period of January 2018 – December 2023 45
Figure 34: Camden Spruce St. One Month Time Series Plot of Maximum 24-hour Average PM2.5 Concentrations in June from 2019 – 2023 47
Figure 35: Camden Spruce St. Annual Variation - Time Series Plot of 24-hr Average PM2.5 Concentrations from 2019 – 2023 48
Figure 36: Elizabeth Lab One Month Time Series Plot of Maximum 24-hour Average PM2.5 Concentrations in June from 2019 – 2023 49
Figure 37: Elizabeth Lab Annual Variation – Time Series Plot of 24-hr PM2.5 Concentrations from 2019 – 2023 50
Figure 38: HYSPLIT 48hr Backward Trajectories - June 6, 2023 – 10, 500, and 1500m AGL 53
Figure 39: HYSPLIT 48hr Backward Trajectories - June 7, 2023 – 10, 500, and 1500m AGL 54

Figure 40: HYSPLIT 48hr Backward Trajectories - June 8, 2023 – 10, 500, and 1500m AGL....55
Figure 41: Combined Backward Trajectory of Full Event Transport – HYSPLIT 120hr Through June 8, 2023 56
Figure 42: HazCam Picture from Brigantine, NJ on June 6, 2023 at 10:00AM 58
Figure 43: HazCam Picture from Brigantine, NJ on June 7, 2023 at 6:00PM 59
Figure 44: HazCam Picture from Brigantine, NJ on June 8, 2023 at 11:00AM....60
Figure 45: HazCam Picture from Brigantine, NJ on June 4, 2023 at 11:00AM (clear day)....61
Figure 46: Seasonal Area (a) and Weekly Area (b) Burned During the 2023 Canadian Wildfire Season 67
Figure 47: Fires, Air Quality Index, and Smoke Plume Showing Massive Scope of Wildfires....68
Figure 48: Image of Wildfire Smoke from Quebec Reaching Europe on June 26, 2023 69
Figure 49: Satellite Image of Quebec on June 25, 2023....70
Figure 50: Active Fires in Quebec on June 26, 2023 70
Figure 51: Simplified, Illustrated Conceptual Model of June 29-30, 2023 Wildfire Event....72
Figure 52: Surface Analysis June 25, 2023 74
Figure 53: Aerosol Watch Satellite Imagery – June 25, 2023, 18UTC 74
Figure 54: Surface Analysis for June 26, 2023, 18UTC....75
Figure 55: Surface Analysis for June 27, 2023, 18UTC....75
Figure 56: Aerosol Watch Satellite Imagery – June 27, 2023, 15UTC 76
Figure 57: Surface Analysis for June 28, 2023, 18UTC....77
Figure 58: Aerosol Watch Satellite Image: Early Morning East Coast June 28, 2023, 11UTC....78
Figure 59: Surface Analysis for June 29, 2023, 18UTC....79
Figure 60: Aerosol Watch Satellite Image: Early Morning East Coast June 29, 2023, 11UTC....79
Figure 61: Surface Analysis for June 30, 2023, 18UTC....80
Figure 62: Aerosol Watch Satellite Image: Early Morning East Coast June 30, 2023, 11UTC....80
Figure 63: 850mb Upper Air Analysis, June 25, 2023....82
Figure 64: 850mb Upper Air Analysis, June 26, 2023....82
Figure 65: 850mb Upper Air Analysis, June 27, 2023....83
Figure 66: 850mb Upper Air Analysis, June 28, 2023....83
Figure 67: 850mb Upper Air Analysis, June 29, 2023....84
Figure 68: 850mb Upper Air Analysis, June 30, 2023....84
Figure 69: Aerosol Optical Depth June 25, 2023 86
Figure 70: Aerosol Optical Depth June 26, 2023 86
Figure 71: Aerosol Optical Depth June 27, 2023 87
Figure 72: Aerosol Optical Depth June 28, 2023 87
Figure 73: Aerosol Optical Depth June 29, 2023 88
Figure 74: Aerosol Optical Depth June 30, 2023 88
Figure 75: Daily PM2.5 AQI June 25, 2023 90
Figure 76: Daily PM2.5 AQI June 26, 2023 90
Figure 77: Daily PM2.5 AQI June 27, 2023 91
Figure 78: Daily PM2.5 AQI June 28, 2023 91
Figure 79: Daily PM2.5 AQI June 29, 2023 92
Figure 80: Daily PM2.5 AQI June 30, 2023 92
Figure 81: Camden Tiering Thresholds for June and Daily PM2.5 Concentrations for the Period of January 2018 – December 2023 95
Figure 82: Elizabeth Lab Tiering Thresholds for June and Daily PM2.5 Concentrations for the Period of January 2018 – December 2023....96

Figure 83: Camden Spruce St. One Month Time Series Plot of Maximum 24-hour Average PM2.5 Concentrations in June from 2019 – 2023 98
Figure 84: Camden Spruce St. Annual Variation - Time Series Plot of 24-hr Average PM2.5 Concentrations from 2019 – 2023 99
Figure 85: Elizabeth Lab One Month Time Series Plot of Maximum 24-hour Average PM2.5 Concentrations in June from 2019 – 2023 100
Figure 86: Elizabeth Lab Annual Variation – Time Series Plot of 24-hr PM2.5 Concentrations from 2019 – 2023 101
Figure 87: HYSPLIT 48hr Backward Trajectories - June 29, 2023 10, 500, and 1500m AGL...103
Figure 88: HYSPLIT 48hr Backward Trajectories - June 30, 2023, 10, 500, and 1500m AGL..104
Figure 89: HYSPLIT 84hr Backward Trajectories - June 30, 2023, 10, 500, 1500m AGL 105
Figure 90: Hourly Average Visibility Light Extinction Measurement at the Brigantine, NJ Monitor: May 28 to July 2, in 2021, 2022, and 2023 107
Figure 91: HazeCam Picture from Brigantine, NJ on June 29, 2023, 11:00 AM 108
Figure 92: HazeCam Picture from Brigantine, NJ on June 30, 2023, 10:00 AM 109
Figure 93: HazeCam Picture from Brigantine, NJ on July 10, 2023, 2:00 PM (clear day) 110

Acronyms and Abbreviations

AGL	Above Ground Level
AOD	Aerosol Optical Depth
AQI	Air Quality Index
AQS	Air Quality System
BC	Black Carbon
C_6H_6	Benzene
CAA	Clean Air Act
CO	Carbon Monoxide
CWFIS	Canadian Wildland Fire Information System
DV	Design Value
EC	Elemental Carbon
EER	Exceptional Events Rule
EST	Eastern Standard Time
FEM	Federal Equivalent Method
FRP	Fire Radiative Power
HC	Hydrocarbon
HCHO	Formaldehyde
HYSPLIT	Hybrid Single-Particle Lagrangian Integrated Trajectory
K	Potassium
km	Kilometer
mb	Millibar
NAAQS	National Ambient Air Quality Standards
NJDEP	New Jersey Department of Environmental Protection
NMHC	Non-Methane Hydrocarbon
NMVOC	Non-Methane Volatile Organic Compounds
NOAA	National Oceanic and Atmospheric Administration
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
O_3	Ozone
OC	Organic Carbon
OTR	Ozone Transport Region
PAMS	Photochemical Assessment Monitoring Station
PBL	Planetary Boundary Layer
PM	Particulate Matter
PM2.5	Fine Particulate Matter
ppb	parts per billion
ppbC	parts per billion of Carbon
ppbv	parts per billion by volume
ppm	parts per million
Q/d	Emissions divided by distance
RSIG	Remote Sensing Information Gateway
tpd	tons per day
ug/m3	micrograms per cubic meter
USEPA	United States Environmental Protection Agency
USG	Unhealthy for Sensitive Groups
UTC	Coordinated Universal Time
VOC	Volatile Organic Compound

Executive Summary

During the spring and summer of 2023, record breaking wildfires of historic magnitude had devastating impacts on air quality across the United States. The plumes of smoke produced by these fires extended for hundreds of miles, impacting much of the northeast. Wildfires originating from Quebec, Canada significantly contributed to New Jersey's degraded air quality during the summer of 2023 resulting in historically high PM2.5 concentrations measured in New Jersey. Due to the transported wildfire smoke and high levels of fine particulates, New Jersey recorded multiple ambient air quality exceedances of the 2024 PM2.5 annual standard of 9 $\mu g/m^3$.

The Clean Air Act (CAA) section 319(b) and USEPA regulations allow the exclusion of air quality monitoring data influenced by exceptional events from use in determinations of exceedances or violations of the National Ambient Air Quality Standards (NAAQS). This analysis demonstrates that certain 24-hour average PM2.5 concentrations at the Camden Spruce St. (340070002) and Elizabeth Lab (340390004) monitors in 2023 qualify as exceptional events due to the impact from Canadian wildfires. Therefore, these concentrations should be excluded from the calculation of New Jersey's 2023 Annual Average and thus, lowering the Design Value (DV) used to assess New Jersey's PM2.5 attainment status for the Initial Area Designations for the 2024 PM2.5 NAAQS.

The dates and ambient air quality monitors included in this Exceptional Event Demonstration are as follows:

- June 6, 7, and 8, 2023: Camden (340070002), Elizabeth Lab (340390004)
- June 29 and 30, 2023: Camden (340070002), Elizabeth Lab (340390004)

Accordingly, New Jersey monitoring data for PM2.5 on these days has been flagged in the United States Environmental Protection Agency's (USEPA) Air Quality System (AQS) as being an exceptional event. On August 15, 2024 in accordance with 40 CFR 50.14(c)(2) of the Exceptional Events Rule, New Jersey notified the USEPA of the intent to request exclusion of ambient air quality data due to the exceptional events noted above. The Exceptional Events Rule (EER) at 40 CFR 50.14 states that an exceptional event must have regulatory significance for the USEPA to consider the demonstration. New Jersey is seeking approval of this exceptional event demonstration to have 2023 wildfire data excluded for the purpose of the Initial Area Designations for the 2024 PM2.5 NAAQS due on February 7, 2025.

This document presents the following evidence that the wildfires in Quebec, Canada resulted in high concentrations of PM2.5 in New Jersey:

- The location of the fires and the resulting levels of smoke in the air traced by satellite from the fire source location to New Jersey.
- Satellite observations of the Aerosol Optical Depth (AOD) on the days leading up to and including the exceptional event dates show that wildfire emissions were transported into New Jersey.
- PM2.5 concentrations on the exceptional event dates were exceptionally high with both monitors recording levels greater than 98th percentile of the highest PM2.5 concentrations typically observed during the last five years (2019 – 2023).

- HYSPLIT back trajectories on the days of the exceptional events in New Jersey show that the wind patterns would have carried the wildfire emissions from the location of the fires into New Jersey on each of the exceptional event dates. The trajectory analyses are further supported by AOD concentrations and satellite imagery.
- Visual Photographic Evidence of Ground-level Smoke at the Monitor (HazeCam Pictures from Brigantine)

Regulatory Significance of Data Exclusion

The Clean Air Act (CAA) section 319(b) allows states to exclude air quality monitoring data influenced by exceptional events from use in determinations of exceedances or violations of the NAAQS. According to the Exceptional Events Rule (EER) at 40 CFR 50.1(j), the definition of an "exceptional event" means "an event(s) and its resulting emissions that affect air quality in such a way that there exists a clear causal relationship between the specific event(s) and the monitored exceedance(s) or violation(s), is not reasonably controllable or preventable, is an event(s) caused by human activity that is unlikely to recur at a particular location or a natural event(s), and is determined by the Administrator in accordance with 40 CFR 50.14 to be an exceptional event."

The EER states that an exceptional event must have regulatory significance for EPA to consider the demonstration. The EER clarifies at 40 CFR 50.14(a)(1) that the regulatory significance of a demonstration applies to the treatment of data showing exceedances or violations for *initial area designations and redesignations*.[1] New Jersey is seeking approval of this exceptional event demonstration to have 2023 wildfire data excluded for the purpose of the Initial Area Designations for the 2024 PM2.5 NAAQS. As a result, excluding the exceptional event days would reduce the 2023 PM2.5 annual average at the Camden and Elizabeth Lab monitors in New Jersey. As stated in the EPA Designations Memo for 2024 PM2.5 NAAQS[2] "The EPA expects that in making final designations decisions, the EPA will rely on air quality data from 2022 to 2024." Thus, the 2023 PM2.5 annual average will be included in the calculations and designation decisions for the 2024 PM2.5 NAAQS Area Designations.

Table 1 compares the annual mean for the most recent 3-year period. From 2021 to 2022, both Camden and Elizabeth Lab observed a greater than 1 $\mu g/m^3$ reduction in annual average PM2.5 ambient air concentrations. For 2023, Table 1 compares the annual mean without EPA concurrence and with EPA concurrence on the Exceptional Event dates. Assuming EPA concurrence, the Camden monitor would result in a 9.47$\mu g/m^3$ annual average and the Elizabeth Lab monitor would result in an 8.82 $\mu g/m^3$ annual average, greatly lowering the annual averages used in the calculations for determining initial area designation.

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[1] USEPA. (2023). Analytical Tools for Preparing Exceptional Events Demonstrations for Wildfire Events that May Influence Ozone and Particulate Matter Concentrations. https://www.epa.gov/system/files/documents/2023-09/Wildfire%20Resource%20Document_Final_Revised.pdf

[2] USEPA. (2024). Initial Area Designations for the 2024 Revised Annual Fine Particle National Ambient Air Quality Standard. https://www.epa.gov/system/files/documents/2024-02/pm-naaqs-designations-memo_2.7.2024-_-jg-signed.pdf

Table 1: Adjusted Annual Average for Exceptional Event (EE) Days

Monitor / Annual Mean (µg/m^3)	**2021**	**2022**	Without EPA Concurrence **2023**	With EPA Concurrence **2023**	Reduction in Annual Average **2023**
Camden	9.93	8.89	10.51	9.47	1.04
Elizabeth Lab	9.81	8.75	9.71	8.82	0.89

Attainment of the 2024 PM2.5 NAAQS is determined by calculating the design value at each air quality monitoring site. The design values for the 2024 PM2.5 NAAQS are calculated using the 3-year average (2021 – 2023) of the annual mean concentrations.[3] Table 2 shows the annual mean for 2021, 2022, 2023 (with EPA concurrence), and the annual mean needed in 2024 to achieve the new standard of 9.0 µg/m^3. From Table 2, the maximum annual average needed in 2024 for Camden would be 8.64 µg/m^3 to meet the new standard of 9.0 µg/m^3 assuming EPA concurrence in 2023. An annual average of 8.64 µg/m^3 would fall between the ranges of previously observed averages in 2021 and 2022, making it a fairly achievable average for the Camden monitor. Additionally, from Table 2, the maximum annual average needed in 2024 for Elizabeth Lab would be 9.43 µg/m^3. Considering previous year's annual averages at Elizabeth Lab were much lower, (8.75 µg/m^3 in 2022 and 8.82 µg/m^3 in 2023 with EPA concurrence), a maximum value of 9.43 µg/m^3 is also reasonably achievable for this monitor.

Table 2: 2021 – 2023 Annual Mean with EPA Concurrence

Monitor / Annual Mean (µg/m^3)	**2021**	**2022**	With EPA Concurrence **2023**	Needed in **2024** to meet 9.0 µg/m^3
Camden	9.93	8.89	9.47	8.64
Elizabeth Lab	9.81	8.75	8.82	9.43

[3] USEPA. (February 7, 2024) *Initial Area Designations for the 2024 Revised Primary Annual Fine Particle National Ambient Air Quality Standard.* https://www.epa.gov/system/files/documents/2024-02/pm-naaqs-designations-memo_2.7.2024-_-jg-signed.pdf

Exceptional Event Demonstration Analysis for PM2.5 During June 6, 7, 8, 2023

I. A Narrative Conceptual Model and a Discussion of the Event that Led to Exceedances at New Jersey Monitors

This section of the document addresses the EER requirement at 40 CFR 50.14(c)(3)(iv)(A), which requires that demonstrations include a narrative conceptual model describing how emissions from the specific fires caused PM2.5 exceedances at a particular location and how these event-related emissions and resulting violations differ from typical high PM2.5 episodes in the area resulting from other natural and anthropogenic sources of emissions. The narrative conceptual model should describe the principal features of the interaction of the event and how direct PM2.5 from the event was transported to the monitor that measured the exceedances/violations.[4] This narrative will include a description of non-event PM2.5 concentrations for the area, what is known about the specific fire whose emissions impacted the monitors, the meteorological conditions leading to emissions being transported from the fire to the monitors, and the monitored values observed in the area.

1. Non-Event PM2.5 in New Jersey

This section discusses the typical variations in PM2.5 concentrations in New Jersey to characterize how the June 2023 exceptional events caused by various wildfires differ from the usual weather patterns and locations of emissions that cause New Jersey to exceed the NAAQS for PM2.5.

<u>Seasonal PM2.5 Variations:</u>

Historically, New Jersey typically experiences short-term PM2.5 increases in the wintertime due to favorable meteorological conditions and increases in wood and coal combustion for heating. As a result, temperature inversions can form resulting in cooler air at the surface and warmer air aloft. In this scenario, air cools as elevation increases above ground level. This phenomenon is often called a nocturnal temperature inversion and occurs after sunset if the ground cools faster than the air above it. This is especially true in wintertime when a snowpack exists on the ground, keeping the surface air cold. In this instance, air temperature increases with elevation, which creates a stable boundary layer that prevents the vertical movement of air and traps pollutants near the ground. The stable boundary layer extends from the ground to only a few hundred meters in altitude.

According to a study on the day-of-week and seasonal patterns of PM2.5:

> "The highest PM2.5 concentrations are observed during wintertime. The large increase in wood and coal combustion for heating is the major reason leading to the appearance of the highest PM2.5 concentrations in wintertime in many regions. In the study, day-of-year curves for 220 monitoring stations showed that 81% of the 220 curves have, at least, two peak values, one in the wintertime (i.e. December and January) and the second in the summertime (i.e. July and August). Alternatively, high PM2.5 concentrations in summertime are often associated with days or periods of enhanced temperature — as shown by (Tai et al., 2010; Liu et al., 2017; Vanos et al., 2015) — that often pair with high pressure, low winds, and stagnant air (e.g., hot dry air masses), thus

[4] USEPA. (2024). *PM2.5 Wildland Fire Exceptional Events Tiering Document.* https://www.epa.gov/system/files/documents/2024-04/final-pm-fire-tiering-4-30-24.pdf

trapping in particulate matter and other pollutants. Additionally, the large increases in tourists and consequently uses of motor vehicles in the summertime are also likely to contribute to the high PM2.5 concentrations”.[5]

High pressure influences:

The evolution of regional PM2.5 episodes often begins with the movement of a large air mass from the Midwest to the middle or southern Atlantic states, where it assimilates into and becomes an extension of the Atlantic (Bermuda) high pressure system. During its movement east, the air mass accumulates air pollutants emitted by large coal-fired power plants and other sources along its transport pathway.[6] These expansive weather systems are conducive to the accumulation of PM2.5 because they result in a gentle sinking motion (subsidence) that causes air to sink and enhances stagnation of pollutants at the surface. As a result, air traveling more slowly and being trapped at the surface allows the pollutants to accumulate. Under a strong area of high pressure, the mechanisms that usually disperse pollutants are not present, which leads to a shorter boundary layer giving the pollutants less "volume" to disperse among compared to if the boundary layer was higher/taller. Also, winds that typically disperse pollutants over large areas are not present, so any pollution generated or transported into the area becomes trapped within the very low levels of the atmosphere, near the ground.

2. Wildfire Description

Abnormally warm and dry conditions over the winter and spring of 2023 amounted to an unusually intense start to Canada’s wildfire season. Much of Canada faced a significant moisture deficit at the onset of the fire season, primarily attributed to prolonged drought and early snowmelt.[7] As such, snow cover over North America during the month of May was the lowest ever recorded and significantly below the historical average (Figure 1).[8] In addition, the timing of wildfire ignitions impacts the overall fire size, and this was particularly evident in 2023, as environmental/weather conditions favored fire growth over fire extinguishment. This allowed for an exceptionally large increase in the number of hectares burned across Canada in 2023 (Figure 2, red line).[9]

In the beginning of June, newly ignited fires from a passing weather system raged in the eastern Canadian province of Quebec, many of which were caused by lightning. Thousands of residents were forced to evacuate, as smoke from the blazes prompted air quality warnings across

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[5] Naizhuo Zhao, Ying Liu, Jennifer K. Vanos, Guofeng Cao, Day-of-week and Seasonal Patterns of PM2.5 Concentrations Over the United States: Time-series Analyses Using the Prophet Procedure, Atmospheric
[6] Environment, Vol. 192 (2018), Accessed July 31, 2024. https://gero.usc.edu/airpollbrain-group/wp-content/uploads/2020/07/zhao..vanos-2018-1-s2.0-S1352231018305715-main.pdf

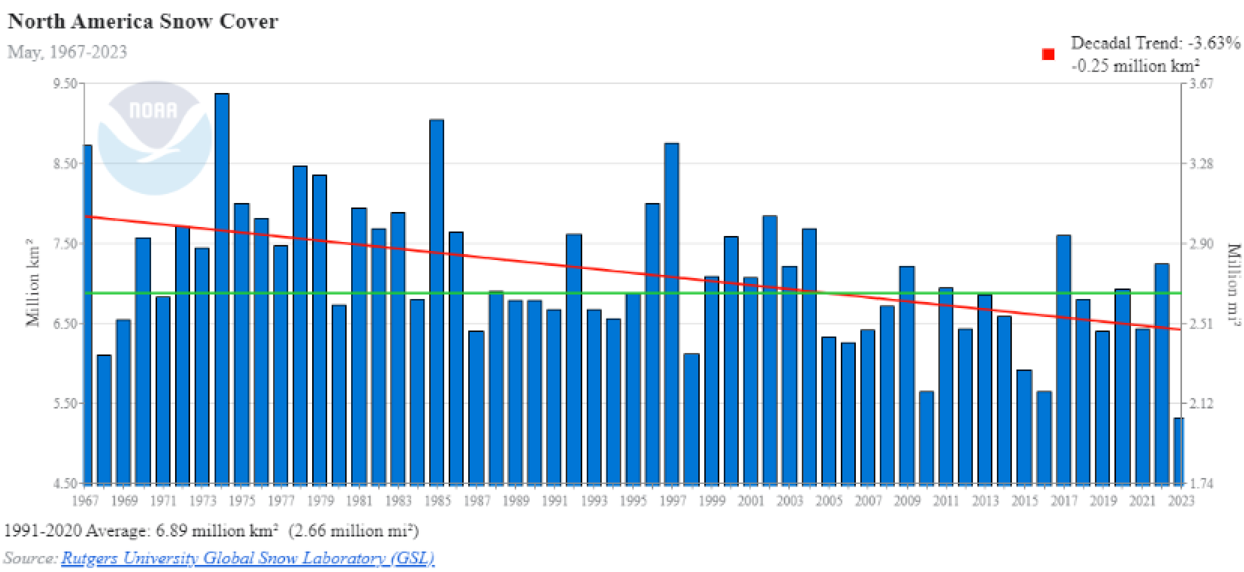
[7] Jain, P., Barber, Q.E., Taylor, S.W. *et al.* Drivers and Impacts of the Record-Breaking 2023 Wildfire Season in Canada. *Nat Commun* **15**, 6764 (2024). https://doi.org/10.1038/s41467-024-51154-7

[8] Maryland Department of the Environment, 2023, “Exceptional Event Demonstration and Analysis of the June 2023 Quebec Canada Wildfires and their Impact on Maryland’s Air Quality on June 7, 2023”. https://mde.maryland.gov/programs/air/AirQualityMonitoring/Documents/ExceptionalEvents/MDE_Ozone_EE_Demo_2023_June_7.pdf

[9] Jain, P., Barber, Q.E., Taylor, S.W. *et al.* Drivers and Impacts of the Record-Breaking 2023 Wildfire Season in Canada. *Nat Commun* **15**, 6764 (2024). https://doi.org/10.1038/s41467-024-51154-7

Quebec.[10] In Mistissini, Quebec, evacuations were ordered as heavy smoke from a nearby forest fire blanketed the town (Figure 3). As the smoke departs from the burn site, winds typically move the plume from fires in Quebec toward the east and out to sea, but in June 2023, a persistent coastal low centered near Prince Edward Island, instead steered smoke south into the United States (Figure 4).[11] Here, the dense smoke plume impacted air quality levels across an expansive area of the northeast, mid-Atlantic, and beyond, having extreme effects on locations in its path allowing PM2.5 concentrations to soar into the very unhealthy category.

Figure 1: North American Snow Cover (Millions km^2) in May 1967 – 2023



Note: Green line represents average, red line represents decadal trend.
Image courtesy of Maryland Department of the Environment

[10] NASA Earth Observatory, (June 3, 2023) "Fires Burn Across Quebec". Accessed September 25, 2024. https://earthobservatory.nasa.gov/images/151430/fires-burn-across-quebec
[11] NASA Earth Observatory, (June 7, 2023) "Smoke Smothers the Northeast". Accessed September 25, 2024. https://earthobservatory.nasa.gov/images/151433/smoke-smothers-the-northeast

Figure 2: Accumulated Hectares Burned 2015 - 2024

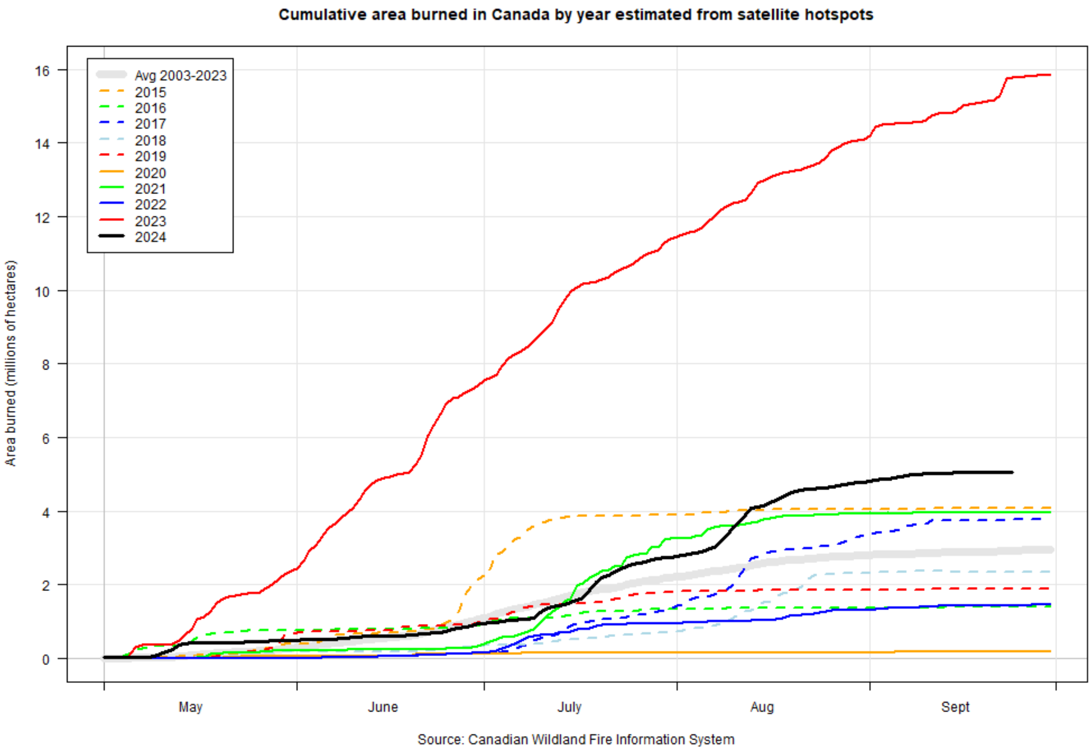


Figure 3: Photo of Wildfire No. 334 near Mistissini, Quebec

Figure 4: Smoke Plume Sweeping NY, PA, and NJ Early Morning Hours – June 7, 2023

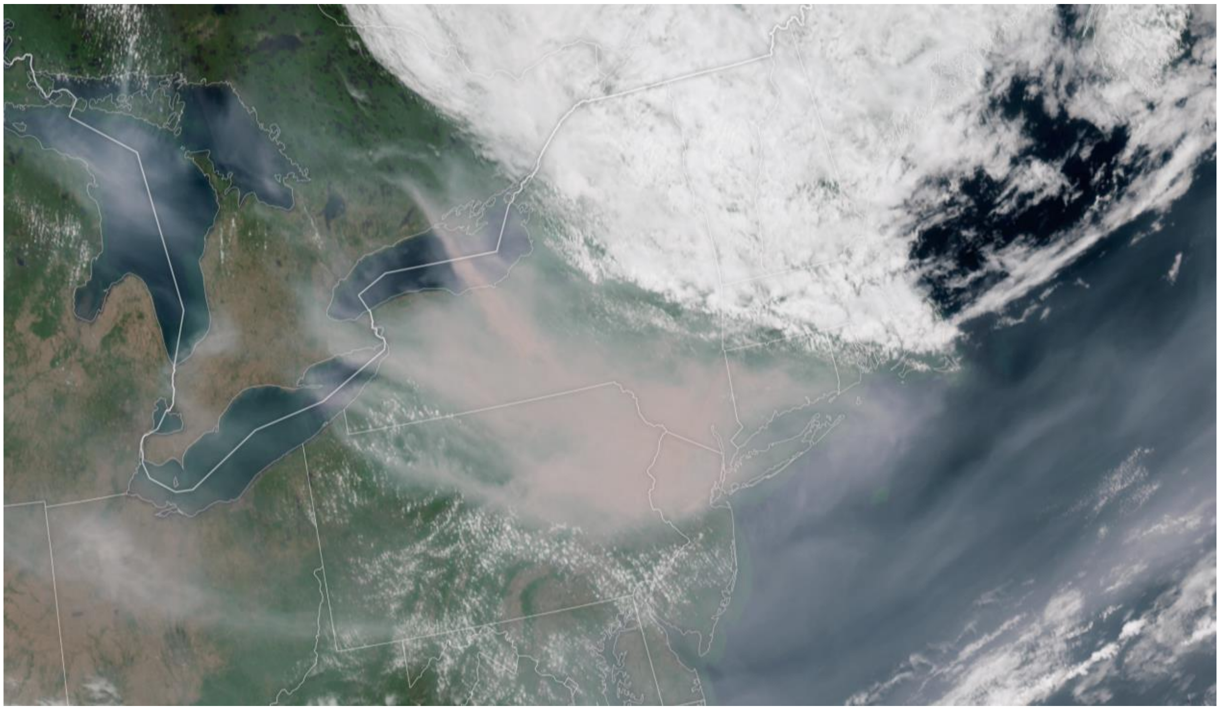


Image from Geostationary Operational Environmental Satellite (GOES-16)

3. Conceptual Model of PM2.5 Concentrations from Wildfires

Smoke from wildfires has been known to raise the level of particle pollution to unhealthy concentrations and create air quality concerns. Because smoke can travel hundreds or thousands of miles, air quality can be a problem at larger distances from the wildfire itself. The intense heat generated by wildfires aids in the process of driving smoke high into the air.[12] The following sections will provide a simplified narrative of the transport during the event, associated meteorological conditions at the surface and aloft, satellite imagery, and regional AQI maps. A simplified illustration of the weather pattern is shown in Figure 5.

3.1 Conceptual Model Discussion

The final week of May 2023 was characterized by a strong Canadian ridge of high pressure migrating from the Pacific Northwest into the Canadian Maritimes providing dry conditions and record-breaking heat to parts of eastern Canada and the Northeast. During the first week of June 2023 in North America, a strong omega pattern (a weather pattern characterized by a prominent, stationary high-pressure system in the shape of the Greek letter omega, Ω) set-up allowing the strong ridge over central Canada to continue to suppress precipitation over most of eastern North America. However, a weak storm system moving through Quebec caused copious

[12] Challenges in Predicting Smoke Concentrations, USEPA, Accessed: 7/18/2024, https://www.epa.gov/wildfire-smoke-course/challenges-predicting-smoke-concentrations.

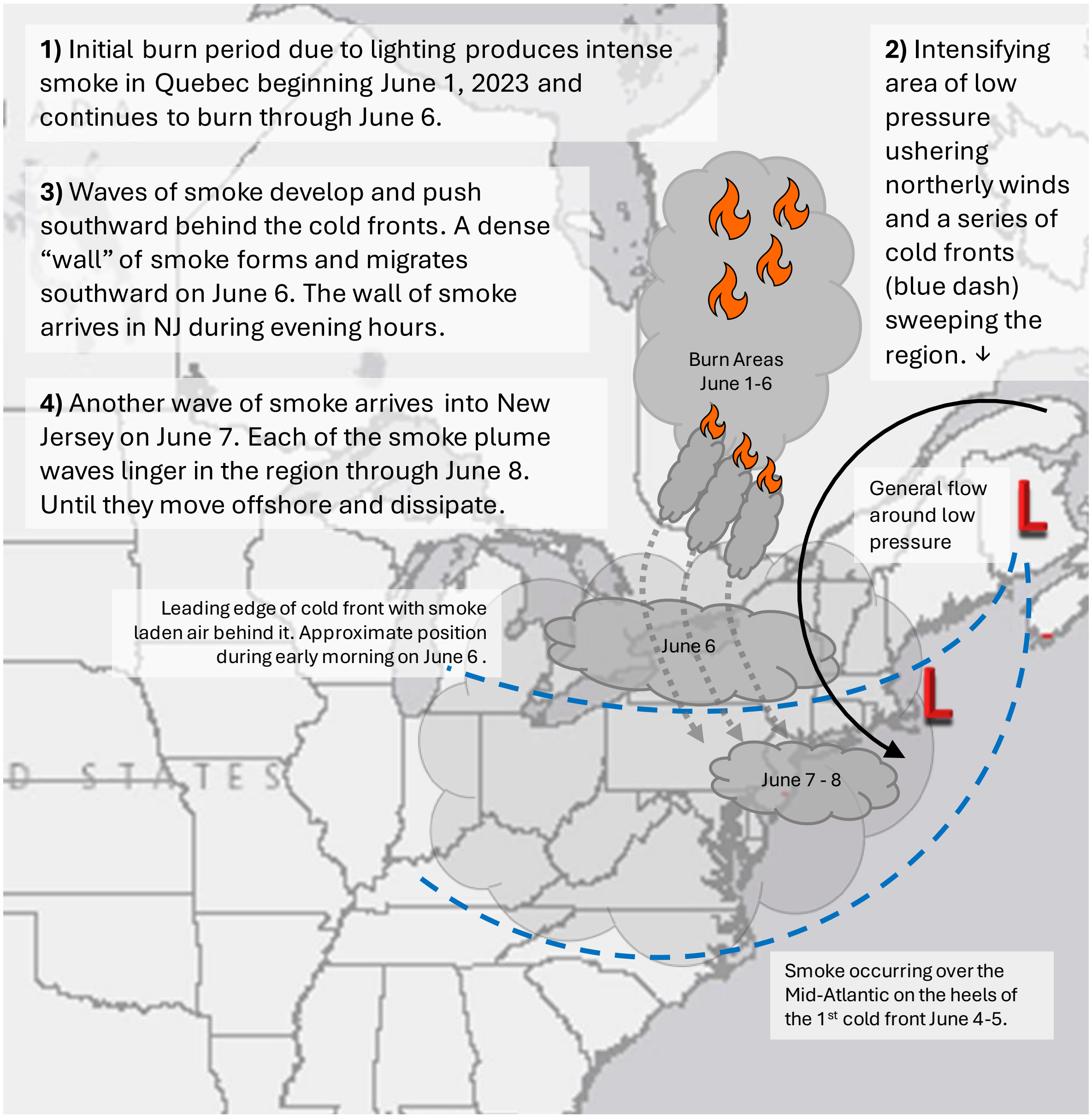
lightning strikes across the province on June 1 (Figure 5, caption #1), igniting fires that burned through the month of June 2023.

Thereafter, northerly flow across Quebec, allowed frequent low-pressure systems across the Canadian Maritimes (Figure 5, caption #2). This area of low pressure deepened, causing an increased pressure gradient across Quebec, which resulted in persistent and increasing winds into June 4-7. The newly ignited fires across the province, with parched fuels and low moistures quickly intensified under the influence of the strong and persistent winds.[13]

Northerly winds associated with the area of low pressure tapped into cooler temperatures allowing a cold front to advance southward across northeastern United States. Little smoke was associated with this first cold-front, however, strengthening of the Canadian Maritime low (Figure 5, caption #2) caused northwest transport by June 5 and 6, which pulled the diffuse smoke across the Great Lakes southeastward. Here, the continued strengthening of the Canadian Maritime low pressure system tapped into additional colder air, allowing a second cold front to sweep the region. This front and the strong northerly winds behind it created an ominous dark plume of smoke or what could be interpreted as a "wall" of smoke, which pushed out of Canada on June 6, (Figure 5, caption #3) and was in transit to New Jersey, arriving in the evening hours of June 6. An additional wave of smoke arrived in the evening hours on June 7, creating another exceptional day of high PM2.5 concentrations on June 8 (Figure 5, caption #4).

[13] Maryland Department of the Environment, 2023, "Exceptional Event Demonstration and Analysis of the June 2023 Quebec Canada Wildfires and their Impact on Maryland's Air Quality on June 7, 2023". https://mde.maryland.gov/programs/air/AirQualityMonitoring/Documents/ExceptionalEvents/MDE_Ozone_EE_Demo_2023_June_7.pdf

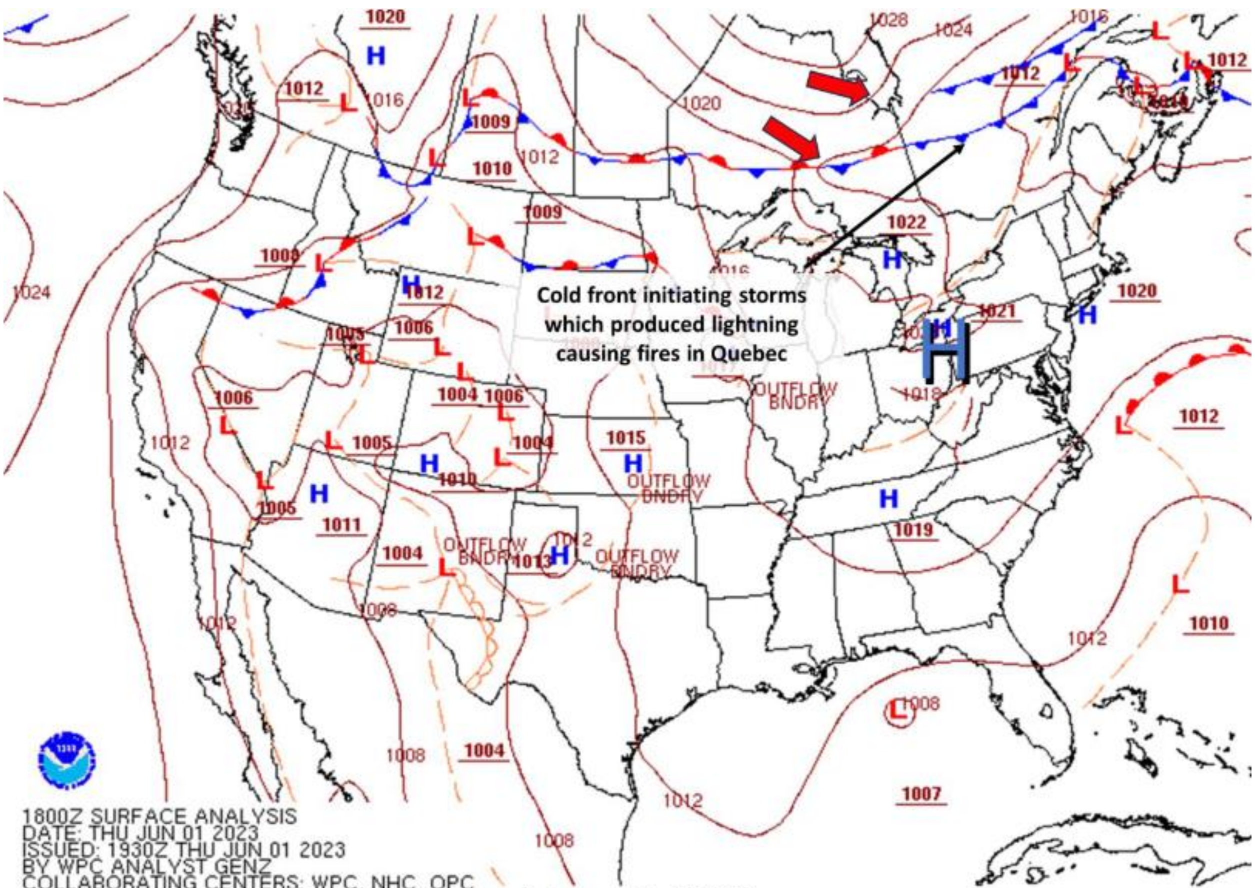
Figure 5: Simplified, Illustrated Conceptual Model of June 6, 7, 8, 2023 Wildfire Event



3.2 Surface Analysis – Transport and Wind Patterns

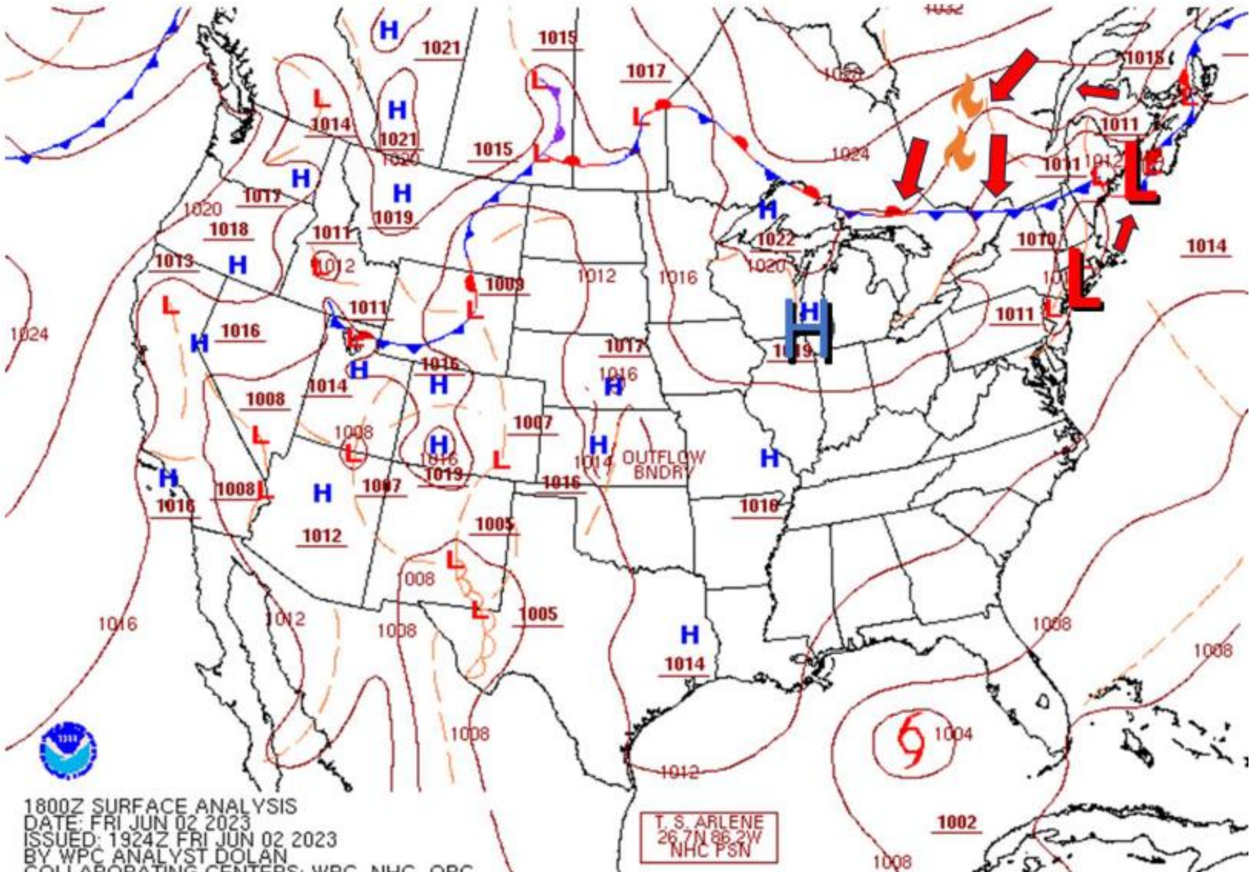
A weak area of high pressure (noted in Figure 6, blue H) over the mid-Atlantic region provided light winds and little atmospheric ventilation to New Jersey beginning on June 1. Meanwhile, a westward trailing cold front extending from a deepening area of low pressure over the Canadian Maritimes initiated storms producing lighting leading to wildfires igniting in Quebec. Westerly winds (noted in Figure 6, red arrows) and newly ignited wildfires allowed smoke plumes to rapidly accumulate. As the area of low pressure continued to strengthen on June 2, wildfire development was enhanced via strengthening winds and recirculation around the low pressure (noted Figure 7, red L, and red arrows). Northerly winds shifted the trajectory of the smoke plume southward into the Great Lakes behind the cold front (Figure 8). At this time, multiple high-pressure centers, and weak wind flow allowed air at the surface to stagnate through June 4, allowing smoke to linger across the Great Lakes region (Figure 9). Another cold front swept the fire location from north to south on June 5 (Figure 10, solid blue line with arrowheads pointing in the direction the cold front is moving) carrying with it, heavy dense smoke on its heels. This cold front continued to migrate southward and was draped across Pennsylvania by June 6 (Figure 11, cold front) while dense smoke quickly filled in behind it due to deepening low pressure and tight pressure gradient indicating increasing wind speeds (noted in Figure 11, red arrows). Here, a sharp cut off/demarcation of the smoke free air (ahead of the cold front) from the smoke plume can be observed on satellite imagery (Figure 12, click link below image to view satellite loop). Another wave of smoke behind the surface trough (orange dashed line draped across New Jersey, Figure 13) can also be observed on satellite imagery (Figure 14, click link below image to view satellite loop) entering New Jersey on June 7 in the early afternoon hours. By June 8, light winds and limited ventilation (Figure 15) associated with weak high pressure taking over the weather pattern allowed residual smoke to linger through June 8 (Figure 16, click link below image to view satellite loop) leading to another day of high PM2.5 concentrations.

Figure 6: Surface Analysis June 1, 2023



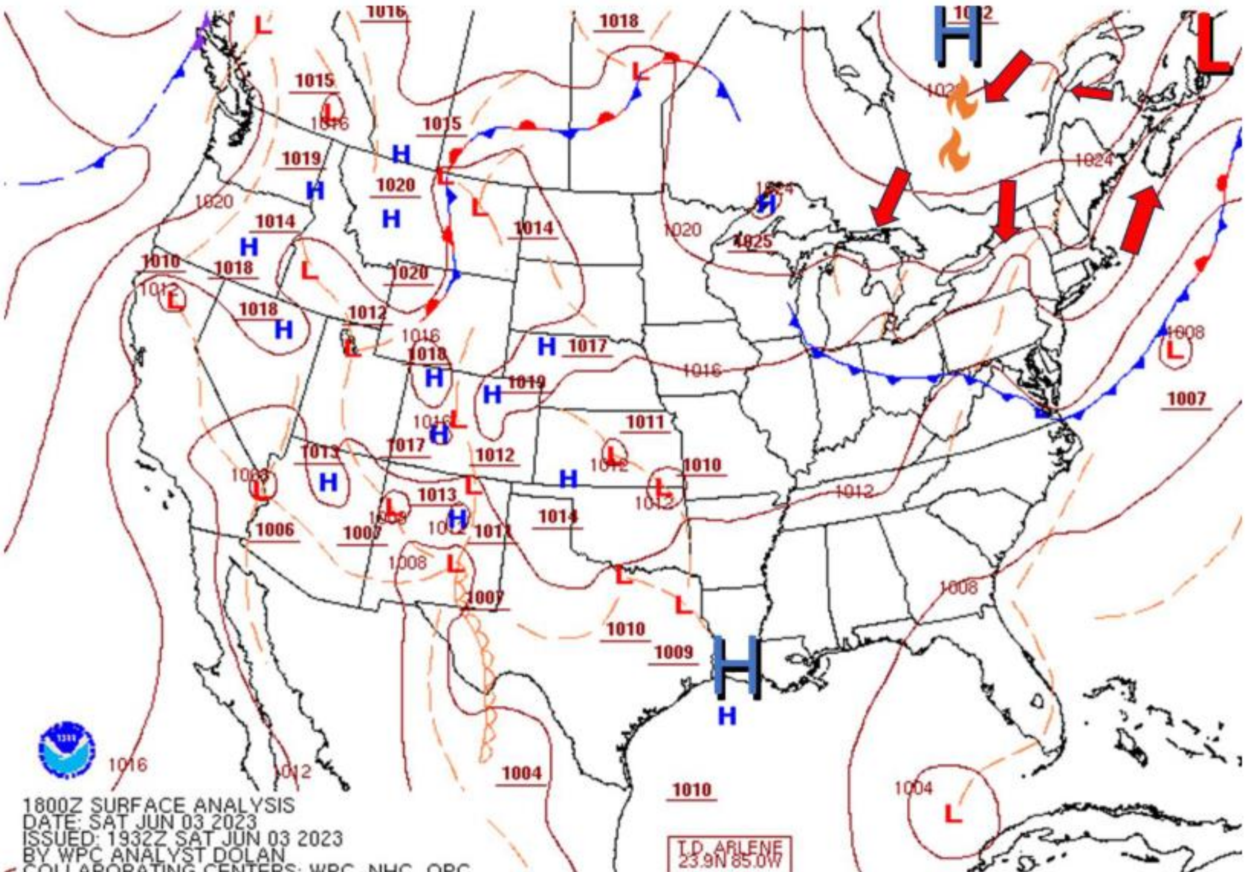
a) June 1, 2023

Figure 7: Surface Analysis June 2, 2023



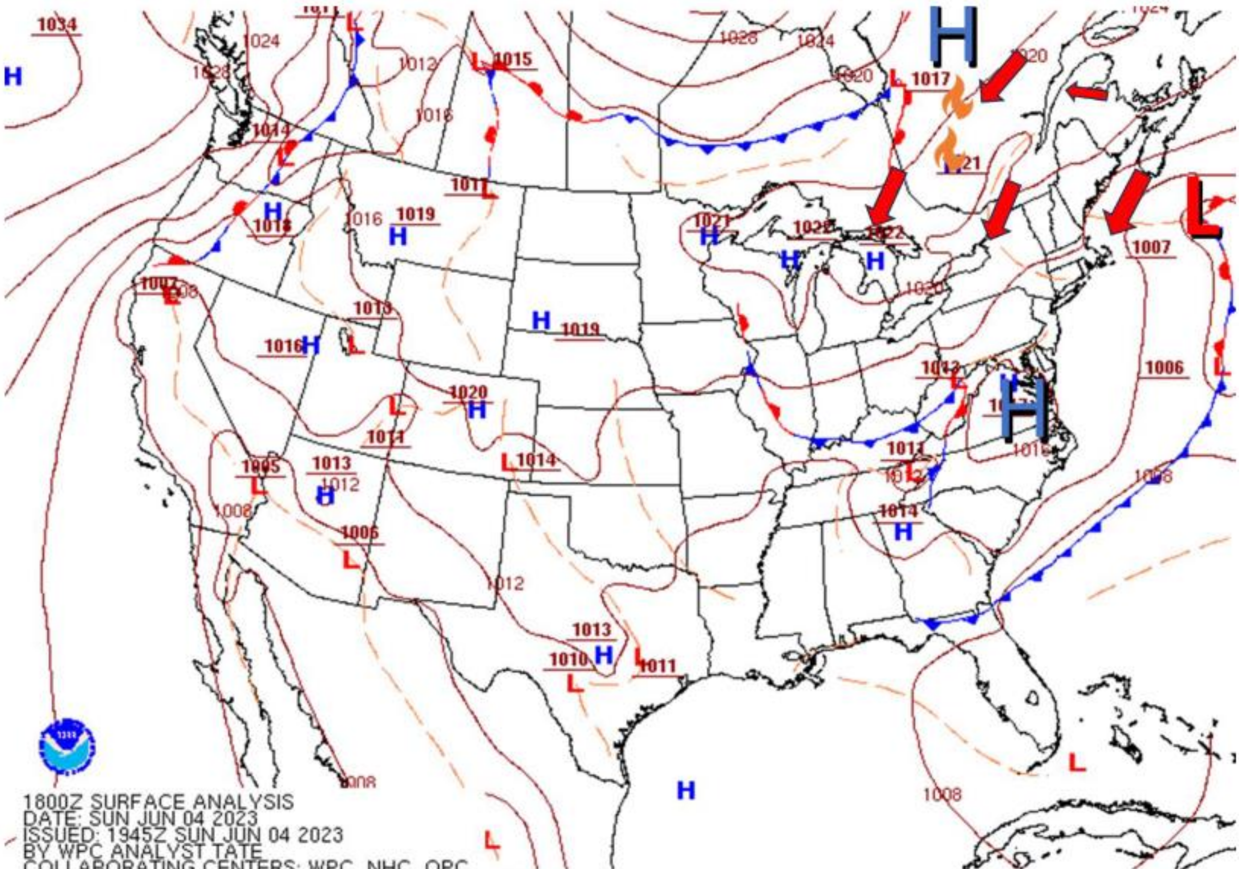
b) June 2, 2023

Figure 8: Surface Analysis June 3, 2023



c) June 3, 2023

Figure 9: Surface Analysis June 4, 2023



d) June 4, 2023

Figure 10: Surface Analysis June 5, 2023

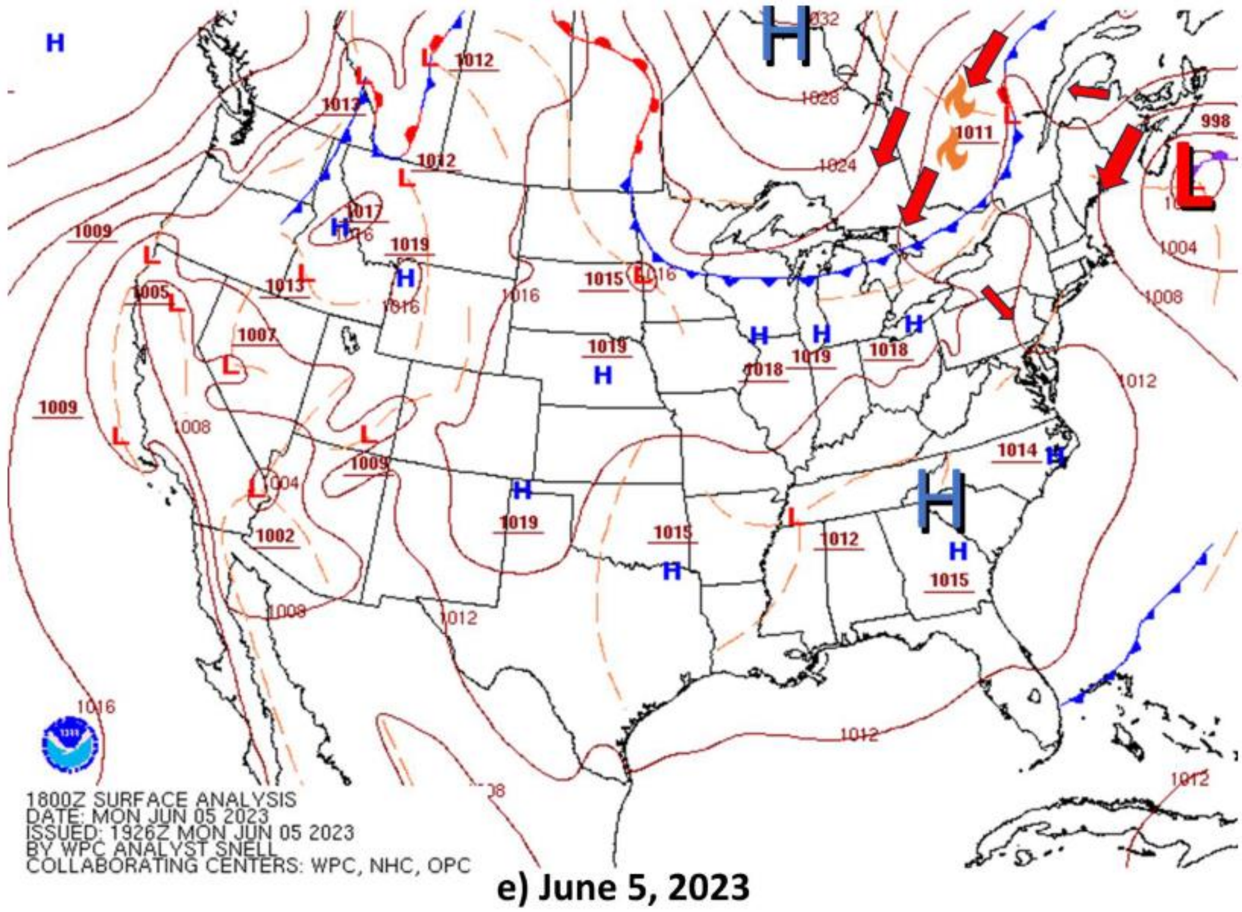


Figure 11: Surface Analysis June 6, 2023

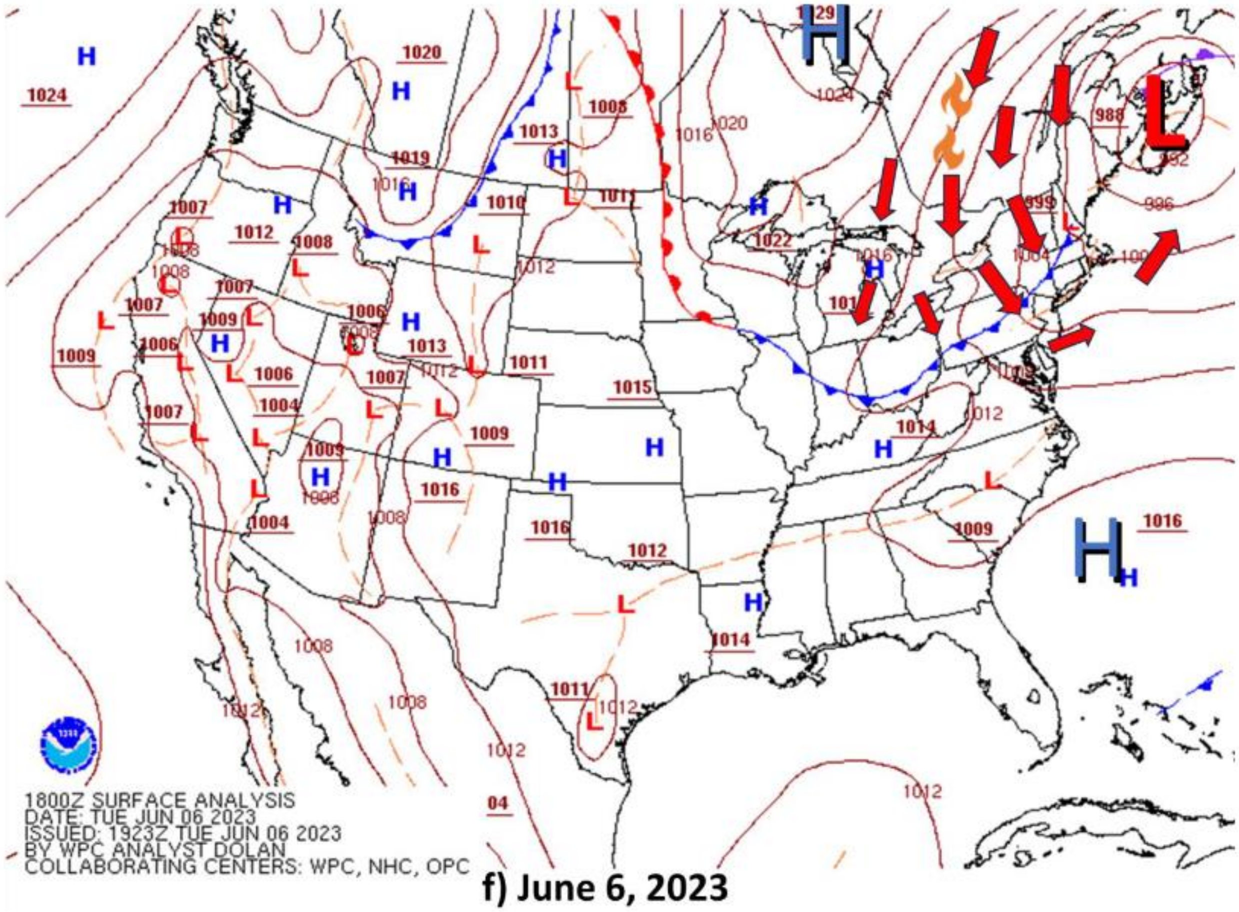
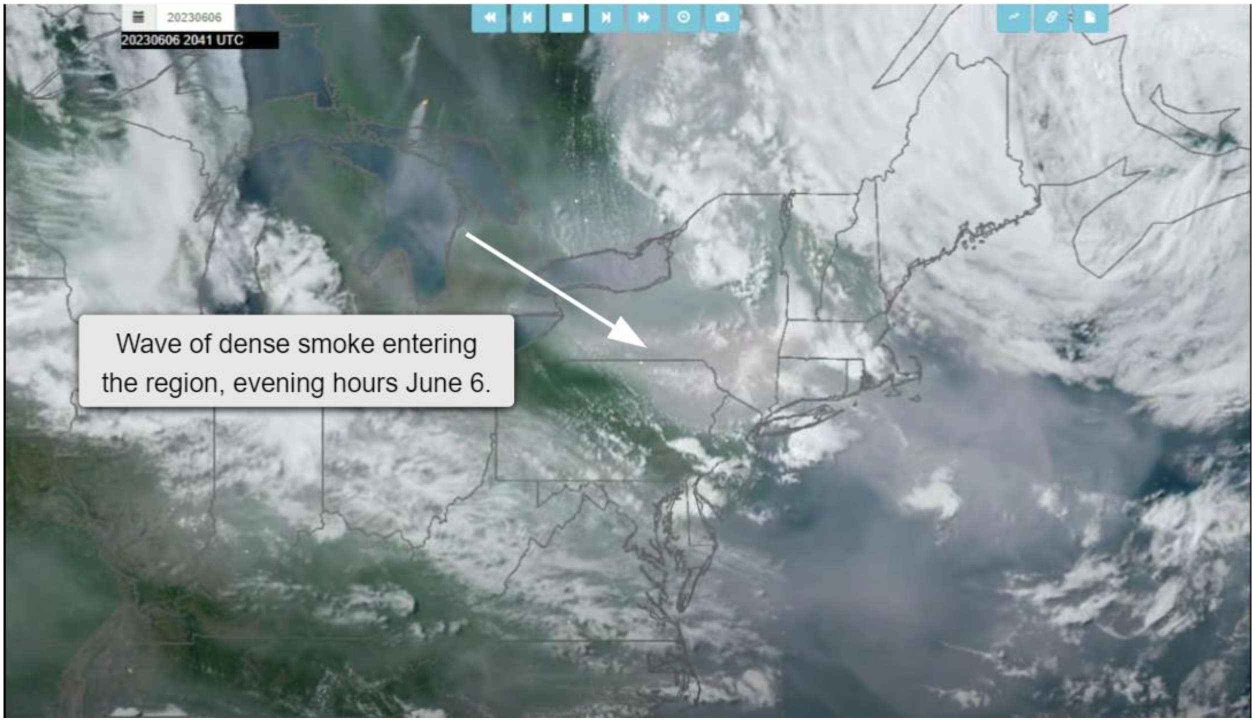


Figure 12: Aerosol Watch Satellite Imagery of Smoke Plume - Early Evening June 6, 2023



View full video clip with captions: [Aerosol Watch | Satellite Loop | June 6, 2023]

Figure 13: Surface Analysis June 7, 2023

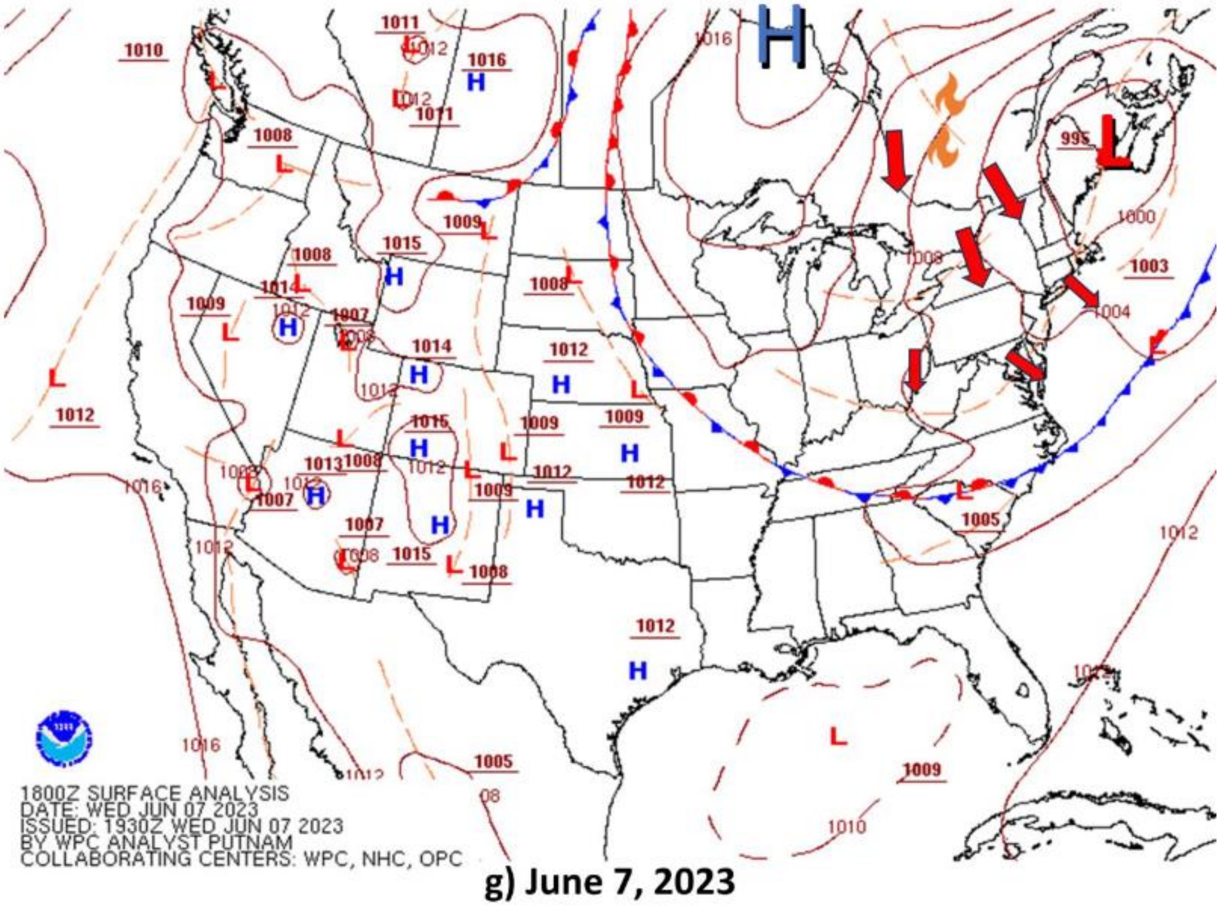
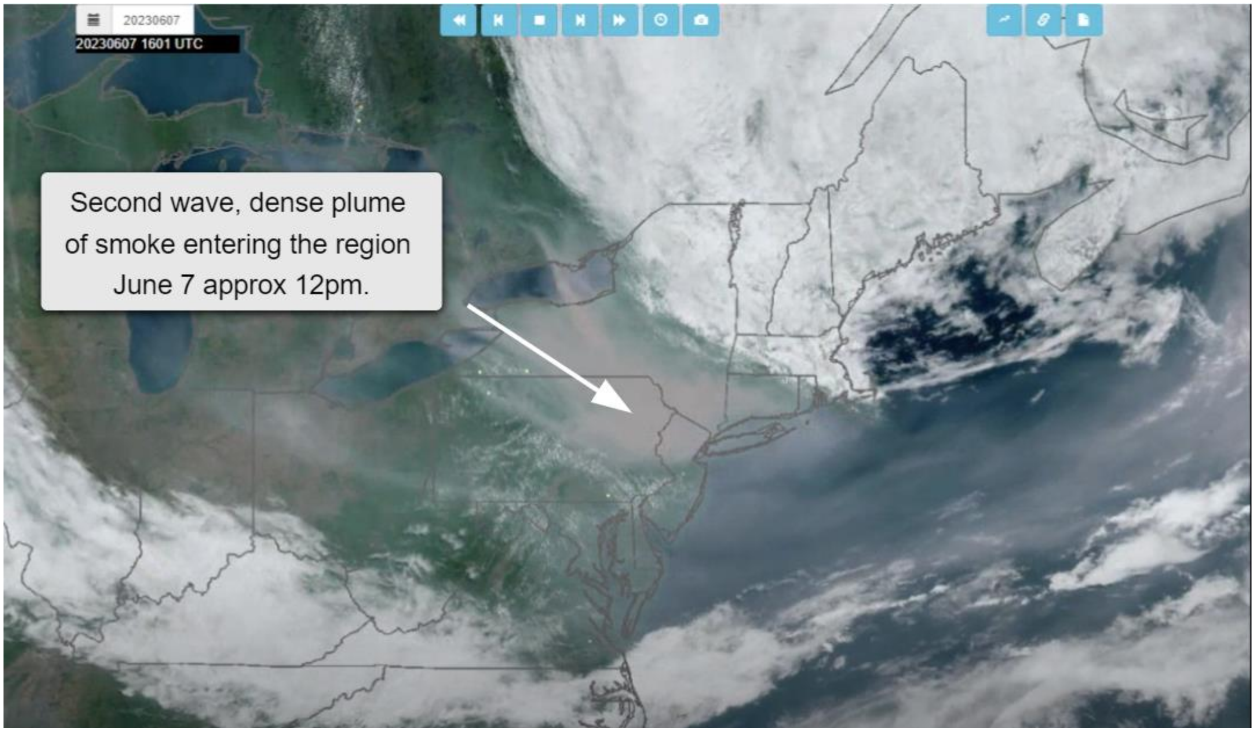
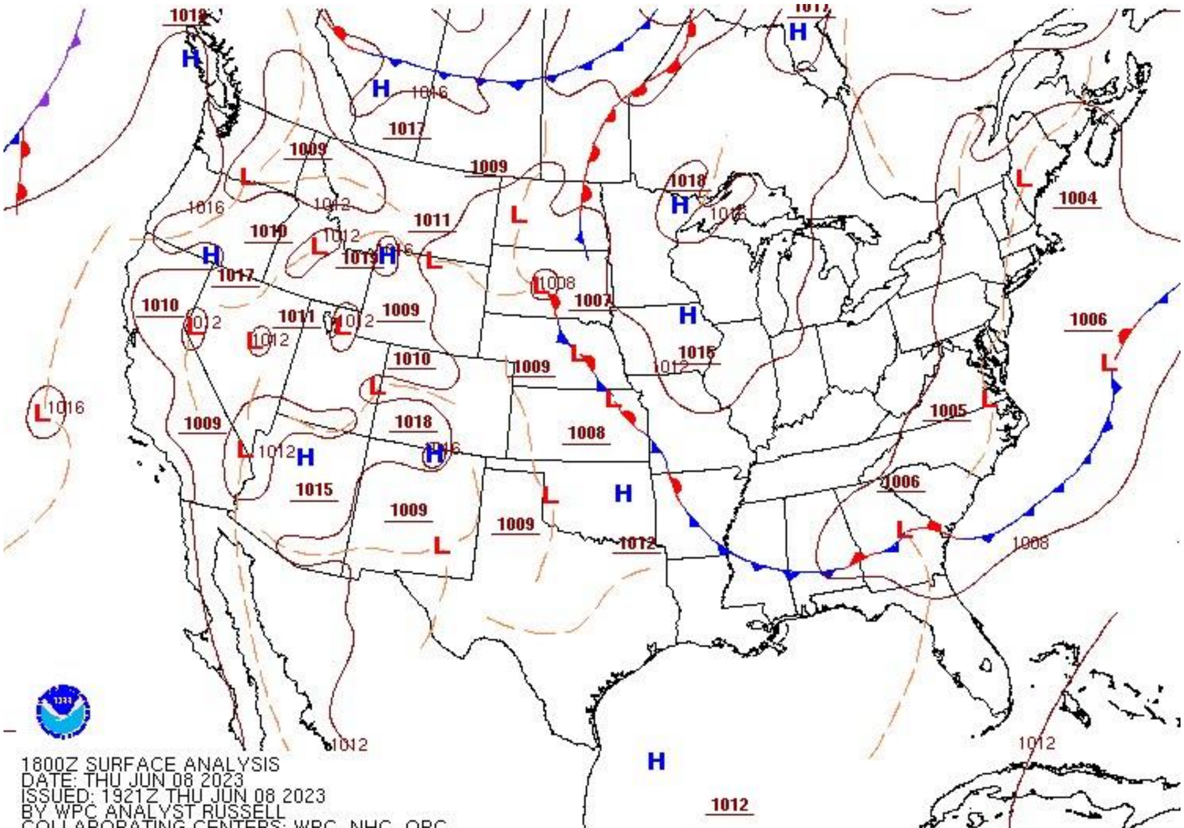


Figure 14: Aerosol Watch Satellite Imagery of Smoke Plume – June 7, 2023



View full video clip with captions: [Aerosol Watch | Satellite Loop | June 7, 2023]

Figure 15: Surface Analysis June 8, 2023



h) June 8, 2023

Figure 16: Aerosol Watch Satellite Imagery – June 8, 2023

View full video clip with captions: [Aerosol Watch | Satellite Loop | June 8, 2023]

3.3 Upper Air Analysis

This section provides an upper air analysis occurring at the 850 millibar (mb) level (approximately 1500 m above sea level). The upper air level sits near the top of the planetary boundary layer (PBL), the atmospheric layer in which pollutants associated with ground level concentrations occur, and can serve as a guide for the transport of pollutants. The analysis of this atmospheric level is given for June 6 – 8, 2023, in Figures 18 – 20 below.

On June 5 (Figure 17), winds across Quebec were generally out of the north as they wrapped around the intensifying area of low pressure over the Canadian Maritimes. This pattern remained in place through June 6 (Figure 18) allowing a similar transport pathway to persist with northerly winds flowing into the Mid Atlantic. This same pattern caused northwesterly winds across the Great Lakes and Mid-Atlantic by June 7, resulting in the initial wave of smoke across the region by that time (Figure 19). Meanwhile, strong northerly flow is evident across Quebec, with a relatively tight temperature and pressure gradient across the same area, indicative of a cold front, which would be responsible for the influx of smoke into June 7 (Figure 19, red arrow, closed rings around center of L, wind barbs showing higher wind speed). By June 8 (Figure 20) the area of low pressure started to weaken but remained anchored over New England allowing the same pattern to persist. The continuous influx of smoky air from the northwest on June 8th allowed smoke to slowly dissipate out to sea throughout the day while still resulting in daily PM2.5 averages to remain in exceedance territory.

Figure 17: 850mb Upper Air Analysis, June 5, 2023

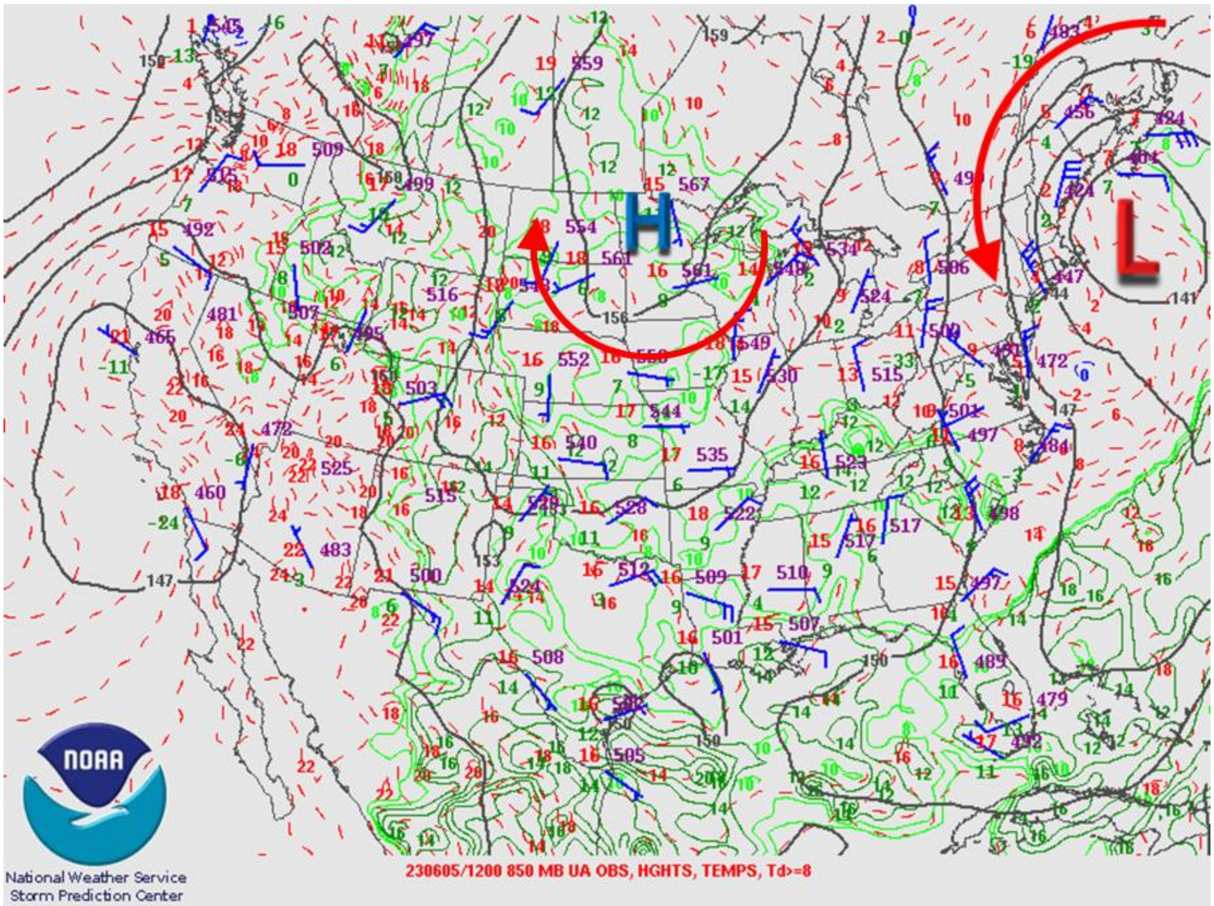


Figure 18: 850mb Upper Air Analysis, June 6, 2023

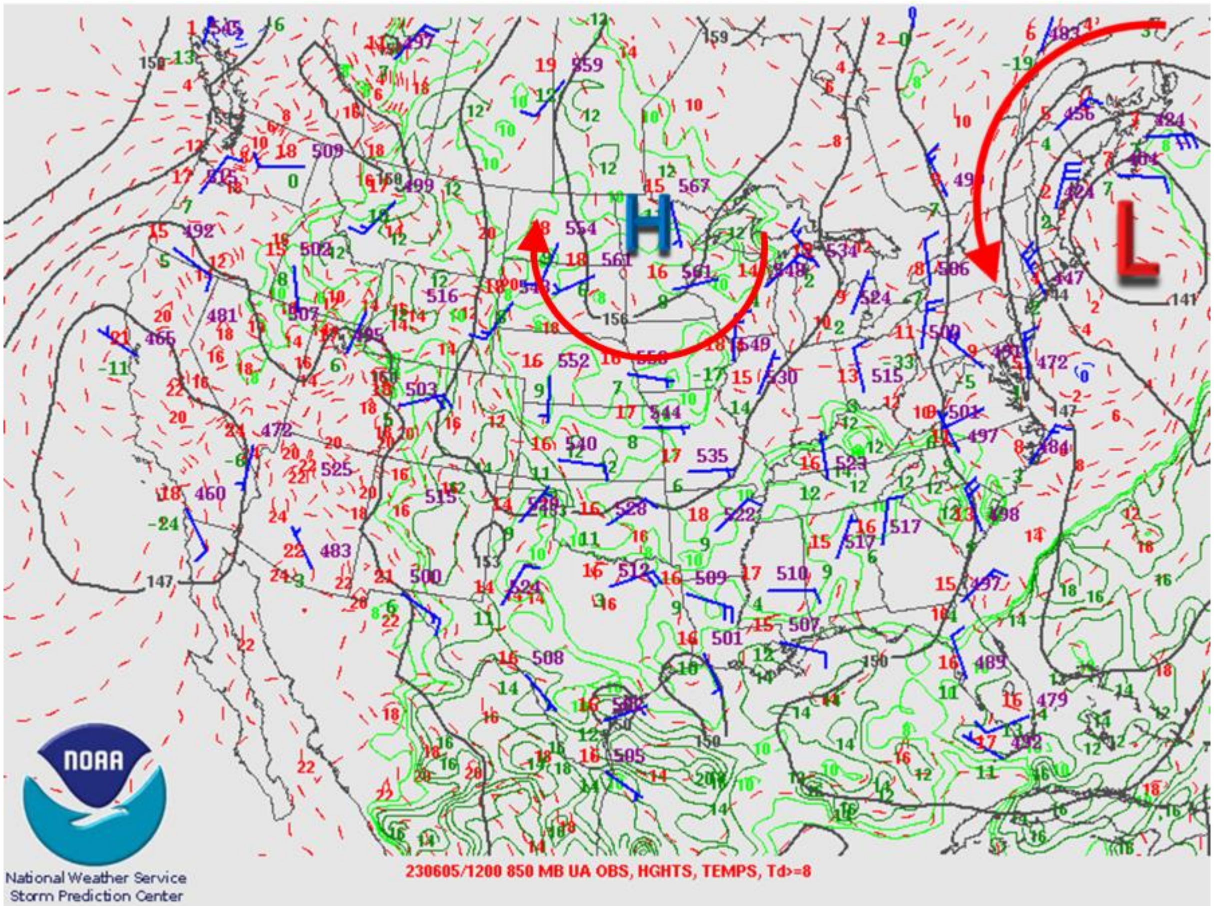


Figure 19: 850b Upper Air Analysis, June 7, 2023

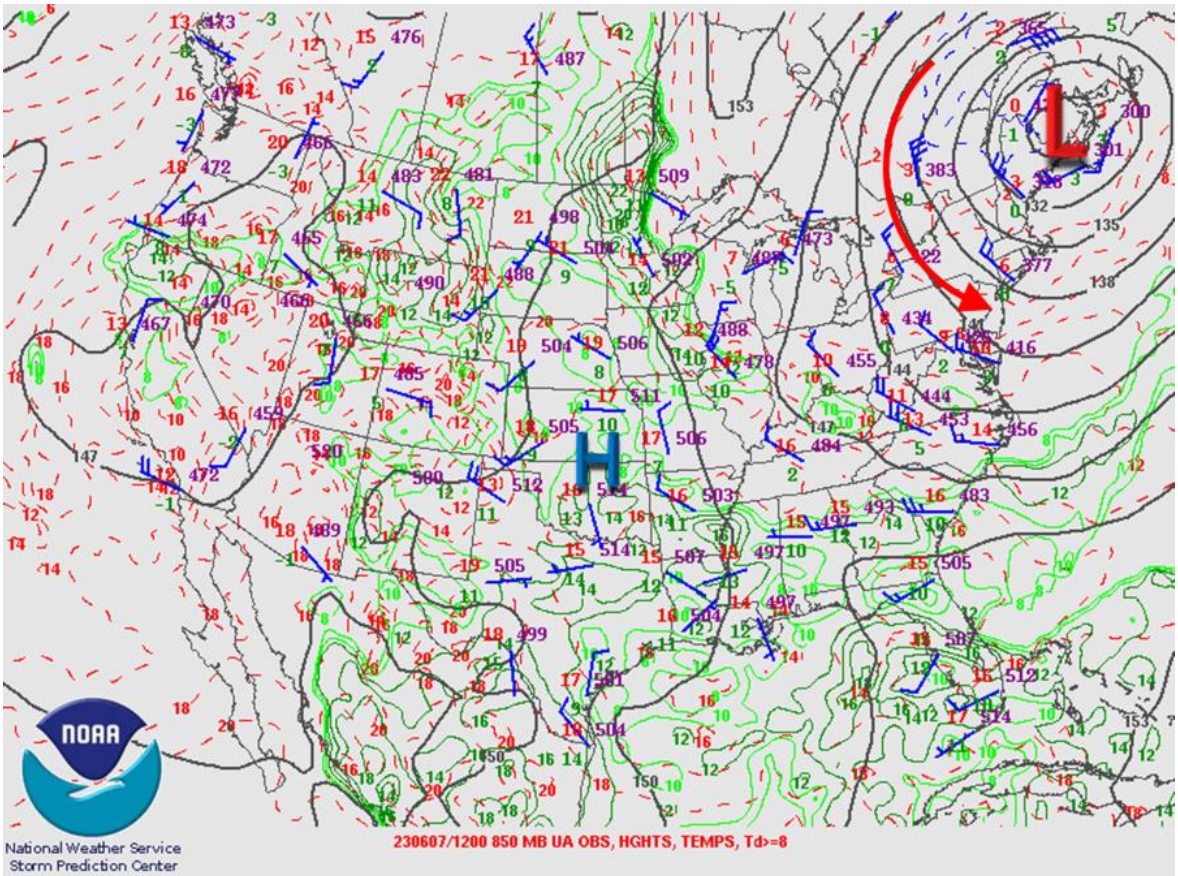
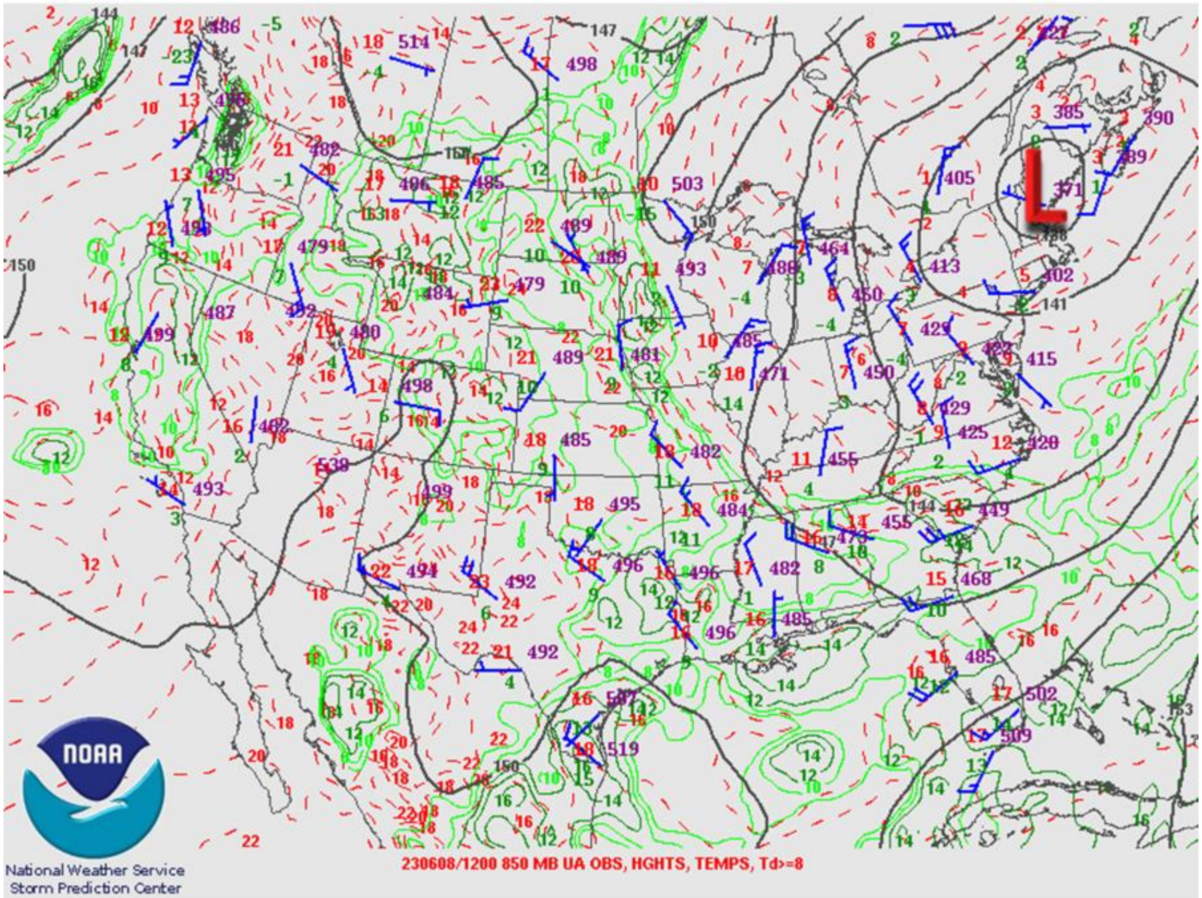
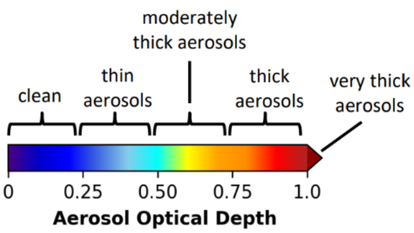


Figure 20: 850mb Upper Air Analysis, June 8, 2023



3.4 Aerosol Optical Depth

Figures 21 – 24 show composite aerosol optical depth (AOD) in the days leading up to the high PM2.5 exceedance event from June 6 – 8, 2023. AOD is a measure of smoke in the atmosphere that is blocking sunlight. Therefore, it is a helpful indicator of wildfire smoke and how much direct sunlight is prevented from reaching the ground by aerosol particles. In the following images, AOD is indicated by the color scale shown below, which represents a scale from 0.0 (clean) to 1.0 (very thick aerosols). [14]



Note, cloud cover can block AOD measurements and it should not be assumed that air masses with cloud cover do not contain wildfire smoke. In addition, on some instances due to the extreme density of the smoke plume, the instrument may have had difficulty determining between cloud cover and smoke plumes.

In the days leading up to the event, the wildfires burning in Quebec sent smoke in a general southward direction toward the United States. On June 5, a large airmass of smoke blocking sunlight from reaching the surface was observed (Figure 21, large dark red area). On June 6 (Figure 22), the instrument appears to malfunction, indicating that lower AOD values at the center of the heaviest smoke plume on this day were lower than the surrounding areas. In addition, the heaviest smoke plume arrived later in the evening, resulting in the composite average for this day to show less than what occurred. A link below Figure 22 has been provided to show full AOD clip from this day. AOD images from June 7 and 8 (Figure 23 and Figure 24), continue to show the deepest red values indicating heavy smoke over the mid-Atlantic was blocking sunlight from reaching the surface for several days.

[14] Huff, Amy. “Accessing and Analyzing Air Quality Data from Geostationary Satellites: Part 2: Air Quality Products from the GOES-R Satellites.” October 18, 2022. Accessed September 27, 2024. https://appliedsciences.nasa.gov/sites/default/files/2022-10/Geostationary_Part2_Final.pdf

Figure 21: Aerosol Optical Depth, June 5, 2023

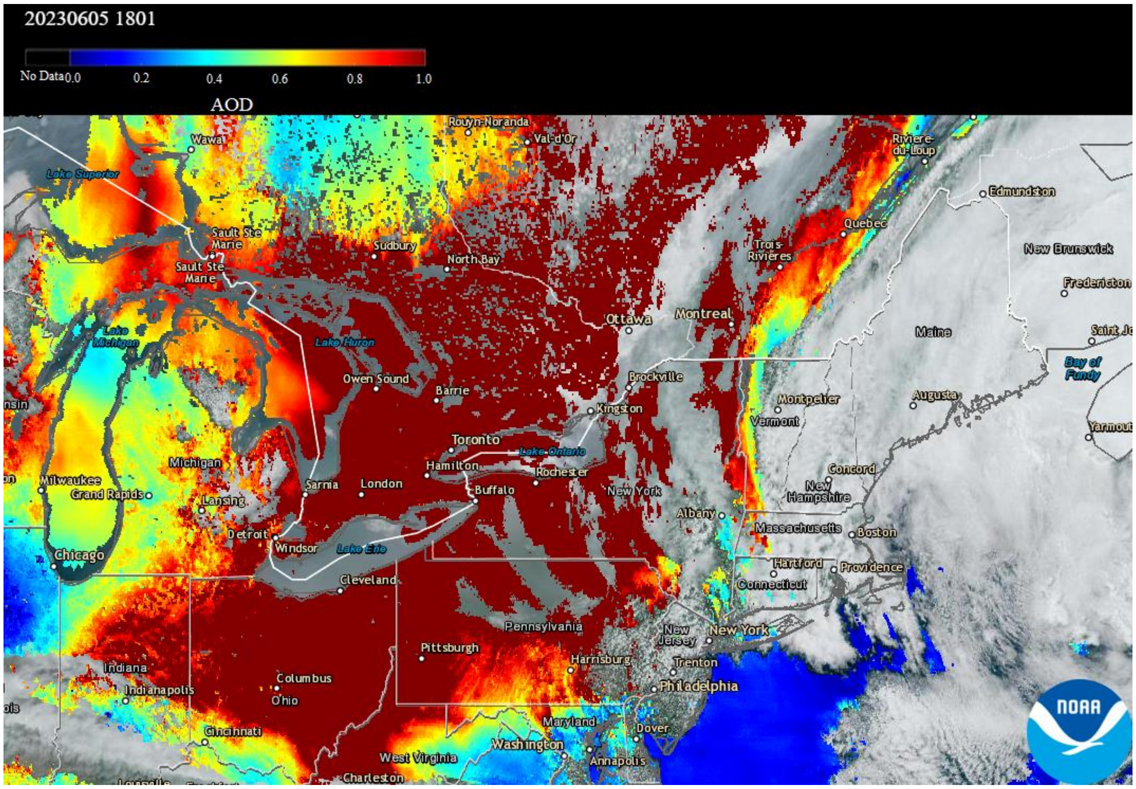
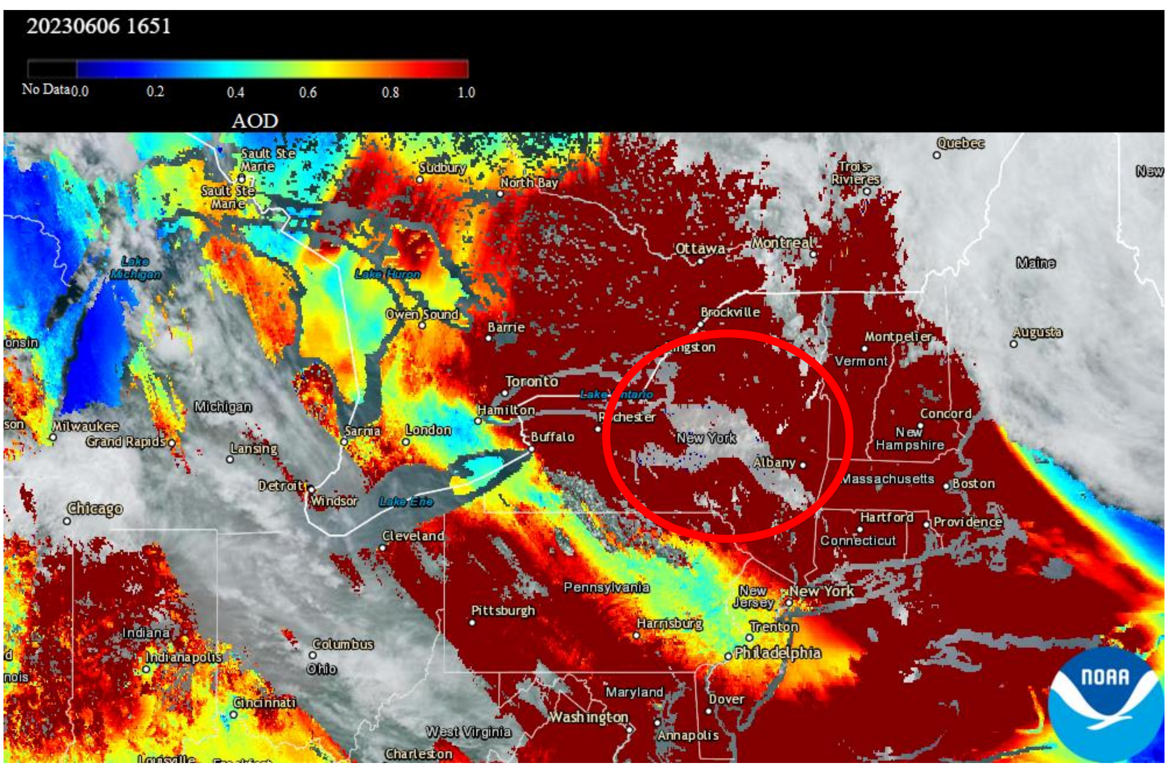


Figure 22: Aerosol Optical Depth, June 6, 2023



View full video clip with captions: [Aerosol Watch | Satellite Loop AOD | June 6, 2023]

Figure 23: Aerosol Optical Depth, June 7, 2023

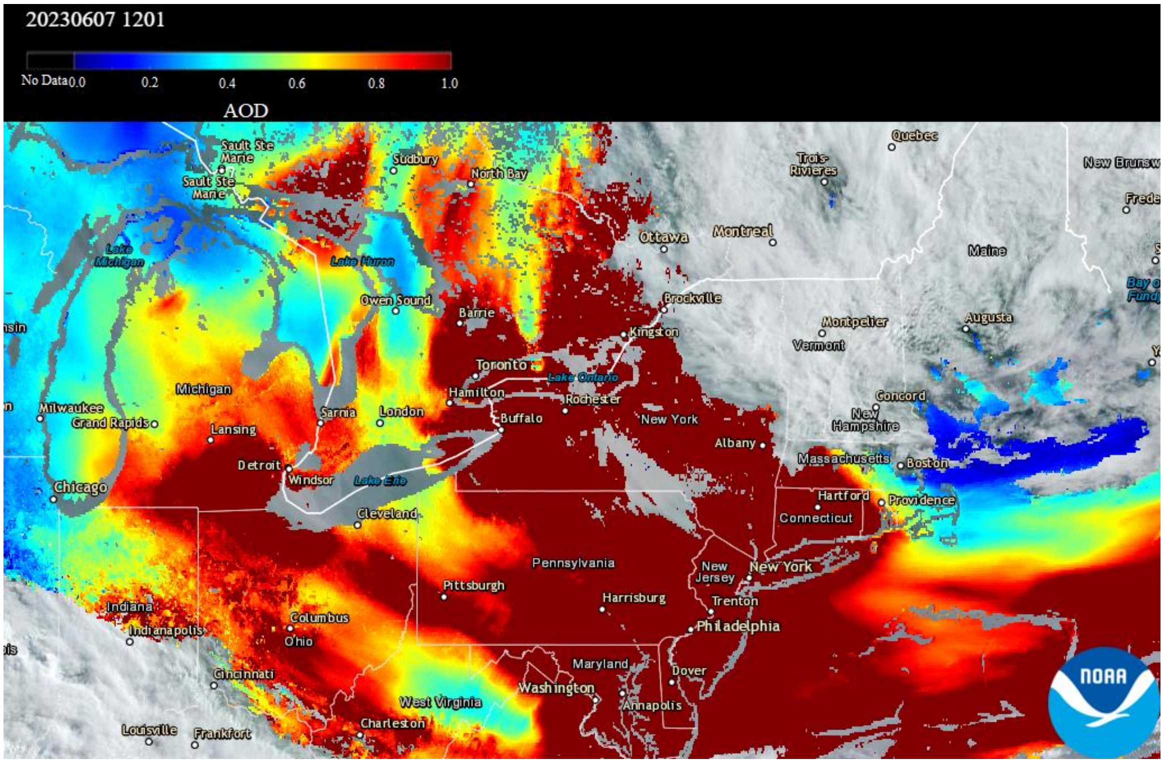
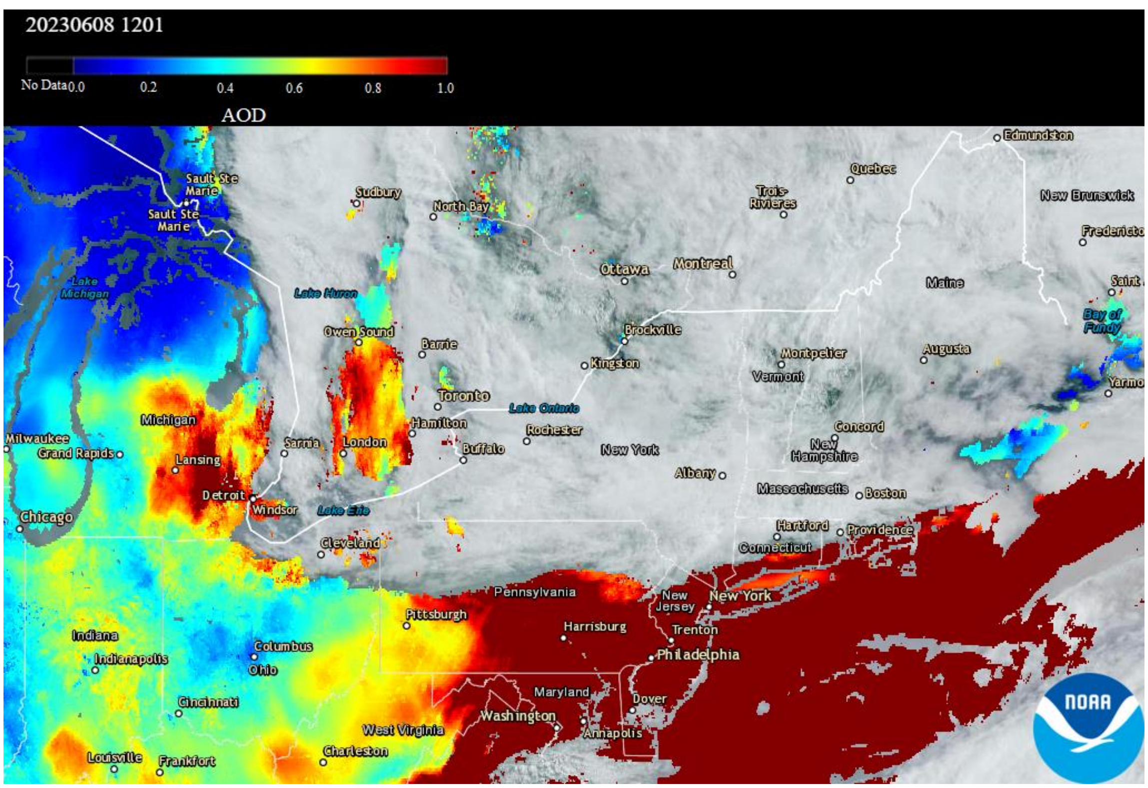


Figure 24: Aerosol Optical Depth June 8, 2023



3.5 Daily PM2.5 AQI Maps

The following images (Figures 25 - 31) show Daily Air Quality Index (AQI) levels observed across the continental United States during the days leading up to and including the exceptional event occurring on June 6 - 8, 2023. The changing level of the AQI in these images corresponds to the progression of PM2.5 levels in the ambient air leading up to the high PM2.5 exceptional event. The PM2.5 AQI levels are provided as an indicator of the presence of the smoke plume. Color contours in the following figures from AirNow.gov are based on the PM AQI scale for the 2012 Annual PM2.5 NAAQS. The AQI scale was updated in 2024 to reflect the 2024 PM2.5 Standard.

The scale used in Figures 25 - 31 for the PM2.5 AQI is as follows:

AQI Category and Index Value	AQI Category Breakpoints (μg/m^3)
Good (0-50)	0.0 – 12.0
Moderate (51-100)	12.1 – 35.4
Unhealthy for Sensitive Groups (101-150)	35.5 – 55.4
Unhealthy (151-200)	55.5 – 150.4
Very Unhealthy (201-300)	150.5 – 250.4
Hazardous (301+)	250.5+

Beginning on June 1st(not pictured/visible on AQI maps due to monitoring site limitations), wildfires ignited in Quebec sending smoke into the atmosphere. By June 2, some of this wildfire smoke reached locations far enough south into portions of southeastern Canada that it was detectable via air quality monitors. On June 2 and 3, the initial plume of wildfire smoke billowing from the fires registered air quality levels in the unhealthy, unhealthy for sensitive groups, and very unhealthy categories for PM2.5 in Canada, northwest of Ottawa (Figure 25 and Figure 26).

On June 4 and 5, (Figure 27 and Figure 28) air quality monitors in southern Ontario/Quebec and the Great Lakes were just starting to record rising PM2.5 concentrations. As the smoke plume migrated southward into the northeast, surface level PM2.5 concentrations began to rise to unhealthy levels where the smoke plume was located on satellite imagery, indicating that wildfire smoke was reaching the surface.

By June 6 (Figure 29), the wildfire smoke had spread southward into the northeast. Here, widespread unhealthy and unhealthy for sensitive groups air quality had flooded the northeast and mid-Atlantic states. The following day, June 7 (Figure 30), the wildfire smoke spread further southward following along the same transport pathway as the day prior. Figure 30 shows the direct pathway that the heaviest smoke plume traversed (purple) and the extensive widespread coverage of the degraded air quality. Here, wildfire smoke from days prior lingered while a new plume arrived allowing the air mass to grow increasingly polluted into the very unhealthy category. The final day of the event, June 8 (Figure 31), was characterized by lingering smoke and limited atmospheric ventilation making the air mass slow to depart. As a result, 24-hr PM2.5 concentrations averaged in the unhealthy category across New Jersey.

Figure 25: Daily PM2.5 AQI June 2, 2023

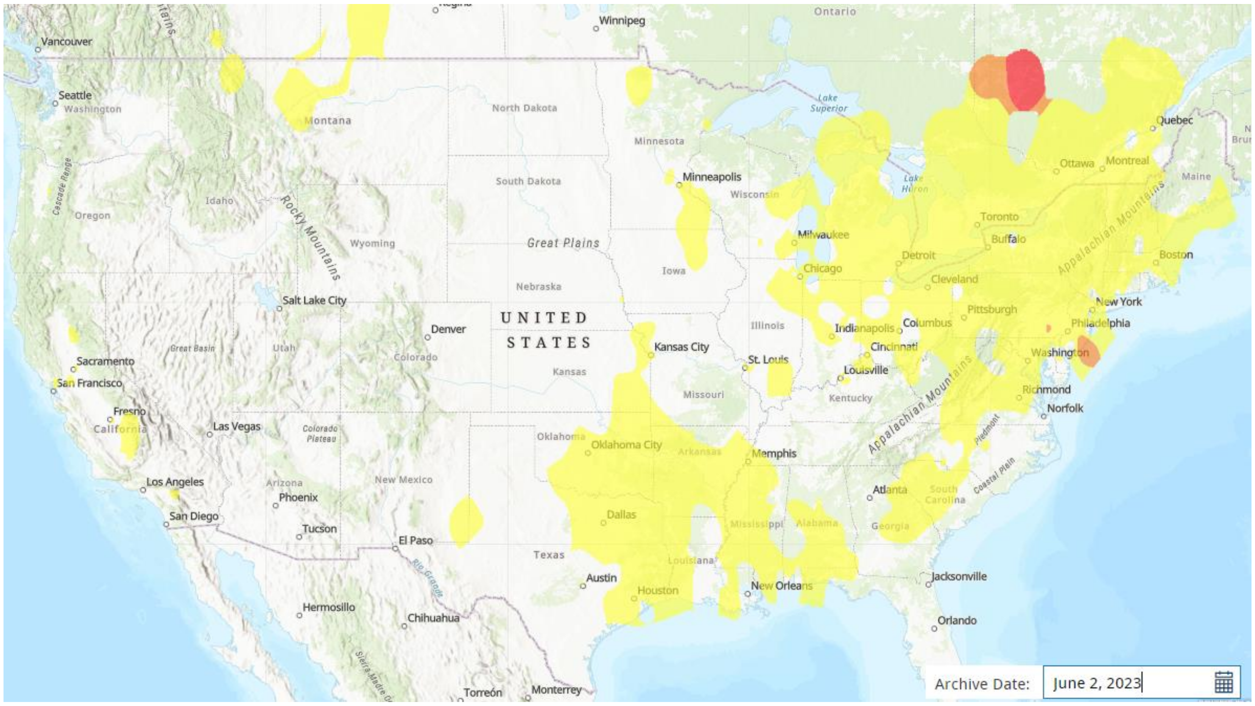


Figure 26: Daily PM2.5 AQI June 3, 2023

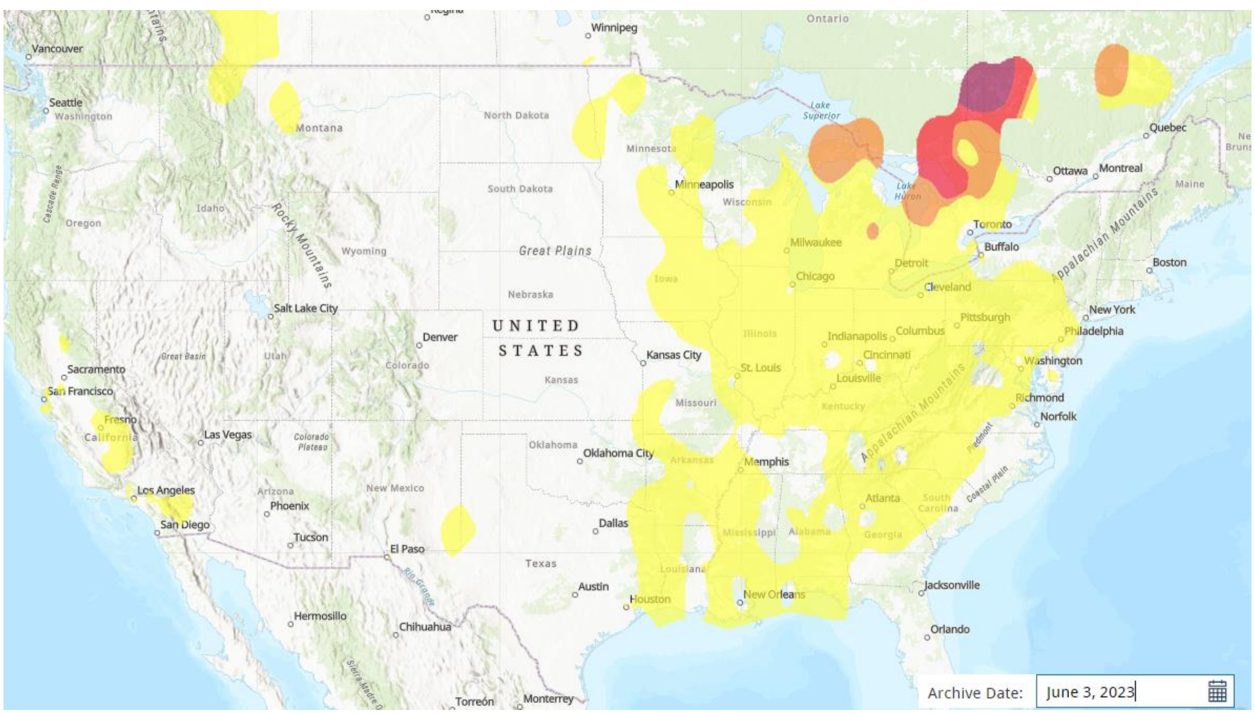


Figure 27: Daily PM2.5 AQI June 4, 2023

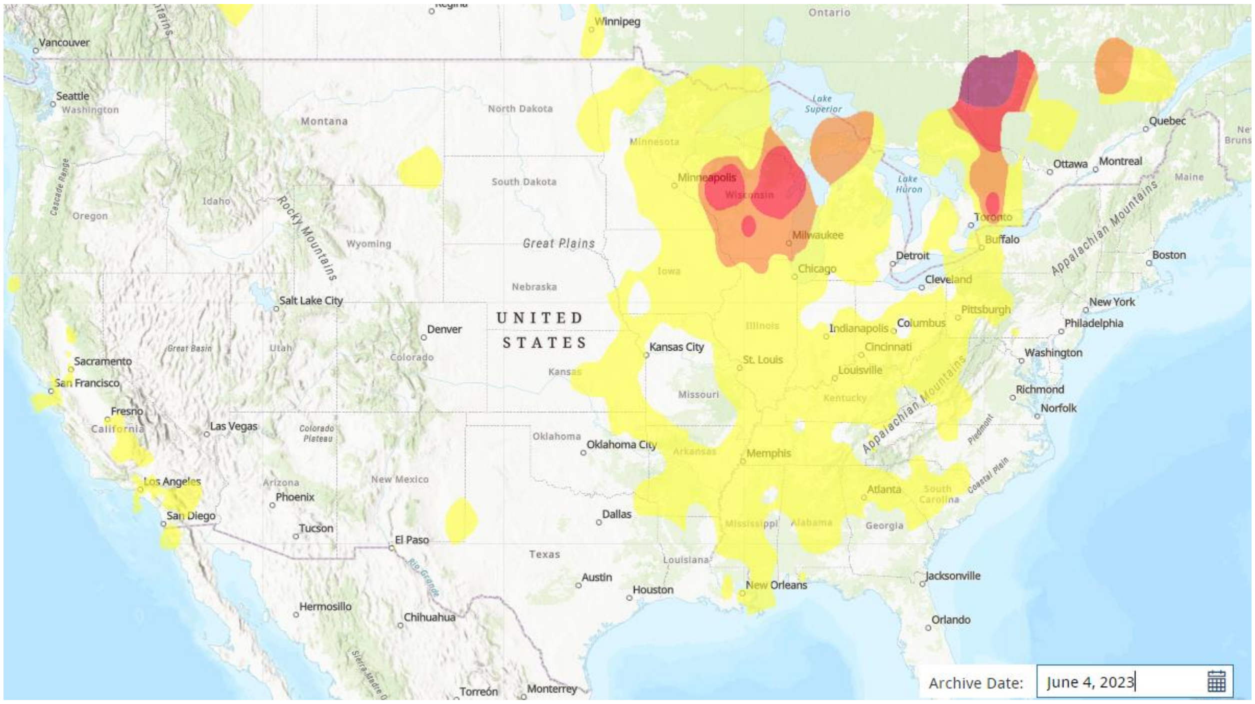


Figure 28: Daily PM2.5 AQI June 5, 2023

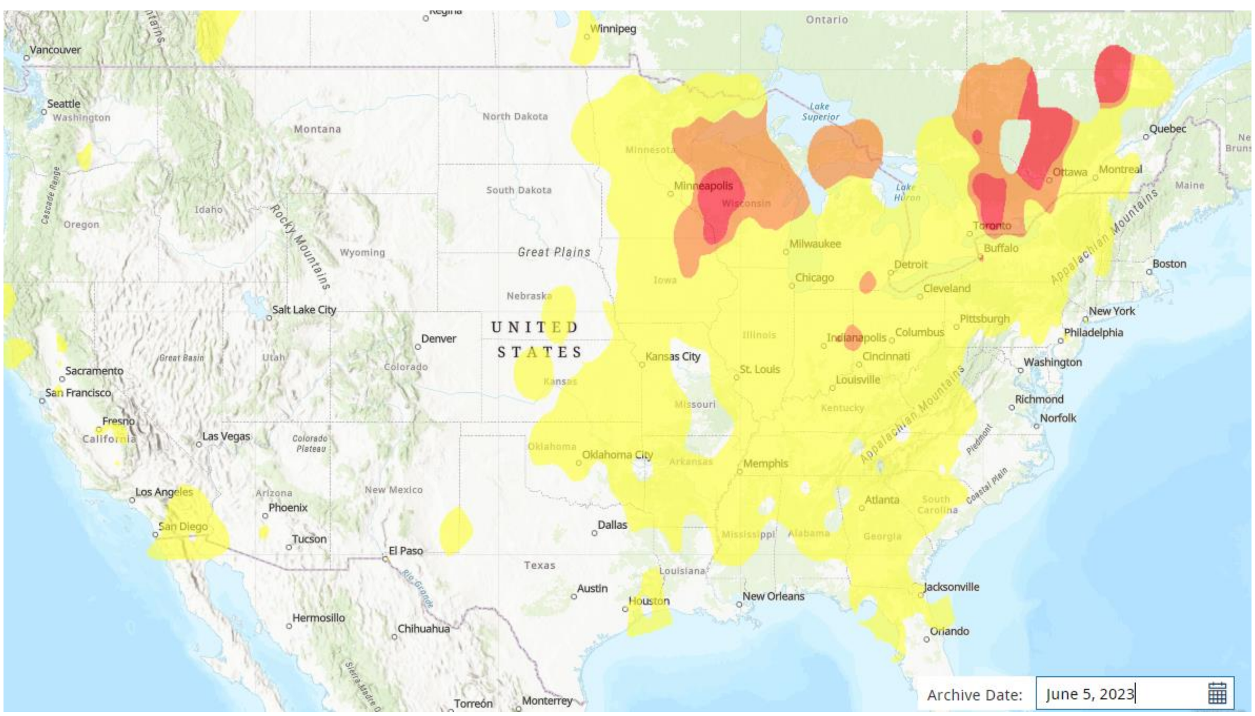


Figure 29: Daily PM2.5 AQI June 6, 2023

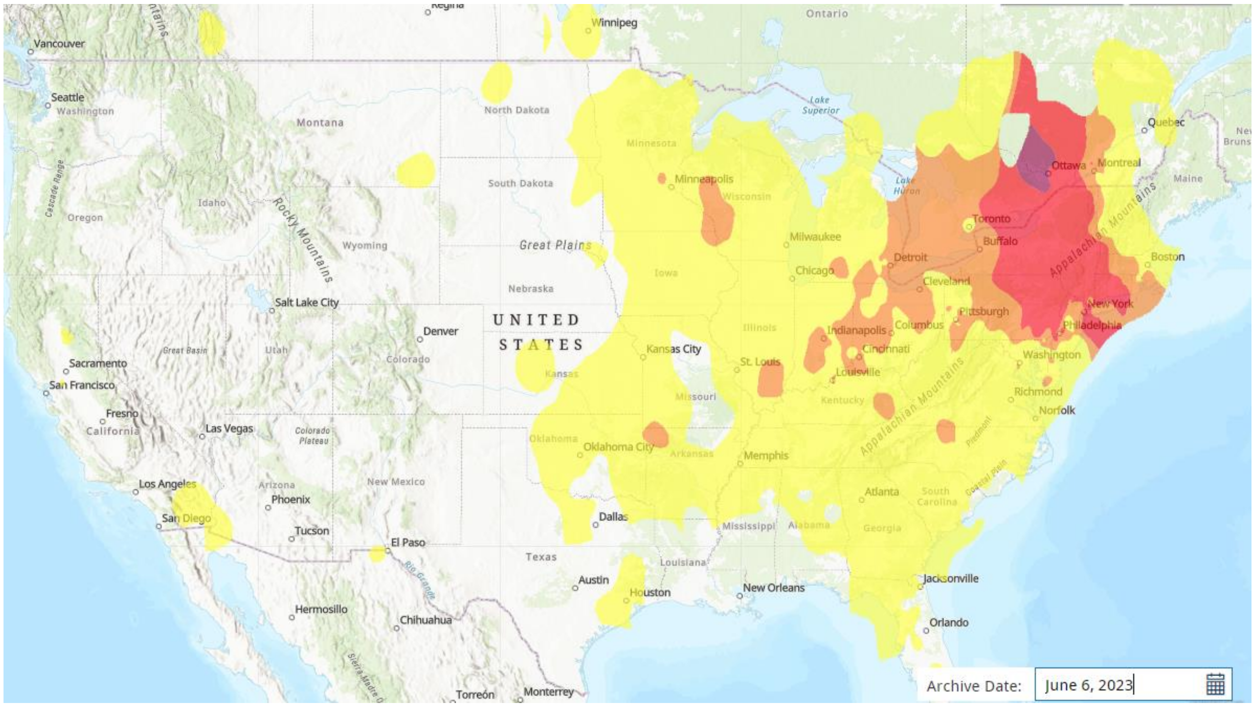


Figure 30: Daily PM2.5 AQI June 7, 2023

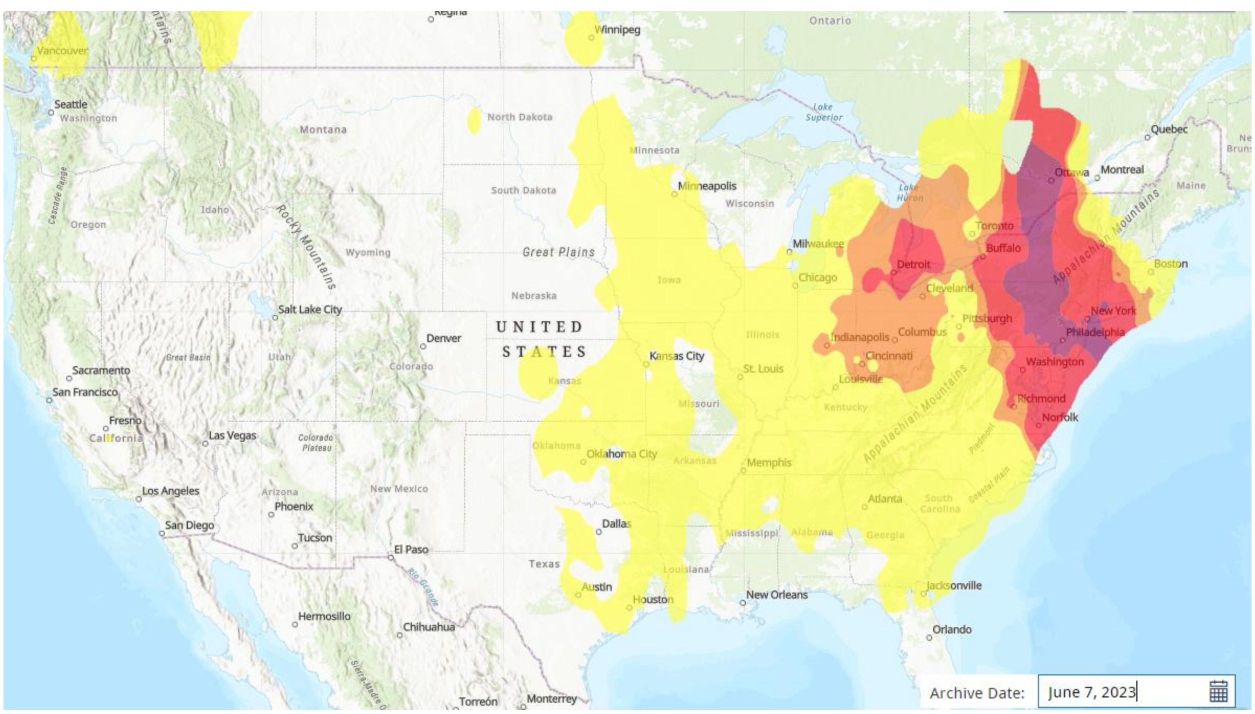
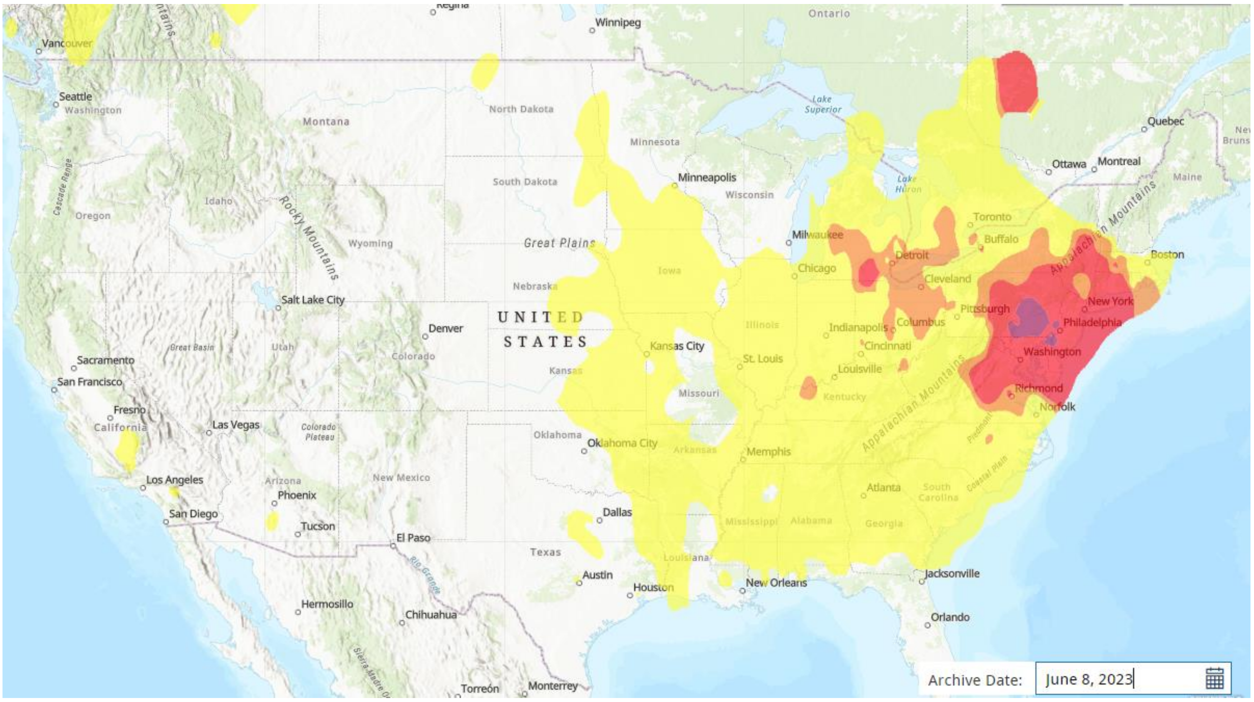


Figure 31: Daily PM2.5 AQI June 8, 2023



II. Clear Causal Relationship Between the Specific Event and the Monitored Concentration

The EER requires demonstrations to address the technical element 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".[15] This section addresses the EER requirements at 40 CFR 50.14(c)(3)(iv)(B) by showing 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. This section is further supported by analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times, fulfilling the requirement at 40 CFR 50.14(c)(3)(iv)(C).

Demonstrations are also required to support the clear causal relationship with a comparison of the PM2.5 data requested for exclusion with historical concentrations at the air quality monitor, that the fire's emissions were transported to the monitor, and that the emissions from the fire influenced the monitored concentrations.

Tiering Overview

Each demonstration submitted to the USEPA under the EER must outline the process for determining an appropriate Tier for a given event. EPA has defined a three-tiered approach of the minimum criteria for addressing the clear causal relationship element, recognizing that some causal relationships may be clearer than others and therefore, require fewer pieces of evidence for the demonstration.[16] The Tiers range from 1 to 3, with Tier 1 requiring the least amount of evidence to satisfy the rule and each subsequent Tier requiring more evidence than the previous one.

The June 2023 exceptional events serve as an example of a Tier 1 analysis for when wildfire smoke caused unmistakable impacts on PM2.5 concentrations in New Jersey at levels well above historical concentrations. A Tier 1 analysis must demonstrate that the event clearly influenced extremely high PM2.5 concentrations at levels not commonly seen at the affected monitors. The Tier 1 analysis is associated with a PM2.5 concentration that is clearly higher than non-event related concentrations when compared to the historical month or annual period, as appropriate.[17]

The evidence presented in this section compliments the conceptual model in section 1 and demonstrates that the Canadian wildfire smoke caused exceptional levels of PM2.5 ambient air quality on June 6, 7, and 8, 2023.

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[15] 40 CFR 50.14(c)(3)(iv)(B)-(C).
[16] USEPA. (2024). *PM2.5 Wildland Fire Exceptional Events Tiering Document.* https://www.epa.gov/system/files/documents/2024-04/final-pm-fire-tiering-4-30-24.pdf
[17] USEPA. (2024). *PM2.5 Wildland Fire Exceptional Events Tiering Document.* https://www.epa.gov/system/files/documents/2024-04/final-pm-fire-tiering-4-30-24.pdf

1. Comparison of Candidate Event Data to Tiering Threshold for Tier 1 Analysis

This section of the demonstration will outline the process of determining/qualifying for a Tier 1 analysis for the candidate event. The key factor that delineates the event-related monitored PM2.5 concentrations for Tier 1 analyses is the uniqueness of the concentration when compared to the typical levels of PM2.5. This section will address the distinct high levels of 24-hour PM2.5 concentrations on the candidate event dates.

The analyses presented in this section fulfills the requirements of a Tier 1 analysis. The Tier 1 analysis consists of comparisons to historical concentrations via a 1-month time series plot covering the most recent 5 years of data, a 1-year time series plot covering the most recent 5 years of data with the lowest 98th percentile, and a trajectory analysis showing evidence that the emissions were transported to the monitors.

Determining the appropriate tiering level begins first with an analysis of the measured PM2.5 concentration associated with the candidate event in relation to historical concentrations.

Calculations:

The tiering threshold is based on the lesser value of either:

(a) *the most recent 5-year month specific 98th percentile for 24-hour PM2.5 data, or*

(b) *the minimum annual 98th percentile for 24-hour PM2.5 data for the most recent 5-year period with Informational (I) qualifiers on the monitoring data excluded.*

As stated in the Wildland Fire Exceptional Events Tiering Document, Tier 1 demonstrations are appropriate for measured 24-hour PM2.5 concentrations greater than or equal to 1.5 times the threshold determined. Table 3 and Figures 32 and 33 show the data used in the tiering threshold calculations and 24-hour average values for the most recent 5-year period.

Table 3: Site Level Tiering Thresholds based on 2019 – 2023 5-year Period

SITE NAME (SITE ID)	STATE	COUNTY	MONTH	EXCLUDED FLAG	MONTHLY 98TH PERCENTILE	ANNUAL 98TH MINIMUM	YEAR OF ANNUAL MINIMUM	STATE	COUNTY	TIER 1
Camden Spruce St. (340070002)	NJ	Camden	JUNE	R and I Wildfire Flags	19.9	18.50	2020	NJ	Camden	27.75
Elizabeth Lab (340390004)	NJ	Union	JUNE	R and I Wildfire Flags	22.0	20.00	2022	NJ	Union	30.00

Camden Spruce Street Tiering Calculations for June:

<u>Candidate Event Dates and 24-hr PM2.5 Averages for Camden Spruce St:</u>
6/6/2023 = 44.3 μg/m^3
6/7/2023 = 135.9 μg/m^3
6/8/2023 = 95.3 μg/m^3

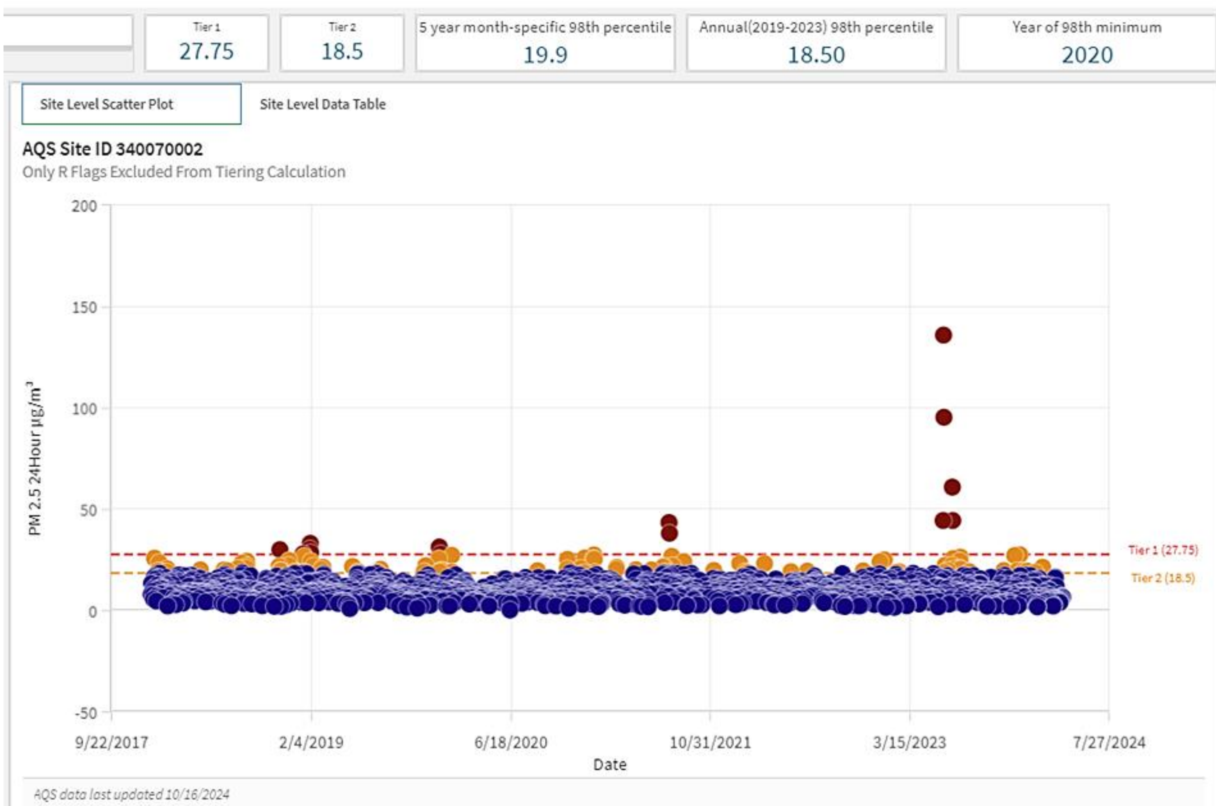
(a) = 5-year Month Specific 98th Percentile for June;
(a) = 19.9 µg/m^3;

(b) = Minimum Annual 98th Percentile;
(b) = 18.50 µg/m^3;

Lesser Value of Tier Threshold (a) and (b) = **(b)**
(a) > **(b)**

Tier 1 Threshold Calculation: 1.5 * **(b)** = Tier 1 Qualifier
1.5 * 18.50 µg/m^3 = 27.75 µg/m^3

Figure 32: Camden Tiering Thresholds for June and Daily PM2.5 Concentrations for the Period of January 2018 – December 2023



Legend: *Red = Tier 1; Orange = Tier 2*
Scatter plot courtesy of EPA, PM2.5 Tiering tool – for Exceptional Events
https://www.epa.gov/air-quality-analysis/pm25-tiering-tool-exceptional-events-analysis

For Tier 1 Analyses, 24-hr PM2.5 concentrations measured on candidate event dates should be greater than or equal to 27.75 µg/m^3 Tier 1 threshold for the Camden Monitor.

The Camden monitor measured concentrations above the Tier 1 qualifier of 27.75 µg/m^3 on June 6, 7, and 8, thus qualifying all candidate dates for a Tier 1 analysis.

Elizabeth Lab Tiering Calculations for June:

<u>Candidate Event Dates and 24-hr PM2.5 Averages for Elizabeth Lab:</u>
6/6/2023 = 61.2 µg/m^3
6/7/2023 = 138.8 µg/m^3
6/8/2023 = 66.3 µg/m^3

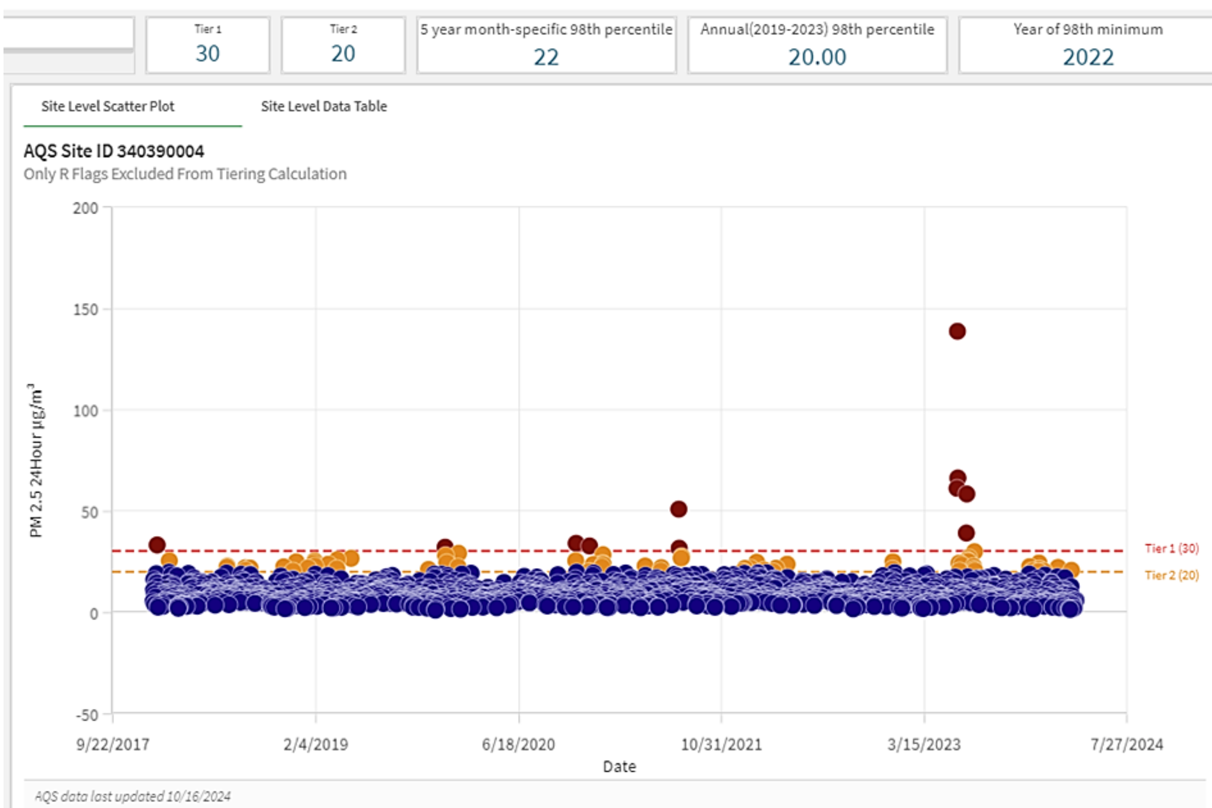
(a) = 5-year Month Specific 98th Percentile for June;
(a) = 22.0 µg/m^3;

(b) = Minimum Annual 98th Percentile;
(b) = 20.00 µg/m^3

Lesser Value of Tier Threshold (a) and (b) = **(b)**
(a) > **(b)**

Tier 1 Threshold Calculation: 1.5 * **(b)** = Tier 1 Qualifier
1.5 * 20.00 µg/m^3 = 30.00 µg/m^3

Figure 33: Elizabeth Lab Tiering Thresholds for June and Daily PM2.5 Concentrations for the Period of January 2018 – December 2023



Legend: *Red = Tier 1; Orange = Tier 2;*
Scatter plot courtesy of EPA, PM2.5 Tiering tool – for Exceptional Events
https://www.epa.gov/air-quality-analysis/pm25-tiering-tool-exceptional-events-analysis

For Tier 1 Analyses, 24-hr PM2.5 concentrations measured on candidate event dates should be greater than or equal to 30.00 µg/m^3 for Elizabeth Lab.

The Elizabeth Lab monitor measured concentrations above the Tier 1 qualifier of 30.00 µg/m^3 on June 6, 7, and 8, thus qualifying all candidate dates for a Tier 1 analysis.

2. Comparison of Event-Related Concentrations to Historical Concentrations

This section of the document further expands on the tiering qualifier and aims to address the key factor for a Tier 1 clear causal relationship. From USEPA Guidance: *Key Factor – Distinct high levels of monitored 24-hour PM2.5 concentrations when compared to historical monthly or annual 24-hour levels of PM2.5.*[18] The key factor that delineates event-related monitored PM2.5 concentrations for Tier 1 analyses is the uniqueness of the concentration when compared to the typical levels of PM2.5.

The comparison of monitored concentrations with historical observations is used to support the clear causal relationship between PM2.5 concentrations and a wildfire event. To do so, it is necessary to compare the event-related exceedance concentrations with historical concentrations measured at the affected monitor or at other monitors in the area during the same season.[19] According to USEPA Wildland Fire Exceptional Events Tiering Document, the PM2.5 tiering threshold was based on a 98th percentile statistic since this statistic is already in use in PM2.5 NAAQS calculations and represents site-specific high PM2.5 values near the top of the distribution of ambient PM2.5 data.

Two analyses at the Camden and Elizabeth Lab monitors are provided to support the determination of the tiering threshold of the events. The NJDEP officially certified the PM2.5 data presented in this analysis, which includes 2023 PM2.5 data.[20]

1) 1-month time series plot covering the most recent 5 years of data for the month that the event day occurred in.

2) 1-year time series plot covering the most recent 5 years of data with the lowest 98th percentile in the period.

The following four figures (Figure 34 – Figure 37) satisfy the requirements stated above including the key factor for Tier 1 analysis for the Camden and Elizabeth Lab monitors. The three event dates, June 6, 7, and 8 are highlighted in red and marked with labels showing the concentration on each day to demonstrate the distinct high levels of 24-hr PM2.5 concentrations when compared to historical concentrations during the same month/year.

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[18] USEPA. (2024). *PM2.5 Wildland Fire Exceptional Events Tiering Document.* *https://www.epa.gov/system/files/documents/2024-04/final-pm-fire-tiering-4-30-24.pdf*

[19] USEPA. (2016). *Guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events that May Influence Ozone Concentrations*. https://www.epa.gov/sites/default/files/2016-09/documents/exceptional_events_guidance_9-16-16_final.pdf

[20] Lim, L. (2024, May 6). [Letter from Luis Lim, Chief of the NJ Bureau of Air Monitoring, to Marina Cubias-Castro, Manager, Technology, Transportation and Partnerships Branch of the USEPA Region 2, 2023].

Figure 34 and Figure 36 show one-month time series plots for the Camden and Elizabeth Lab monitors. In these figures, monitored values during the month of June at the monitors are compared from 2019 through 2023.

Figure 35 and Figure 37 show one-year time series plots of 24-hour PM2.5 values for the last 5 years (2019 – 2023) at the Camden and Elizabeth Lab monitors. At the Camden monitor, the most recent year in the last 5-years with the lowest 98th percentile is 2020 with a value of 18.50 µg/m^3(marked with orange line). Meanwhile, the most recent year in the last 5-years with the lowest 98th percentile at the Elizabeth Lab monitor is 2022 with a value of 20.00 µg/m^3 and is marked on Figure 37 with an orange line. Thus, Figure 35 and Figure 37 show how the magnitude of the event-related exceedances are clearly and significantly larger than any of the other measured concentrations/exceedances that are not attributable to other EPA concurred upon or otherwise documented exceptional events.

Figure 34: Camden Spruce St. One Month Time Series Plot of Maximum 24-hour Average PM2.5 Concentrations in June from 2019 – 2023

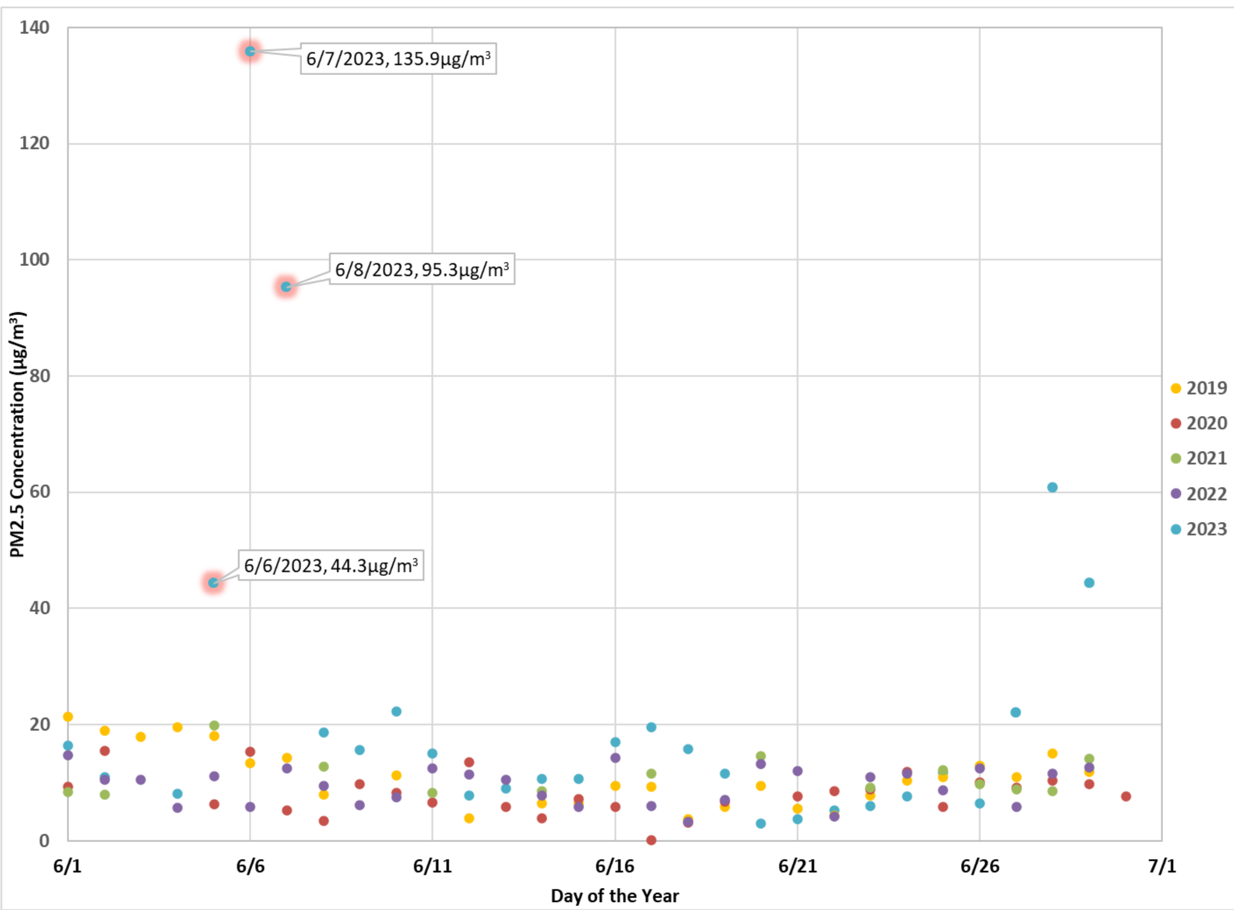


Figure 35: Camden Spruce St. Annual Variation - Time Series Plot of 24-hr Average PM2.5 Concentrations from 2019 – 2023

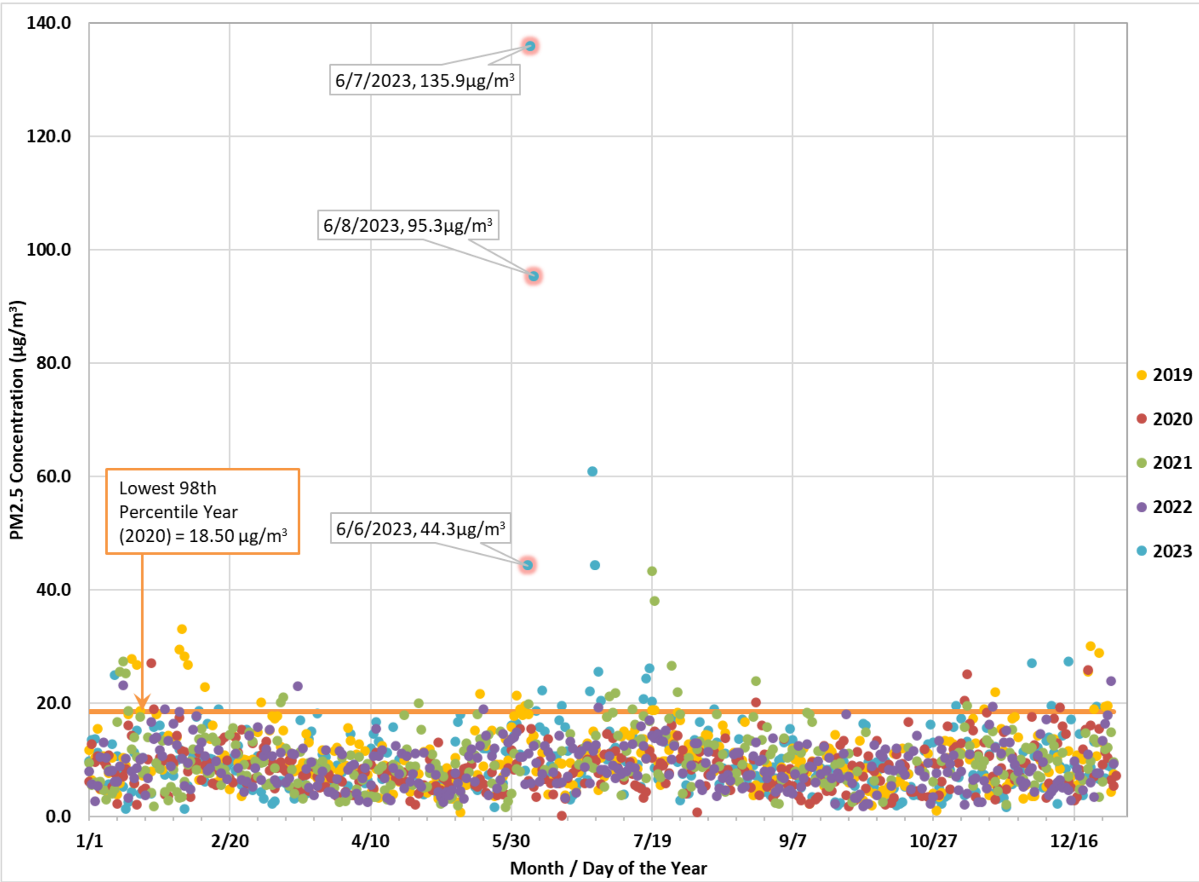


Figure 36: Elizabeth Lab One Month Time Series Plot of Maximum 24-hour Average PM2.5 Concentrations in June from 2019 – 2023

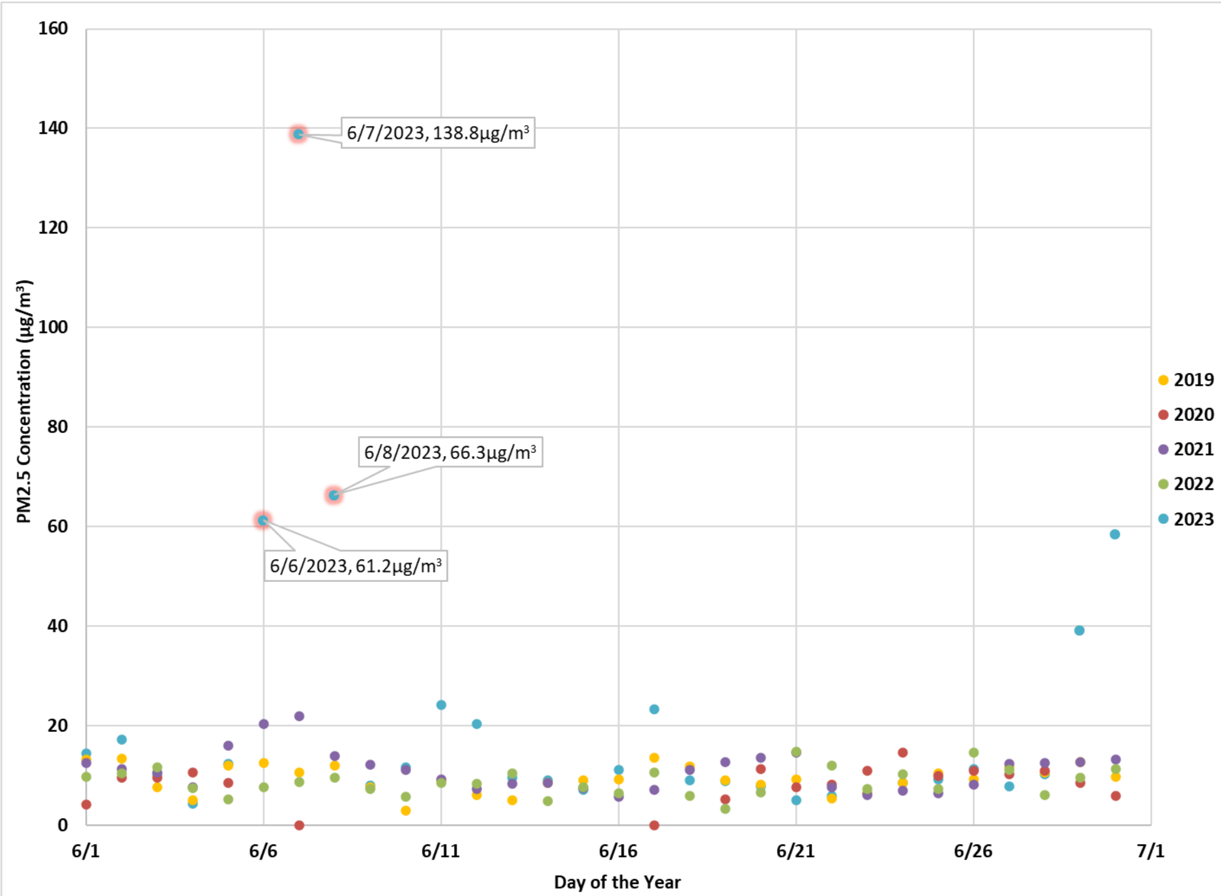
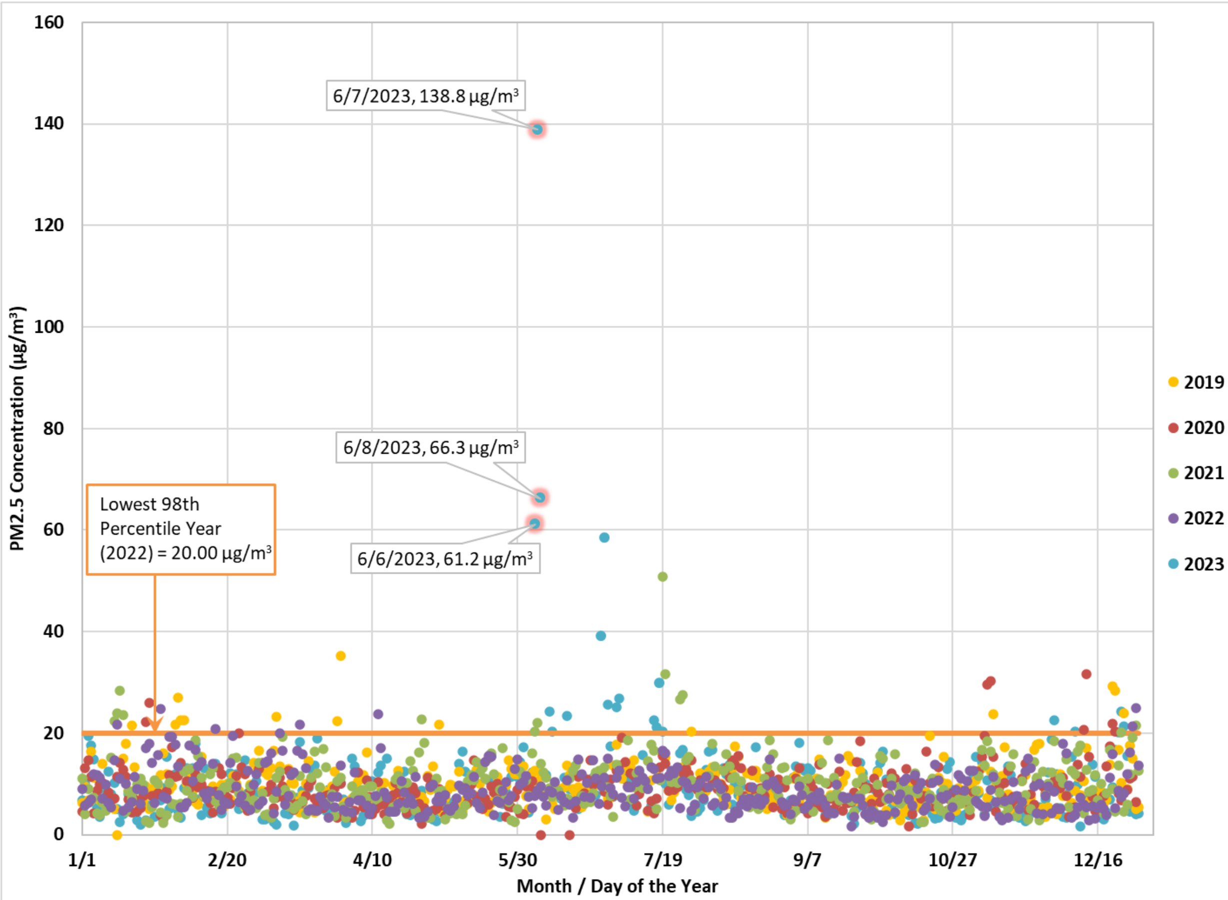


Figure 37: Elizabeth Lab Annual Variation – Time Series Plot of 24-hr PM2.5 Concentrations from 2019 – 2023



3. Evidence that Fire Emissions were Transported to the Monitor

A trajectory analysis can be used to show that the emissions from the fire were transported to the monitors, based on the methodology recommended in USEPA Guidance.[21] New Jersey presents trajectory modeling results in this section to show that emissions from wildfires in Quebec were transported to New Jersey.

3.1 Trajectory Analysis

The Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model was employed to calculate backward trajectories arriving in New Jersey on June 6, 7, and 8, 2023. The meteorological model that was used to compute the backward trajectories was obtained from the North American Mesoscale Forecast System, 12km, (NAM 12).

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[21] USEPA. (September 2016). *Guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events that May Influence Ozone Concentrations.* https://www.epa.gov/system/files/documents/2023-12/guidance-on-the-preparation-of-ee-wf-ozone.pdf

Figures 38 – 41 show trajectories at three different wind heights with endpoints at the Camden and Elizabeth Lab monitors in New Jersey on June 6, 7, and 8, 2023. The green trajectory represents the upper air layer (1500m), the blue trajectory represents the mid-level trajectory (500m), and the red trajectory represents the surface layer (10m). The figures illustrate where the air came from during the 48 hours preceding the 24-hour PM2.5 standard exceedances on June 6, 7, and 8, 2023. Figure 41 shows the complete combined transport pattern from June 6, 7, and 8, as a 120-hour backward trajectory to capture the 48-hours preceding the first day of the event through the last day of the event.

June 6

On June 6, the surface level back trajectories (Figure 38, red lines) show that air at the surface originated near Lake Ontario and upstate New York, which saw copious amounts of wildfire smoke in the days leading up to the exceedances. During much of their journey, trajectories at the surface traveled through regions that saw widespread moderate, USG, and unhealthy levels of PM2.5 concentrations. Air traveled in a southerly direction before intersecting a surface trough, causing air to shift to a southeasterly flow. Due to the presence of high pressure, most of the trajectories experienced a heavy sinking motion, allowing any wildfire smoke aloft to mix down to the surface and enhance PM2.5 levels.

The mid-level trajectories (blue lines) show that air followed a similar transport pathway as the surface air. Originating in southern Ontario, trajectories traveled in a general southeast direction through Ontario, New York and Pennsylvania before arriving at their destination in New Jersey. Here, both sets of trajectories converged where a large plume of wildfire smoke was causing widespread unhealthy, and USG air quality. During the final 12 hours of transit, mid-level trajectories transported this polluted air mass into the region impacting monitors across the Northeast. Due to multiple surface trough encounters, air at the mid-levels changed altitude indicating that mixing aloft likely allowed any smoke or pollutants at higher levels to be brought down to lower levels.

The upper-level trajectories (green lines) show that air originated over the southern points of the Hudson Bay in Canada and traveled in a general southerly direction through portions of Ontario and Quebec. On June 5th, air initially picked up some wildfire smoke in eastern portions of Canada and transported it southward into upstate New York. From here, air made a turn toward the south-southeast through upstate New York where it encountered a very dense plume of wildfire smoke causing the air mass to grow increasingly polluted. Air continued to transport this plume of smoke southward impacting much of the Mid-Atlantic and Northeast. Through transit, upper air traversed many states where moderate, USG, and unhealthy air quality was observed.

June 7

On June 7, surface, mid-level, and upper-level back trajectories (Figure 39) show that air at many levels of the atmosphere originated in central portions of Quebec, an area that was experiencing hundreds of uncontrolled wildfires for multiple days prior to this event. Trajectories at many levels of the atmosphere followed similar transport pathways through transit to their destinations. These air parcels flowed in a primarily southerly direction, rotating counterclockwise around the periphery of strong low pressure anchored over Nova Scotia. These air parcels grew increasingly polluted as they traversed south over Quebec, picking up dense wildfire smoke aloft and transporting it towards the surface. All trajectories traveled over northern New York before continuing south into eastern Pennsylvania and southern New York prior to arrival. Air aloft continued to descend towards the surface upon arrival in the northeast due to advancing high pressure and a surface trough over the region, allowing PM2.5 levels to rise into the Very Unhealthy and Hazardous categories.

June 8

On June 8, surface, mid-level, and upper-level back trajectories (Figure 40) followed similar transport pathways through transit. Trajectories show that air originated in Quebec and traveled in a general southerly direction through an area of the province that was experiencing hundreds of uncontrolled wildfires for multiple days prior to this event. These air parcels traveled in a primarily south-southwesterly direction, rotating counterclockwise around the periphery of strong low pressure anchored over Nova Scotia. Upon reaching Toronto, this airmass encountered a surface trough causing the air to change direction toward the southwest through upstate New York. Through the duration of transit, trajectories at all heights made a steady decline in elevation, indicating that wildfire smoke was being brought down to the surface from higher elevations.

Figure 38: HYSPLIT 48hr Backward Trajectories - June 6, 2023 – 10, 500, and 1500m AGL

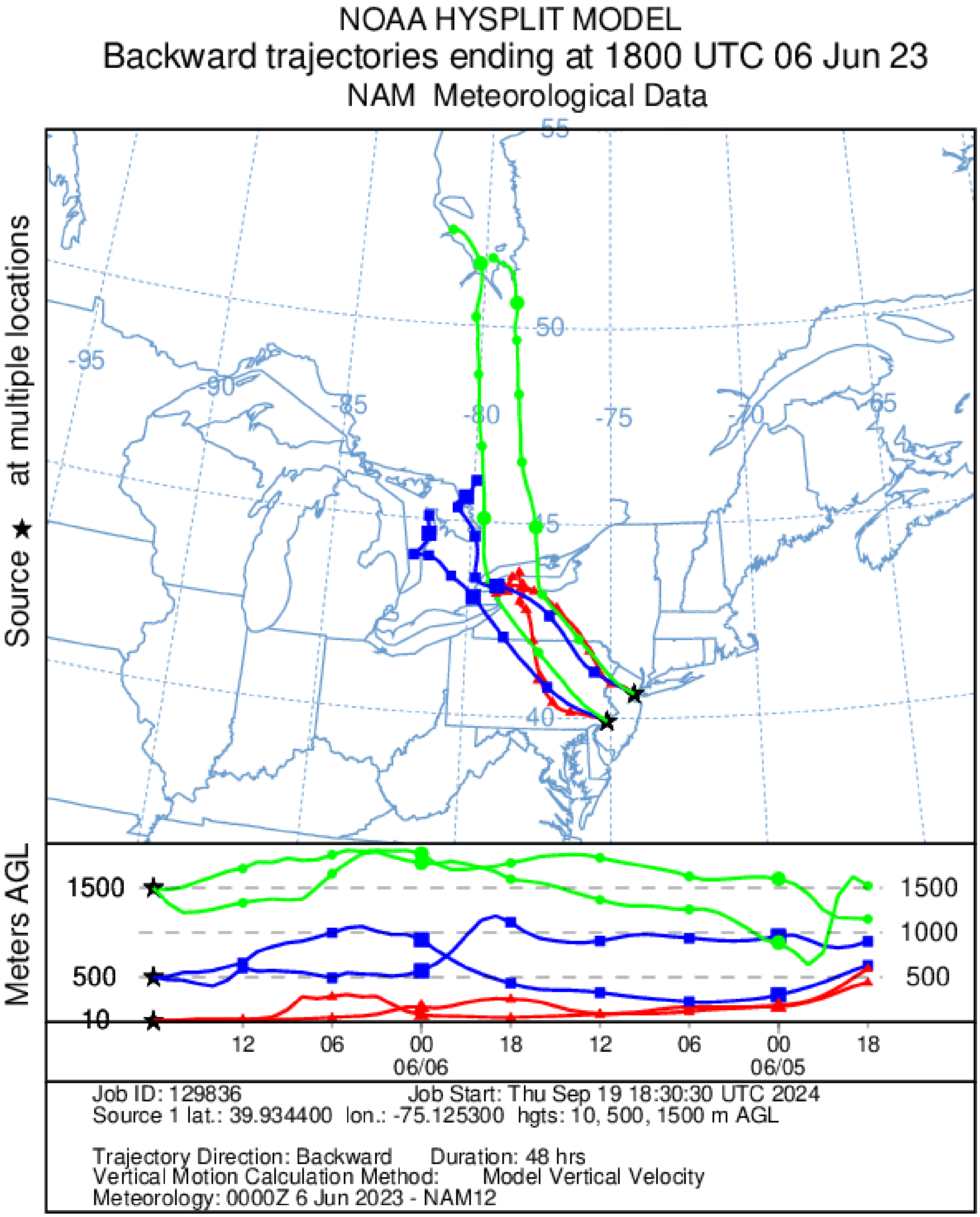


Figure 39: HYSPLIT 48hr Backward Trajectories - June 7, 2023 – 10, 500, and 1500m AGL

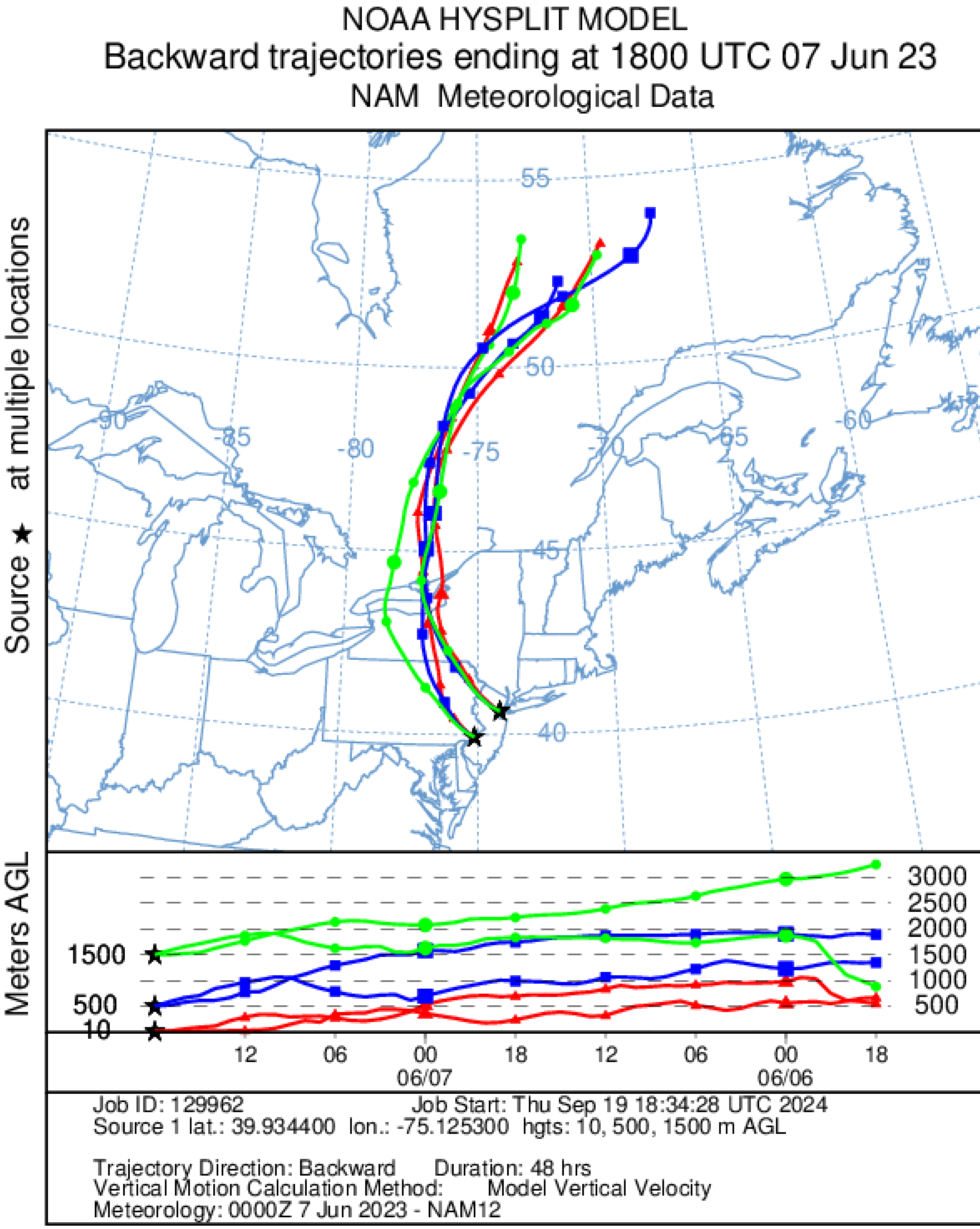


Figure 40: HYSPLIT 48hr Backward Trajectories - June 8, 2023 – 10, 500, and 1500m AGL

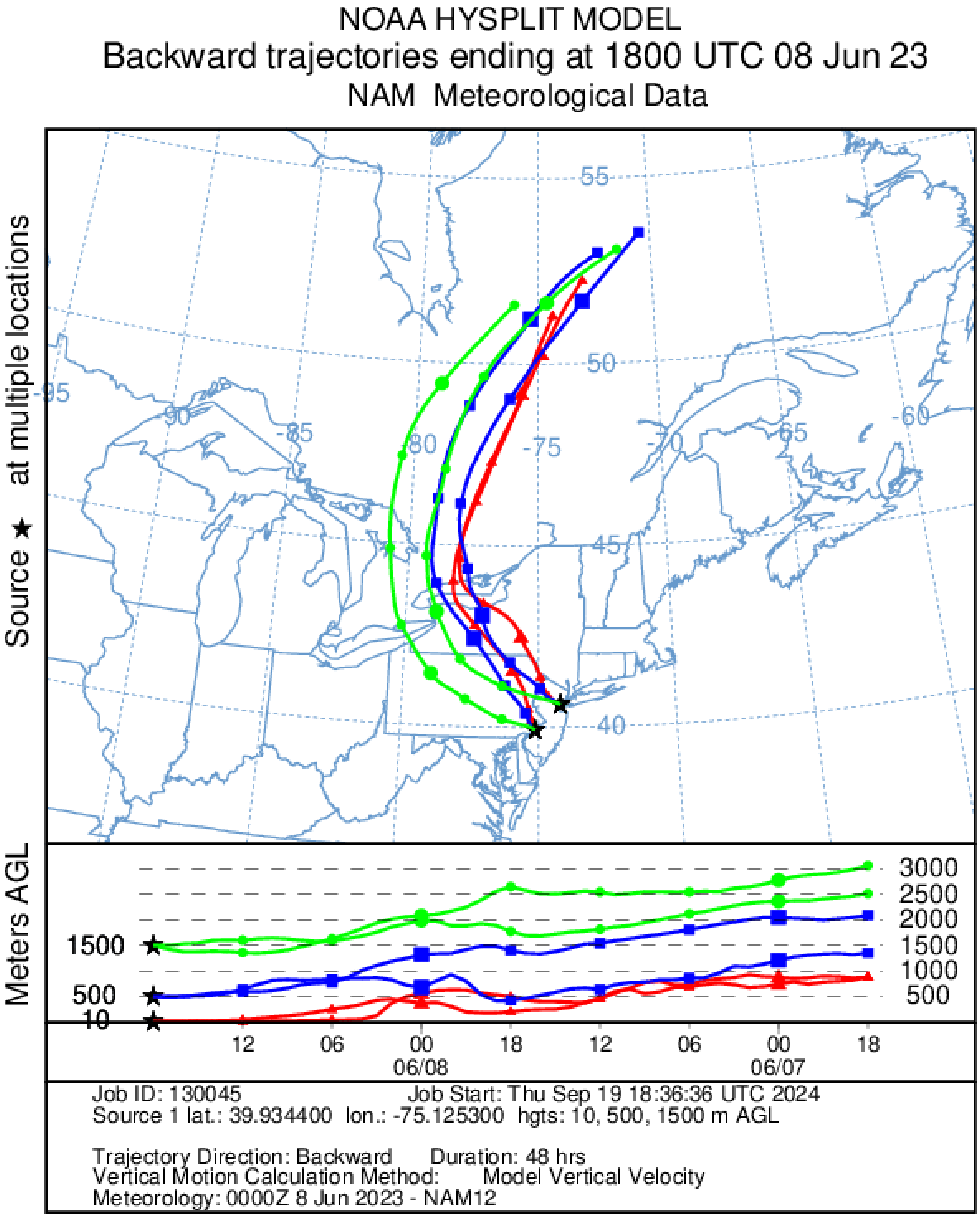
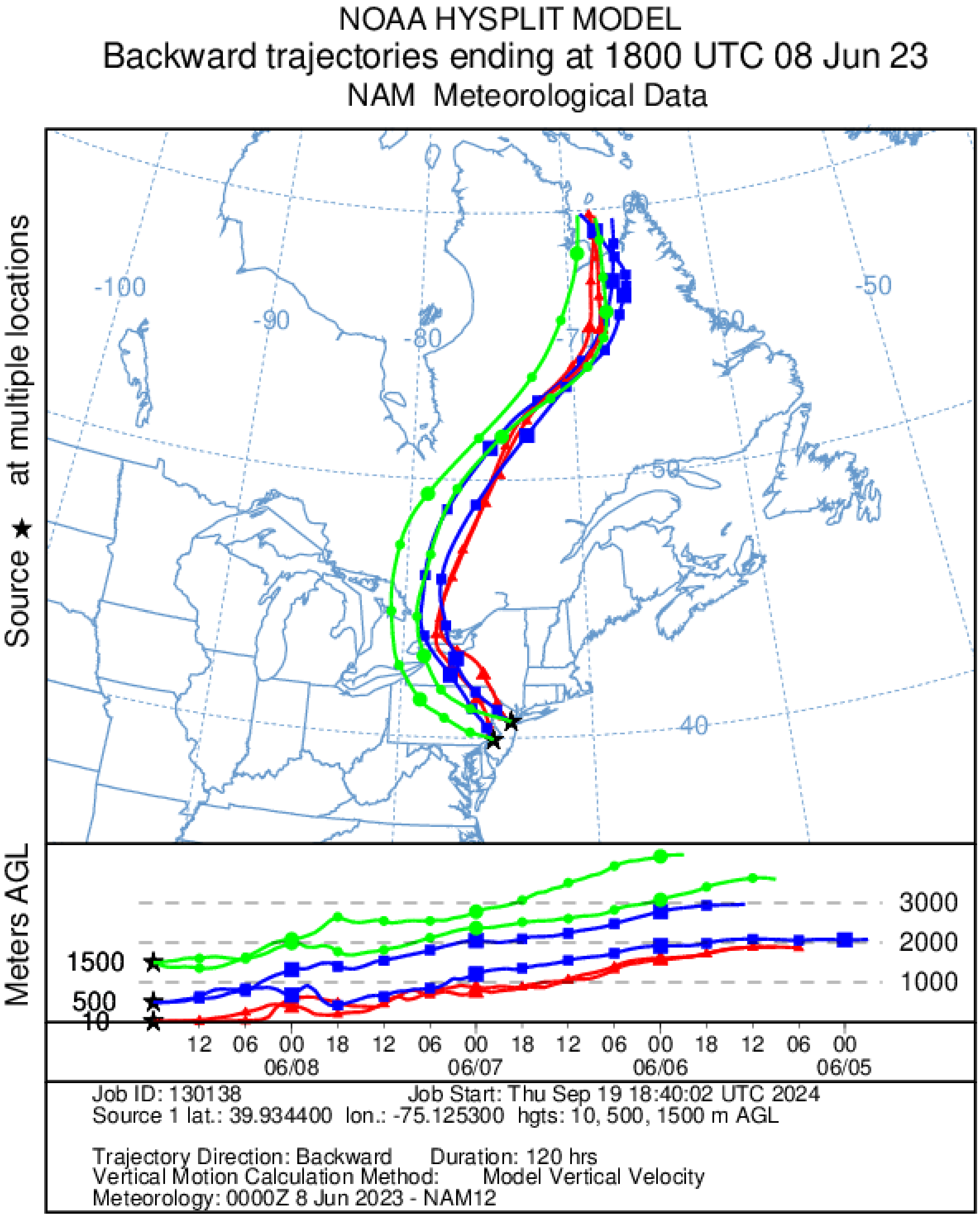


Figure 41: Combined Backward Trajectory of Full Event Transport – HYSPLIT 120hr Through June 8, 2023



4. Evidence that the Fire Emissions Affected New Jersey Monitors

This section adds to the weight of evidence that the emissions from the fires affected the monitored PM2.5 concentrations at New Jersey monitors, as suggested by USEPA Guidance.[22]

According to the USEPA Guidance, elevated light extinction measurements at or near the monitoring site that cannot be explained by emissions from other sources and are consistent with wildfire impact can be used as evidence to support the impact of fire emissions on affected monitors.[23]

New Jersey measures visibility using a nephelometer at the Brigantine monitor. Please reference Section 4.1 Light Extinction on page 105. Figure 90 presents light extinction data measured at Brigantine from May 28 to July 2, in 2021, 2022, and 2023. A visible peak can be seen on June 6 - 9, 2023. As shown on the chart, the light extinction levels at Brigantine were generally low in 2021 and 2022, while 2023 had higher levels during this period. This peak can be attributed to the smoke from Quebec wildfires.

4.1 Visual Photographic Evidence of Ground-level Smoke at the Monitor (HazCam Pictures from Brigantine)

New Jersey uses remote cameras at Brigantine, NJ, to evaluate visibility conditions throughout the year.[24] Figures 42-45 show pictures taken before and during the exceptional event that occurred in New Jersey on June 6, 7, and 8, 2023. On June 6, 7, and 8, the distant skyline of Atlantic City was completely obscured and hazy in appearance. However, on June 4, two days before the exceptional event began, clear skies with no visibility impairment or haze conditions were observed (Figure 45).

[22] USEPA. (September 2016). *Guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events that May Influence Ozone Concentrations.* *https://www.epa.gov/system/files/documents/2023-12/guidance-on-the-preparation-of-ee-wf-ozone.pdf*

[23] NJDEP. (2017). *Exceptional Event Demonstration Analysis For Ozone During May 25-26, 2016.* https://www.epa.gov/sites/default/files/2017-12/documents/final_ee_for_nj.pdf

[24] Camnet (n.d.). Visibility HazeCam. https://hazecam.net/

Figure 42: HazCam Picture from Brigantine, NJ on June 6, 2023 at 10:00AM

Figure 43: HazCam Picture from Brigantine, NJ on June 7, 2023 at 6:00PM

Figure 44: HazCam Picture from Brigantine, NJ on June 8, 2023 at 11:00AM

Figure 45: HazCam Picture from Brigantine, NJ on June 4, 2023 at 11:00AM (clear day)

III. A Demonstration that the Exceptional Event was Both Not Reasonably Controllable and Not Reasonably Preventable

According to the Clean Air Act and the Exceptional Events Rule, an exceptional event must be "not reasonably controllable or preventable."[25,26] In its July 2018 "Update to Frequently Asked Questions" for the 2016 Revisions to the Exceptional Events Rule, the USEPA states, "it is presumptively assumed that if evidence supports that a wildfire occurred on wildland, such a wildfire event will satisfy both factors of the 'not reasonably controllable or preventable' criterion, provided the Administrator determines that there is no compelling evidence to the contrary in the record."[27] The USEPA Exceptional Event Guidance also states that wildfire events on wildland are not generally reasonable to control or prevent.[28]

As previously stated in this document and reported in news articles, the Quebec fires pertinent to this exceptional event, were ignited by lightning, and occurred in wildland areas.[29, 30, 31] The Quebec wildfires, which occurred outside of the United States can be considered not reasonably controllable or preventable by New Jersey. Therefore, emissions from these wildfires meet the criterion for an exceptional event.

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[25] 42 U.S.C. 7401 et seq.

[26] 40 CFR 50.14

[27] USEPA. (2018, July). *2016 Revisions to the Exceptional Events Rule: Update to Frequently Asked* Questions.

[28] 42 U.S.C. 7619(b)(1)(iii), *Guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events that May Influence Ozone Concentration*s. EPA-HQ-OAR-2015-0229-0130, U.S. Environmental Protection Agency. Page 30: https://www.epa.gov/sites/default/files/2016-09/documents/exceptional_events_guidance_9-16-16_final.pdf

[29] NASA Earth Observatory. (2023, October 24). *Tracking Canada's Extreme 2023 Fire Season*. Retrieved February 22, 2024. https://earthobservatory.nasa.gov/images/151985/tracking-canadas-extreme-2023-fire-season.

[30] Korte, C. (2023, June 27). How did the Canadian Wildfires Start? A look at what caused the fires that are sending smoke across the U.S. *CBS News*. https://www.cbsnews.com/news/how-did-wildfires-in-canada-start-spread-to-europe-midwest/

[31] Reuters. (2023, August 19). Canada wildfires: what are the causes and when will it end. https://www.reuters.com/world/americas/canadas-record-wildfire-season-whats-behind-it-when-will-it-end-2023-08-17/

IV. Caused by Human Activity that is Unlikely to Recur at a Particular Location or a Natural Event

According to the CAA and the Exceptional Events Rule, an exceptional event must be "an event caused by human activity that is unlikely to recur at a particular location or a natural event"[32, 33] The Exceptional Events Rule's definition of wildfire is "any fire started by an unplanned ignition caused by lightning; volcanoes; other acts of nature; unauthorized activity; or accidental, human-caused actions, or a prescribed fire that has developed into a wildfire. A wildfire that predominantly occurs on wildland is a natural event." [34, 35]

The Quebec fires examined in this analysis are categorized as wildfires. Sections I and II of this demonstration provide detailed descriptions and visual representations, demonstrating that these fires meet the criteria for being considered a "natural event". The unplanned fires were ignited by lightning in wildland areas or due to unknown causes. The USEPA generally considers the PM2.5 and resulting emissions from wildfires on wildland to meet the regulatory definition of a natural event at 40 CFR 50.1(k), defined as one 'in which human activity plays little or no direct causal role.' As such, NJDEP has demonstrated that these events qualify as natural occurrences and may be considered for treatment as exceptional events.

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32 42 U.S.C. 7401 et seq.

33 [40 CFR 50.14](40 CFR 50.14)

34 42 U.S.C. 7619(b)(1)(iii), *Guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events that May Influence Ozone Concentrations*. EPA-HQ-OAR-2015-0229-0130, U.S. Environmental Protection Agency. Page 30: https://www.epa.gov/sites/default/files/2016-09/documents/exceptional_events_guidance_9-16-16_final.pdf

35 40 CFR 50.1(n)

Exceptional Event Demonstration Analysis for PM2.5 During June 29 & 30, 2023

I. A Narrative Conceptual Model and a Discussion of the Event that Led to Exceedances at New Jersey Monitors

This section of the document addresses the EER requirement at 40 CFR 50.14(c)(3)(iv)(A), which requires that demonstrations include a narrative conceptual model describing how emissions from the specific fires caused PM2.5 exceedances at a particular location and how these event-related emissions and resulting violations differ from typical high PM2.5 episodes in the area resulting from other natural and anthropogenic sources of emissions. The narrative conceptual model should describe the principal features of the interaction of the event and how direct PM2.5 from the event was transported to the monitor that measured the exceedances/violations.[36]

1. Non-Event PM2.5 in New Jersey

This section discusses the typical variations in PM2.5 concentrations in New Jersey to characterize how the June 2023 exceptional events caused by various wildfires differ from the usual weather patterns and locations of emissions that cause New Jersey to exceed the NAAQS for PM2.5.

Seasonal PM2.5 Variations:

Historically, New Jersey typically experiences short-term PM2.5 increases in the wintertime due to favorable meteorological conditions and increases in wood and coal combustion for heating. As a result, temperature inversions can form resulting in cooler air at the surface and warmer air aloft. In this scenario, air cools as elevation increases above ground level. This phenomenon is often called a nocturnal temperature inversion and occurs after sunset if the ground cools faster than the air above it. This is especially true in wintertime when a snowpack exists on the ground, keeping the surface air cold. In this instance, air temperature increases with elevation, which creates a stable boundary layer that prevents the vertical movement of air and traps pollutants near the ground. The stable boundary layer extends from the ground to only a few hundred meters in altitude.

According to a study on the day-of-week and seasonal patterns of PM2.5:

> "The highest PM2.5 concentrations are observed during wintertime. The large increase in wood and coal combustion for heating is the major reason leading to the appearance of the highest PM2.5 concentrations in wintertime in many regions. In the study, day-of-year curves for 220 monitoring stations showed that 81% of the 220 curves have, at least, two peak values, one in the wintertime (i.e. December and January) and the second in the summertime (i.e. July and August). Alternatively, high PM2.5 concentrations in summertime are often associated with days or periods of enhanced temperature — as shown by (Tai et al., 2010; Liu et al., 2017; Vanos et al., 2015) — that often pair with high pressure, low winds, and stagnant air (e.g., hot dry air masses), thus trapping in particulate matter and other pollutants. Additionally, the large increases in

[36] USEPA. (2024). *PM2.5 Wildland Fire Exceptional Events Tiering Document.* https://www.epa.gov/system/files/documents/2024-04/final-pm-fire-tiering-4-30-24.pdf

tourists and consequently uses of motor vehicles in the summertime are also likely to contribute to the high PM2.5 concentrations".[37]

High pressure influences:

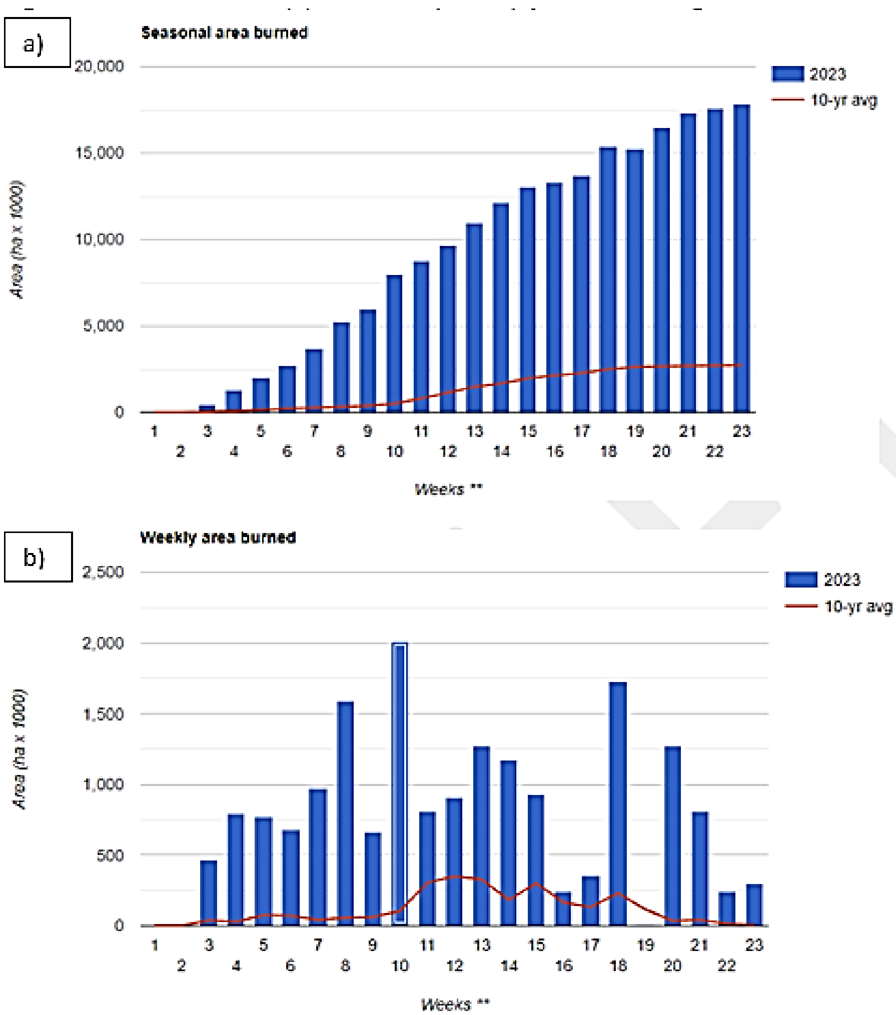
The evolution of regional PM2.5 episodes often begins with the movement of a large air mass from the Midwest to the middle or southern Atlantic states, where it assimilates into and becomes an extension of the Atlantic (Bermuda) high pressure system. During its movement east, the air mass accumulates air pollutants emitted by large coal-fired power plants and other sources along its transport pathway. These expansive weather systems are conducive to the accumulation of PM2.5 because they result in a gentle sinking motion (subsidence) that causes air to sink and enhances stagnation of pollutants at the surface. As a result, air traveling more slowly and being trapped at the surface allows the pollutants to accumulate. Under a strong area of high pressure, the mechanisms that usually disperse pollutants are not present, which leads to a shorter boundary layer giving the pollutants less "volume" to disperse among compared to if the boundary layer was higher/taller. Also, winds that typically disperse pollutants over large areas are not present, so any pollution generated or transported into the area becomes trapped within the very low levels of the atmosphere, near the ground.

2. Wildfire Description

The wildfires across Canada in 2023 broke records, burning significantly more than the seasonal averages, as shown in Figure 46a, and affected large areas across Canada. Additionally, the duration of the fires exceeded the norm.[38] The abnormally dry conditions contributed to this especially severe fire season, along with drought, high temperatures, and low snowfall in the preceding winter.[39] By June 28, 2023, Canadian Wildland Fire Information System (CWFIS) reported a total-to-date burned area of 7,974,865 hectares (ha) with 363 active fires, which was 2,016,839 ha more burned compared to the total-to-date for the previous week.[40] Figure 46b shows the weekly area burned in hectares during the 2023 fire season, with June 28 being shown as week 10.

[37] Naizhuo Zhao, Ying Liu, Jennifer K. Vanos, Guofeng Cao, Day-of-week and Seasonal Patterns of PM2.5 Concentrations Over the United States: Time-series Analyses Using the Prophet Procedure, Atmospheric Environment, Vol. 192 (2018), Accessed July 31, 2024. https://gero.usc.edu/airpollbrain-group/wp-content/uploads/2020/07/zhao..vanos-2018-1-s2.0-S1352231018305715-main.pdf
[38] NASA Earth Observatory. (2023, October 24). *Tracking Canada's Extreme 2023 Fire Season*. Retrieved February 22, 2024, from https://earthobservatory.nasa.gov/images/151985/tracking-canadas-extreme-2023-fire-season
[39] Reuters. (2023, August 19). Canada wildfires: what are the causes and when will it end. Retrieved February 22, 2024 from https://www.reuters.com/world/americas/canadas-record-wildfire-season-whats-behind-it-when-will-it-end-2023-08-17/
[40] Canadian Wildland Fire Information System. (n.d.). Archived Reports. Retrieved February 22, 2024 from https://cwfis.cfs.nrcan.gc.ca/report/archives?year=2023&month=06&day=28&process=Submit

Figure 46: Seasonal Area (a) and Weekly Area (b) Burned During the 2023 Canadian Wildfire Season[41]



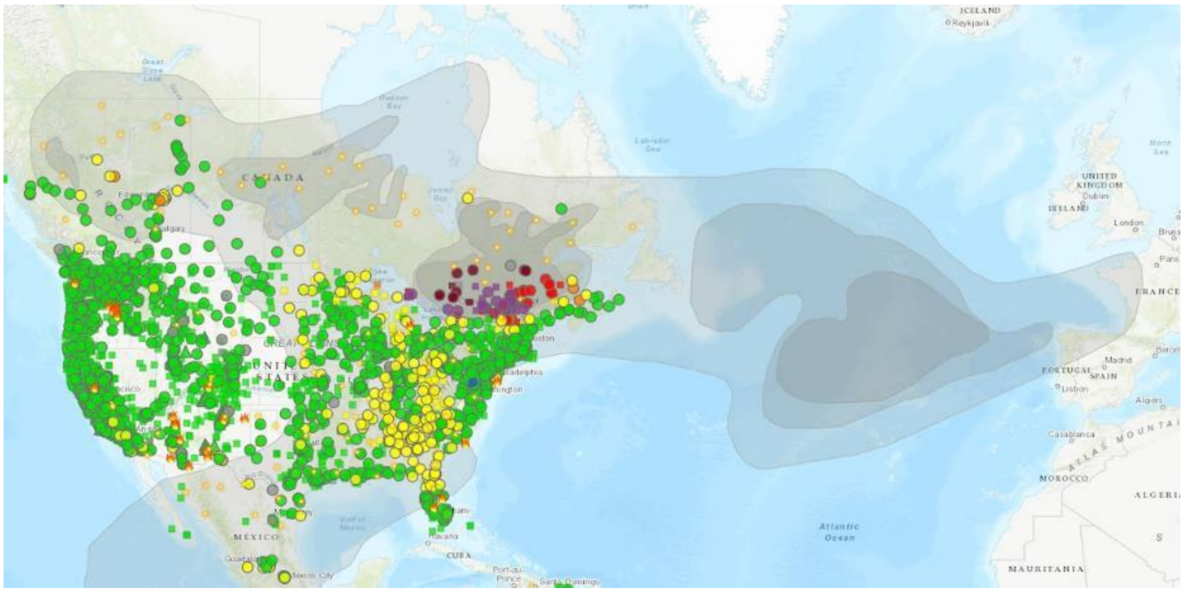
Note: *Weeks since the fire season began on April 26, 2023.*
Seasonal/Weekly Area Burned measured in ha(hectares) x 1000.

In early June, lightning ignited numerous wildfires in Quebec, which spread and experienced a huge surge in late June and early July. The surge was likely due to the abnormally high temperatures and drought conditions in this area.[42] During the week preceding June 29 and 30, 2023 (specifically, June 19 to 25, 2023), Quebec saw 989,249 ha burned.[43] Smoke from these

[41] Canadian Wildland Fire Information System. (n.d.). Weekly Graphs. Retrieved February 22, 2024, from https://cwfis.cfs.nrcan.gc.ca/report/graphs#gr6
[42] NASA Earth Observatory. (2023, October 24). *Tracking Canada's Extreme 2023 Fire Season*. Retrieved February 22, 2024 from https://earthobservatory.nasa.gov/images/151985/tracking-canadas-extreme-2023-fire-season
[43] Livingston, I. (2023, June 26). It's Canada's worst fire season in modern history, as smoke fills skies. *The Washington Post*. Retrieved February 22, 2024 from https://www.washingtonpost.com/weather/2023/06/26/canada-wildfire-worst-season-quebec-ontario-smoke/

fires spread throughout Canada and the Northeastern US, with some plumes reaching as far as Europe (See Figure 47 and Figure 48).[44] Figure 49 and Figure 50 illustrate the large area of land impacted by the largely uncontrolled wildfires leading up the exceptional events.

Figure 47: Fires, Air Quality Index, and Smoke Plume Showing Massive Scope of Wildfires[45]



[44] Ibid

[45] AirNow. (n.d.). *Interactive Map of Air Quality*. Retrieved February 22, 2024, from https://gispub.epa.gov/airnow/index.html?tab=3

Figure 48: Image of Wildfire Smoke from Quebec Reaching Europe on June 26, 2023[46]

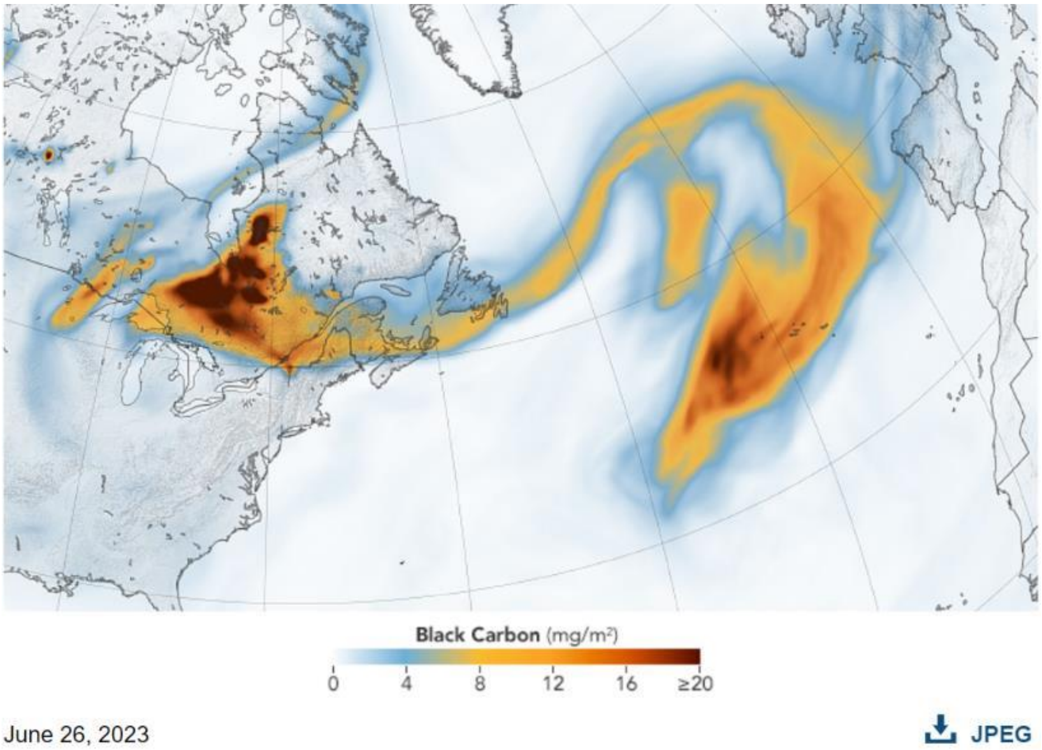
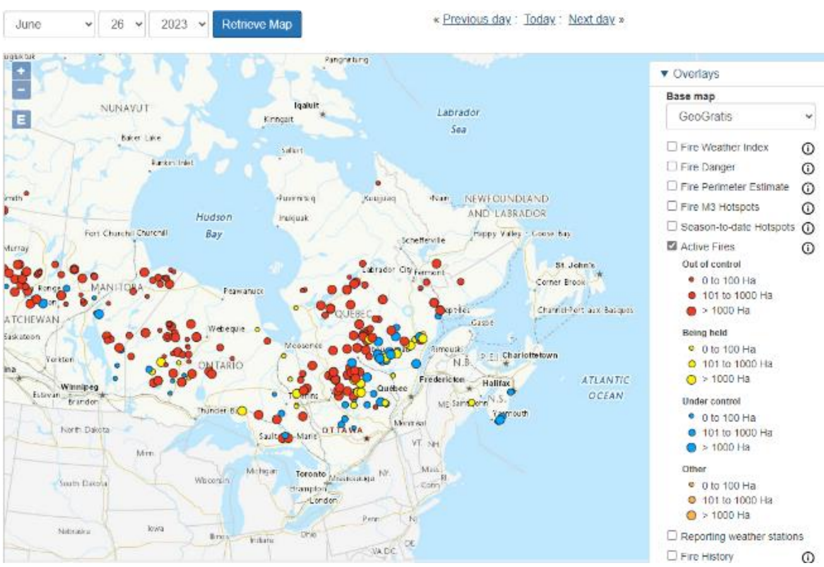


Image from: [Moderate Resolution Imaging Spectroradiometer](#) (MODIS) on NASA's [Terra](#) satellite.

[46] NASA Earth Observatory. (2023, June 26). *Canadian Wildfire Smoke Reaches Europe*. Retrieved March 15, 2024 from https://earthobservatory.nasa.gov/images/151507/canadian-smoke-reaches-europe.

Figure 49: Satellite Image of Quebec on June 25, 2023[47]

Figure 50: Active Fires in Quebec on June 26, 2023



Note: Active fires are color coded depending on control status[48]

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[47] NASA. (n.d.). *Worldview Snapshots*. Retrieved February 22, 2024 from https://wvs.earthdata.nasa.gov/?LAYERS=MODIS_Terra_CorrectedReflectance_TrueColor,MODIS_Terra_Thermal_Anomalies_Day&CRS=EPSG:4326&TIME=2023-06-25&COORDINATES=44.1105,-80.8925,63.4595,-55.9775&FORMAT=image/jpeg&AUTOSCALE=TRUE&RESOLUTION=10km&COUNTRY=CAN&SUB_COUNTRY=QC&PADDING=5

[48] Canadian Wildland Fire Information System. (n.d.). *Interactive Map*. Retrieved February 22, 2024 from https://cwfis.cfs.nrcan.gc.ca/interactive-map?zoom=0&center=-50805.10211146048%2C1168759.4948053593&month=6&day=26&year=2023 - iMap

3. Conceptual Model of PM2.5 Concentrations from Wildfires

Smoke from wildfires has been known to raise the level of particle pollution to unhealthy concentrations and create air quality concerns. Because smoke can travel hundreds or thousands of miles, air quality can be a problem at larger distances from the wildfire itself. The intense heat generated by wildfires aids in the process of driving smoke high into the air.[49] The following sections will provide a simplified narrative of the transport during the event, associated meteorological conditions at the surface and aloft, satellite imagery, and regional AQI maps.

3.1 Conceptual Model Discussion

During the first week of June 2023 in North America, a strong omega pattern (a weather pattern characterized by a prominent, stationary high-pressure system in the shape of the Greek letter omega, Ω) set up allowing a strong ridge over central Canada to suppress precipitation over most of eastern North America. In the weeks following, this pattern remained the dominant weather set-up but the persistent blocking pattern slowly weakened during the week of June 21-26.[50] Meanwhile, an intense burn period was initiated in Quebec (See gray cloud in Figure 51) due to the extreme drought conditions experienced over northwestern Canada. During this burning, stagnation existed over Quebec, allowing smoke to accumulate to concentrations over parts of southern Quebec that exceeded the EPA Air Quality Index (AQI) scale with a maximum PM2.5 24-hour average concentration of 593 $\mu g/m^3$, achieved on June 25.[51] This value is a good indicator for smoke in the atmosphere when compared to the PM2.5 24-hour average National Ambient Air Quality Standard of 35 $\mu g/m^3$.

This burn period was exacerbated by the recirculation of high pressure passing by during this week (noted with blue "H" in Figure 51). By June 26th, an intensifying area of low pressure (noted with red "L" in Figure 51) migrated eastward allowing the omega pattern to break. As this low tracked northeastward through June 29, counterclockwise winds provided a direct pathway for wildfire smoke from Quebec into the Mid-Atlantic albeit slowly. Meanwhile, high pressure filled in behind as the next weather maker through June 30, allowing subsidence to transport smoke at higher levels of the atmosphere to ground level. A simplified illustration of the weather pattern is shown in Figure 51.

[49] Challenges in Predicting Smoke Concentrations, USEPA, Accessed: 7/18/2024, https://www.epa.gov/wildfire-smoke-course/challenges-predicting-smoke-concentrations.
[50] NOAA National Centers for Environmental Information, Monthly Synoptic Discussion for June 2023, published online July 2023, retrieved on March 11, 2024 from https://www.ncei.noaa.gov/access/monitoring/monthly-report/synoptic/202306.
[51] Maryland Department of the Environment, 2023, "Exceptional Event Demonstration and Analysis of the June 2023 Quebec Wildfires and their Impact on Maryland Air Quality" https://mde.maryland.gov/programs/air/AirQualityMonitoring/Documents/ExceptionalEvents/MDE_Ozone_EE_Demo_2023_June_29-30.pdf

Figure 51: Simplified, Illustrated Conceptual Model of June 29-30, 2023 Wildfire Event

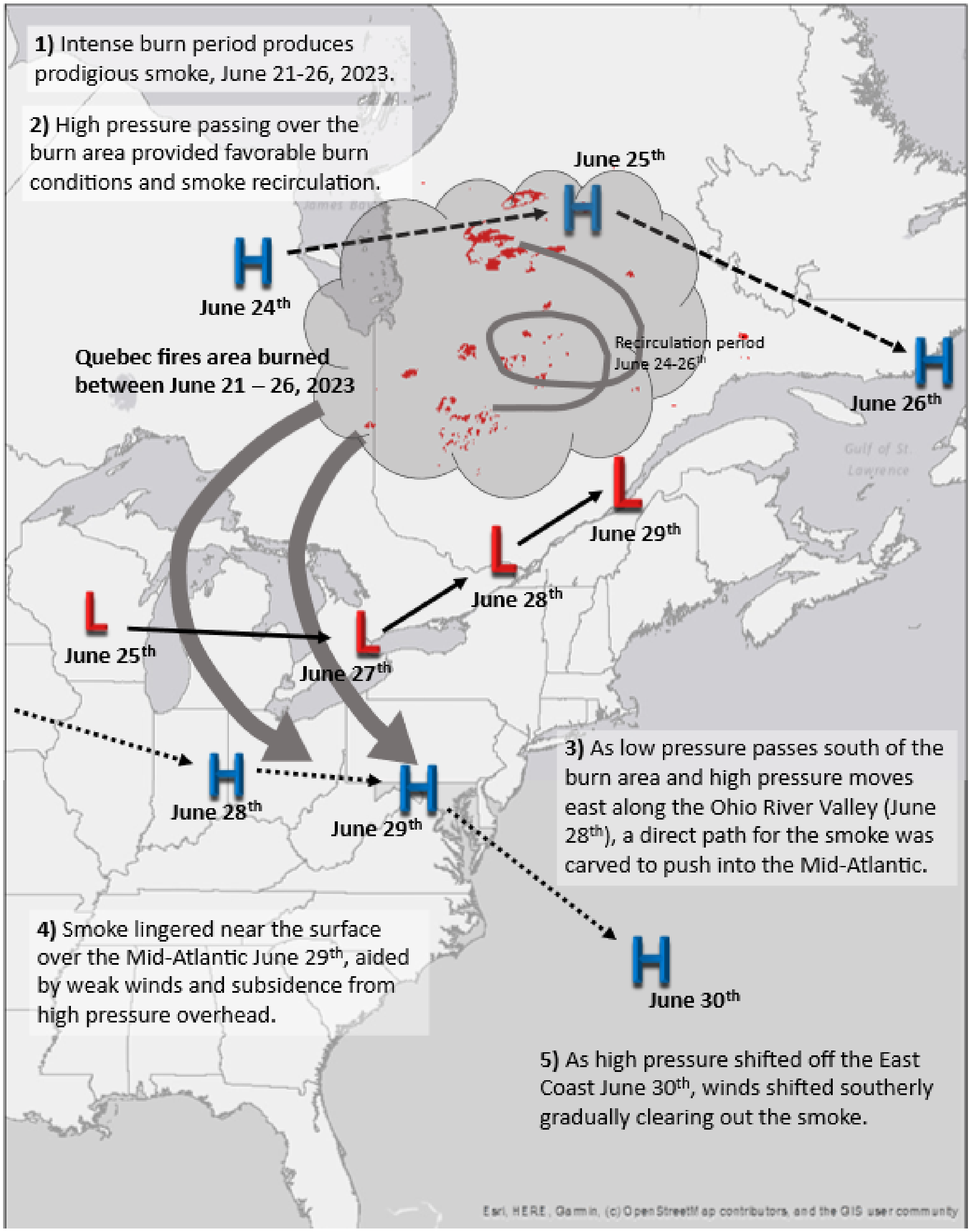


Image courtesy of Maryland Department of the Environment

3.2 Surface Analysis – Transport and Wind Patterns

High pressure located over the Mid-Atlantic region was slowly being pushed eastward as a strong area of low pressure across the western Great Lakes region, followed closely behind (Figure 52). Meanwhile, a broad area of high pressure across Quebec (Figure 52) provided light winds with little atmospheric ventilation at the burn location on June 25 (Figure 53). On June 26, (Figure 54) widespread unsettled weather across the northern Great Lakes and Ontario/Quebec was observed as the intensifying area of low pressure began to pull smoke southwestward as its progression eastward slowed. This allowed winds on the western side of the low to begin to pull smoke southward on June 26 and 27 (Figure 55) over the Great Lakes, as high pressure developed across the Midwest resulting in a broad area of divergent winds from Wisconsin through Ohio and Pennsylvania. Due to the abundant cloud cover and unsettled weather, much of the smoke progression was not visible on satellite imagery (Figure 56). As high pressure strengthened over the Ohio Valley on June 28 (Figure 57), the smoke progressed eastward within the area of high pressure. Winds in this area remained light, and as a result, smoke transport was slow and lingered over portions of Ohio (Figure 58). On June 29, high pressure strengthened and migrated overhead of the Mid-Atlantic (Figure 59). Here, air experienced subsidence (gentle sinking motion within high pressure systems), which allowed wildfire smoke and fine particles to reach the surface beginning on this day. Figure 60 shows the extent of the dense wildfire smoke plume impacting portions of the northeast and southern New Jersey on June 29. Under the influence of high pressure (Figure 61), smoke lingered for a second day into June 30, leading to the increased build-up of smoke at the surface due to light winds, limited atmospheric ventilation, and subsidence. As a result, wildfire smoke at the surface continued to accumulate through June 30, while becoming more widespread and diffuse (Figure 62). In the following days, smoke continued to dissipate as unsettled weather helped to provide cleaner air to the region.

Figure 52: Surface Analysis June 25, 2023

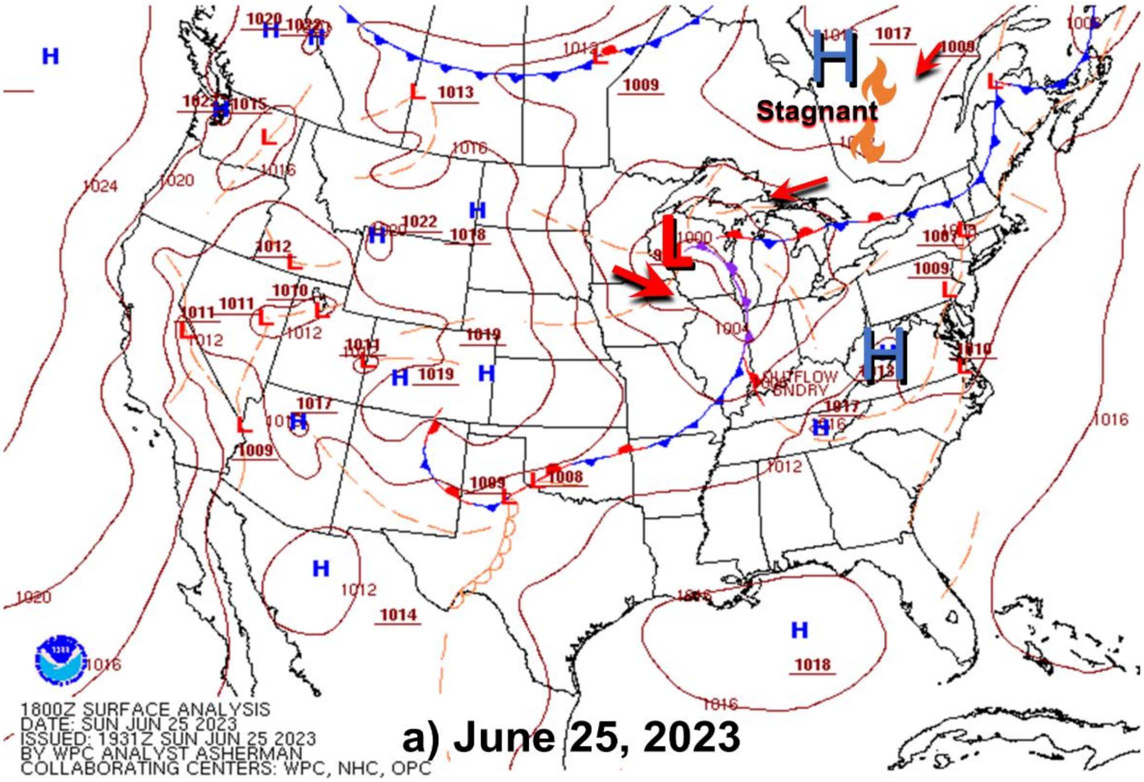


Figure 53: Aerosol Watch Satellite Imagery – June 25, 2023, 18UTC

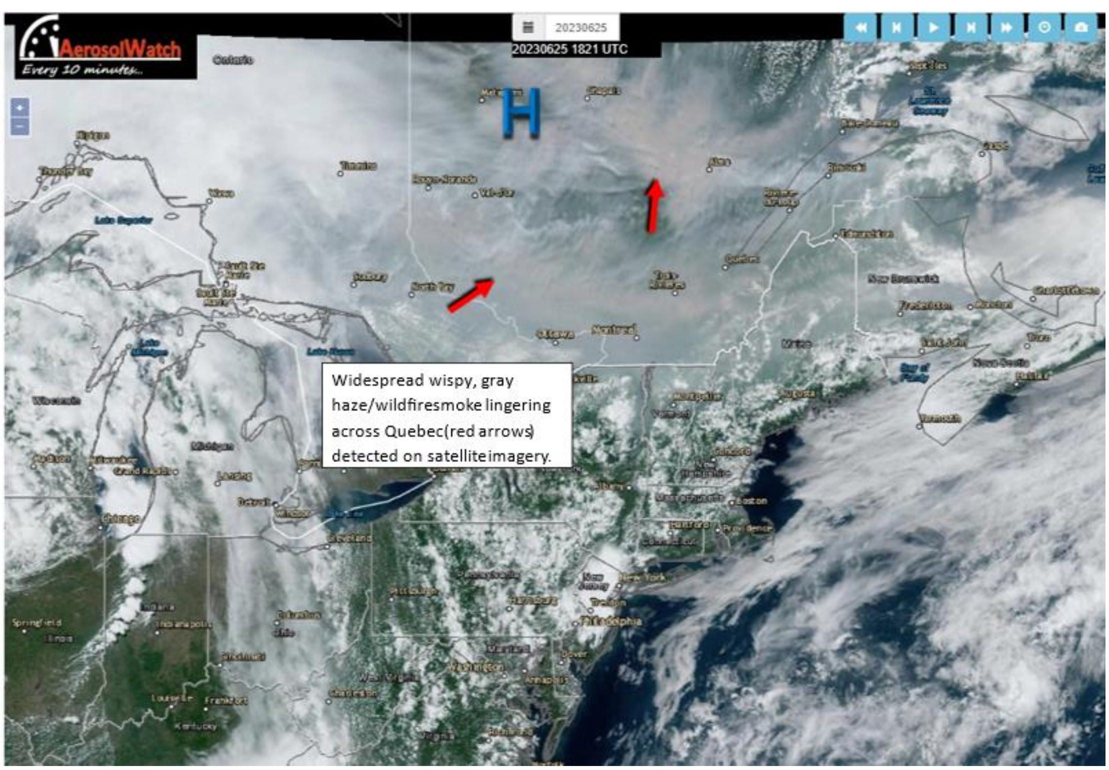


Figure 54: Surface Analysis for June 26, 2023, 18UTC

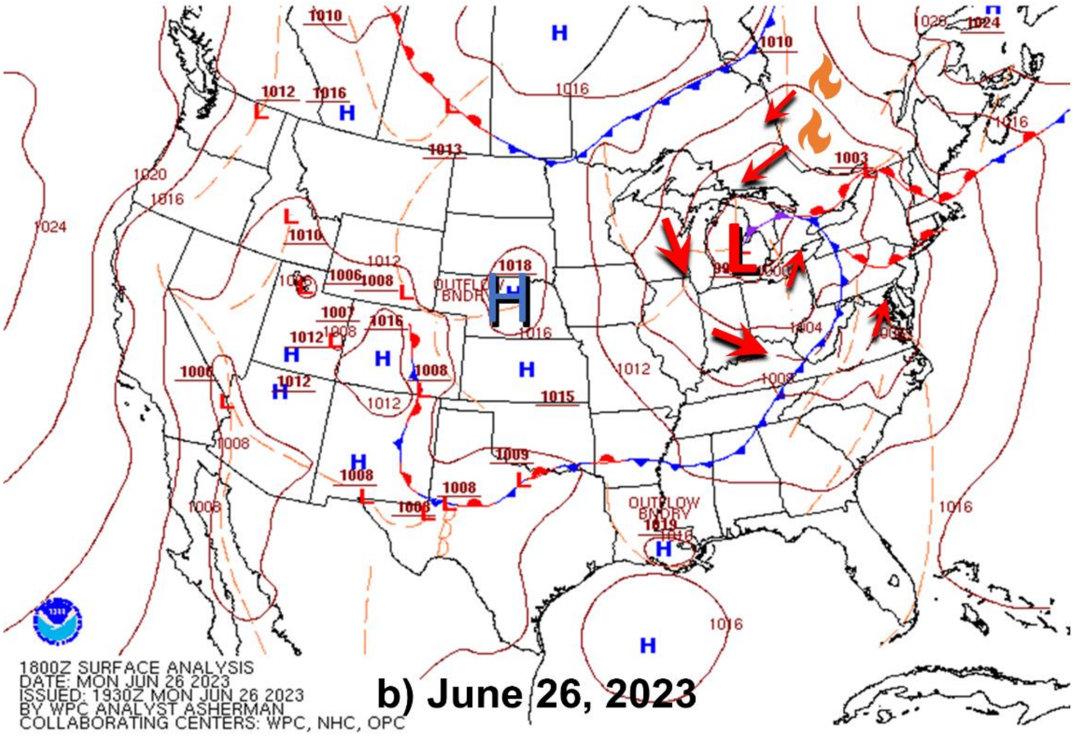


Figure 55: Surface Analysis for June 27, 2023, 18UTC

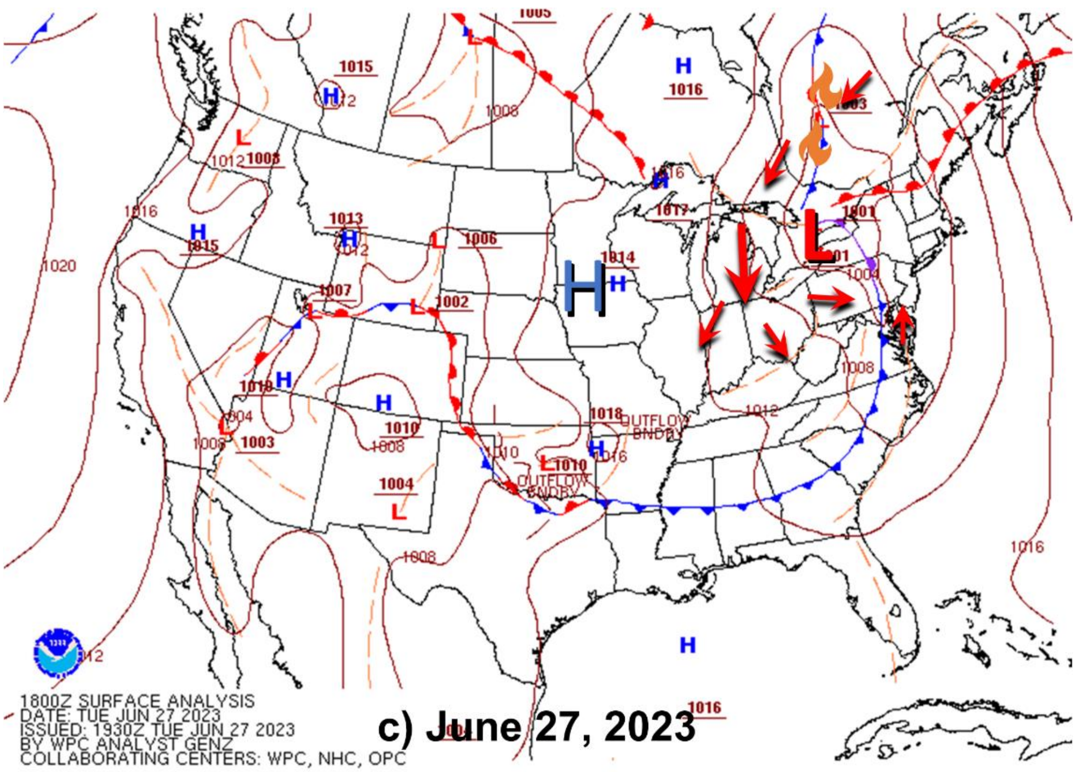


Figure 56: Aerosol Watch Satellite Imagery – June 27, 2023, 15UTC

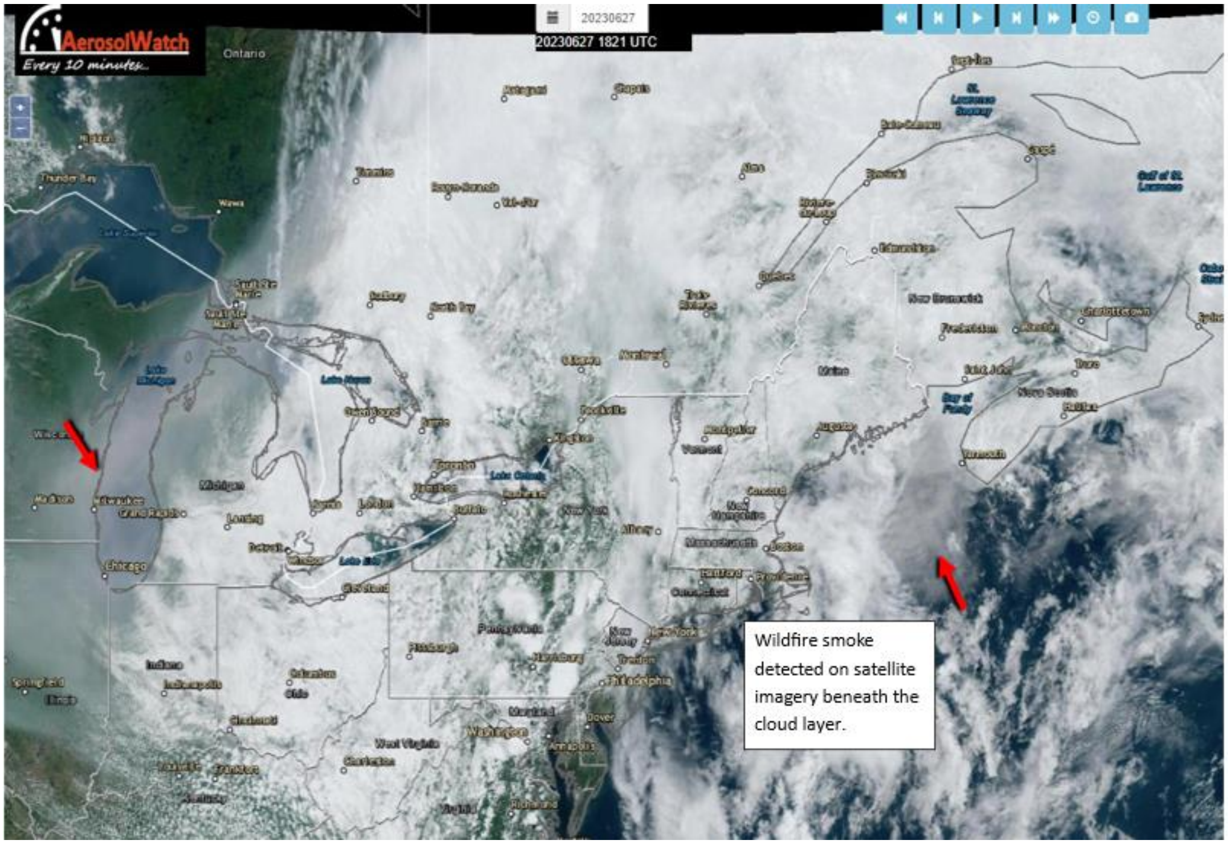


Figure 57: Surface Analysis for June 28, 2023, 18UTC

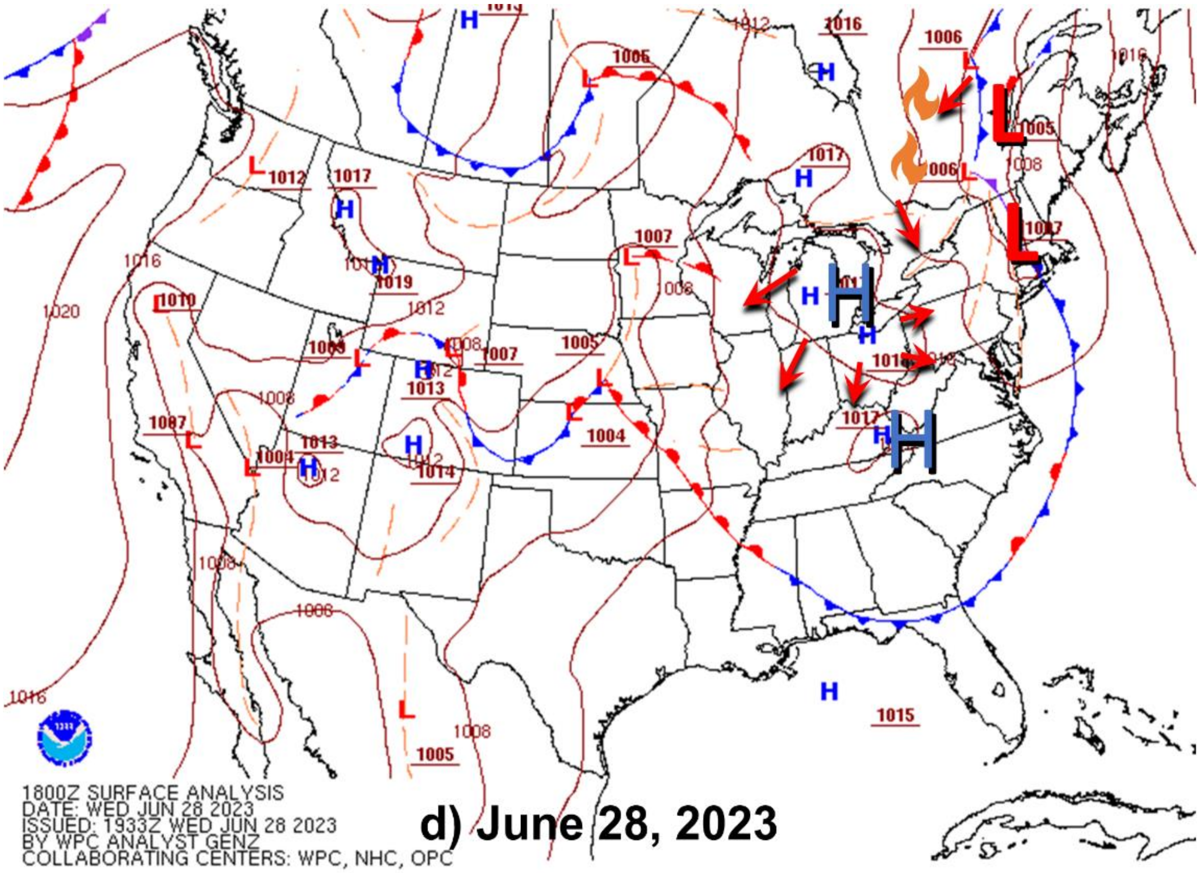


Figure 58: Aerosol Watch Satellite Image: Early Morning East Coast June 28, 2023, 11UTC

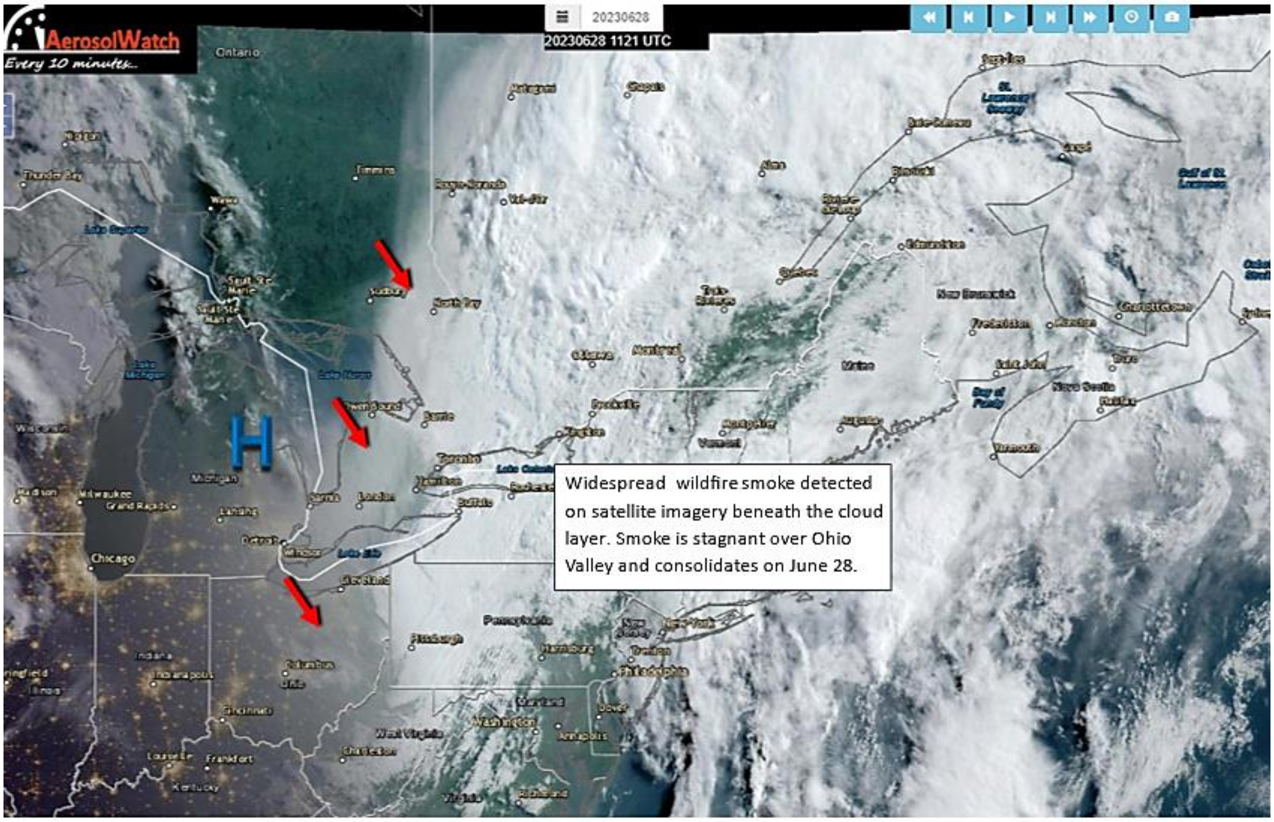


Figure 59: Surface Analysis for June 29, 2023, 18UTC

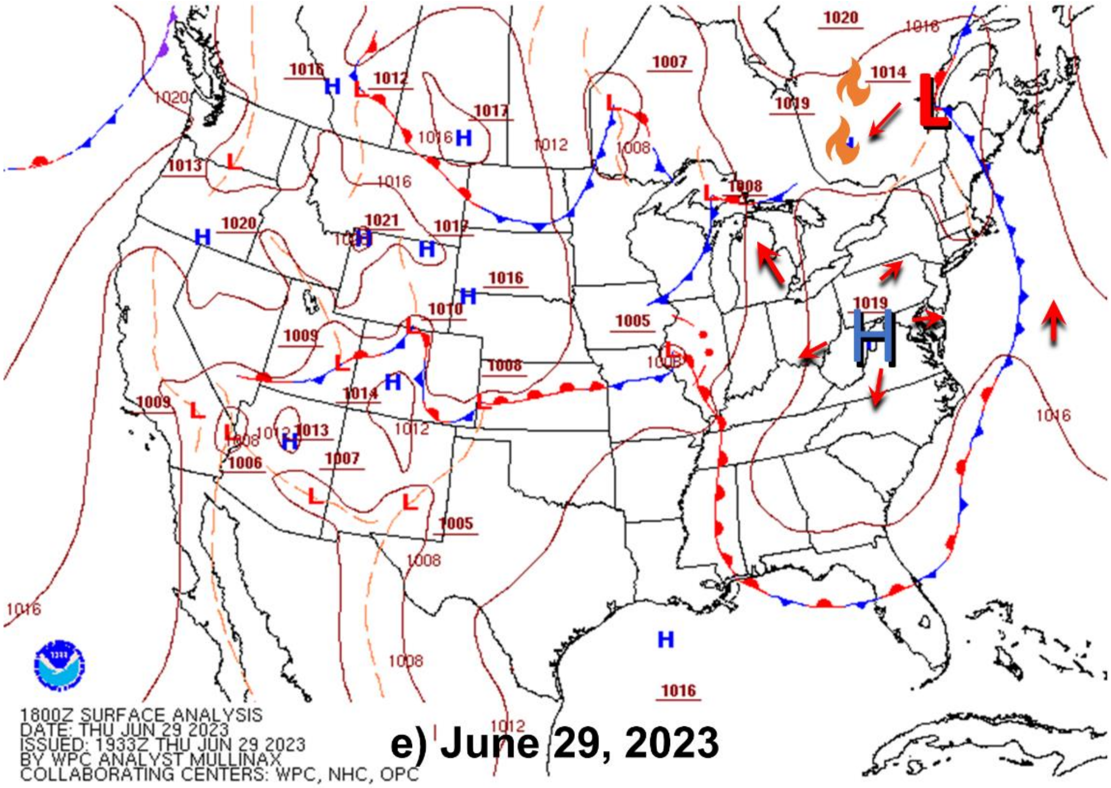


Figure 60: Aerosol Watch Satellite Image: Early Morning East Coast June 29, 2023, 11UTC

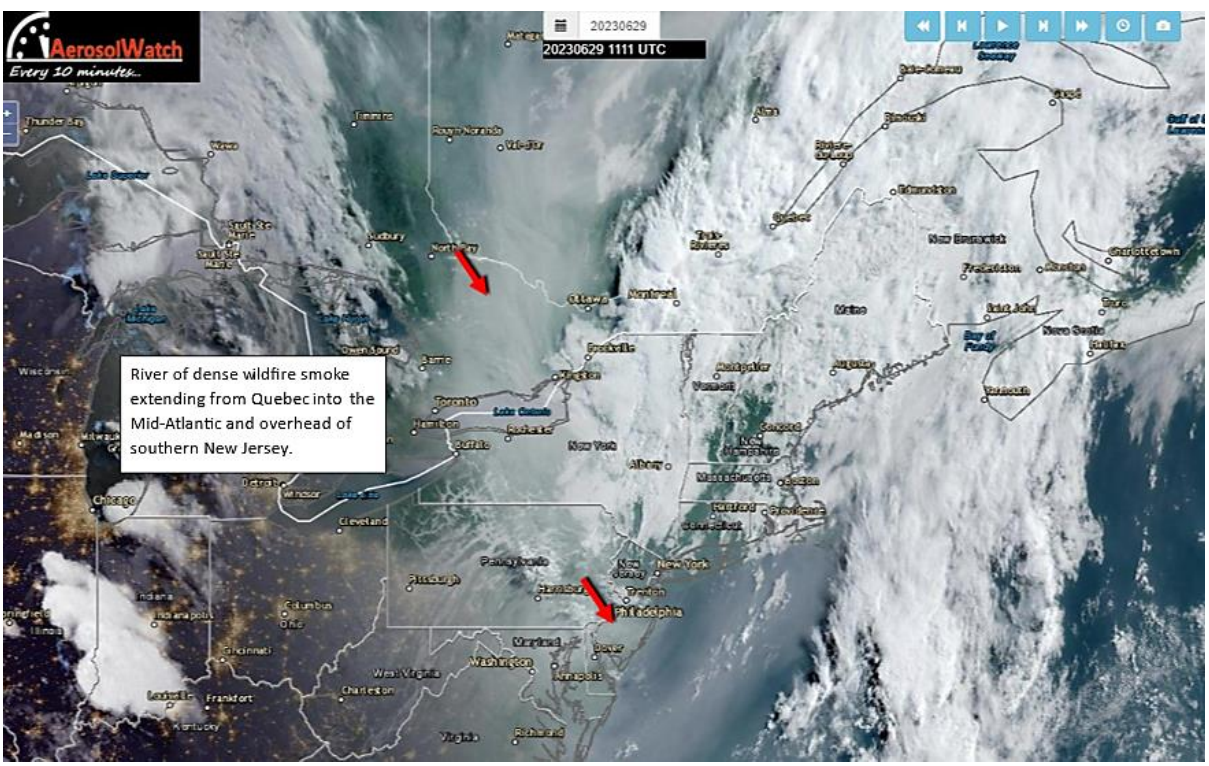


Figure 61: Surface Analysis for June 30, 2023, 18UTC

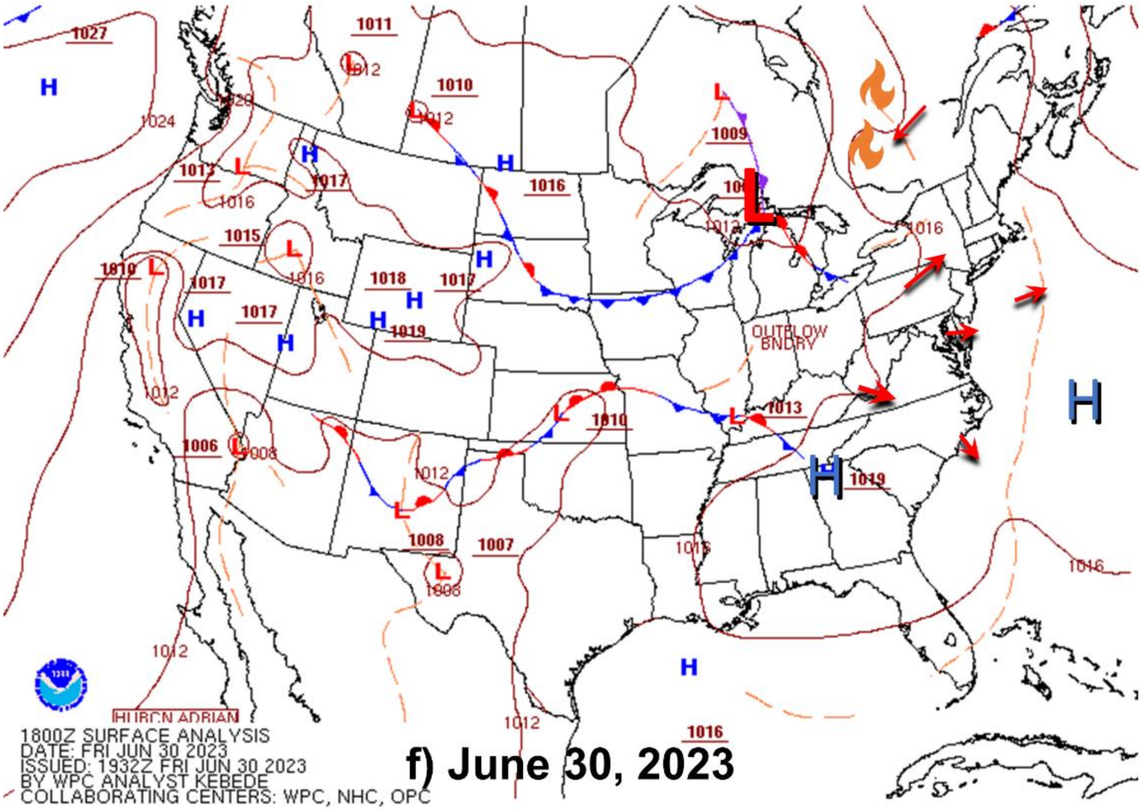


Figure 62: Aerosol Watch Satellite Image: Early Morning East Coast June 30, 2023, 11UTC

3.3 Upper Air Analysis

This section will provide an upper air analysis occurring at the 850 millibar (mb) level (approximately 1500 m above sea level). This upper air level sits near the top of the planetary boundary layer (PBL), the atmospheric layer in which pollutants associated with ground level concentrations and human health develops, and so can serve as a guide for the transport of pollutants. The analysis of this atmospheric level is given for June 25 – 30, 2023, in Figures 63 – 68 below.

Beginning on June 25, the area of low pressure, “L”, over the northern plains continued to strengthen through June 26 and migrate eastward into the Great Lakes. Meanwhile, a weak area of high pressure aloft, “H”, over Quebec provided recirculation to the burn area and subsidence, allowing wildfire smoke to accumulate in this area (Figure 63 and Figure 64). This pattern is consistent with observations in the surface analysis. By June 27 at 850mb, the area of low pressure begins to weaken as a ridge of high pressure, "H”, fills in behind it from the west. Here, smoke finds a direct pathway between these two air masses where air converges aloft (red arrows, Figure 65) allowing smoke to penetrate the Mid-West region. On June 28 (Figure 66), the ridge of high pressure sinks south/east while the area of low pressure continues to weaken and drift farther eastward creating a pathway for the wildfire smoke to push into the Ohio Valley (red arrows, Figure 66). Here, south/southeasterly winds on the backside of the low in combination with subsidence around the perimeter of high pressure helped to keep wildfire smoke near the surface as it approached the Mid-Atlantic region. At the start of the event on June 29, few changes in the upper-level pattern were observed from the previous day which allowed the smoke to continue flowing into the Mid-Atlantic from the northwest (Figure 67). The final day of the event, June 30, was largely a transition day where the departing airmass, laden with wildfire smoke, gradually departed and a new air mass arrived. At this time, much of the stable weather pattern had weakened and high pressure migrated south/eastward and was pumping a new airmass into the region from the southwest (red arrows, Figure 68).

Figure 63: 850mb Upper Air Analysis, June 25, 2023

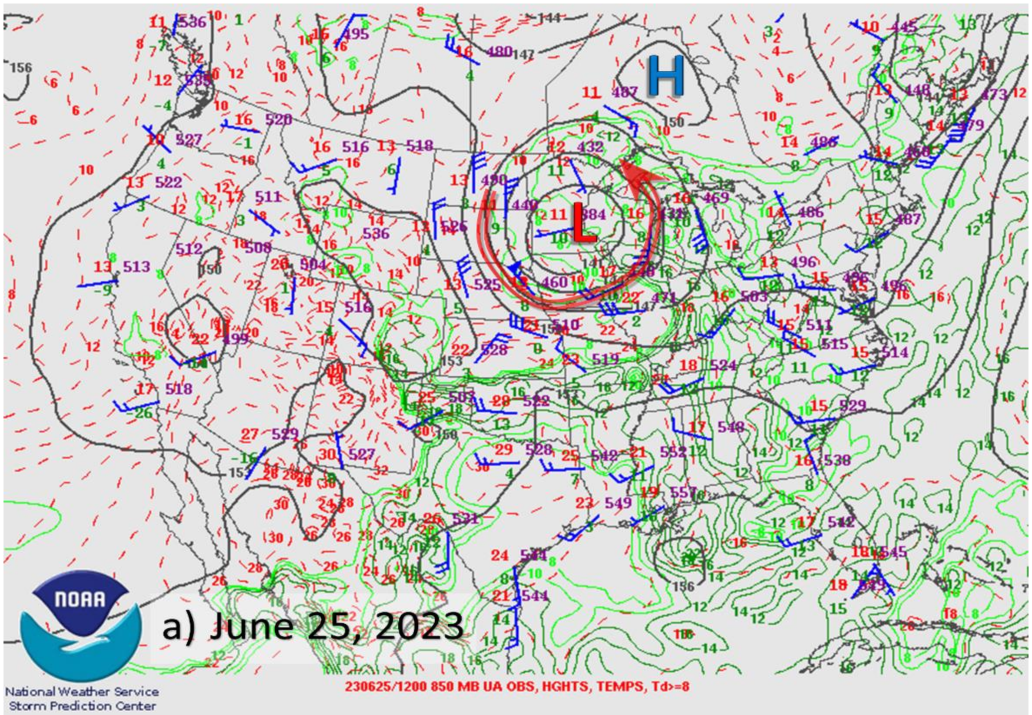


Image courtesy of Maryland Department of the Environment

Figure 64: 850mb Upper Air Analysis, June 26, 2023

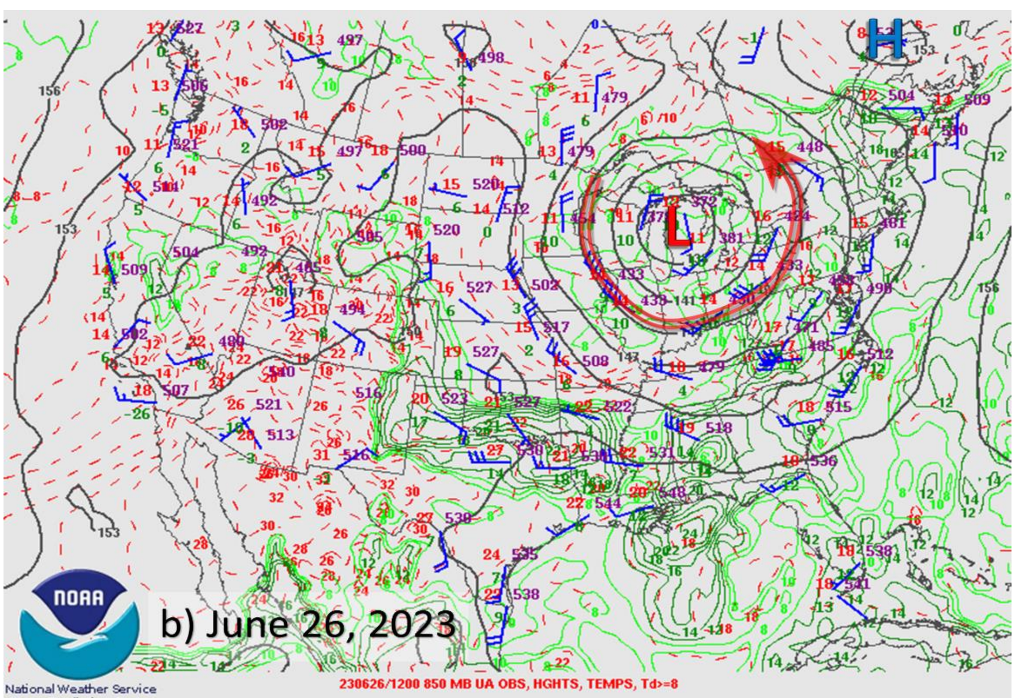


Image courtesy of Maryland Department of the Environment

Figure 65: 850mb Upper Air Analysis, June 27, 2023

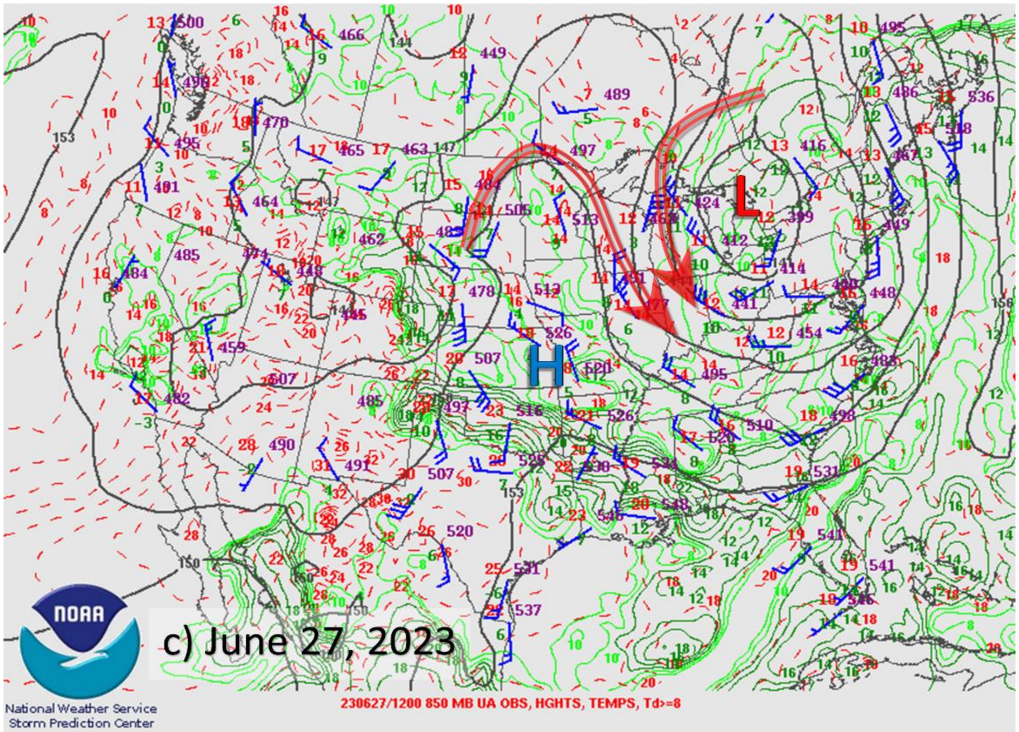


Image courtesy of Maryland Department of the Environment

Figure 66: 850mb Upper Air Analysis, June 28, 2023

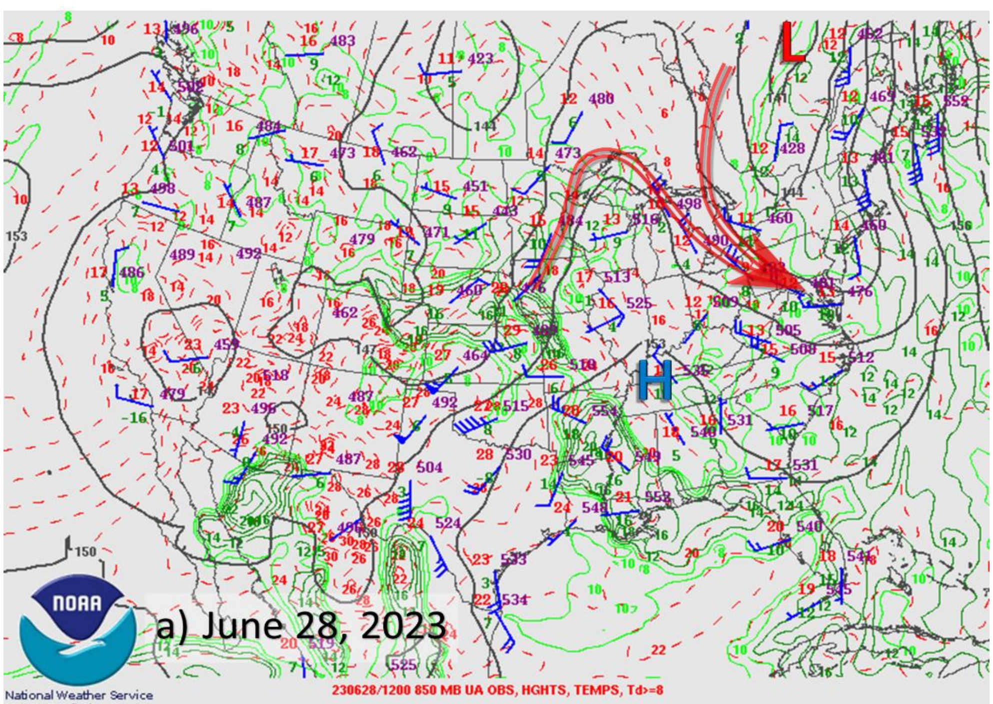


Image courtesy of Maryland Department of the Environment

Figure 67: 850mb Upper Air Analysis, June 29, 2023

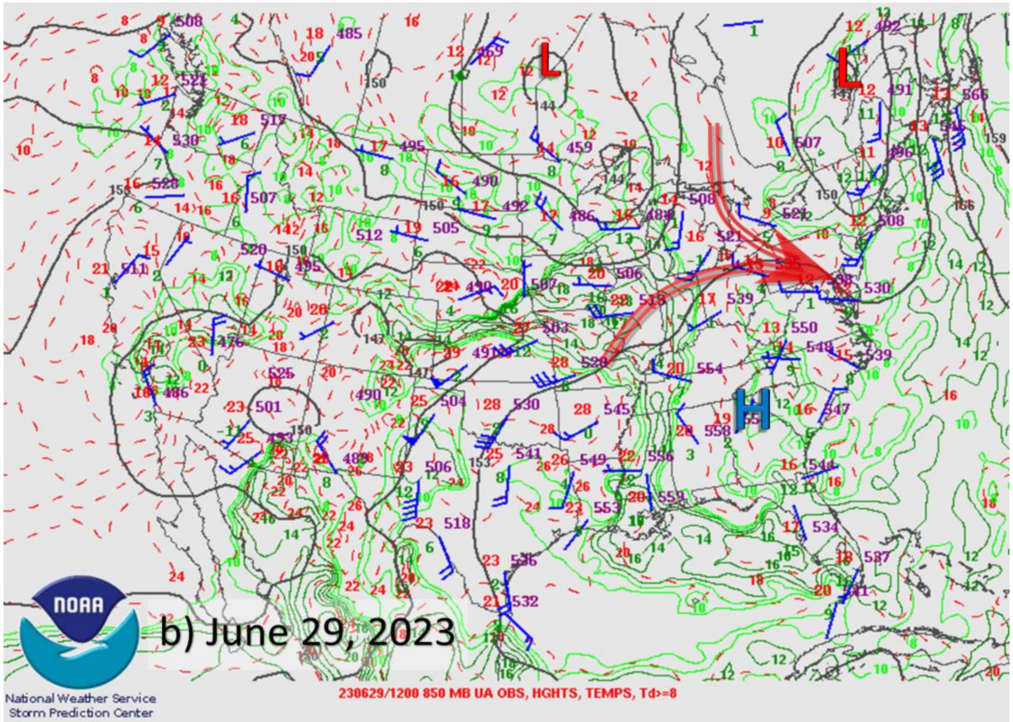


Image courtesy of Maryland Department of the Environment

Figure 68: 850mb Upper Air Analysis, June 30, 2023

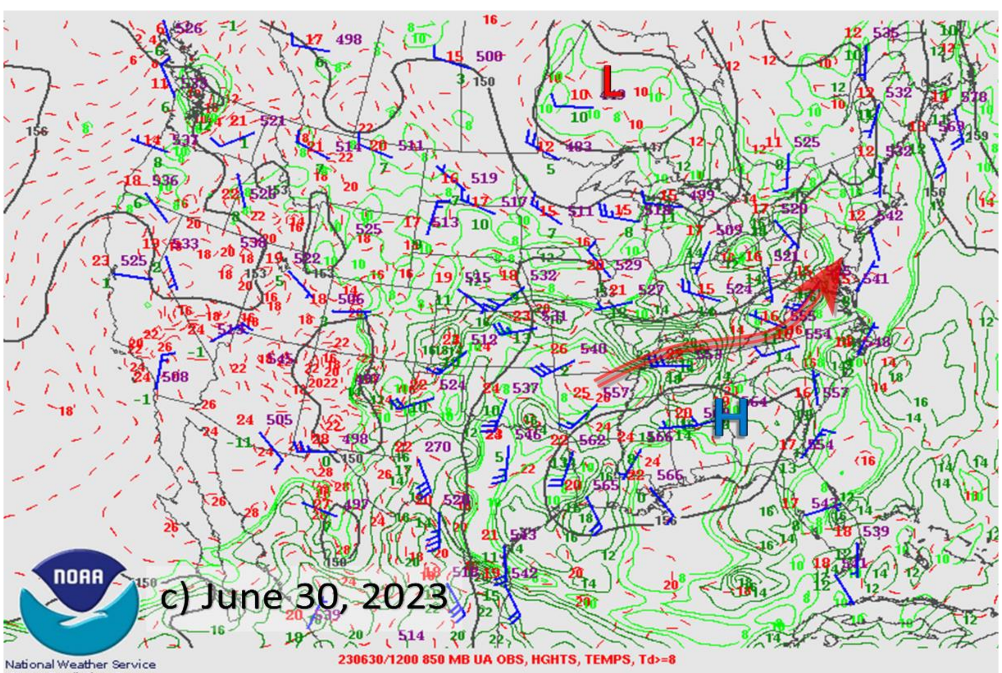
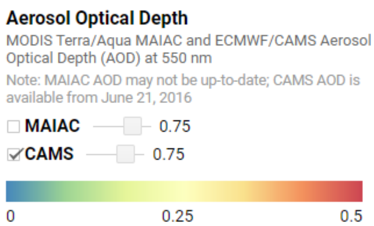


Image courtesy of Maryland Department of the Environment

3.4 Aerosol Optical Depth

Figures 69–74 show aerosol optical depth (AOD) in the days leading up to the high PM2.5 exceedance event on June 29–30, 2023. AOD is a measure of smoke in the atmosphere that is blocking sunlight. Therefore, it is a helpful indicator of wildfire smoke and how much direct sunlight is prevented from reaching the ground by aerosol particles. An extremely clean atmosphere corresponds to a value of 0.01 (dark blue) and a very hazy condition would correspond to a value of 0.4 (orange-red).[52] In the following images, AOD is indicated by the color scale from cool tones (blue) to warm tones (red), which represents a scale from 0.0 to 0.5.



Beginning on June 25 and 26, the plume of heavy, dense smoke (circled, Figure 69) is concentrated in the Quebec/Ontario region as the influence of high pressure on this area allowed the wildfire smoke to recirculate and linger while the fires continued to burn. Figure 69 and Figure 70 show the widespread, dense nature of the plume, and the spatial extent it encompassed.

On June 27 and 28 (Figure 71 and Figure 72) dense smoke was pulled southeastward into the Ohio Valley and Great Lakes as smoke swirled counterclockwise around low pressure. This is shown as the circled area. The heaviest concentrations of smoke arrived over New Jersey and the Mid-Atlantic region on June 29 and 30 (Figure 73 and Figure 74), encompassing much of the region. The aerosol optical depth maps shown below provide additional support for the magnitude and size of the wildfire smoke plume impacting New Jersey on the exceedance days.

[52] NOAA Earth System Research Laboratories. (n.d.). *SURFRAD Aerosol Optical Depth*. Retrieved December 13, 2023 from https://gml.noaa.gov/grad/surfrad/aod/ - :~:text=Aerosol%20optical%20depth%20is%20a,ground%20by%20these%20aerosol%20particles..

Figure 69: Aerosol Optical Depth June 25, 2023

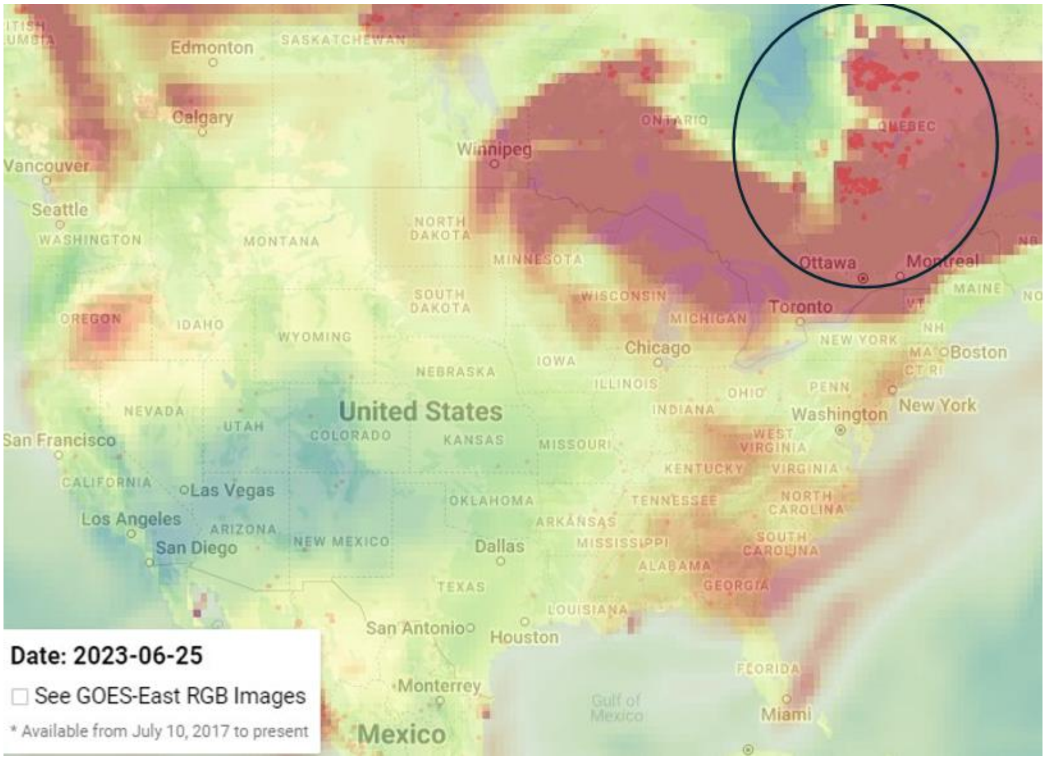


Figure 70: Aerosol Optical Depth June 26, 2023

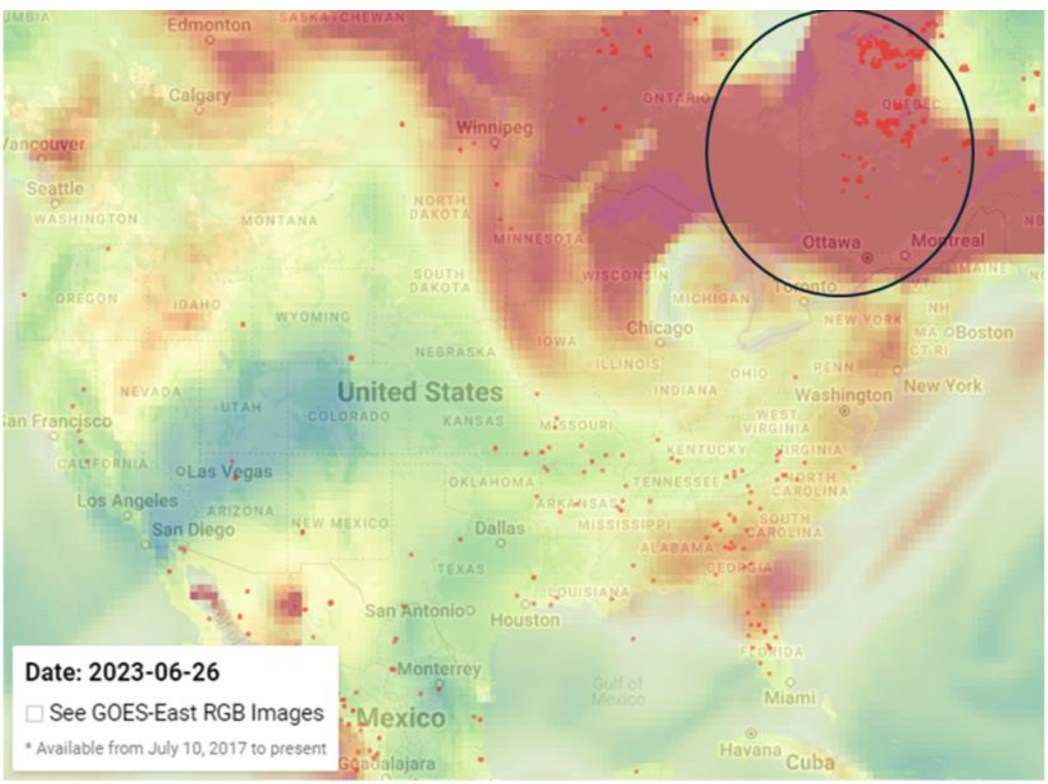


Figure 71: Aerosol Optical Depth June 27, 2023

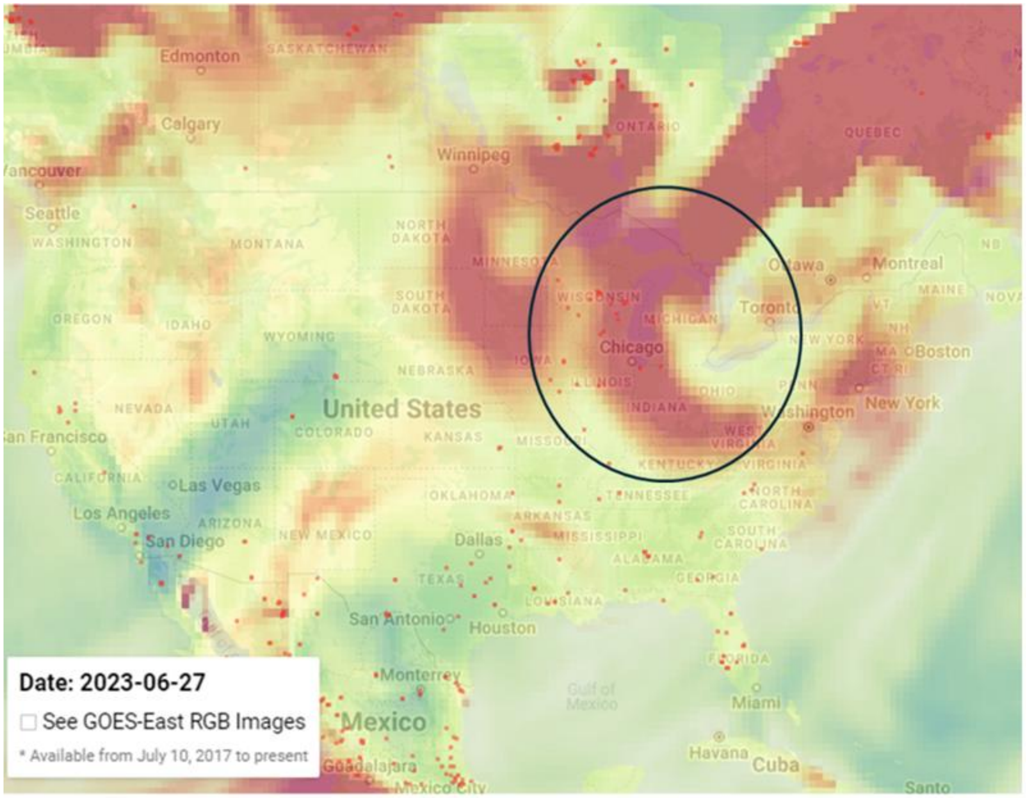


Figure 72: Aerosol Optical Depth June 28, 2023

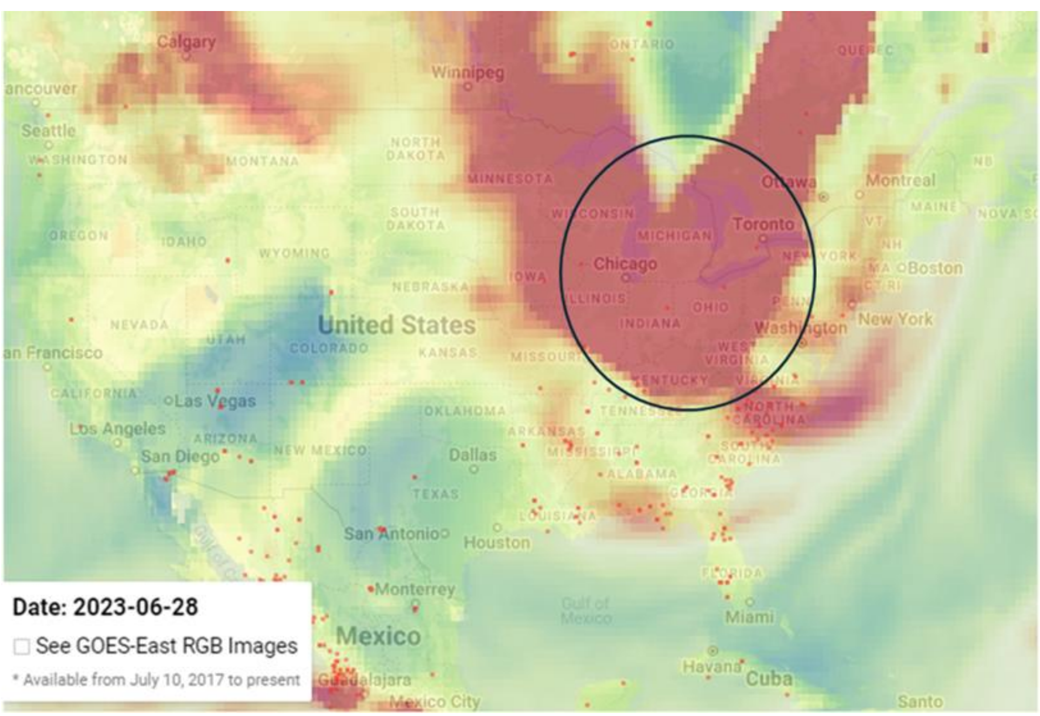


Figure 73: Aerosol Optical Depth June 29, 2023

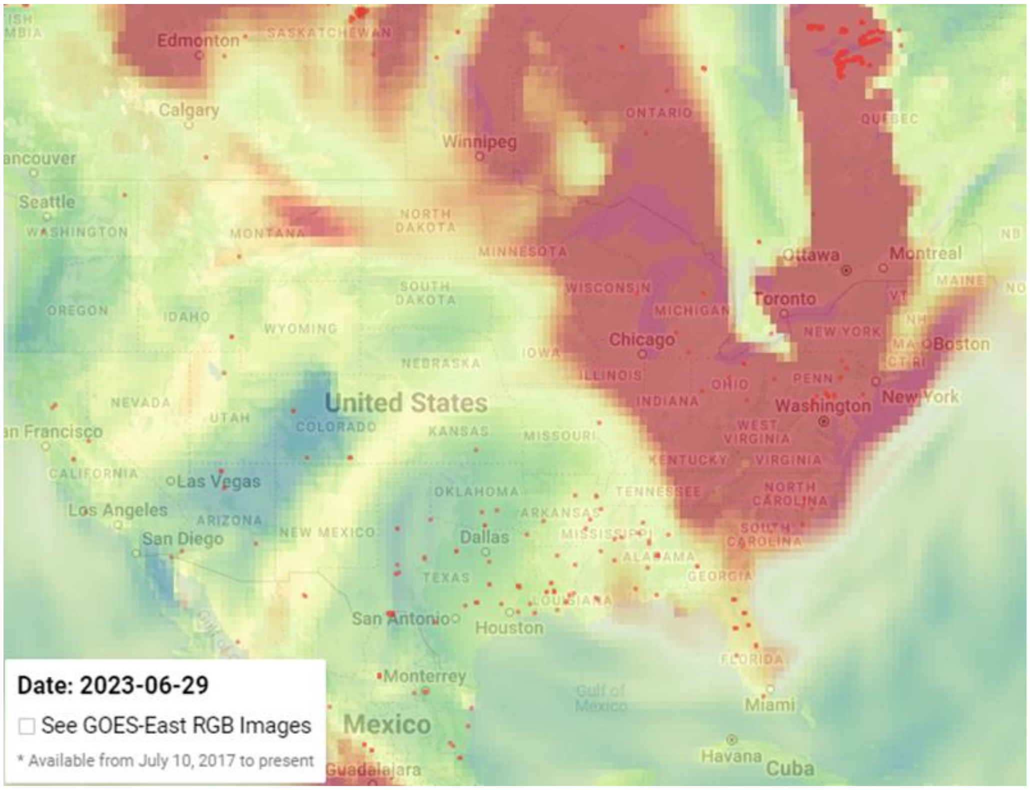
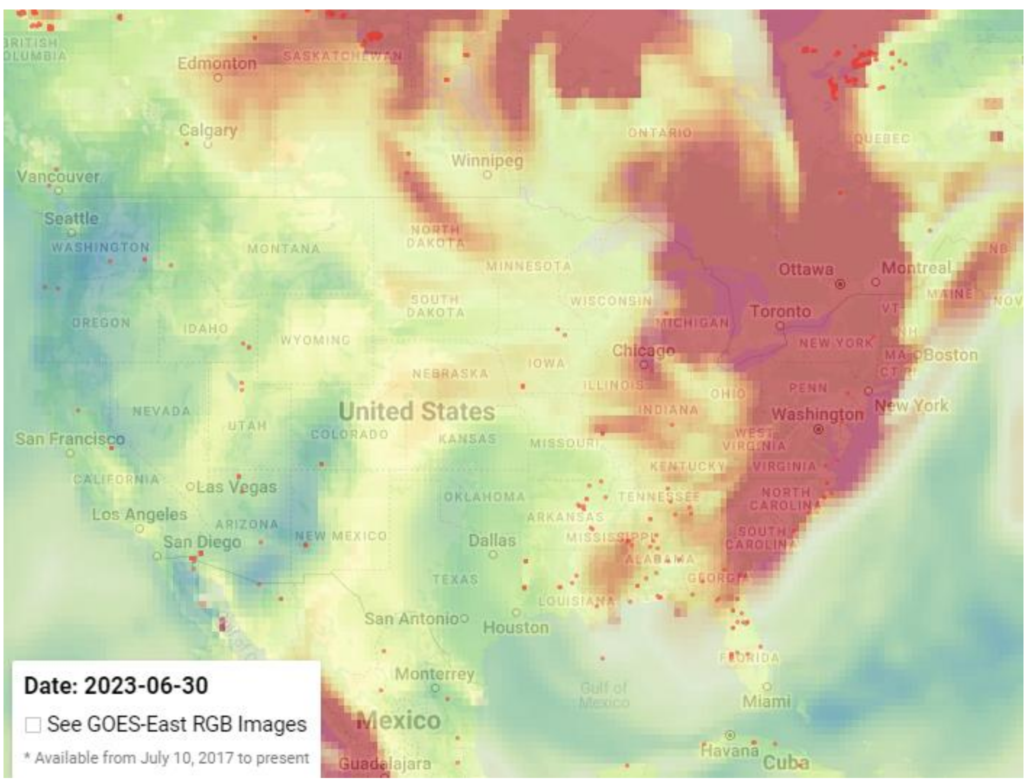


Figure 74: Aerosol Optical Depth June 30, 2023



3.5 Daily PM2.5 AQI Maps

The following images (Figures 75-80) show Daily Air Quality Index (AQI) levels observed across the continental United States during the days leading up to and including the exceptional event occurring on June 29 - 30, 2023. The changing level of the AQI in these images corresponds to the progression of PM2.5 levels in the ambient air leading up to the high PM2.5 exceptional event. The PM2.5 AQI levels are provided as an indicator of the presence of the smoke plume. Color contours in the following figures from AirNow.gov are based on the former PM AQI scale.

The scale used in Figures 75-80 for the PM2.5 AQI is as follows:

AQI Category and Index Value	AQI Category Breakpoints (µg/m^3)
Good (0-50)	0.0 – 12.0
Moderate (51-100)	12.1 – 35.4
Unhealthy for Sensitive Groups (101-150)	35.5 – 55.4
Unhealthy (151-200)	55.5 – 150.4
Very Unhealthy (201-300)	150.5 – 250.4
Hazardous (301+)	250.5+

Beginning on June 25 and 26, as heavy wildfire smoke recirculated under the influence of high pressure in Quebec, surface level PM2.5 concentrations spiked into the very unhealthy and hazardous categories for human health where the plume was located (Figure 75 and Figure 76). At this time, PM2.5 concentrations at the surface reflect the smoke plume location indicating that the plume was so dense that it greatly impacted PM2.5 concentrations at the surface.

By June 27, as low pressure pulled smoke southward into the Great Lakes and upper Mid-West, PM2.5 concentrations rose dramatically in this area (Figure 77). Here, widespread PM2.5 concentrations in the unhealthy and very unhealthy categories were observed. As the plume migrated, it had an immediate impact on surface PM2.5 concentrations in locations it traversed. This pattern repeats again the following day on June 28, with unhealthy and very unhealthy PM2.5 concentrations becoming widespread while the plume advanced eastward (Figure 78).

While some dispersion is expected through transit, the heaviest smoke observed in New Jersey arrived on June 29 and 30. At this time PM2.5 concentrations increased into the unhealthy for sensitive groups and unhealthy categories upon arrival (Figure 79 and Figure 80). It is clear that the widespread nature and historically high PM2.5 concentrations across the Mid-Atlantic and Mid-West regions indicate that smoke from the same airmass influenced PM2.5 across this large area.

Figure 75: Daily PM2.5 AQI June 25, 2023

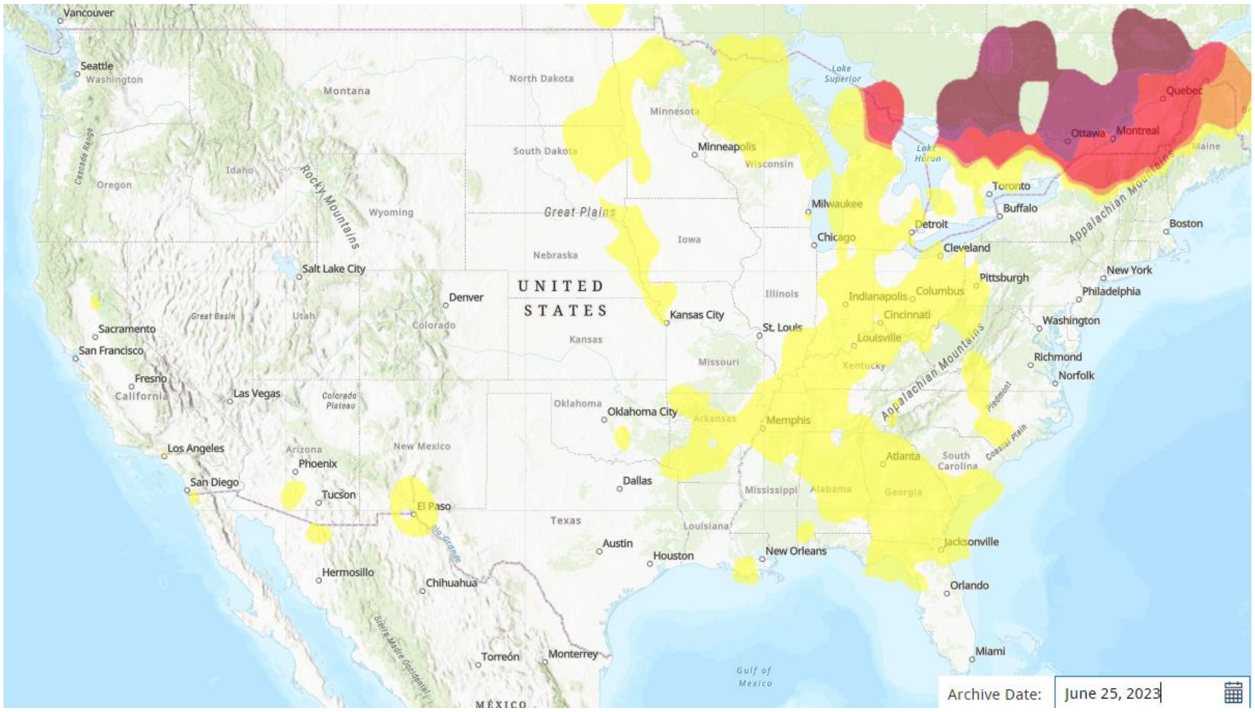


Figure 76: Daily PM2.5 AQI June 26, 2023

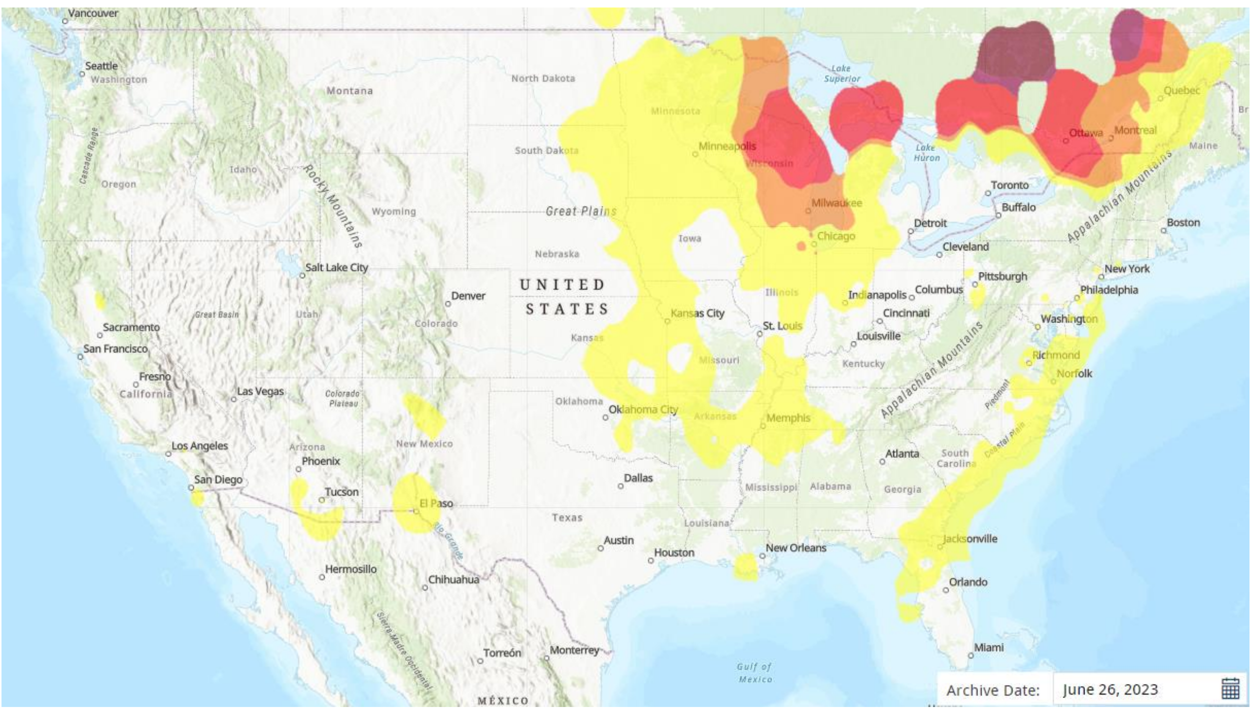


Figure 77: Daily PM2.5 AQI June 27, 2023

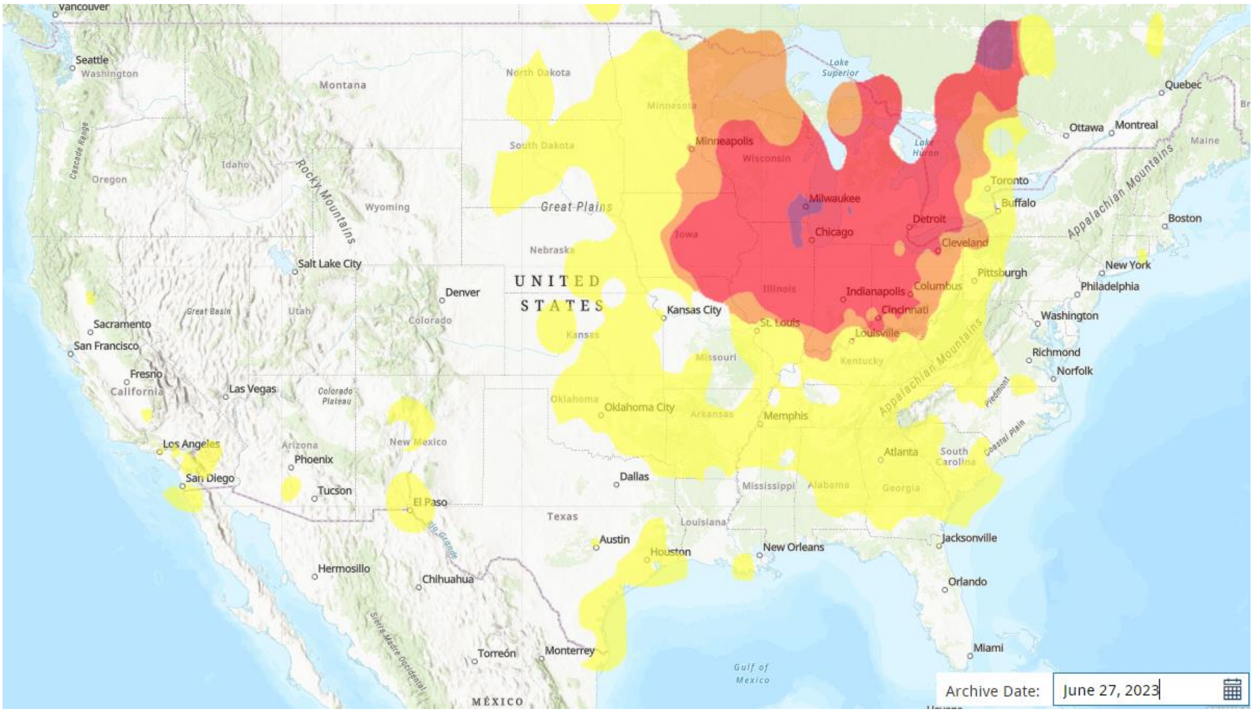


Figure 78: Daily PM2.5 AQI June 28, 2023

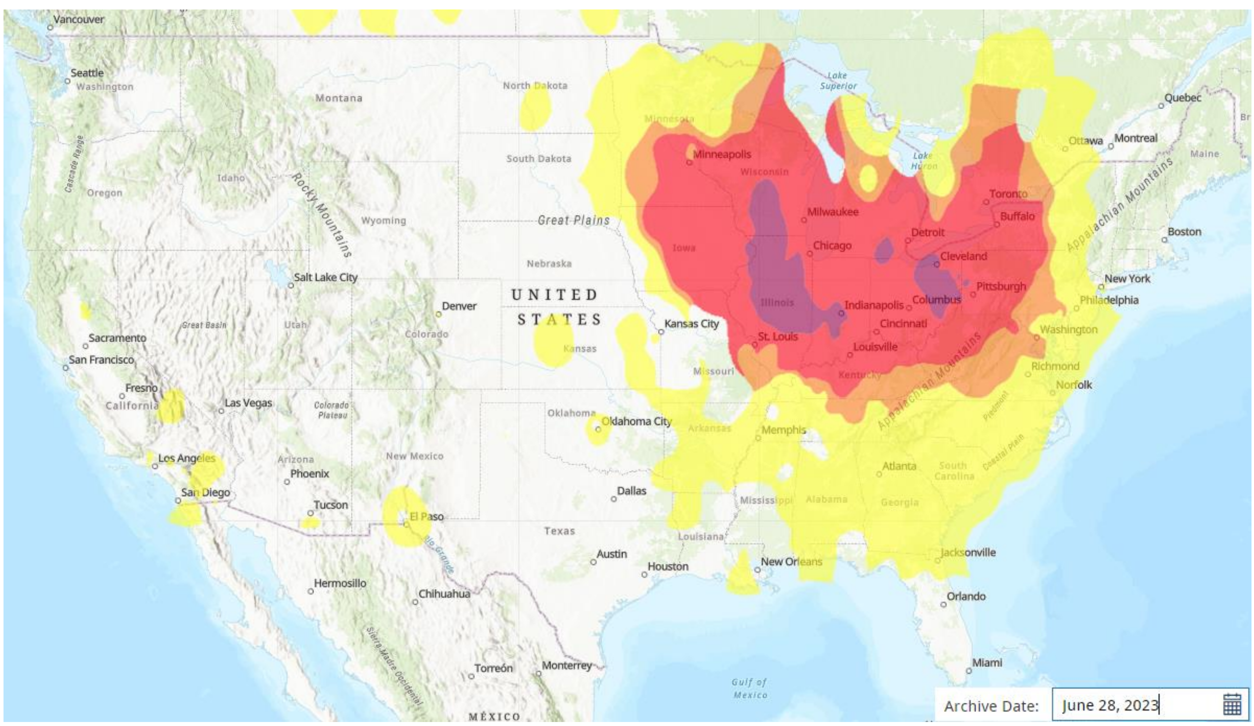


Figure 79: Daily PM2.5 AQI June 29, 2023

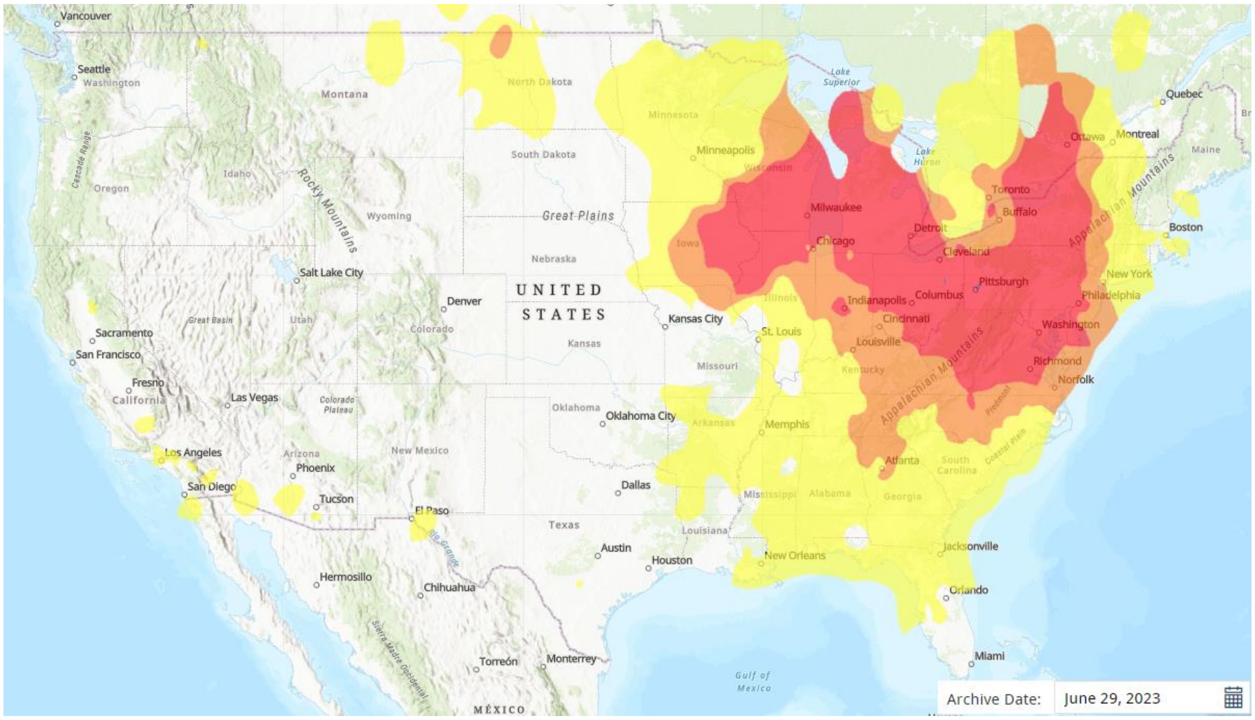
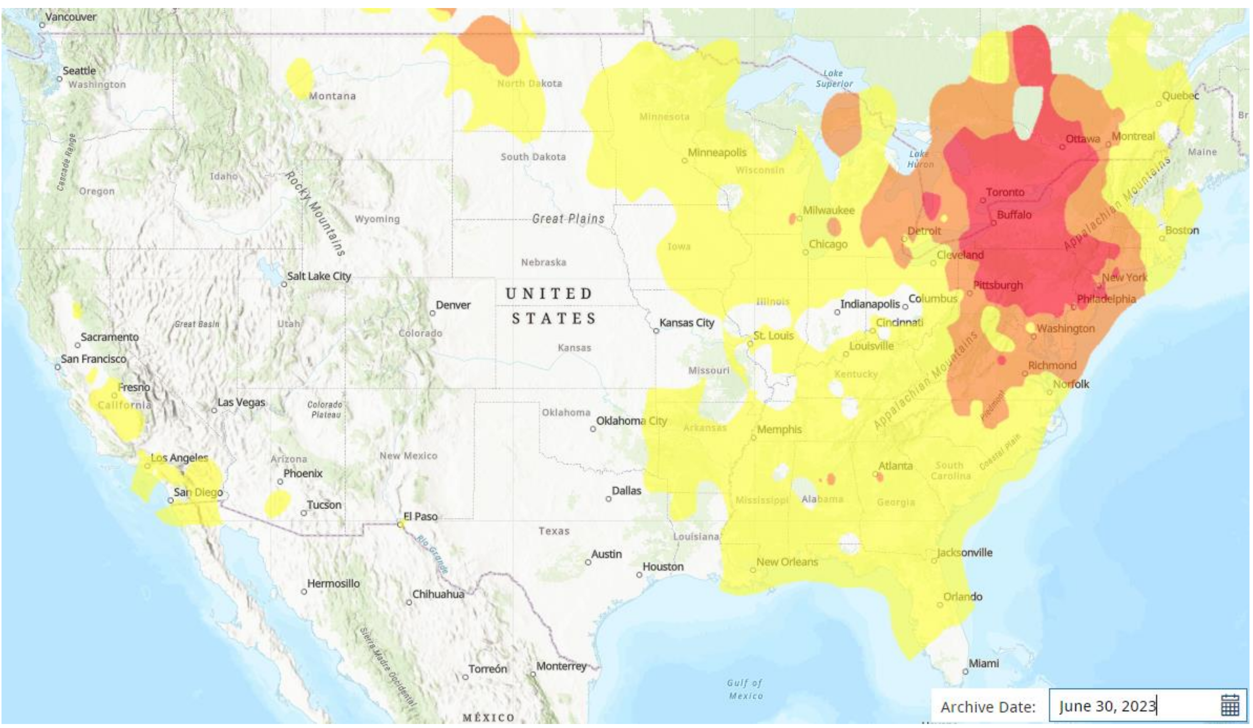


Figure 80: Daily PM2.5 AQI June 30, 2023



II. Clear Causal Relationship between the Specific Event and the Monitored Concentration

The EER requires demonstrations to address the technical element 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”.[53] This section addresses the EER requirements at 40 CFR 50.14(c)(3)(iv)(B) by showing 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. This section is further supported by analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times, fulfilling the requirement at 40 CFR 50.14(c)(3)(iv)(C).

Demonstrations are also required to support the clear causal relationship with a comparison of the PM2.5 data requested for exclusion with historical concentrations at the air quality monitor, that the fire’s emissions were transported to the monitor, and that the emissions from the fire influenced the monitored concentrations.

Tiering Overview

Each demonstration submitted to the USEPA under the EER must outline the process for determining an appropriate Tier for a given event. EPA has defined a three-tiered approach of the minimum criteria for addressing the clear causal relationship element, recognizing that some causal relationships may be clearer than others and therefore, require fewer pieces of evidence for the demonstration.[54] The Tiers range from 1 to 3, with Tier 1 requiring the least amount of evidence to satisfy the rule and each subsequent Tier requiring more evidence than the previous one.

The June 2023 exceptional events serve as an example of a Tier 1 analysis for when wildfire smoke caused unmistakable impacts on PM2.5 concentrations in New Jersey at levels well above historical concentrations. A Tier 1 analysis must demonstrate that the event clearly influenced extremely high PM2.5 concentrations at levels not commonly seen at the affected monitors. The Tier 1 analysis is associated with a PM2.5 concentration that is clearly higher than non-event related concentrations when compared to the historical month or annual period, as appropriate.[55]

The evidence presented in this section compliments the conceptual model in section 1 and demonstrates that the Canadian wildfire smoke caused exceptional levels of PM2.5 ambient air quality on June 6, 7, and 8, 2023.

[53] 40 CFR 50.14(c)(3)(iv)(B)-(C).
[54] USEPA. (2024). *PM2.5 Wildland Fire Exceptional Events Tiering Document.* https://www.epa.gov/system/files/documents/2024-04/final-pm-fire-tiering-4-30-24.pdf
[55] USEPA. (2024). *PM2.5 Wildland Fire Exceptional Events Tiering Document.* https://www.epa.gov/system/files/documents/2024-04/final-pm-fire-tiering-4-30-24.pdf

1. Comparison of Candidate Event Data to Tiering Threshold for Tier 1 Analyses

This section of the demonstration will outline the process of determining/qualifying for a Tier 1 analysis for the candidate event. The key factor that delineates the event-related monitored PM2.5 concentrations for Tier 1 analyses is the uniqueness of the concentration when compared to the typical levels of PM2.5. This section will address the distinct high levels of 24-hour PM2.5 concentrations on the candidate event dates.

The analyses presented in this section fulfills the requirements of a Tier 1 analysis. The Tier 1 analysis consists of comparisons to historical concentrations via a 1-month time series plot covering the most recent 5 years of data, a 1-year time series plot covering the most recent 5 years of data with the lowest 98th percentile, and a trajectory analysis showing evidence that the emissions were transported to the monitors.[56]

Determining the appropriate tiering level begins first with an analysis of the measured PM2.5 concentration associated with the candidate event in relation to historical concentrations.

Calculations:

The tiering threshold is based on the lesser value of either:

> ***(a)*** *the most recent 5-year month specific 98th percentile for 24-hour PM2.5 data, or*
>
> ***(b)*** *the minimum annual 98th percentile for 24-hour PM2.5 data for the most recent 5-year period with Informational (I) qualifiers on the monitoring data excluded.*

As stated in the Wildland Fire Exceptional Events Tiering Document, Tier 1 demonstrations are appropriate for measured 24-hour PM2.5 concentrations greater than or equal to 1.5 times the threshold determined. Table 4, Figure 81, and Figure 82 show the data used in the tiering threshold calculations and 24-hour average values for the most recent 5-year period.

Table 4: Site Level Tiering Thresholds based on 2019 – 2023 5-year Period

SITE NAME (SITE ID)	STATE	COUNTY	MONTH	EXCLUDED FLAG	MONTHLY 98TH PERCENTILE	ANNUAL 98TH MINIMUM	YEAR OF ANNUAL MINIMUM	STATE	COUNTY	TIER 1
Camden Spruce St. (340070002)	NJ	Camden	JUNE	R and I Wildfire Flags	19.9	18.50	2020	NJ	Camden	27.75
Elizabeth Lab (340390004)	NJ	Union	JUNE	R and I Wildfire Flags	22.0	20.00	2022	NJ	Union	30.00

Camden Spruce Street Tiering Calculations for June:

<u>Candidate Event Dates and 24-hr PM2.5 Averages for Camden Spruce St:</u>
6/29/2023 = 60.8 µg/m^3
6/30/2023 = 44.3 µg/m^3

---

[56] USEPA. (2024). *PM2.5 Wildland Fire Exceptional Events Tiering Document.* https://www.epa.gov/system/files/documents/2024-04/final-pm-fire-tiering-4-30-24.pdf

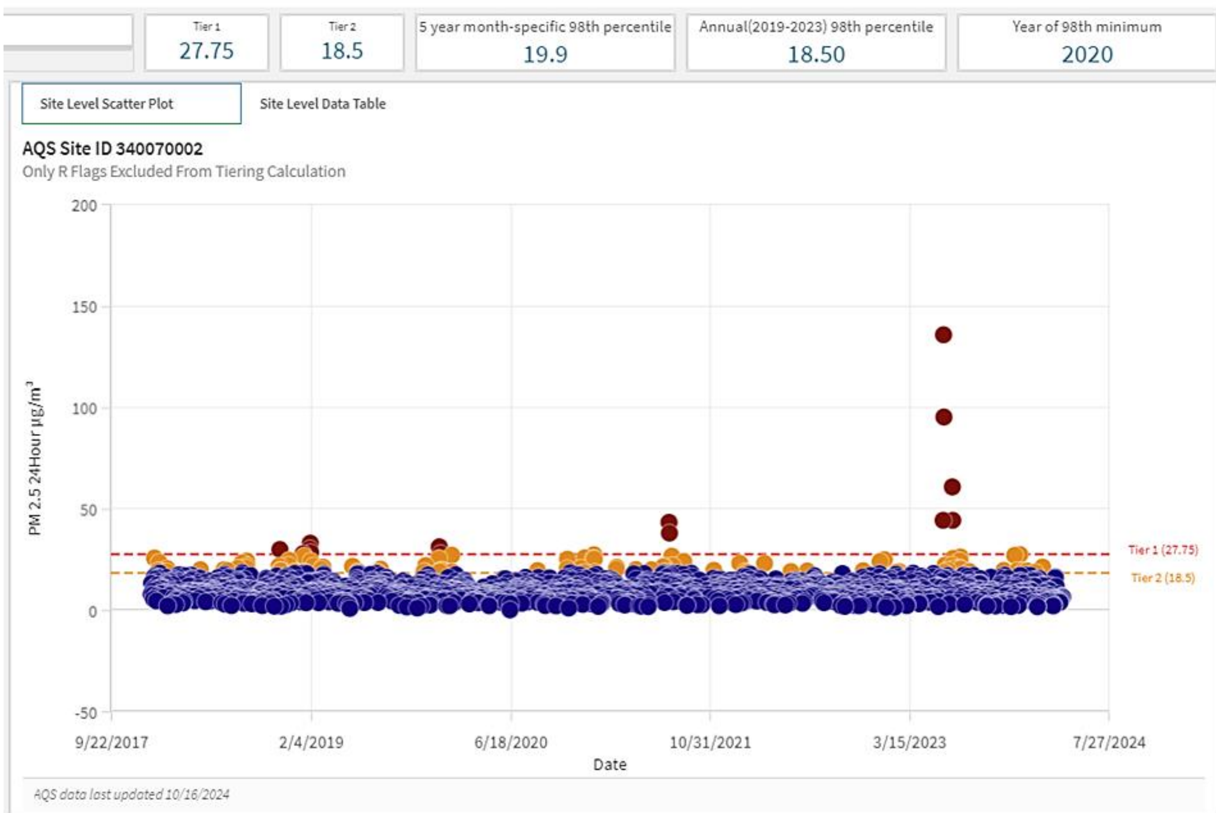
(a) = 5-year Month Specific 98th Percentile for June;
(a) = 19.9 µg/m^3;

(b) = Minimum Annual 98th Percentile;
(b) = 18.50 µg/m^3;

Lesser Value of Tier Threshold (a) and (b) = **(b)**
(a) > **(b)**

Tier 1 Threshold Calculation: 1.5 * **(b)** = Tier 1 Qualifier
1.5 * 18.50 µg/m^3 = 27.75 µg/m^3

Figure 81: Camden Tiering Thresholds for June and Daily PM2.5 Concentrations for the Period of January 2018 – December 2023



Legend: *Red = Tier 1; Orange = Tier 2*
Scatter plot courtesy of EPA, PM2.5 Tiering tool – for Exceptional Events
https://www.epa.gov/air-quality-analysis/pm25-tiering-tool-exceptional-events-analysis

For Tier 1 Analyses, 24-hr PM2.5 concentrations measured on candidate event dates should be greater than or equal to 27.75 µg/m^3 for the Camden Monitor.

The Camden monitor measured concentrations above the Tier 1 qualifier of 27.75 µg/m^3 on June 29 and 30, thus qualifying all candidate dates for a Tier 1 analysis.

Elizabeth Lab Tiering Calculations for June:

<u>Candidate Event Dates and 24-hr PM2.5 Averages for Elizabeth Lab:</u>
6/29/2023 = 39.1 μg/m^3
6/30/2023 = 58.4 μg/m^3

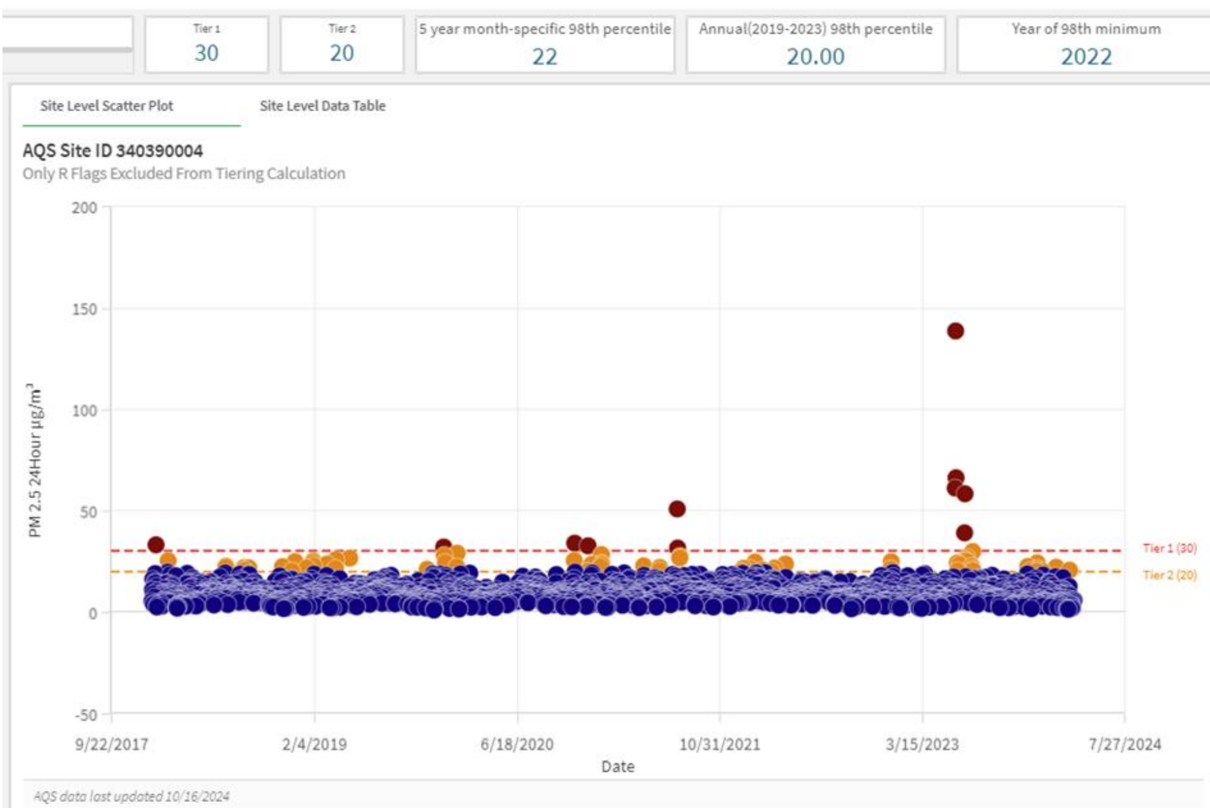
(a) = 5-year Month Specific 98th Percentile for June;
(a) = 22.0 μg/m^3;

(b) = Minimum Annual 98th Percentile;
(b) = 20.00 μg/m^3

Lesser Value of Tier Threshold (a) and (b) = **(b)**
(b) > **(b)**

Tier 1 Threshold Calculation: 1.5 * **(b)** = Tier 1 Qualifier
1.5 * 20.00 μg/m^3 = 30.00 μg/m^3

Figure 82: Elizabeth Lab Tiering Thresholds for June and Daily PM2.5 Concentrations for the Period of January 2018 – December 2023



Legend: *Red = Tier 1; Orange = Tier 2*
Scatter plot courtesy of EPA, PM2.5 Tiering tool – for Exceptional Events
https://www.epa.gov/air-quality-analysis/pm25-tiering-tool-exceptional-events-analysis

For Tier 1 Analyses, 24-hr PM2.5 concentrations measured on candidate event dates should be greater than or equal to 30.00 μg/m^3 for Elizabeth Lab.

The Elizabeth Lab monitor measured concentrations above the Tier 1 qualifier of 30.00 μg/m^3 on June 29 and 30, thus qualifying all candidate dates for a Tier 1 analysis.

2. Comparison of Event-Related Concentrations to Historical Concentrations

This section of the document expands on the tiering qualifier and aims to address the key factor for a Tier 1 clear causal relationship. Per USEPA Guidance: *Key Factor – Distinct high levels of monitored 24-hour PM2.5 concentrations when compared to historical monthly or annual 24-hour levels of PM2.5,*[57] the key factor that delineates event-related monitored PM2.5 concentrations for Tier 1 analyses is the uniqueness of the concentration when compared to the typical levels of PM2.5.

The comparison of monitored concentrations with historical observations is used to support the clear causal relationship between PM2.5 concentrations and a wildfire event. To do so, it is necessary to compare the event-related exceedance concentrations with historical concentrations measured at the affected monitor or at other monitors in the area during the same season.[58] According to USEPA Wildland Fire Exceptional Events Tiering Document, the PM2.5 tiering threshold was based on a 98th percentile statistic since this statistic is already in use in PM2.5 NAAQS calculations and represents site-specific high PM2.5 values near the top of the distribution of ambient PM2.5 data.

Two analyses are provided to support the determination of the tiering threshold of the events. The NJDEP officially certified the PM2.5 data presented in this analysis, which includes 2023 PM2.5 data.[59] These analyses include:

1) 1-month time series plot covering the most recent 5 years of data for the month that the event day occurred in.

2) 1-year time series plot covering the most recent 5 years of data with the lowest 98th percentile in the period.

The following four figures (Figure 83 – Figure 86) satisfy the requirements stated above including the key factor for Tier 1 analysis for the Camden and Elizabeth Lab monitors. The event dates, 6/29 and 6/30 are highlighted in red and marked with labels showing the concentration on each day to demonstrate the distinct high levels of 24-hour average PM2.5 concentrations when compared to historical concentrations during the same month/year.

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[57] USEPA. (2024). *PM2.5 Wildland Fire Exceptional Events Tiering Document.* *https://www.epa.gov/system/files/documents/2024-04/final-pm-fire-tiering-4-30-24.pdf*

[58] USEPA. (2016). *Guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events that May Influence Ozone Concentrations*. https://www.epa.gov/sites/default/files/2016-09/documents/exceptional_events_guidance_9-16-16_final.pdf

[59] Lim, L. (2024, May 6). [Letter from Luis Lim, Chief of the NJ Bureau of Air Monitoring, to Marina Cubias-Castro, Manager, Technology, Transportation and Partnerships Branch of the USEPA Region 2, 2023].

Figure 83 and Figure 85 show one-month time series plots for the Camden and Elizabeth Lab monitors. In the figures, monitored values during the month of June at the monitors are compared from 2019 through 2023.

Figure 84 and Figure 86 show one-year time series plots of 24-hour average PM2.5 values for the last 5 years (2019 – 2023) at the Camden and Elizabeth Lab monitors. At the Camden monitor, the most recent year in the last 5-years with the lowest 98th percentile is 2020 with a value of 18.50 µg/m^3, this is marked on Figure 84 with an orange line. Meanwhile, at the Elizabeth Lab monitor, the most recent year in the last 5-years with the lowest 98th percentile is 2022 with a value of 20.00 µg/m^3, (Figure 86, marked with orange line). Thus, Figure 84 and Figure 86 show how the magnitude of the event-related exceedances are clearly and significantly larger than any of the other measured concentrations/exceedances that are not attributable to other EPA concurred upon or otherwise documented exceptional events.

Figure 83: Camden Spruce St. One Month Time Series Plot of Maximum 24-hour Average PM2.5 Concentrations in June from 2019 – 2023

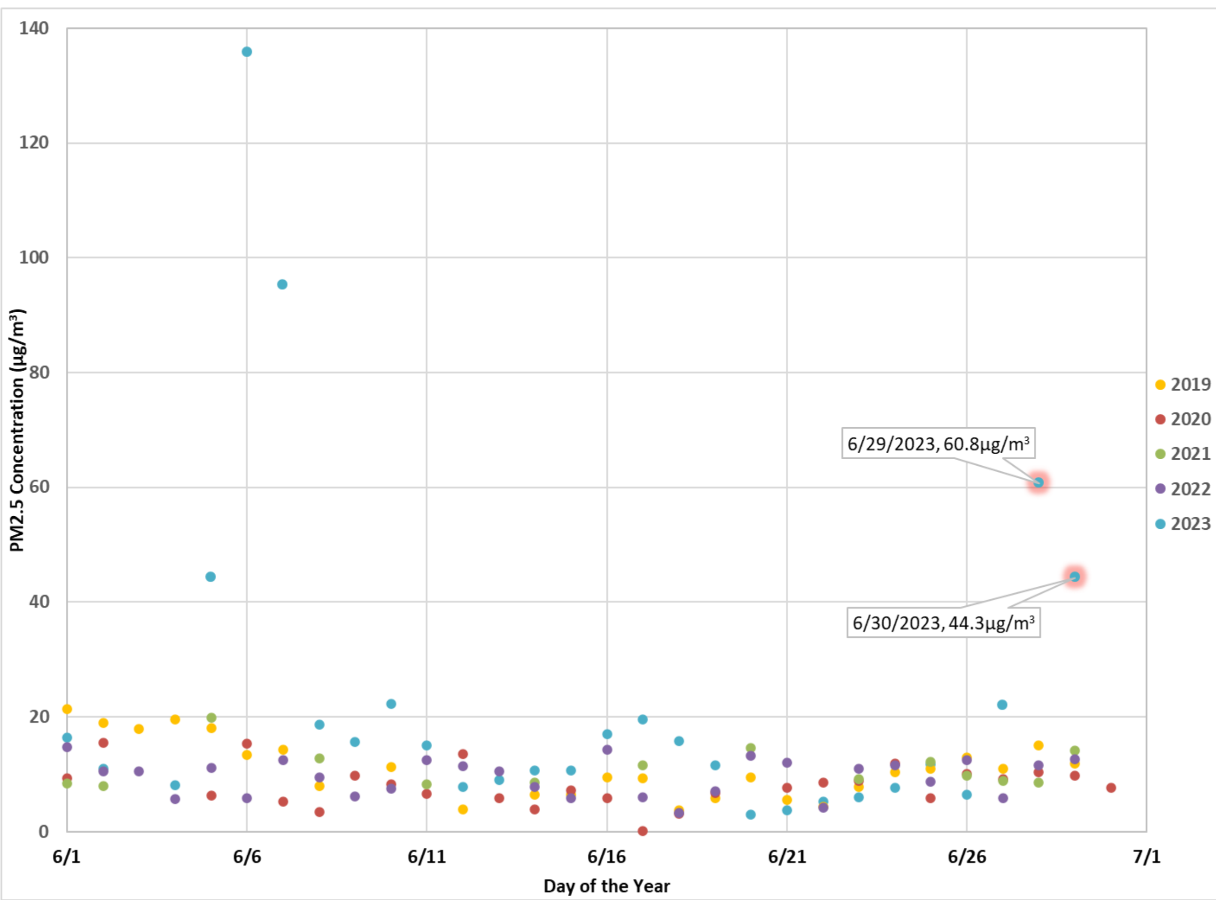


Figure 84: Camden Spruce St. Annual Variation - Time Series Plot of 24-hr Average PM2.5 Concentrations from 2019 – 2023

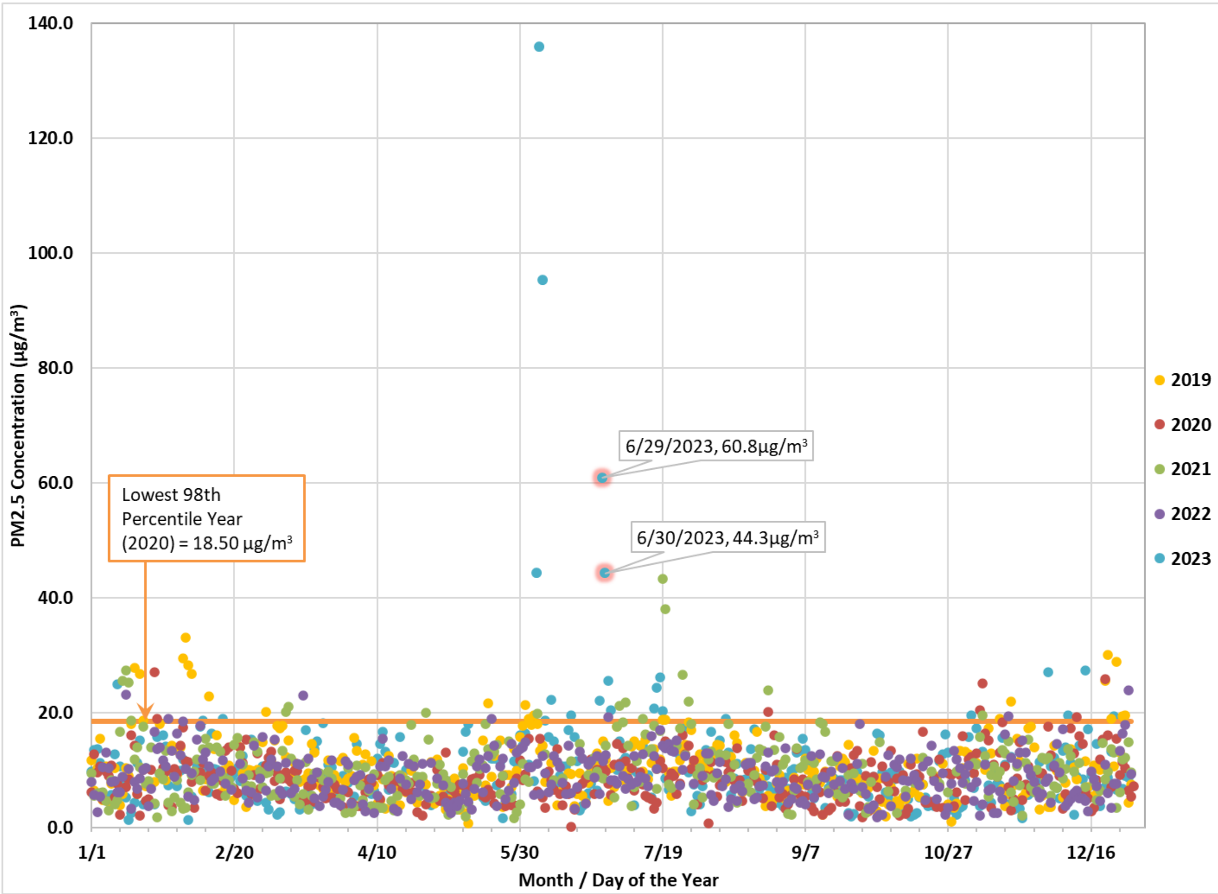


Figure 85: Elizabeth Lab One Month Time Series Plot of Maximum 24-hour Average PM2.5 Concentrations in June from 2019 – 2023

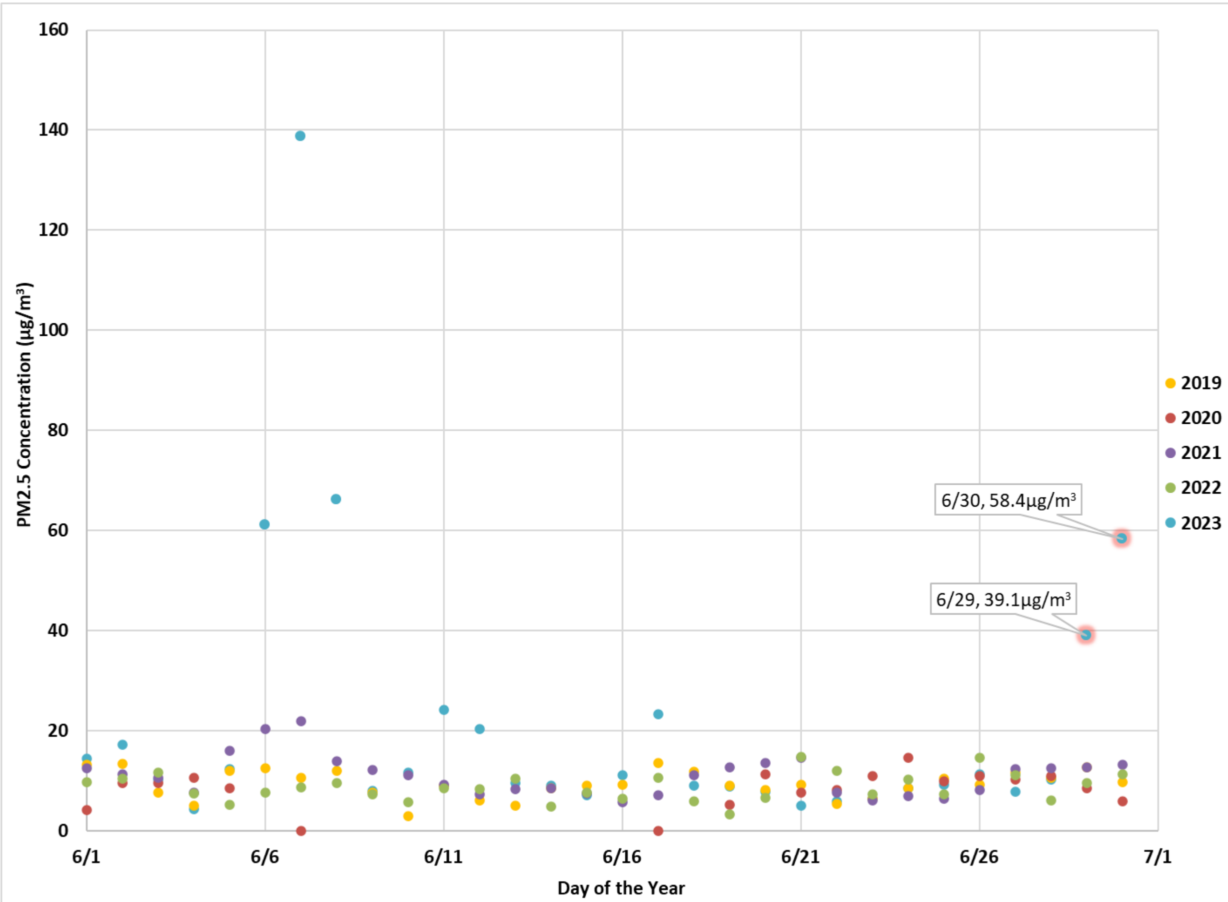
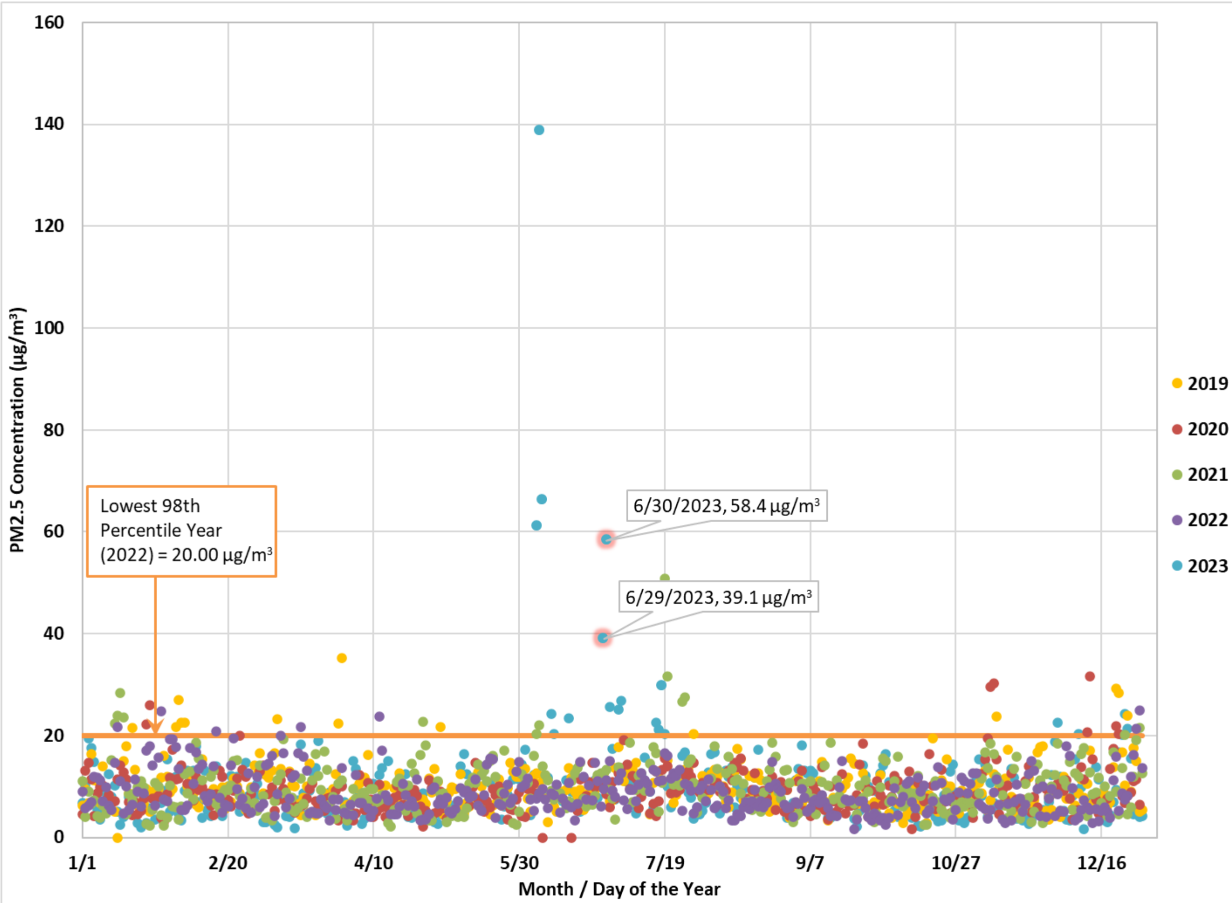


Figure 86: Elizabeth Lab Annual Variation – Time Series Plot of 24-hr PM2.5 Concentrations from 2019 – 2023



3. Evidence that Fire Emissions were Transported to New Jersey Monitors

A trajectory analysis can be used to show that the emissions from the fire were transported to the monitors, based on the methodology recommended in USEPA Guidance.[60] New Jersey presents trajectory modeling results in this section to show that emissions from west-central Canadian fires were transported to New Jersey.

3.1 Trajectory Analysis

The Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model was employed to calculate backward trajectories arriving in New Jersey on June 29 and 30, 2023. The meteorological model that was used to compute the backward trajectories was obtained from the North American Mesoscale Forecast System, 12km, (NAM 12).

Figures 87– 89 show trajectories at 3 different wind heights with an endpoint at the Camden and Elizabeth Lab monitors in New Jersey on June 29 and 30, 2023. The green trajectory

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[60] NJDEP. (2017). *Exceptional Event Demonstration Analysis for Ozone During May 25-26, 2016.* https://www.epa.gov/sites/default/files/2017-12/documents/final_ee_for_nj.pdf

represents the upper air layer (1500m), the blue trajectory represents the mid-level trajectory (500m), and the red trajectory represents the surface layer (10m). The figures illustrate where the air came from during the 48 hours preceding the 24-hour PM2.5 standard exceedances on June 29 and 30, 2023. Figure 89 shows the combined transport pattern from June 29 and 30, along with 84-hour backward trajectories that end on June 30.

June 29

Back trajectories ending on June 29 (Figure 87) originated over various places across Quebec, Ontario, and Lake Huron. As mentioned previously, elevated PM2.5 levels were observed in this region due to the wildfire smoke plume, which allowed the trajectories to become heavily polluted with wildfire smoke from its origin. From here, trajectories moved in a southerly direction, influenced by the counterclockwise winds associated with an area of low pressure passing through this region. Trajectories made a turn toward the southeast and traversed over Pennsylvania and New York State. As trajectories drew closer to their endpoint in Camden, they continued to transport high levels of wildfire smoke before arriving at their destination. Meanwhile, air at all levels experienced a gentle sinking motion through transit, allowing smoke to reach the surface and enhance PM2.5 concentrations at the surface in New Jersey leading to above normal PM2.5 exceedances.

June 30

Back trajectories ending on June 30 in Camden, New Jersey show that air at the surface originated in nearby locations, such as Maryland, while mid- and upper-level trajectories originated near Lake Huron and upstate New York (Figure 88). During transit, dense plumes of wildfire smoke had migrated into the Great Lakes region by June 28, the starting time for trajectories in Figure 88. As low pressure passed over New England, and high pressure strengthened over the Mid-Atlantic, surface trajectories (red, Figure 88) showed signs of high-pressure overhead by the recirculation pattern. Upon the arrival of wildfire smoke into the Mid-Atlantic region, it was likely trapped under the influence of high pressure with little atmospheric ventilation leading to a build-up of wildfire smoke in New Jersey for a second day. By evening on June 29, mid and upper-level trajectories arrived near the I-95 corridor where they encountered a wind shift due to high pressure advancing eastward causing the wind direction to shift out of the southwest. Throughout their path, the trajectories continued to carry wildfire smoke into the region as they had days prior. This dense wildfire smoke helped PM2.5 concentrations to remain elevated through June 30th across the mid-Atlantic and northeast, leading to regionwide exceedances throughout the nonattainment area. Figure 89 shows the same backward trajectory over the previous 84 hours.

Figure 87: HYSPLIT 48hr Backward Trajectories - June 29, 2023 10, 500, and 1500m AGL

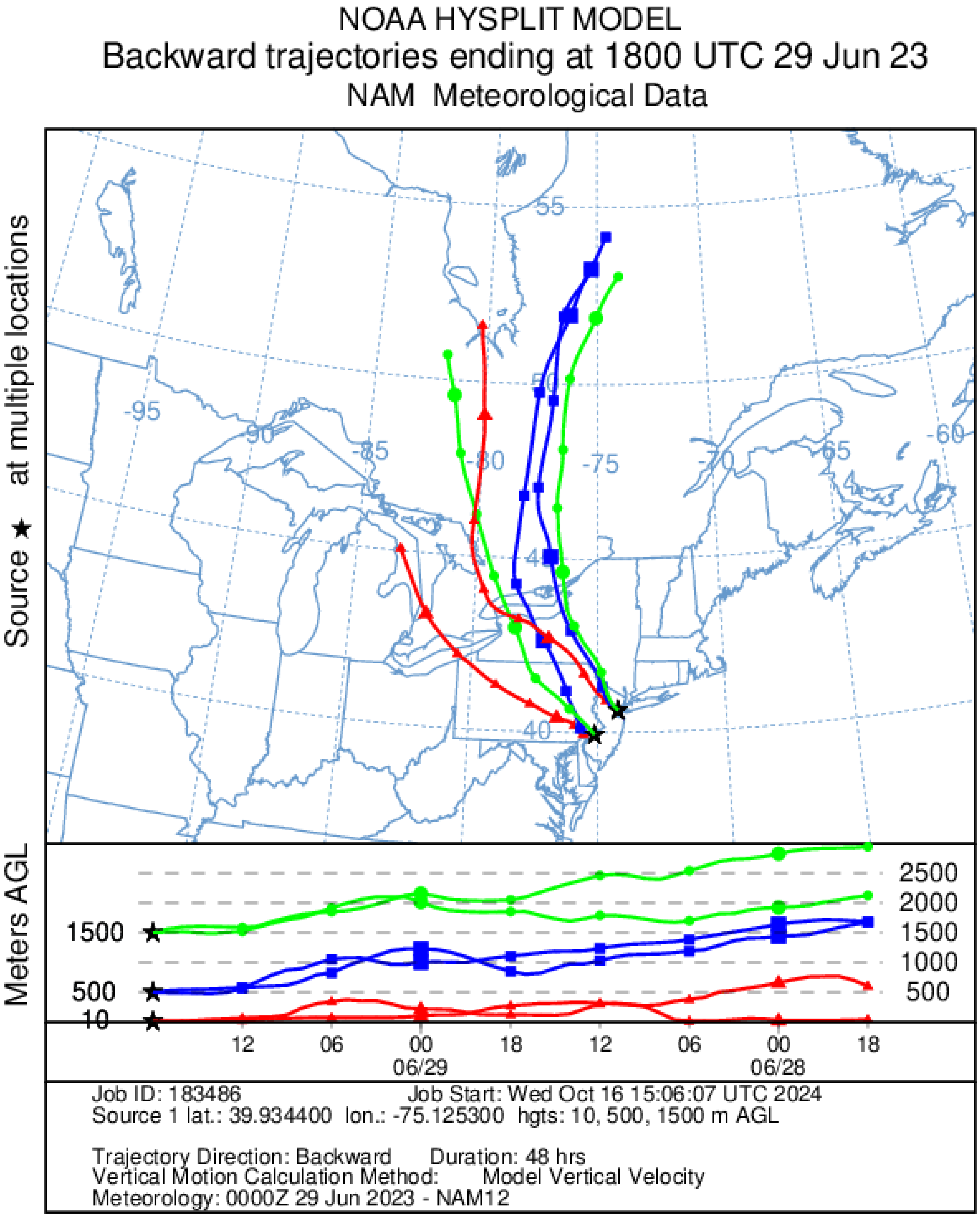


Figure 88: HYSPLIT 48hr Backward Trajectories - June 30, 2023, 10, 500, and 1500m AGL

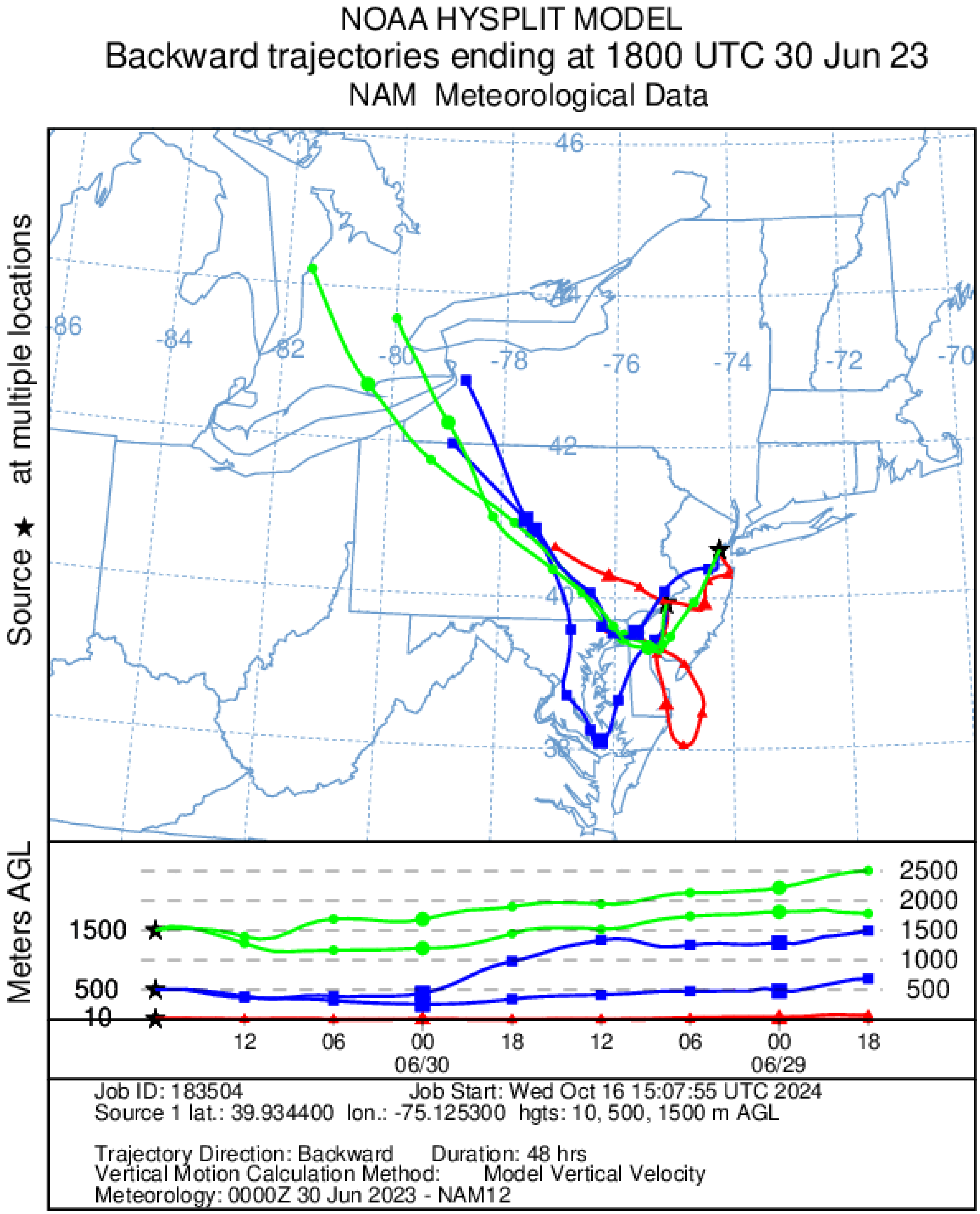
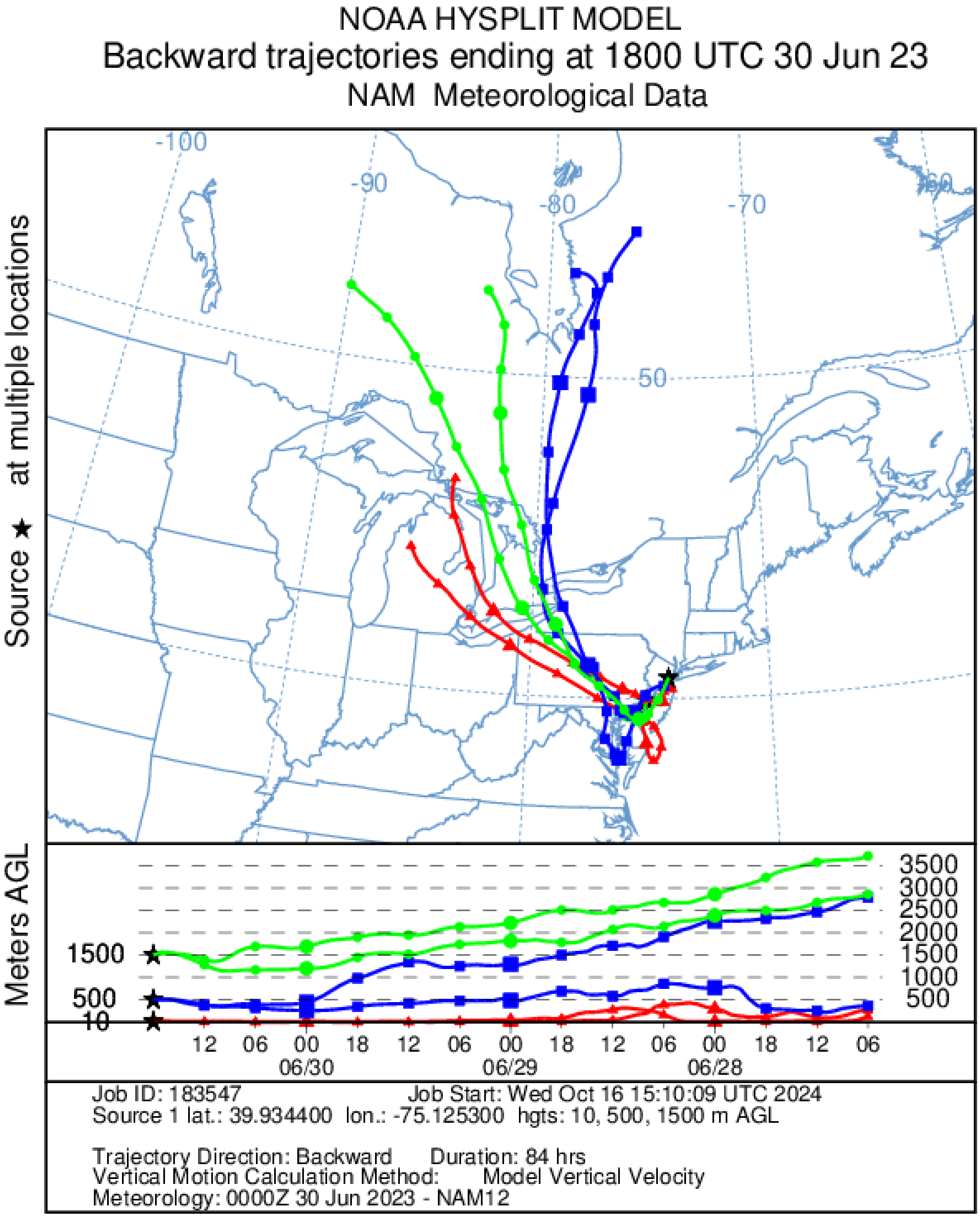


Figure 89: HYSPLIT 84hr Backward Trajectories - June 30, 2023, 10, 500, 1500m AGL



4. Evidence that Fire Emissions Affected New Jersey Monitors

This section adds to the weight of evidence that the emissions from the fires affected the monitored PM2.5 concentrations at New Jersey monitors, as recommended by USEPA Guidance.[61]

4.1 Light Extinction

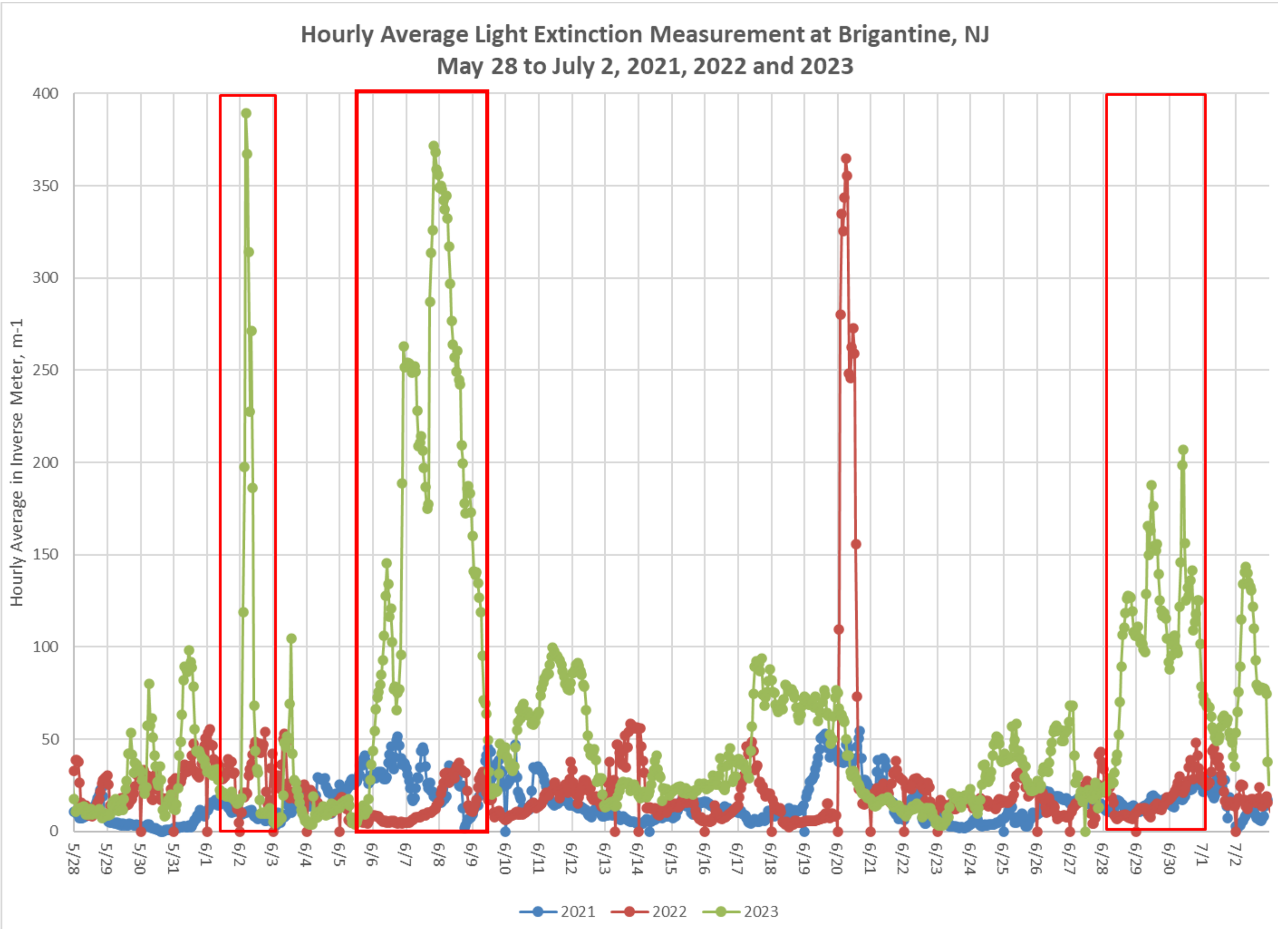
According to the USEPA Guidance, elevated light extinction measurements at or near the monitoring site that cannot be explained by emissions from other sources and are consistent with wildfire impact can be used as evidence to support the impact of fire emissions on affected monitors.[62]

New Jersey measures visibility using a nephelometer at the Brigantine monitor. Figure 90 presents light extinction data measured at Brigantine from May 28 to July 2, in 2021, 2022 and 2023. A visible peak can be seen on June 29 and 30, 2023. As shown on the chart, the light extinction levels at Brigantine were generally low in 2021 and 2022, while 2023 had higher levels during this period. This peak can be attributed to the smoke from Quebec wildfires.

Brigantine is located in a rural area, and usually does not experience elevated light extinction levels, however, on June 29 and 30, 2023, the light extinction levels at Brigantine were higher-than-normal. Light extinction levels were also generally higher throughout June 2023 than at the same period in previous years, indicating the presence of smoke in the atmosphere due to the wildfires.

[61] NJDEP. (2017). *Exceptional Event Demonstration Analysis For Ozone During May 25-26, 2016.* https://www.epa.gov/sites/default/files/2017-12/documents/final_ee_for_nj.pdf
[62] NJDEP. (2017). *Exceptional Event Demonstration Analysis For Ozone During May 25-26, 2016.* https://www.epa.gov/sites/default/files/2017-12/documents/final_ee_for_nj.pdf

Figure 90: Hourly Average Visibility Light Extinction Measurement at the Brigantine, NJ Monitor: May 28 to July 2, in 2021, 2022, and 2023



4.2 Visual Photographic Evidence of Ground-level Smoke at the Monitor (HazeCam Pictures from Brigantine)

New Jersey uses remote cameras at Brigantine, NJ to evaluate visibility conditions throughout the year.[63] Figures 91 – 93 show pictures taken during and after the exceptional event that occurred in New Jersey on June 29 and 30, 2023. Figure 91 and Figure 92 show pictures taken on June 29 and June 30. In the figures, the skyline of Atlantic City is completely obscured, discolored and hazy. However, on July 10, several days after the exceptional event, when the smoke plume moved out of New Jersey, a noticeable improvement in visibility and haze conditions were observed (Figure 93).

[63] Camnet (n.d.). Visibility HazeCam. https://hazecam.net/

Figure 91: HazeCam Picture from Brigantine, NJ on June 29, 2023, 11:00 AM

Figure 92: HazeCam Picture from Brigantine, NJ on June 30, 2023, 10:00 AM

Figure 93: HazeCam Picture from Brigantine, NJ on July 10, 2023, 2:00 PM (clear day)

III. A Demonstration that the Exceptional Event was Both Not Reasonably Controllable and Not Reasonably Preventable

According to the Clean Air Act and the Exceptional Events Rule, an exceptional event must be "not reasonably controllable or preventable."[64,65] In its July 2018 "Update to Frequently Asked Questions" for the 2016 Revisions to the Exceptional Events Rule the USEPA states, "it is presumptively assumed that if evidence supports that a wildfire occurred on wildland, such a wildfire event will satisfy both factors of the 'not reasonably controllable or preventable' criterion, provided the Administrator determines that there is no compelling evidence to the contrary in the

[64] 42 U.S.C. 7401 et seq.
[65] 40 CFR 50.14

record."[66] The USEPA Exceptional Event Guidance also states that wildfire events on wildland are not generally reasonable to control or prevent.[67]

As previously stated in this document and reported in news articles, the Quebec fires pertinent to this exceptional event, were ignited by lightning, accidental human activities, or unknown sources, and occurred in wildland areas.[68,69] The Quebec wildfires, which occurred outside of the United States can be considered not reasonably controllable or preventable by New Jersey. Therefore, emissions from these wildfires were not reasonably controllable or preventable and meet the criterion for an exceptional event.

IV. Caused by Human Activity that is Unlikely to Recur at a Particular Location or a Natural Event

According to the CAA and the Exceptional Events Rule, an exceptional event must be "an event caused by human activity that is unlikely to recur at a particular location or a natural event."[70,71] The Exceptional Events Rule's definition of wildfire is "any fire started by an unplanned ignition caused by lightning; volcanoes; other acts of nature; unauthorized activity; or accidental, human-caused actions, or a prescribed fire that has developed into a wildfire. A wildfire that predominantly occurs on wildland is a natural event." [72,73]

The Quebec fires examined in this analysis are categorized as wildfires. Sections I and II of this demonstration provide detailed descriptions and visual representations, demonstrating that these fires meet the criteria for being considered a "natural event". The unplanned fires were ignited by lightning in wildland areas or due to unknown causes. The USEPA generally considers PM2.5 and resulting emissions from wildfires on wildland to meet the regulatory definition of a natural event at 40 CFR 50.1(k), defined as one 'in which human activity plays little or no direct causal role.' As such, NJDEP has demonstrated that these events qualify as natural occurrences and may be considered for treatment as exceptional events.

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66 USEPA. (2018, July). *2016 Revisions to the Exceptional Events Rule: Update to Frequently Asked* Questions.

67 42 U.S.C. 7619(b)(1)(iii), *Guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events that May Influence Ozone Concentration*s. EPA-HQ-OAR-2015-0229-0130, U.S. Environmental Protection Agency. Page 30: https://www.epa.gov/sites/default/files/2016-09/documents/exceptional_events_guidance_9-16-16_final.pdf

68 Korte, C. (2023, June 27). How did the Canadian wildfires start? A look at what caused the fires that are sending smoke across the U.S. *CBS News*. https://www.cbsnews.com/news/how-did-wildfires-in-canada-start-spread-to-europe-midwest/

69 Reuters. (2023, August 19). Canada wildfires: what are the causes and when will it end. https://www.reuters.com/world/americas/canadas-record-wildfire-season-whats-behind-it-when-will-it-end-2023-08-17/

70 42 U.S.C. 7401 et seq.

71 40 CFR 50.14

72 42 U.S.C. 7619(b)(1)(iii), *Guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events that May Influence Ozone Concentration*s. EPA-HQ-OAR-2015-0229-0130, U.S. Environmental Protection Agency. Page 30: https://www.epa.gov/sites/default/files/2016-09/documents/exceptional_events_guidance_9-16-16_final.pdf

73 40 CFR 50.1(n)

Conclusion

The 2023 burn season in Canada was unprecedented. By the end of September 2023, wildfires had ravaged an estimated 18 million hectares – an area roughly the size of North Dakota. This surpassed the previous record set in 1989, when 7.6 million hectares were charred.[74] The fires started in the spring and raged continuously in various regions of Canada throughout the summer, releasing billowing waves of smoke across the United States. The smoke influenced by meteorological conditions was transported to New Jersey.

The Canadian wildfires generated copious amounts of PM2.5 and haze affecting human health and visibility. These emissions resulted in elevated PM2.5 concentrations at certain ambient air monitors in New Jersey, surpassing the minimum annual 98th percentile over the last five years and significantly impacting New Jersey's ability to meet certain regulatory requirements. Additionally, the meteorological conditions observed during these events were not consistent with the meteorological conditions typically observed with other historically high PM2.5 days in New Jersey. This demonstration establishes that the 24-hour PM2.5 concentrations exceeding 9 μg/m^3 during the exceptional event days in New Jersey qualify for data exclusion as an exceptional event. The meteorological conditions favored the transport of smoke from Canada into the New Jersey monitors. There is a clear causal relationship between the specific events and the monitored exceedances of the PM2.5 NAAQS in New Jersey on June 6, 7, and 8, 2023 and June 29 and 30, 2023. Therefore, these PM2.5 measurements should be excluded from: 2023 PM2.5 monitoring data, the calculation of the 2023 PM2.5 Annual Average, and the 2022 – 2024 Design Value calculations for the purpose of initial area designations.

[74] NASA Earth Observatory. (2023, June 1 – July 23). *Tracking Canada's Extreme 2023 Fire Season*. Retrieved February 6, 2024, https://earthobservatory.nasa.gov/images/151985/tracking-canadas-extreme-2023-fire-season