



Maryland
Department of
the Environment

Using Satellite Data for Exceptional Events Monitoring

22nd meeting of the CEOS Atmospheric Composition Virtual Constellation

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Maryland Department of the Environment
3 June, 2026

The Allegory of Exceptional Events

Failure!
More Work!



MDE
(states)



EPA
(federal)

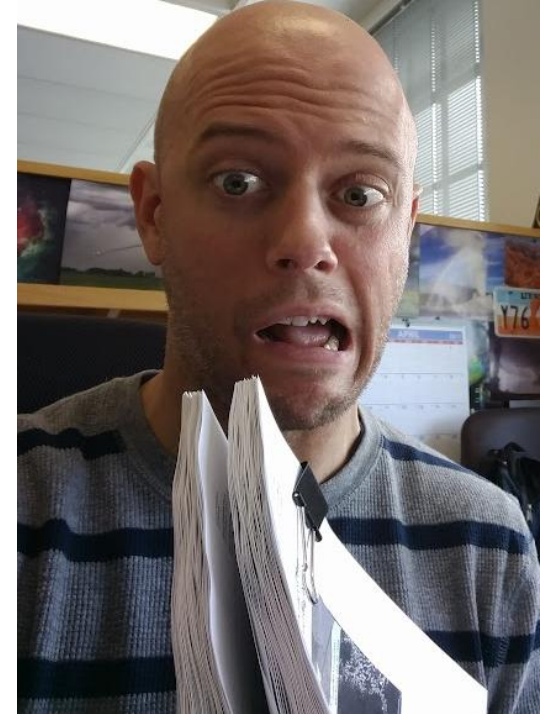


What are Exceptional Events & Why they Matter

An Exceptional Event is an unusual, naturally occurring or human-caused event that affects air quality and is not reasonably controllable or preventable.

- ❖ Consequences for states that do not meet air quality goals
- ❖ 'Exceptional' Data may be excluded from regulatory determinations

- What happens:
 - “Initial notification” – Submit a notification to EPA
 - Communication with Regional EPA Office (Phone call or Email)
 - Establish what is necessary (Tier 1, 2, or 3 demonstration)
- State agencies must show the Environmental Protection Agency (EPA) a “**clear relationship**” between an air quality event and a monitored violation.
- **Major** decision with **major** implications
 - *It's a mini-master's thesis!*



900 pages and 7 exceptional event demonstrations later... Maryland is still in attainment!

<https://www.epa.gov/air-quality-analysis/example-demonstrations-and-epa-responses-prepared-under-2016-exceptional>



Exceptional Event Demonstrations

Demonstration Requirements:

1. A Conceptual Model of the Event (The Story)
2. Clear Causal Relationships (Scientific Connection)
3. State it is a natural event and/or will not recur, and
4. Event is not reasonably controllable or preventable

- The data is flagged if the event is 'concurred' by EPA and not used for regulatory determinations
- Demonstrations may prevent 'consequences':
Inspection programs, loss of D.O.T. funds*, as examples
- **Satellites** are a major portion of our demonstrations

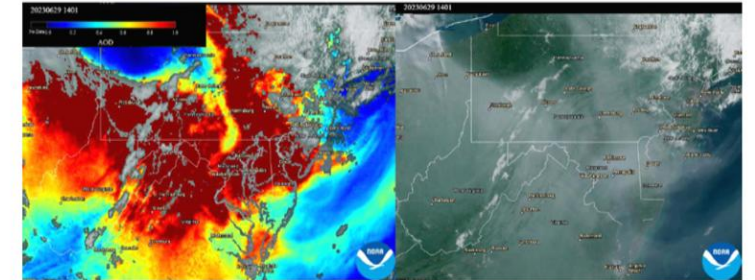
*Extreme, but possible consequence



Maryland
Department of
the Environment

Wes Moore, Governor
Aruna Miller, Lt. Governor
Serena McIlwain, Secretary
Suzanne E. Dorsey, Deputy Secretary

State of Maryland
Exceptional Event Demonstration and Analysis
of the June 2023 Quebec Canada Wildfires and their
Impact on Maryland's Ozone Air Quality on
June 29 and 30, 2023



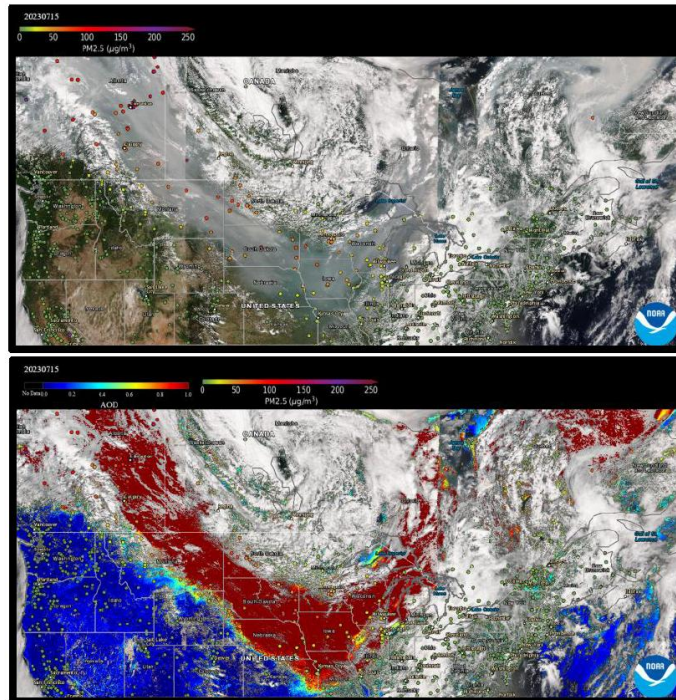
ARA / Ambient Air Monitoring Program
Maryland Department of the Environment
1800 Washington Blvd., Suite 730
Baltimore, MD 21230-1720

December 2023



State of Maryland

Exceptional Event Demonstration and Analysis of the British Columbia and Alberta Wildfires' Impact on Maryland's Ozone Air Quality on July 17 and 18, 2023

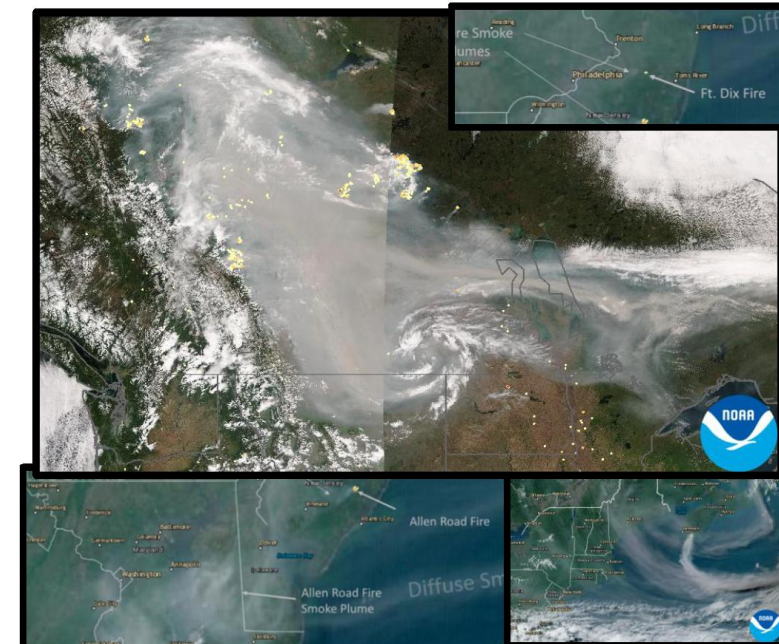


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State of Maryland

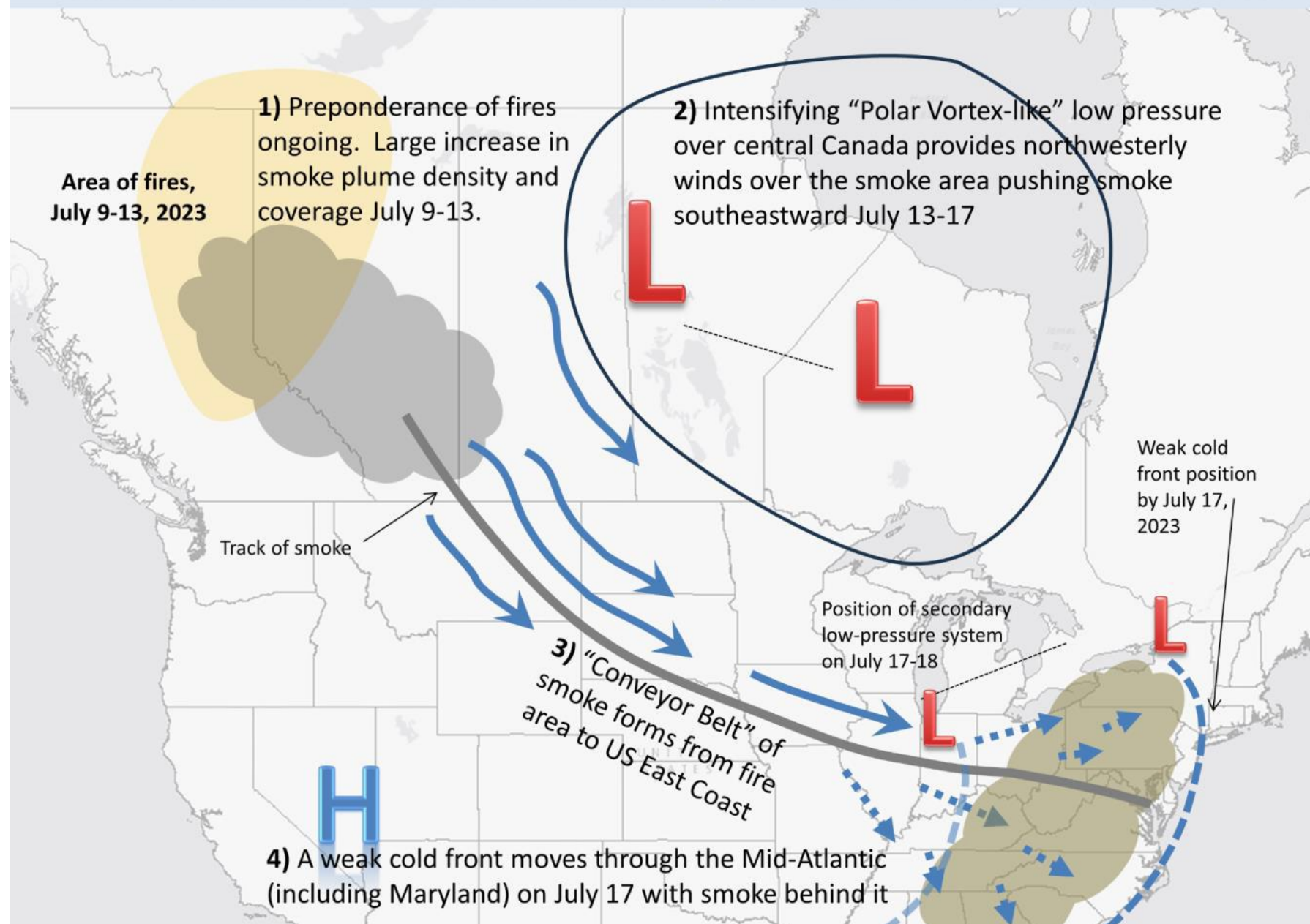
Exceptional Event Demonstration and Analysis of the West- Central and Nova Scotia, Canada and New Jersey Wildfires' Impact on Maryland's Ozone Air Quality on June 2, 2023



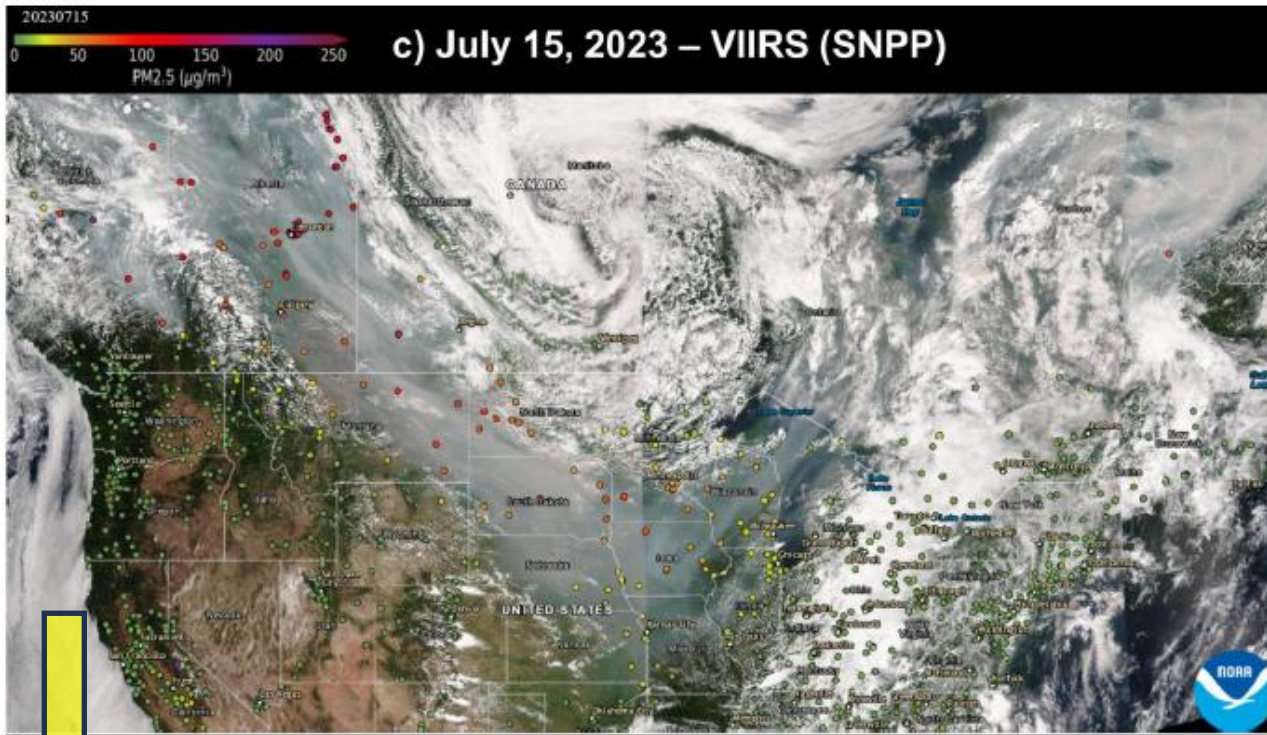
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CONCEPTUAL MODEL OF METEOROLOGY, SMOKE AND OZONE TRANSPORT

The Conceptual Model



- Imagine being introduced to an event for the first time! Very complex.
- A Picture = “1000 Words”
- A “Conceptual Model” for EE Demonstrations. July 17-18, 2023 shown
- Its a “cartoon” version of the event
- The model is largely built upon the story the satellite tells!



Satellite images from the [AerosolWatch website](#)



Tracking Plumes...

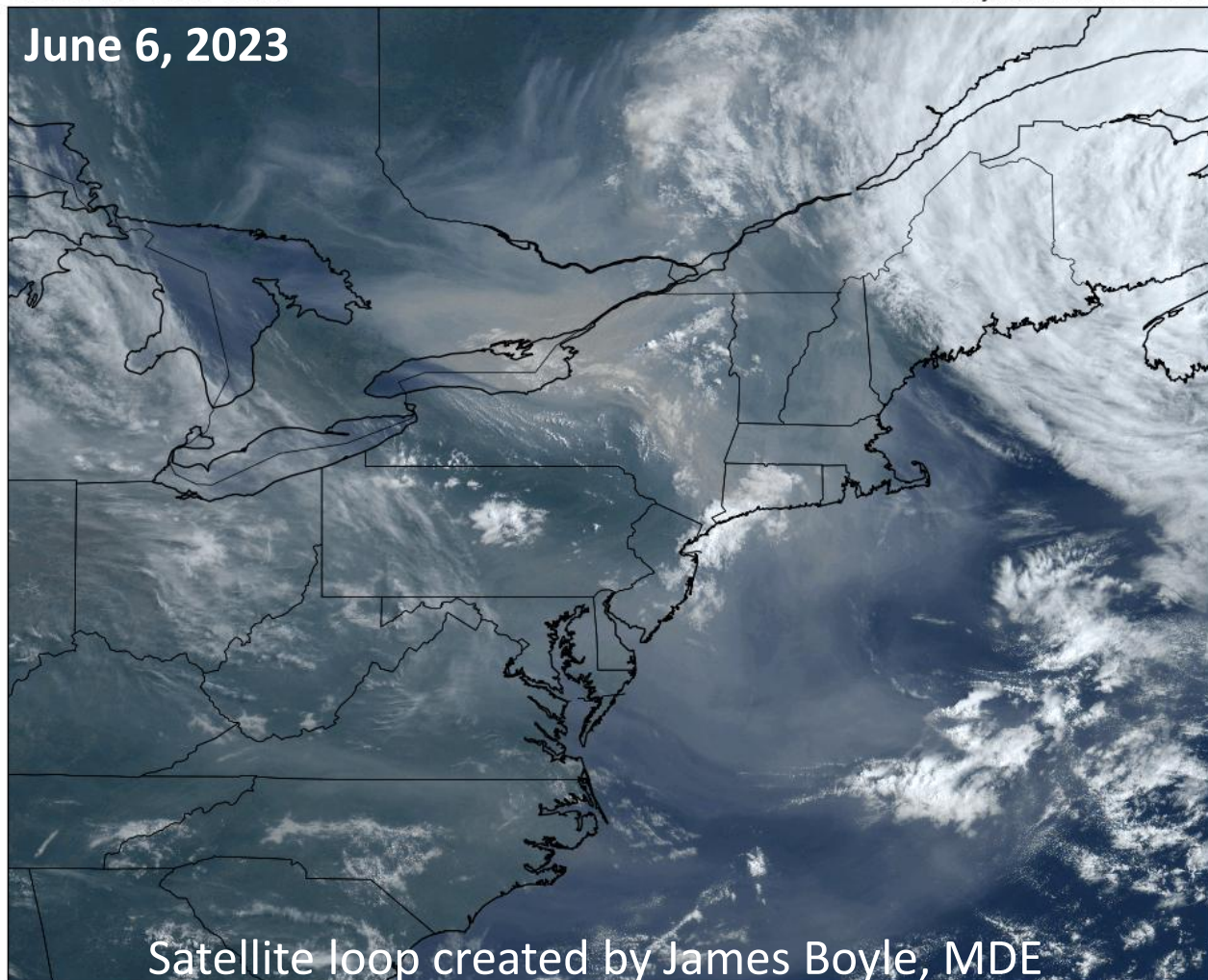
20230605 2141



GOES-16 True Color

06 June 2023 13:33 UTC

June 6, 2023

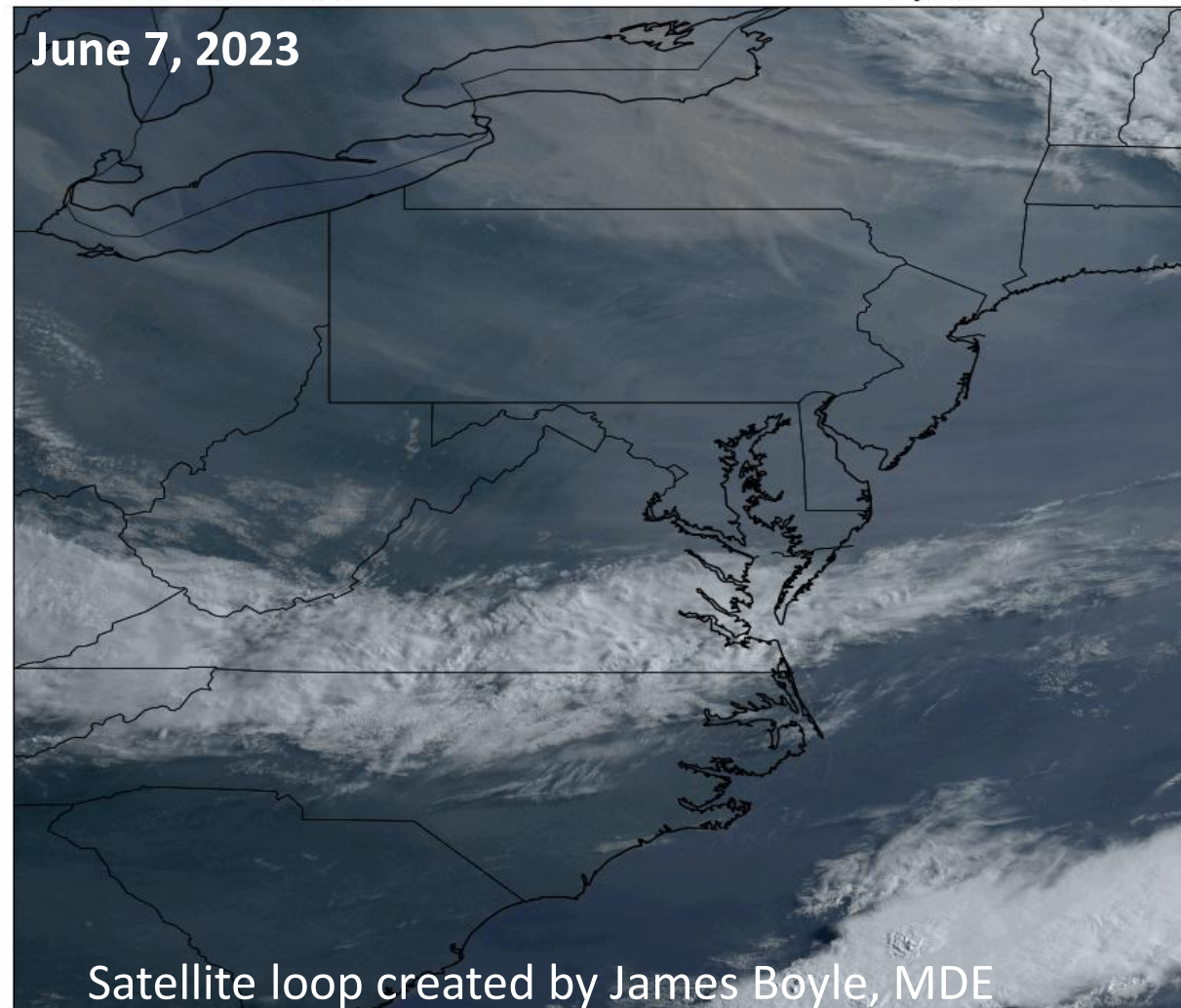


Satellite loop created by James Boyle, MDE

GOES-16 True Color

07 June 2023 12:03 UTC

June 7, 2023



Satellite loop created by James Boyle, MDE



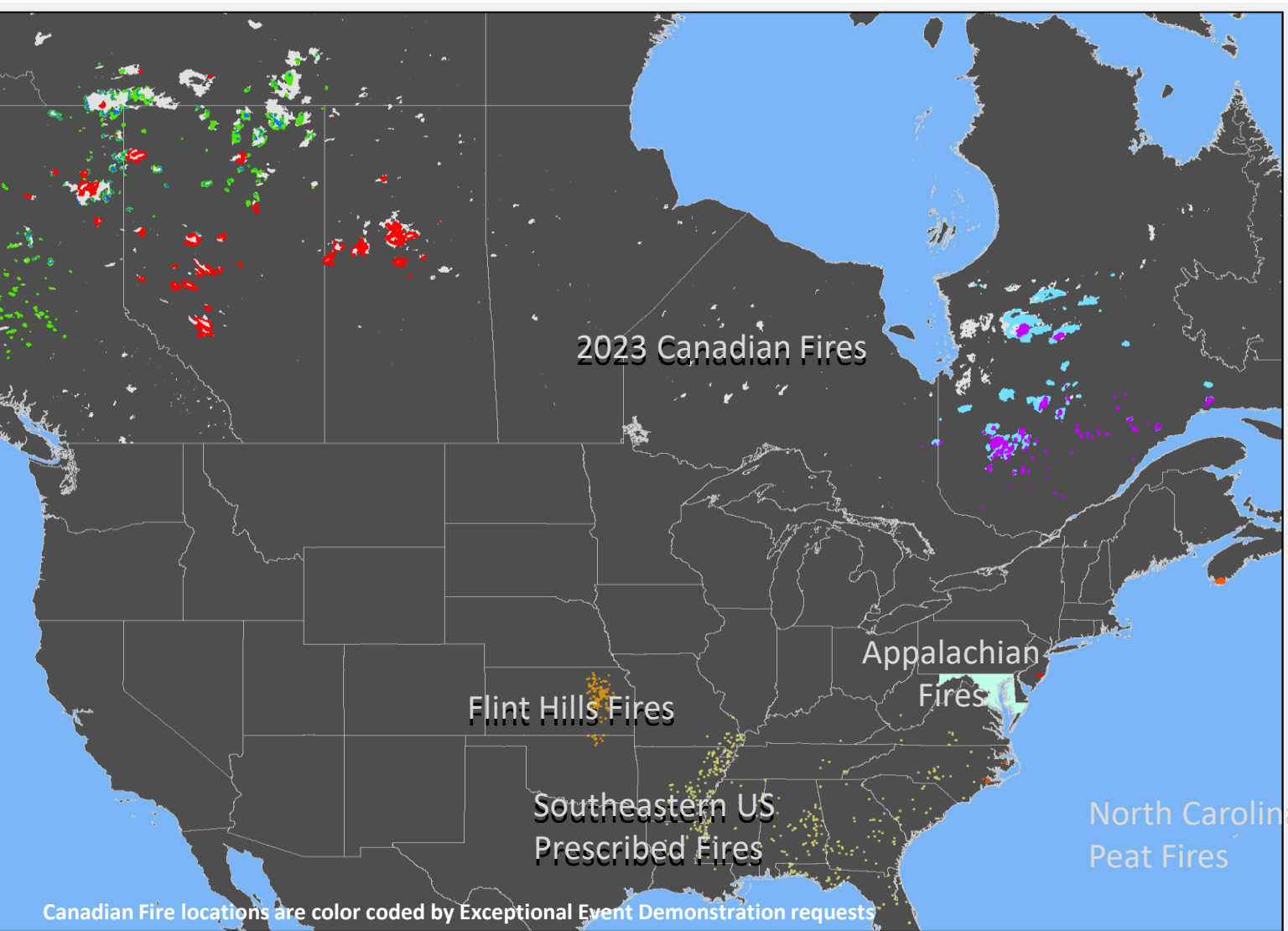
Satellite images from the [AerosolWatch website](https://aerosolwatch.org/)





Maryland Exceptional Events & AQ Impacts

Fire Event Locations from Satellite Detections:



Fire Events Affecting Maryland

Date	Fire Event/Source	Remarks; Color Peak AQI
March 27	NC Peat Fires	“Plastic Smell” in DC
April 4	MD, Soldiers Delight	Local Fire; 321 Acres
April 13	Flint Hills, SE US	Ozone Ex
April 22	SE US, NC Peat Fires	Ozone/smells
May 12	Al. & Sk. Canada	Ozone
June 1 - 3	Al., Sk., N.S., & NJ US	Ozone
June 6-9	Quebec (Qc)	Ozone & PM
June 11	Qc & SE US (aged)	Ozone
June 15	Qc (aged)	Ozone
June 19	Qc (aged)	Ozone
June 29-30	Qc	Ozone & PM
July 11-13	Al. & Sk.	Ozone
July 17-18	Bc., Al., & Sk.	Ozone & PM (12-12 Ex)
July 26 & 28	Bc. & Al.	Ozone

13 fire events impacted air quality on 23 days in 2023, resulting in 25* violations of Federal standards, or 96% of the violating days in 2023.

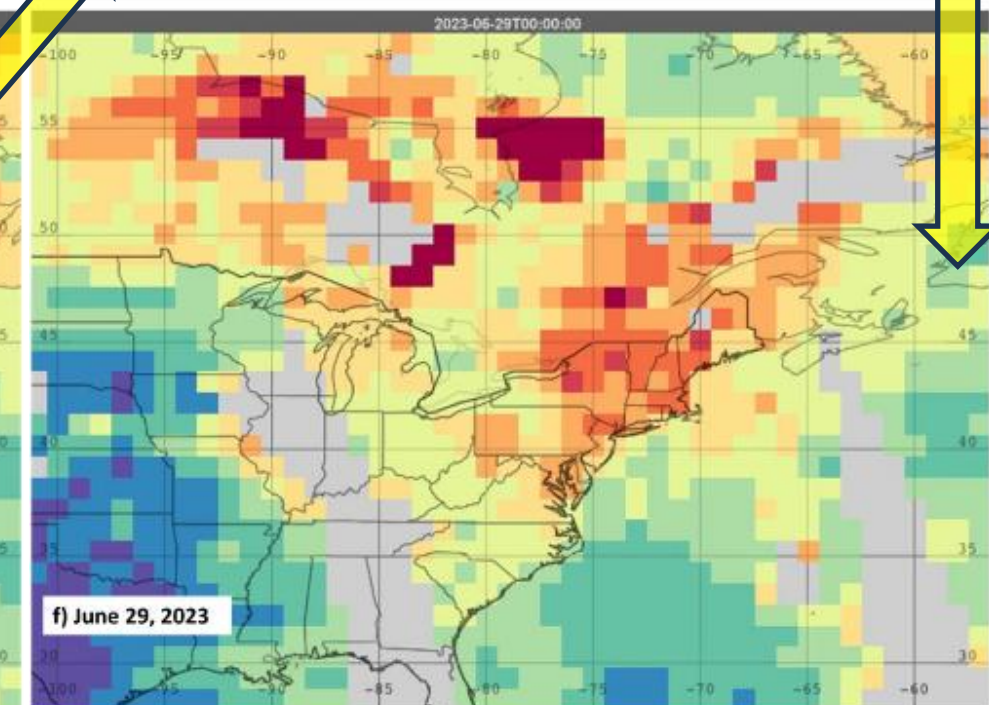
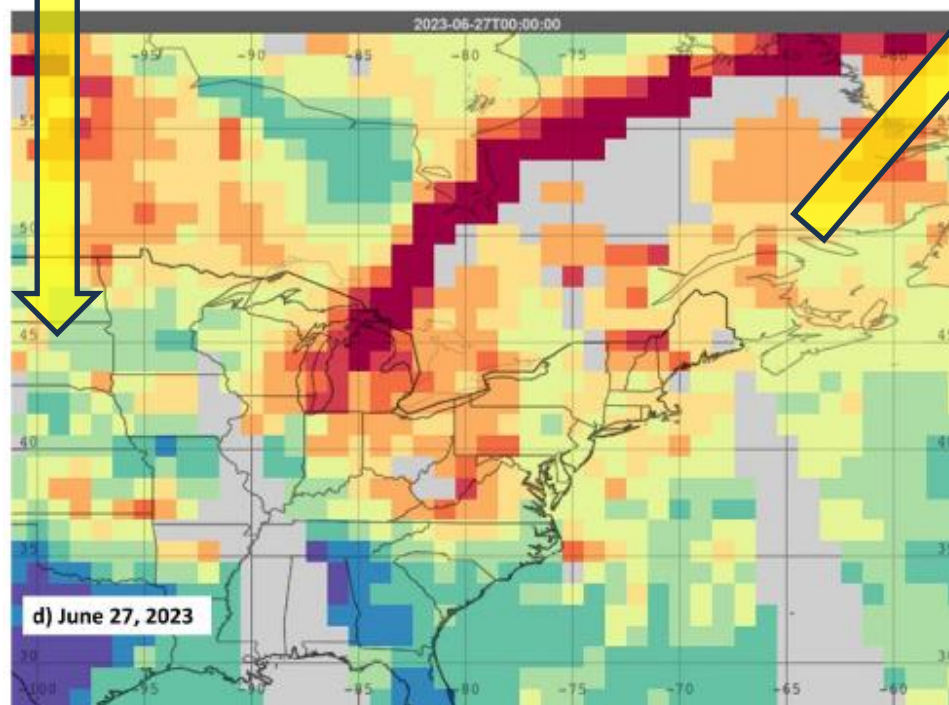
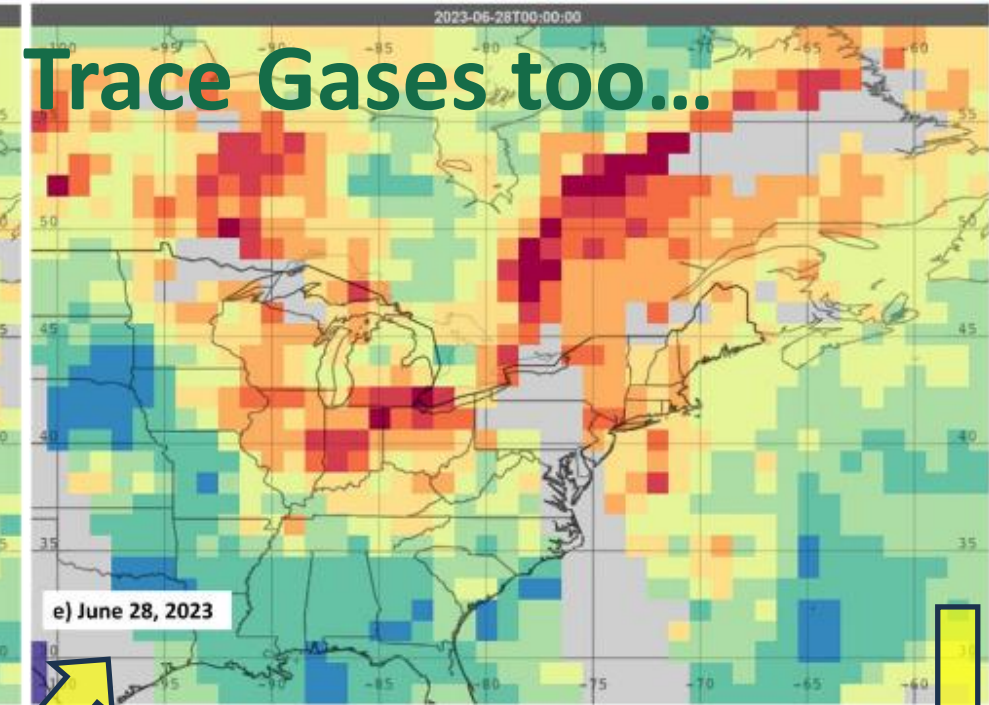
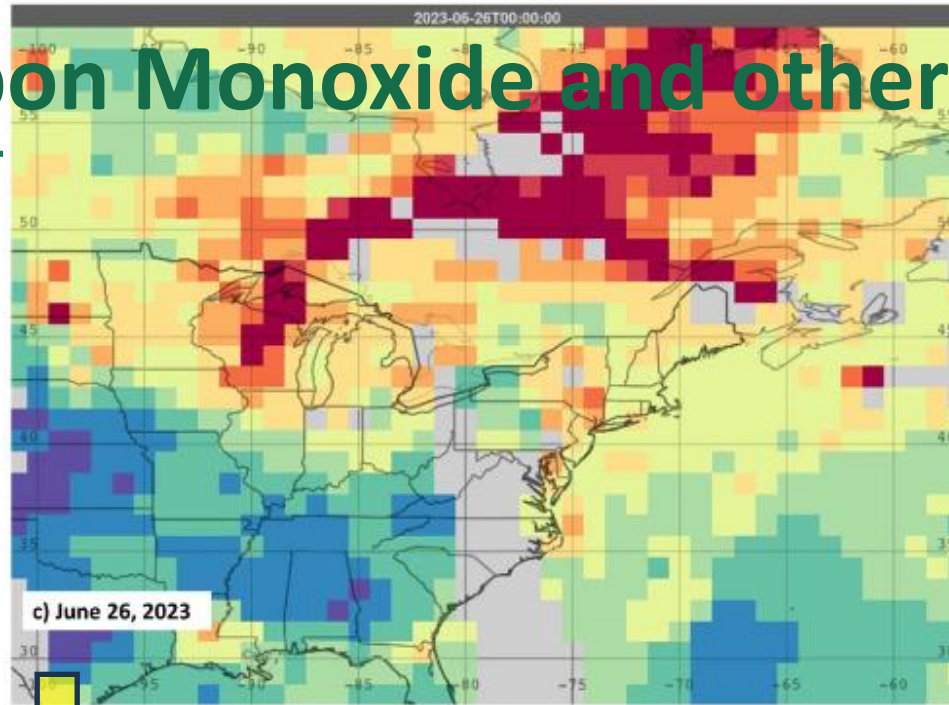
*19 ozone exceedances with evidence of smoke + 5 official midnight to midnight PM2.5 exceedances + 1 noon to noon PM2.5 ‘exceedance’

➡ **Over 18,400,000 hectares burned in Canada alone in 2023;
An area half the size of Germany, or all of Portugal and Hungary combined**



Carbon Monoxide and other Trace Gases too...

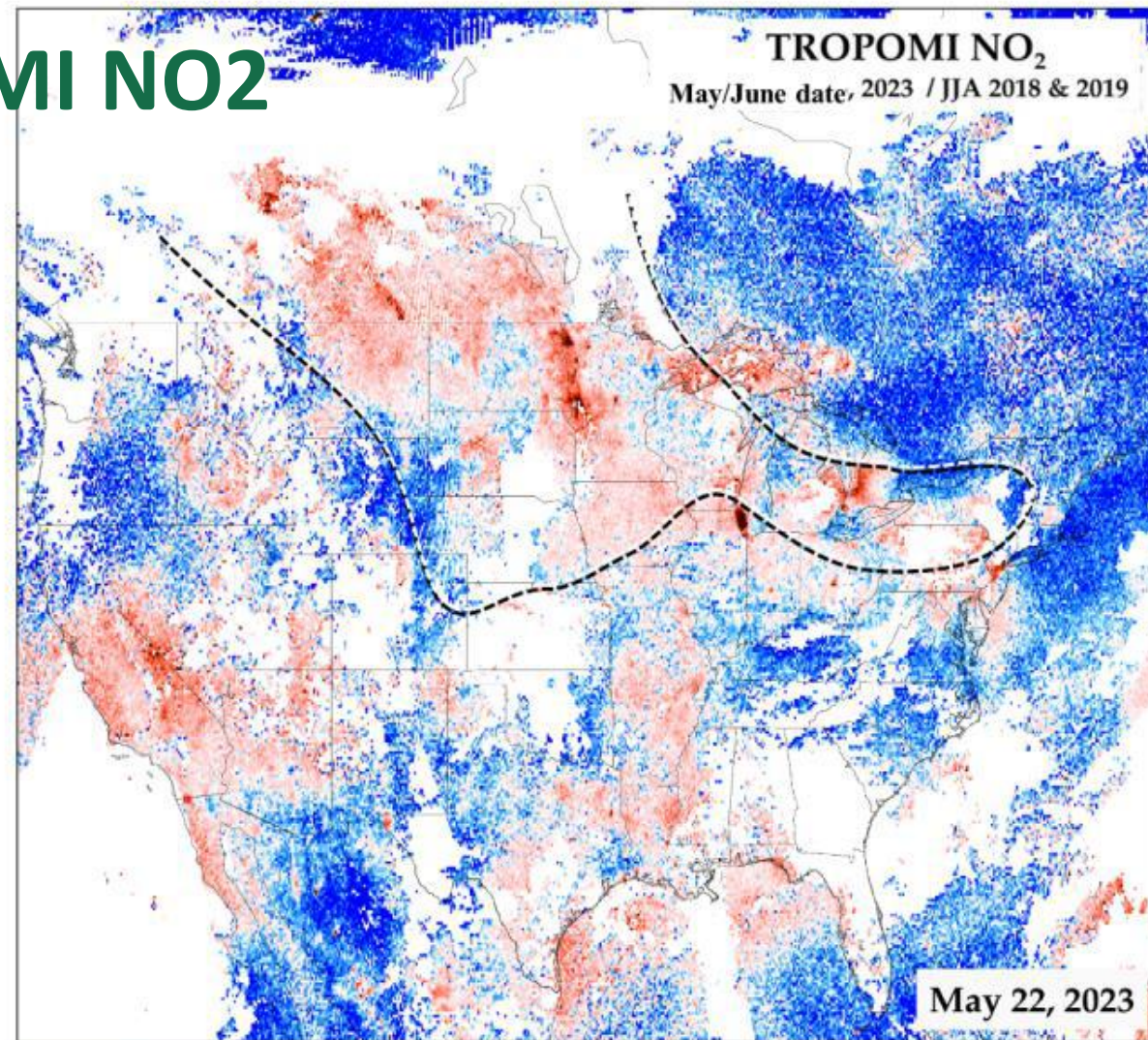
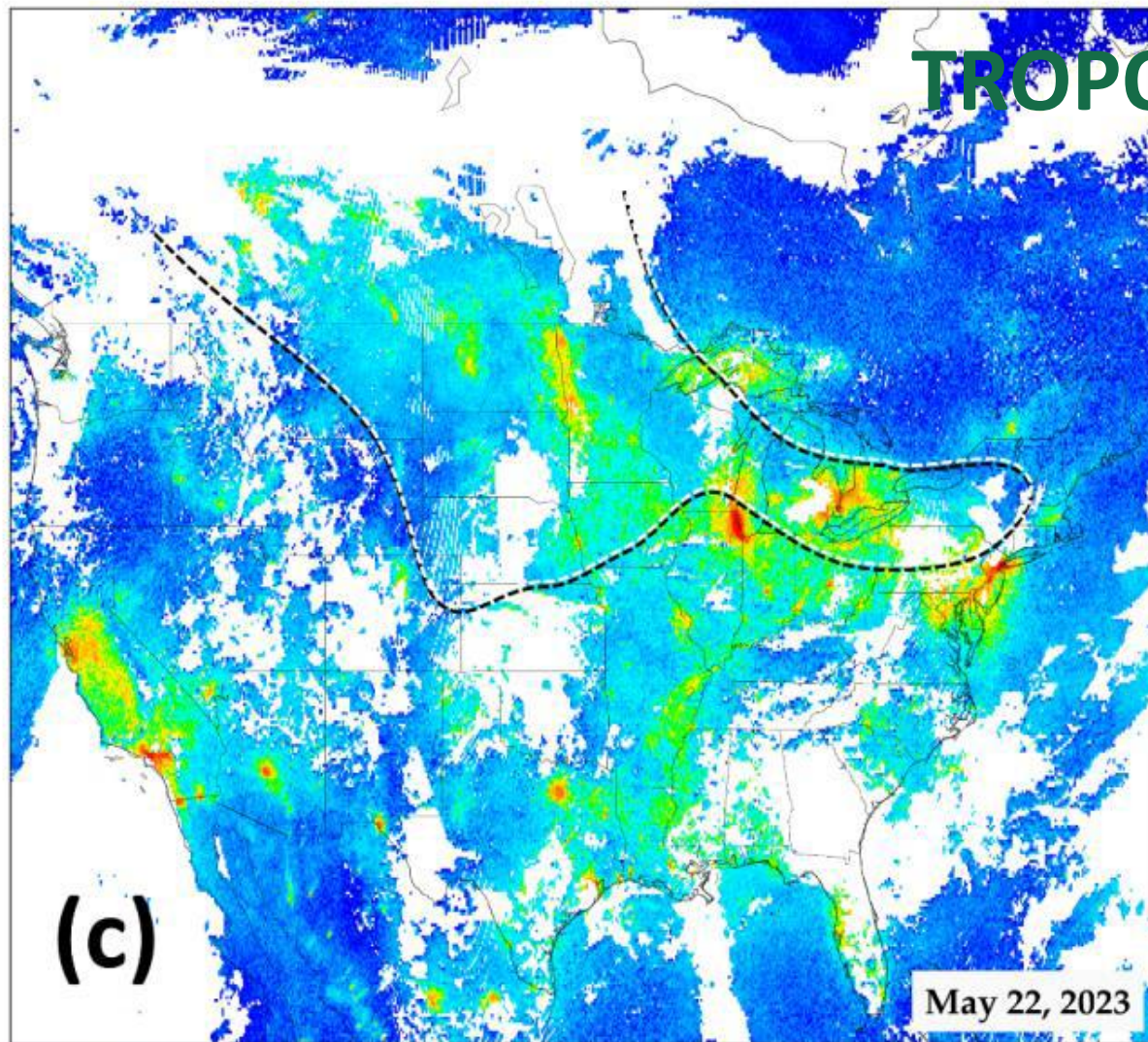
- AIRS Carbon Monoxide (CO) in June 2023
- We've also used TROPOMI CO in EE demonstrations
- We will use anything available to justify our argument that the monitored violation was caused by an Exceptional Event.



Summary

- **The Exceptional Events process allows state agencies to petition EPA to exclude data from regulatory determinations for circumstances beyond their control.**
- **Agreement [“Concurrence”] by EPA on these demonstrations can have extensive implications for state governments and residents**
- **[Easy] Access to satellite data allows agencies to make deliberative and informed decisions on the pursuit of demonstrations**
- **Satellite data plays a significant role building arguments within Exceptional Event demonstrations**

TROPOMI NO₂



0.0 0.25 0.5 0.75 1.0 1.5 2.0 2.5 3.0 4.0 5.0 7.5 10.0+ 10^{15} molec/cm²

0.33 0.50 0.75 1.00 2.00 3.00 Ratio

TROPOMI column NO₂ satellite retrievals in molecules per square centimeter (left) and departure from June, July, August (JJA) average concentration from 2018 and 2019 (right) for May 20 - June 2 (a-n).

The dashed line outlines the smoke, both seen in visible imagery and as heightened NO₂ concentrations. Retrieval of these products is available through <https://tropomino2.us/>. The NO₂ retrieval algorithm is described in Goldberg et al. (2021). Special North American domain provided courtesy Dr. Goldberg.

Tracking Plumes...

20230605 2141

Tuesday, June 6, 8 am

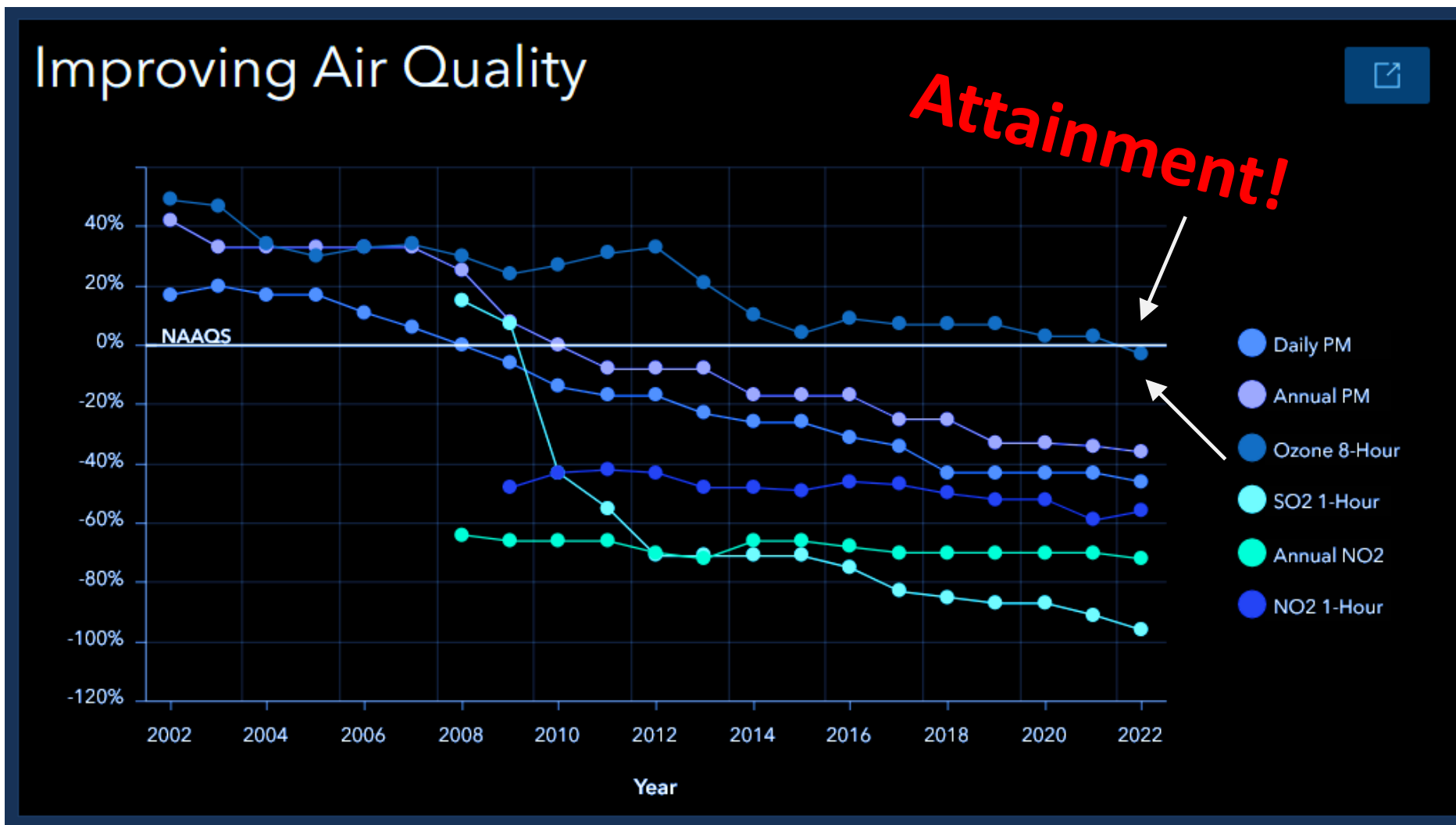


Satellite images from the [AerosolWatch website](#)



Maryland Air Quality & Federal Attainment

- For the first time in history, Maryland was in attainment of all National Ambient Air Quality Standards (NAAQS) at the end of 2022
- Maryland was considering requesting a “clean data determination” from the EPA
- The ongoing modeling partnership with *The University of Maryland College Park* was switching gears to focus on the influence of wildland fires on Maryland air quality in 2023.



Maryland NAAQS Design Values as a percentage of attainment. Maryland took until 2022 for ozone to be in attainment. Source: [Maryland 2023 Clean Air Progress Report](#).



Consequences of Fire Non-Attainment/Serious Designation..

At the beginning of 2023 Maryland:

- Was on the cusp of Clean Data and attainment redesignation
- No SIP obligations due to NAAQS
- Modeling wildland fires to understand seasonal impacts

Due to Smoke in 2023, Maryland could face:

- Redesignation to “Serious”
- 3 SIPs [Baltimore, Philly, DC]...

The Serious SIPs would have to include (summarized/abridged):

1. Photochemical modeling demonstration – 2016 platform for the 2026 future attainment year and all support documents

1. RACT; RACM; [NO_x/VOCs]

2. Mobile Budgets

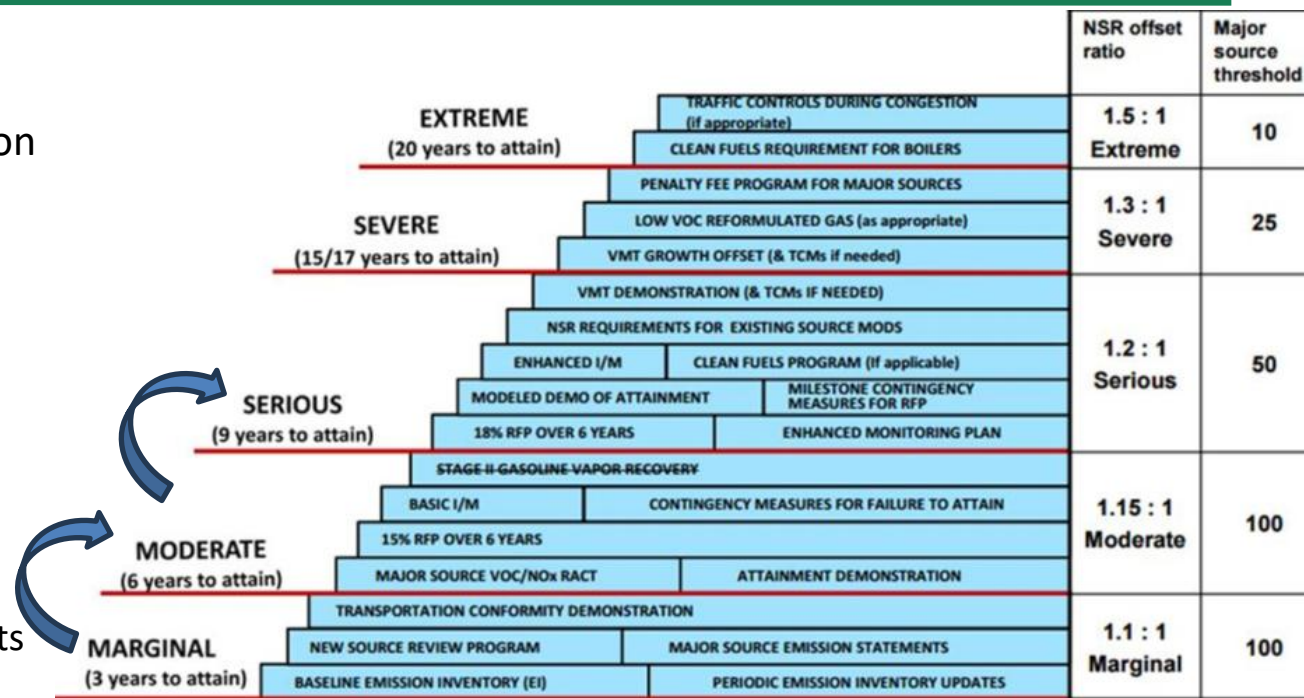
3. **Additional 9% emissions reductions for RFP** (which may require new regulations - those take about 1 to 1.5 years to do)

1. Reasonable Further Progress - 3% per year (9% overall for the 3 additional years) of reductions in ozone precursors. The reductions must be federally enforceable so regs not permit conditions for Maryland. They also have to be in effect by the start of O.S. 2026.

4. Contingency Measures (which may require new regulations - again, 1 to 1.5 years)

- All control strategies must be in place by start of ozone season 2026.

- Short timeline from failure to attain, SIP development, SIP implementation, and attainment date. Egregious amount of work to accomplish in one year and that assumes that EPA is proactive in bumping areas up



Everything hinges on the outcome of the Exceptional Event Demonstrations



Thank You

Picture taken by MDE meteorologist Joel Dreessen on June 8, 2023 at 7:52 am EDT* from the Montgomery Park Offices in southeastern Baltimore City.

The picture corresponds to the circle highlighted by the blue arrow. The hourly concentration was $179 \mu\text{g m}^{-3}$.

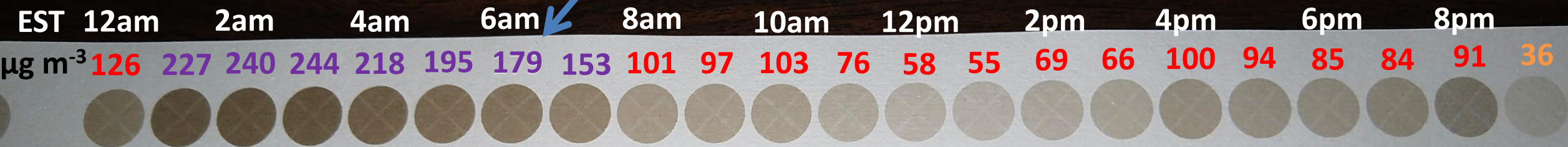
*Note: EPA requires all observations in EST

View is to the south, towards the Chesapeake Bay. The Key Bridge would be visible 4 miles away, nearly where the blue arrow is pointing.

$179 \mu\text{g m}^{-3}$

The Baltimore Convention Center is 1.6 miles east in the picture.

June 8, 2023



The above image is an MDE $\text{PM}_{2.5}$ "Beta Attenuation Monitor" (BAM) sample tape from June 8, 2023. Each circle corresponds to a 1-hour sample spanning midnight to midnight on June 8 from the Lake Montebello site in downtown Baltimore. The filter collects what is in the air onto a filter for measurement, essentially illustrating what would end up in your lungs if breathing outside for an hour. The $\text{PM}_{2.5}$ standard is $35.4 \mu\text{g m}^{-3}$ as a 24-hour average. The hour highlighted measured $179 \mu\text{g m}^{-3}$.