Maryland
Department of the Environment

# 5B.1 The State of Maryland Air Quality Science, ~~Policy, Research, and Relevance~~ Fire & Smoke in Contemporary Times

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Baltimore, Maryland
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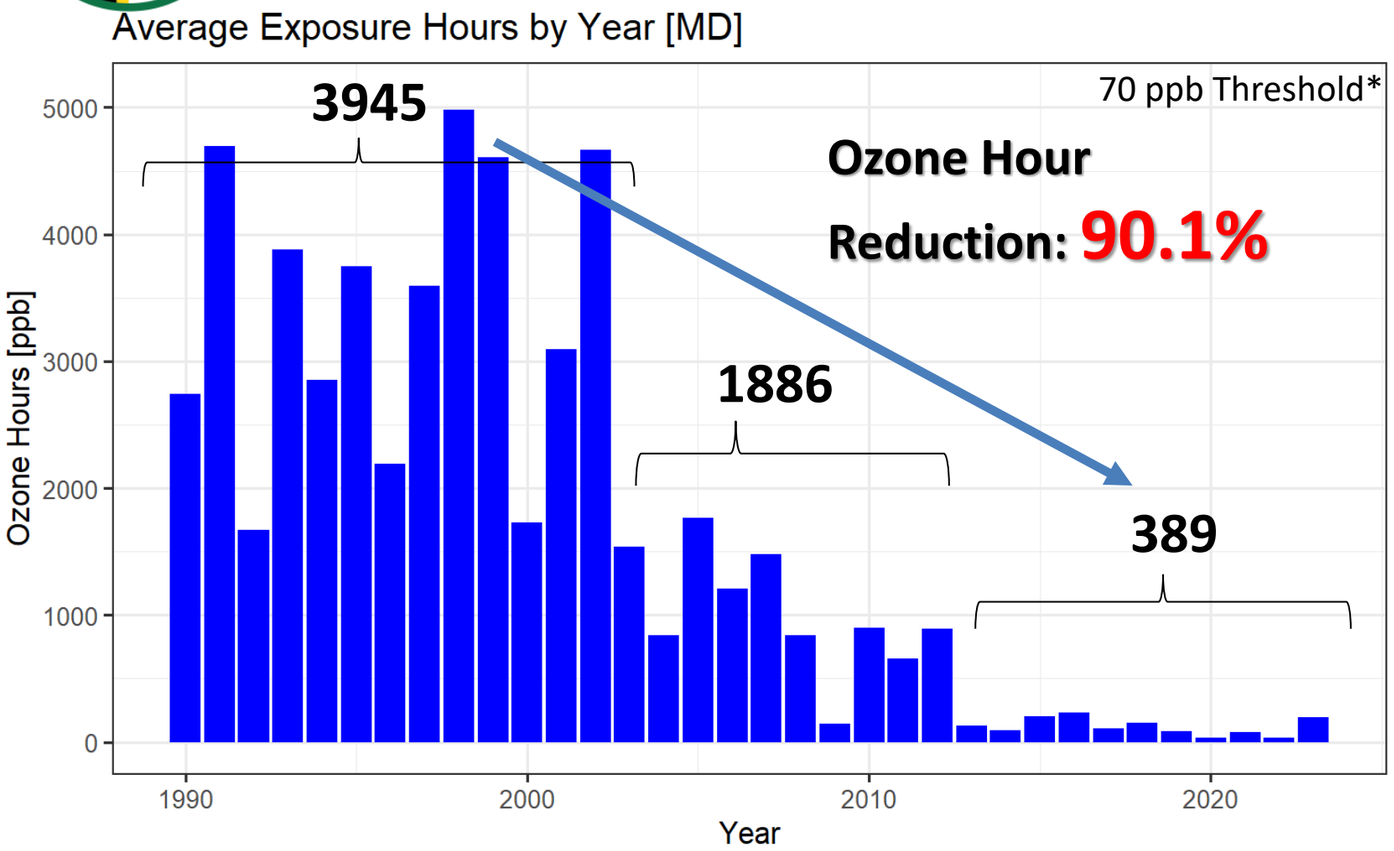
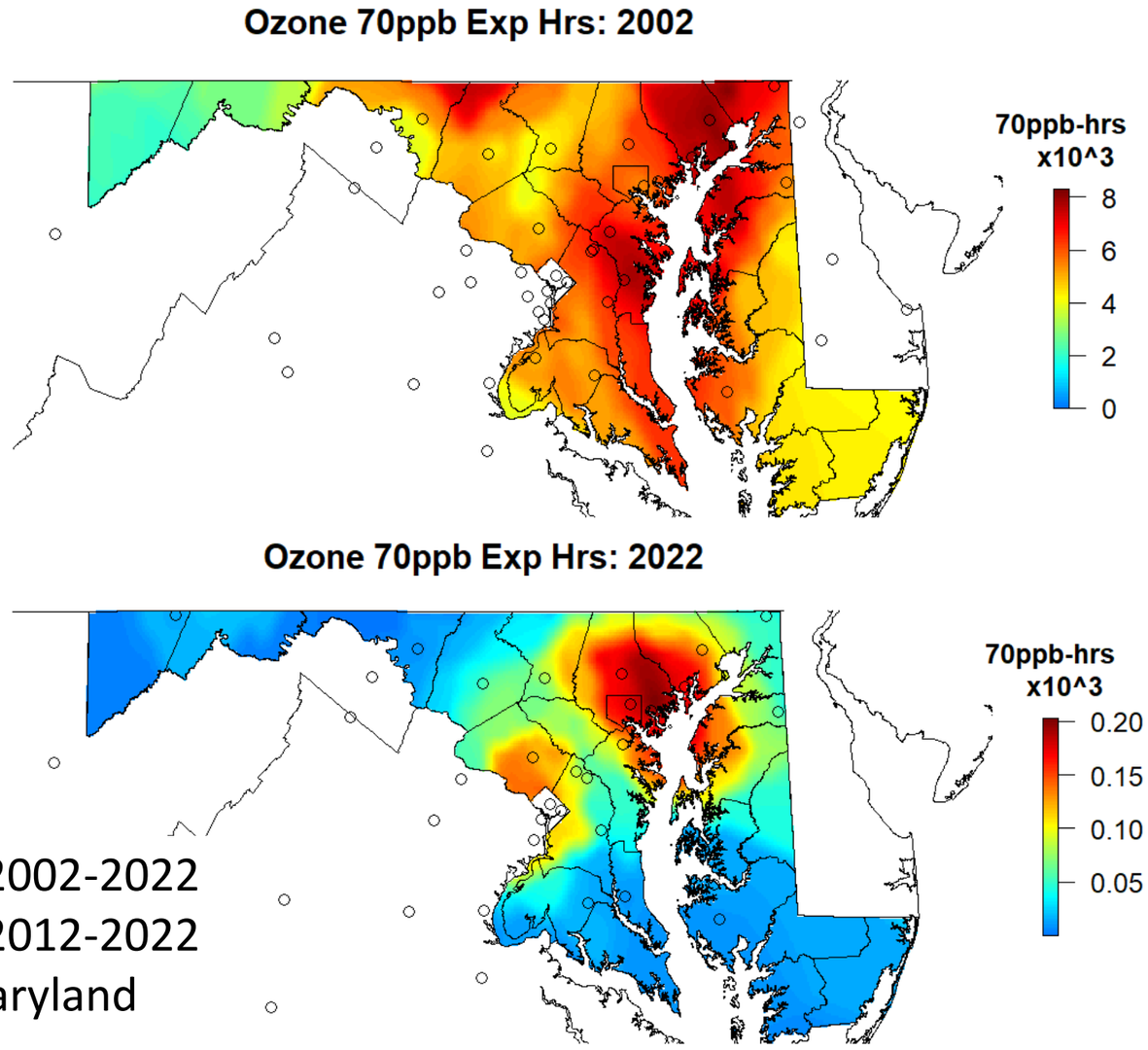
# Decades of Progress: Ozone Exposure above 70ppb*




- A 90% decrease in ozone exposure above 70 ppb in Maryland, 2002-2022
- A 79% decrease in ozone exposure above 70 ppb in Maryland, 2012-2022
- Urban areas are now cleaner than the most remote areas of Maryland were just 10 years ago
- "Hot spots" remain, dominated by urban areas
- Disproportional impacts from air quality is an increasing focus

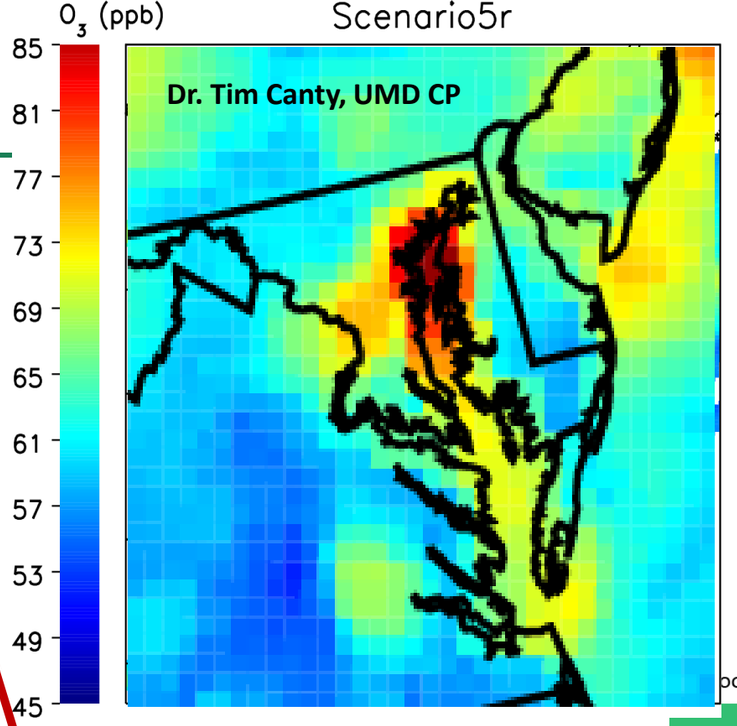
***Exposure Hours are an integrated count of hours above a particular level [e.g. 70 ppb] at a particularly monitor and year. A 1-hour ozone concentration at 76 ppb is 6 exposure hours.**

# Science Driven Success

- **Scientific Partnerships**
  - ***University of Maryland College Park***
    - Observations (Plane flights, Cars)
    - Modeling
    - Aid with SIPs
  - Ozonesondes at ***Howard University Beltsville***
    - (Balloon-borne ozone and met measurements)
  - Several Additional agencies over the years (NASA, NOAA)
  - OWLETS-2018, DISCOVER-AQ

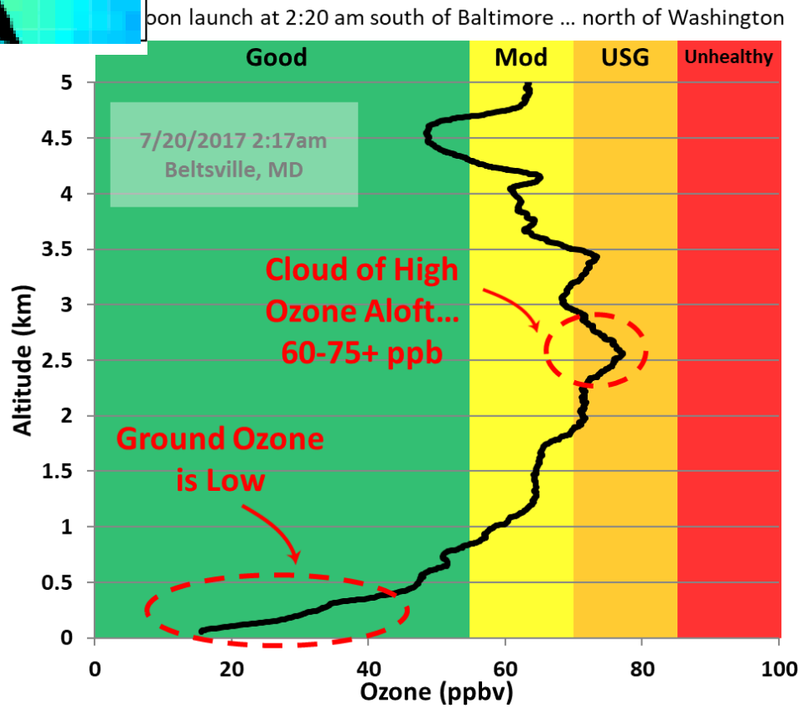
- **Development of a conceptual model**
  - Cause and effect
  - A key element for policy
  - Make science an easily digestible story that explains the relevance

- **Removed the Nitrogen Dioxide from the atmosphere**
  - **Reduce Nitrogen Dioxide from Power Sector**
  - **Improved Mobile Emission Technology & Fleet Turn-over**
    - MD Clean Car Program (increase ZEVs sales in state)
    - Anti tampering and bad actors
    - Drayage emission reduction
    - NOx reductions from "Tier 2" (vehicle standards)
    - Tier 3 Gasoline (lower gasoline sulfur content (2017))



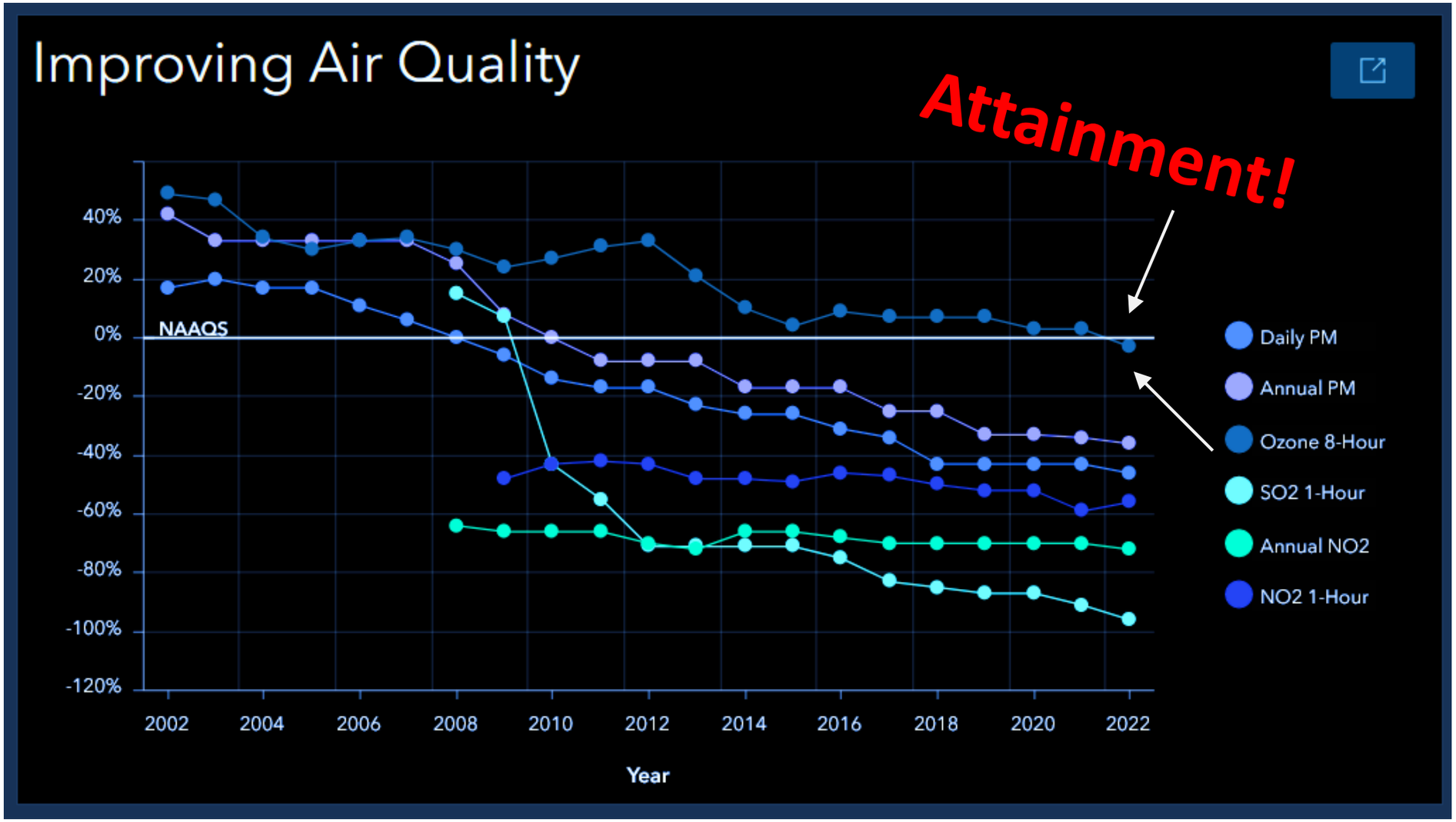

**Non-exhaustive list of AMS talks related to continued work or partnerships in cleaning up the air**

**1.4 – Flores et al.**
**4B.1 – Ren et al.**
**5B.2 – Dickerson et al.**
**5A.4 – Singh et al.**
**15A.2 – Ring et al.**
**16.2 – Daley et al.**
**P598 – Stratton et al.**
**P599 – Sebol et al.**



# 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
- **<u>Life was good!</u>**
- The ongoing modeling partnership with ***The University of Maryland College Park*** was switching gears to focus on the influence of <u>wildland fires</u> 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.

# Then came...summer 2023

20230606 1141

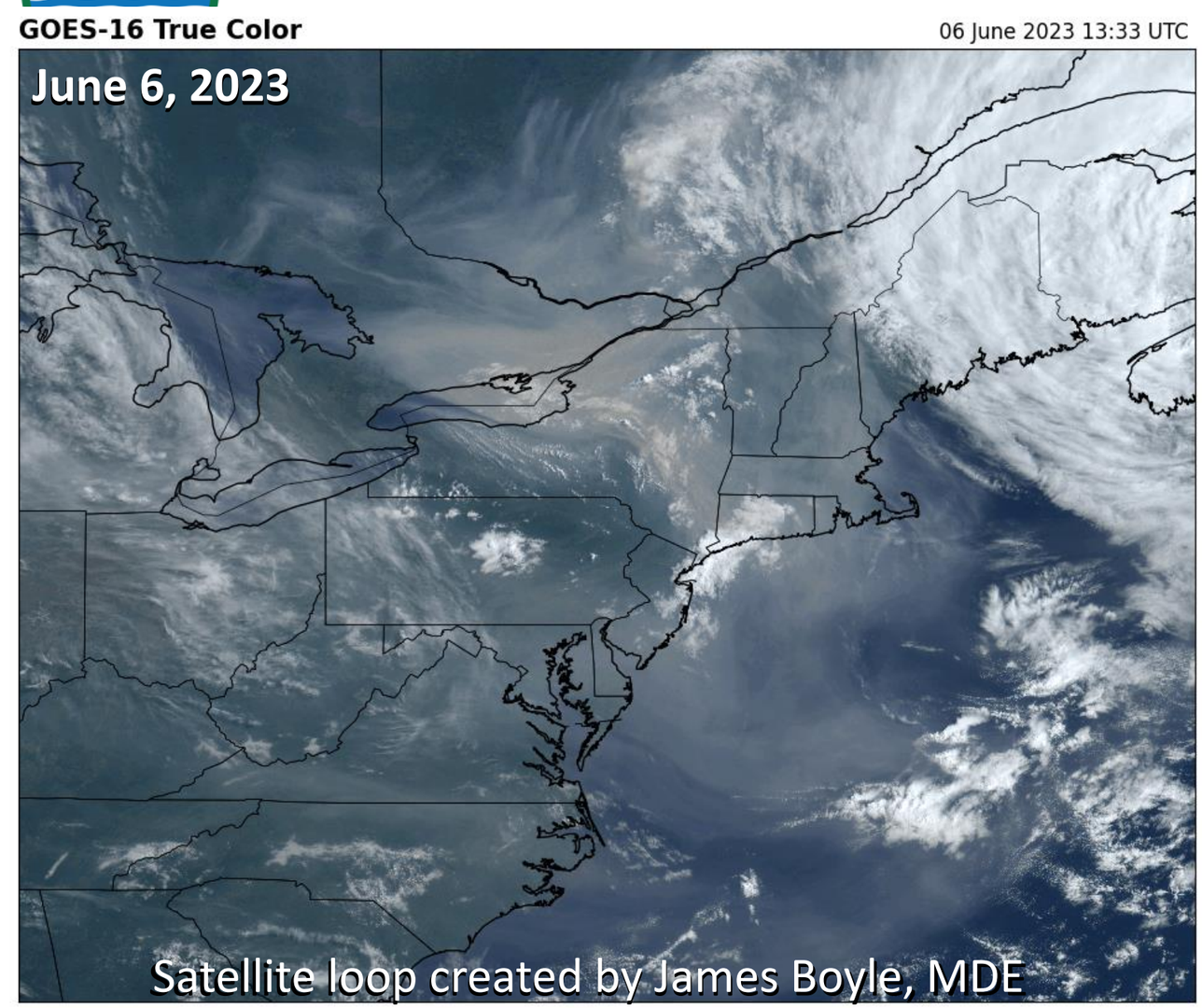
20230605 2141

Tuesday, June 6, 8 am

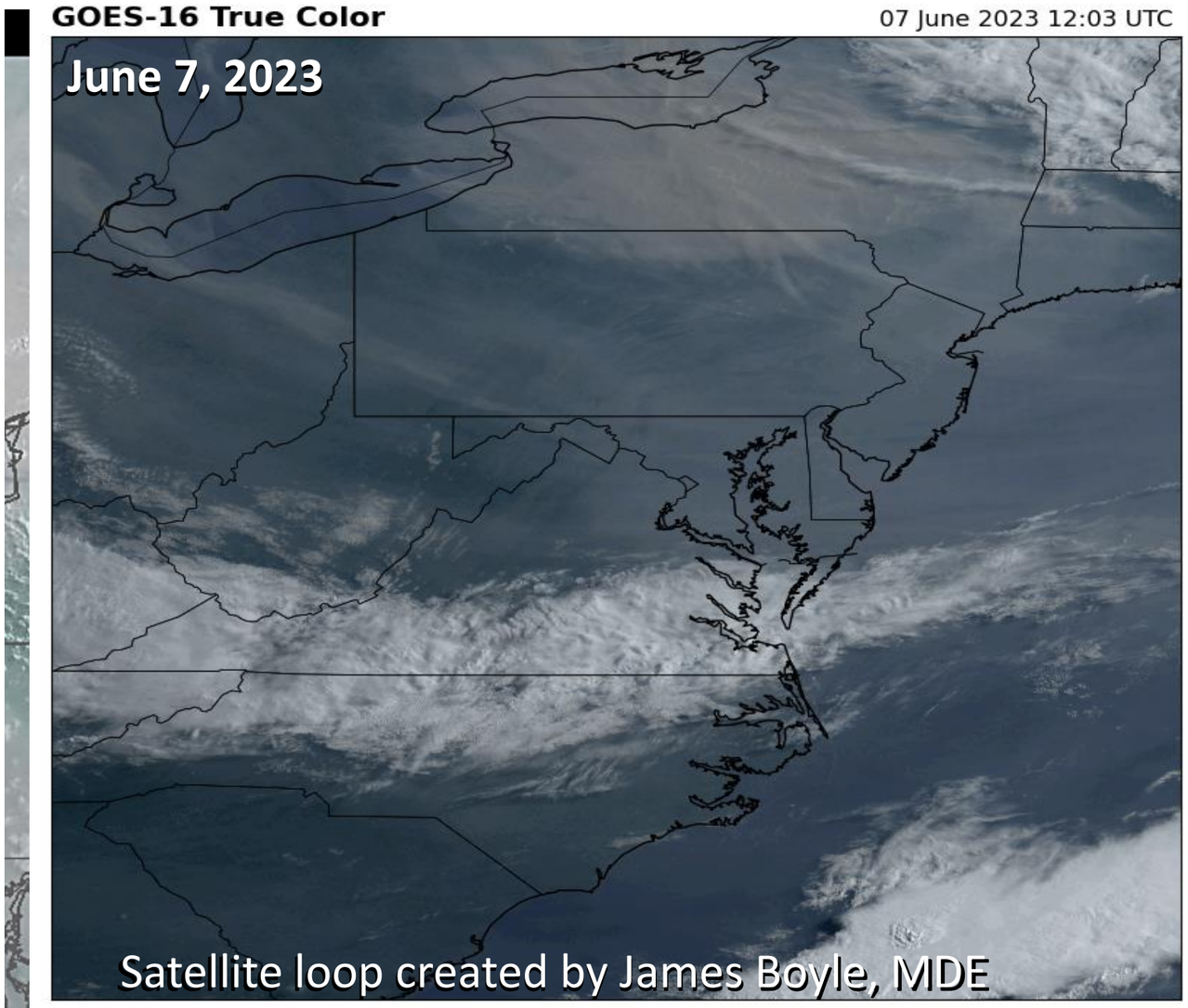
Satellite images from the AerosolWatch website

For more on this event, see session 8.1; Huff et al., room 326 @ 4:30pm Tuesday
session 3.1, Rodriguez et al., room 316 @ 1:45pm Monday

# Then came...summer 2023





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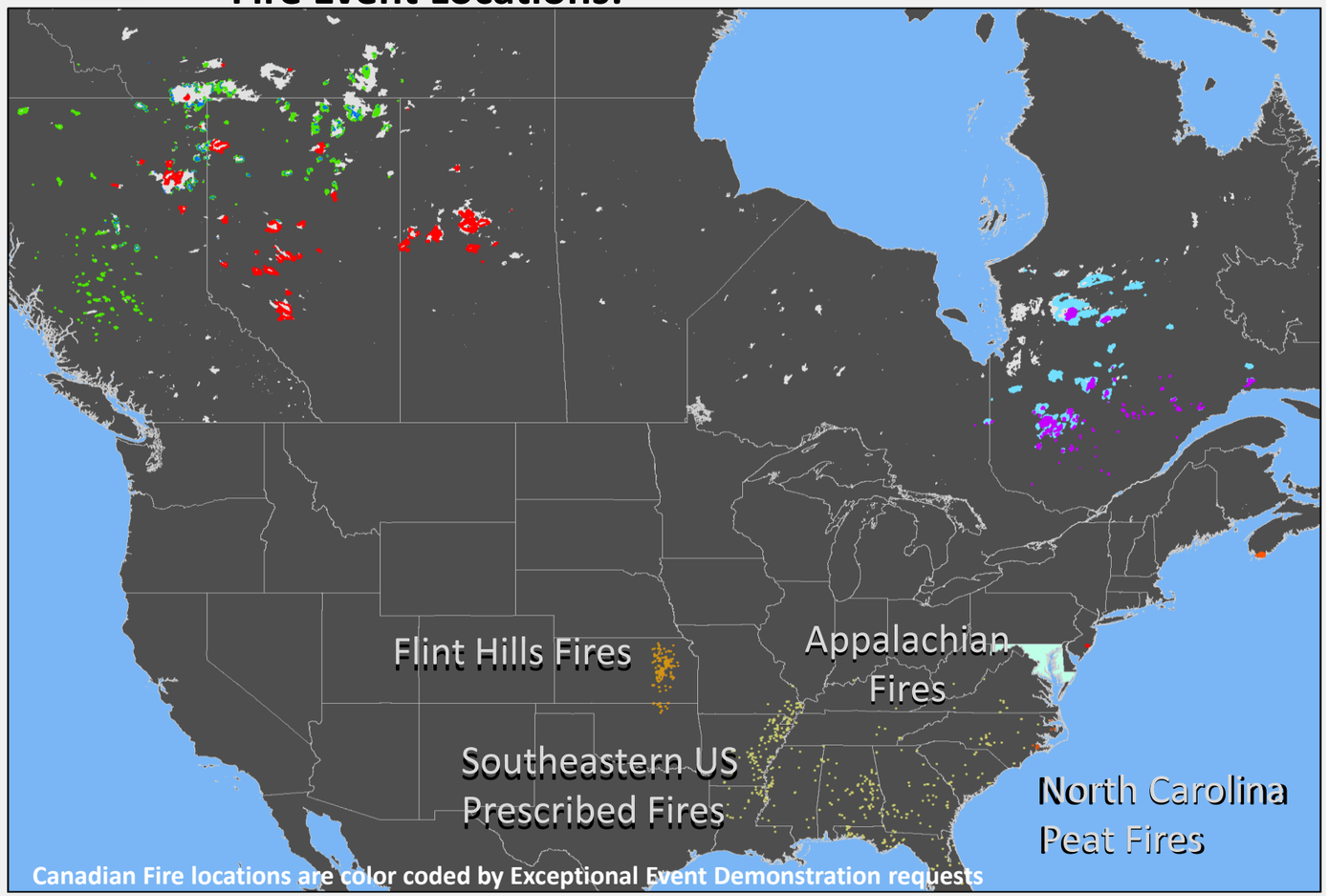
# Maryland 2023 Smoke Event Impacts on Air Quality

## Fire Event Locations:




## 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 |

**Over 18,400,000 hectares burned in Canada alone; An area greater than the size of the State of Missouri.**

**Controlled burns happen regularly, but earlier warmth may cause increasing impacts on air quality**

**13 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'

# 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

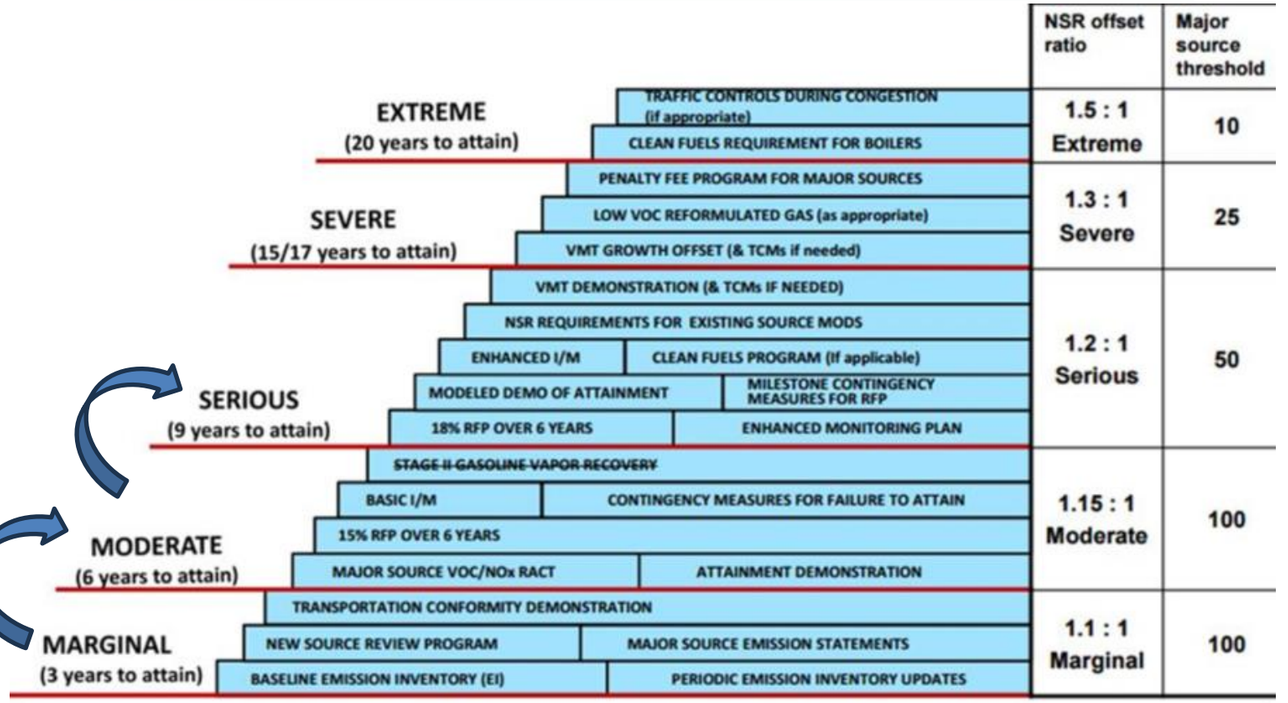
## Due to Smoke in 2023, Maryland could face:

- **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
2. RACT; RACM; [NOx/VOCs]
3. Mobile Budgets
4. **Additional 9% NOx 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.
5. Contingency Measures (which may require new regulations - again, 1 to 1.5 years)

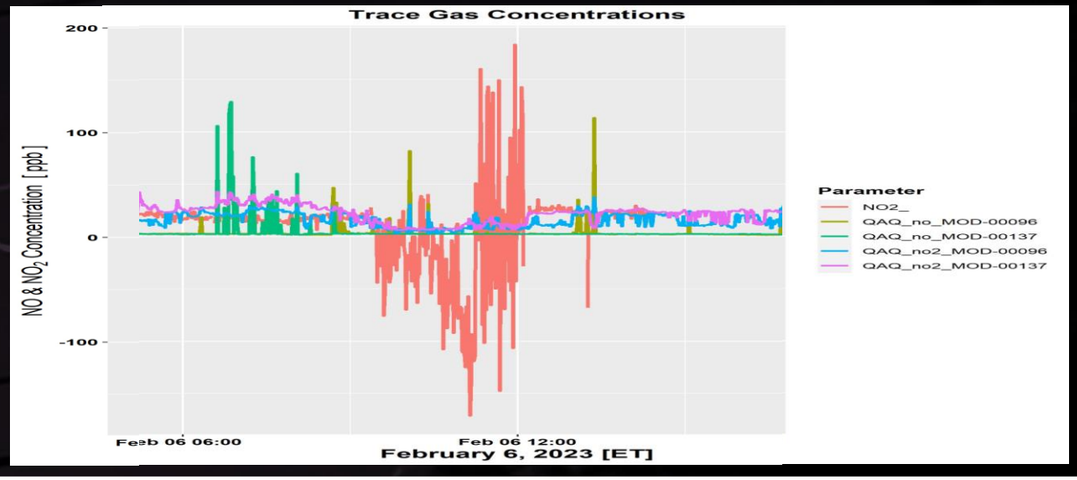
- All control strategies must be in place by start of ozone season 2026.
- Short timeline from failure to attain, SIP development, SIP implementation, and attainment date. Egregious amount of work to accomplish in one year and that assumes that EPA is proactive in bumping areas up




**Everything hinges on the outcome of the Exceptional Event Demonstrations**

# Contemporary Topics and Needs*

- NAAQS
  - In a NOx limited world, 'outlier' emitters disproportionately impact their local environment since the atmosphere responds faster going "up" the curve NOx.
  - Is there a better form of these standards to address contemporary issues (e.g., EJ)?
  - **Fire contribution to ozone generation (FIREX-AQ)**
- Environmental Justice
  - State agencies are getting slammed with the proliferation of small sensors
  - **Handling data quality is taking up too much time to adequately address the salient findings of community groups**
- Climate Change
- Approach Issues with Earth System Science
  - "low hanging fruit" are those topics which can beneficially impact multiple facets of the environment





**Maryland FRM filter under magnification shows a "fiber" of blue color. Image credit: A. Lindstrom/NIST. Used with permission**

- **<u>My Predictions for the Future*:</u>**
  - **<u>Plastics:</u>** the world-wide oil spill is finding its way into the air (health, hygroscopicity, and hydrophilicity). <u>Meteorological community should pay attention to this</u>.
  - Agriculture and the Science of Food

*Personal Reflections. These do not necessarily reflect the views of MDE

# 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 µg $m^{-3}$.

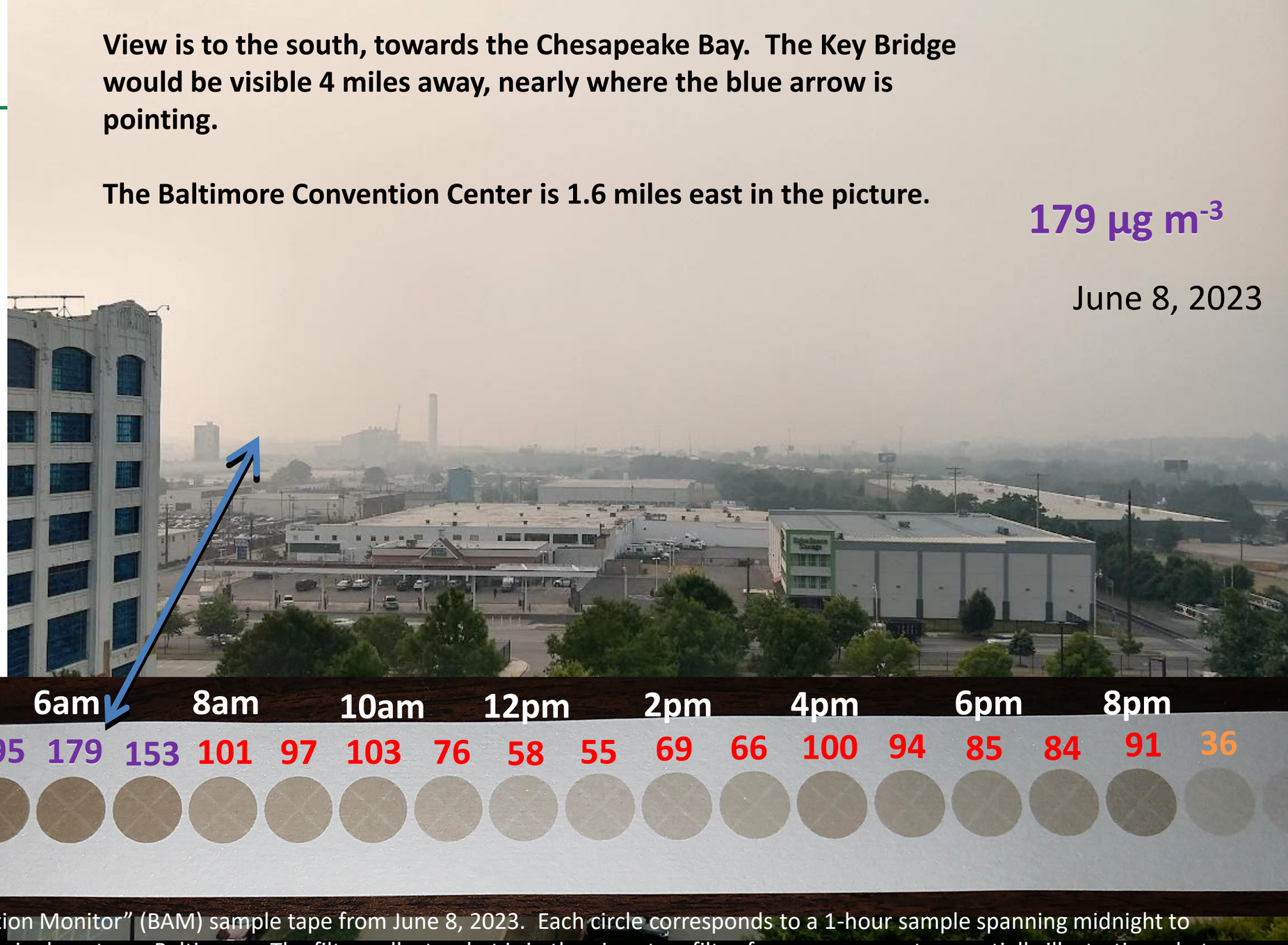
*Note: EPA requires all observations in EST

**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.**

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

**179 µg $m^{-3}$**

June 8, 2023




The above image is an MDE $PM_{2.5}$ "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 $PM_{2.5}$ standard is 35.4 µg $m^{-3}$ as a 24-hour average. The hour highlighted measured 179 µg $m^{-3}$.

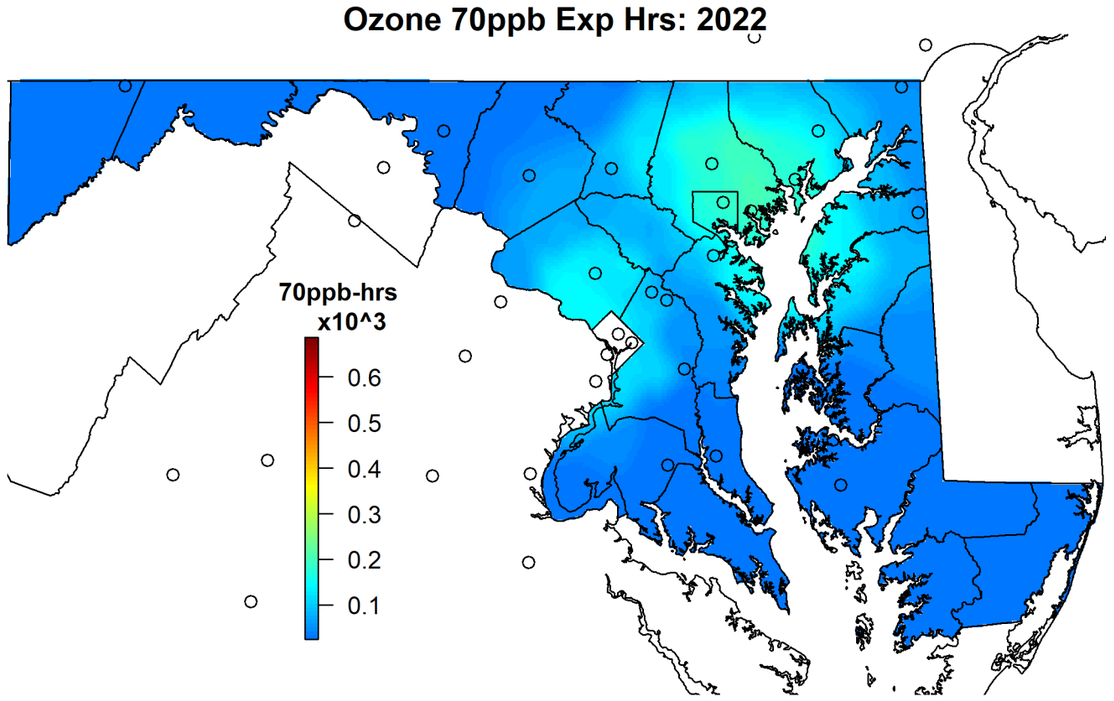
# Beta-Attenuation Monitor (BAM) Filter Tape Strips of the June 8, 2023 Smoke Event

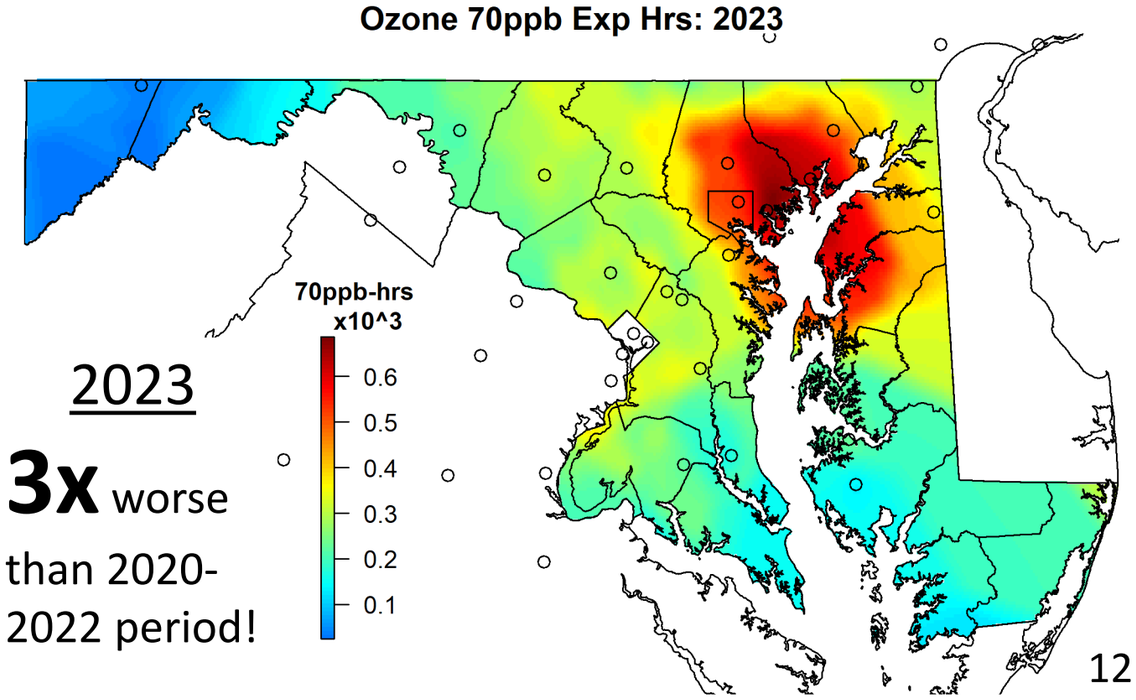
# Consequences of Smoke in 2023

- Using the "Exposure Hour" with thresholds of 70 ppb for ozone and 35.4 µg $m^{-3}$ for $PM_{2.5,}$ compared to the average of the past 3 years, <u>statewide</u> average exposure in 2023 was **<u>3x</u>** worse for ozone, and **<u>43x</u>** worse for $PM_{2.5}$*!!!

- Attainment for ozone is 70 ppb; As of the end of 2023, data shows a design value of <u>73 ppb</u>

- Maryland needed 5 **Exceptional Events demonstrations**, all with regulatory significance, to attempt attainment
  - ~600 pages
  - We must have readily available resources to construct these demonstrations
  - Extreme timeline due to legal timelines of designation
  - ***<u>A big thank you to all partners and agencies who offer this data freely and easily (NOAA, NASA, UMD, etc.)</u>***



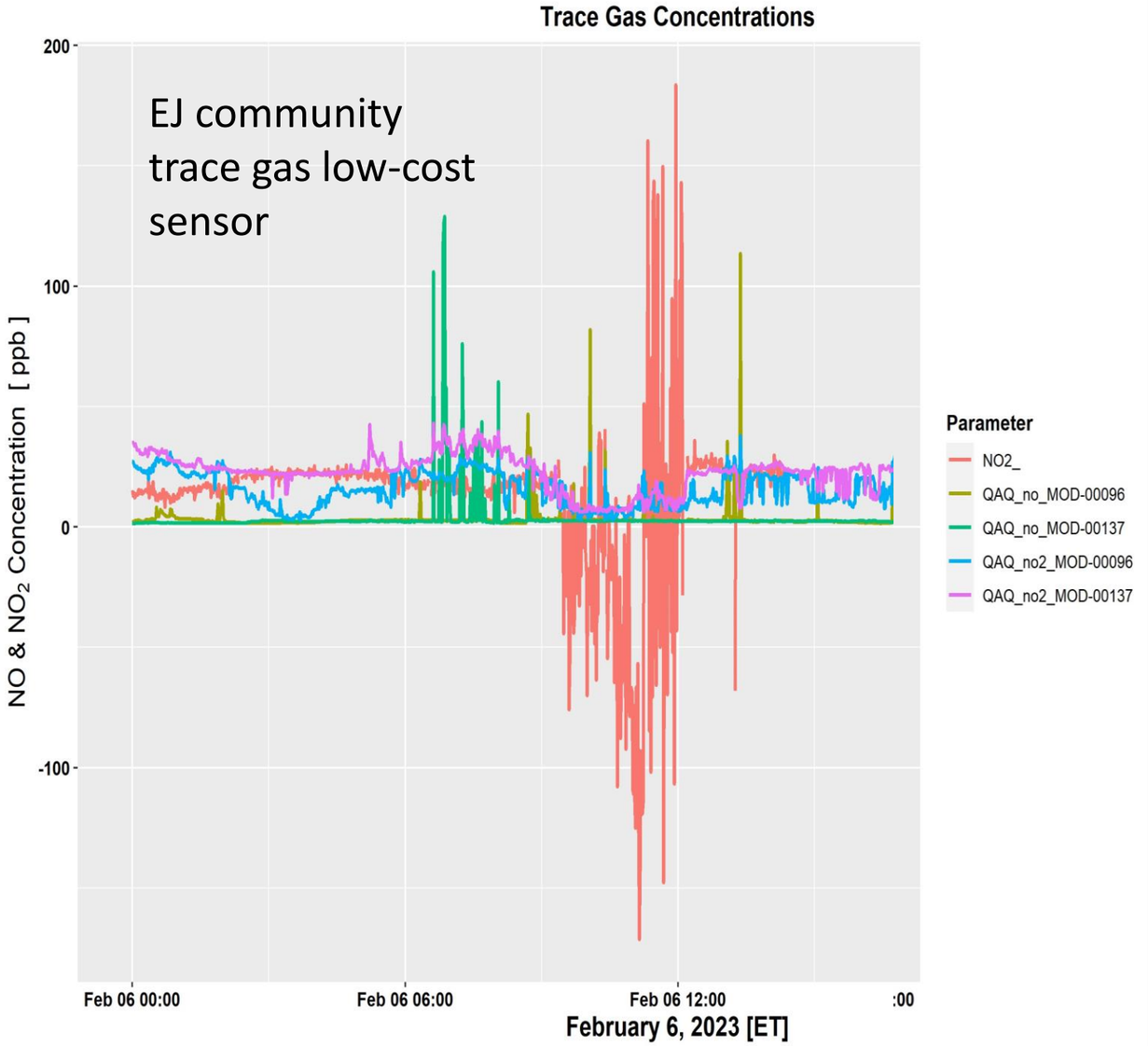

<u>2023</u>

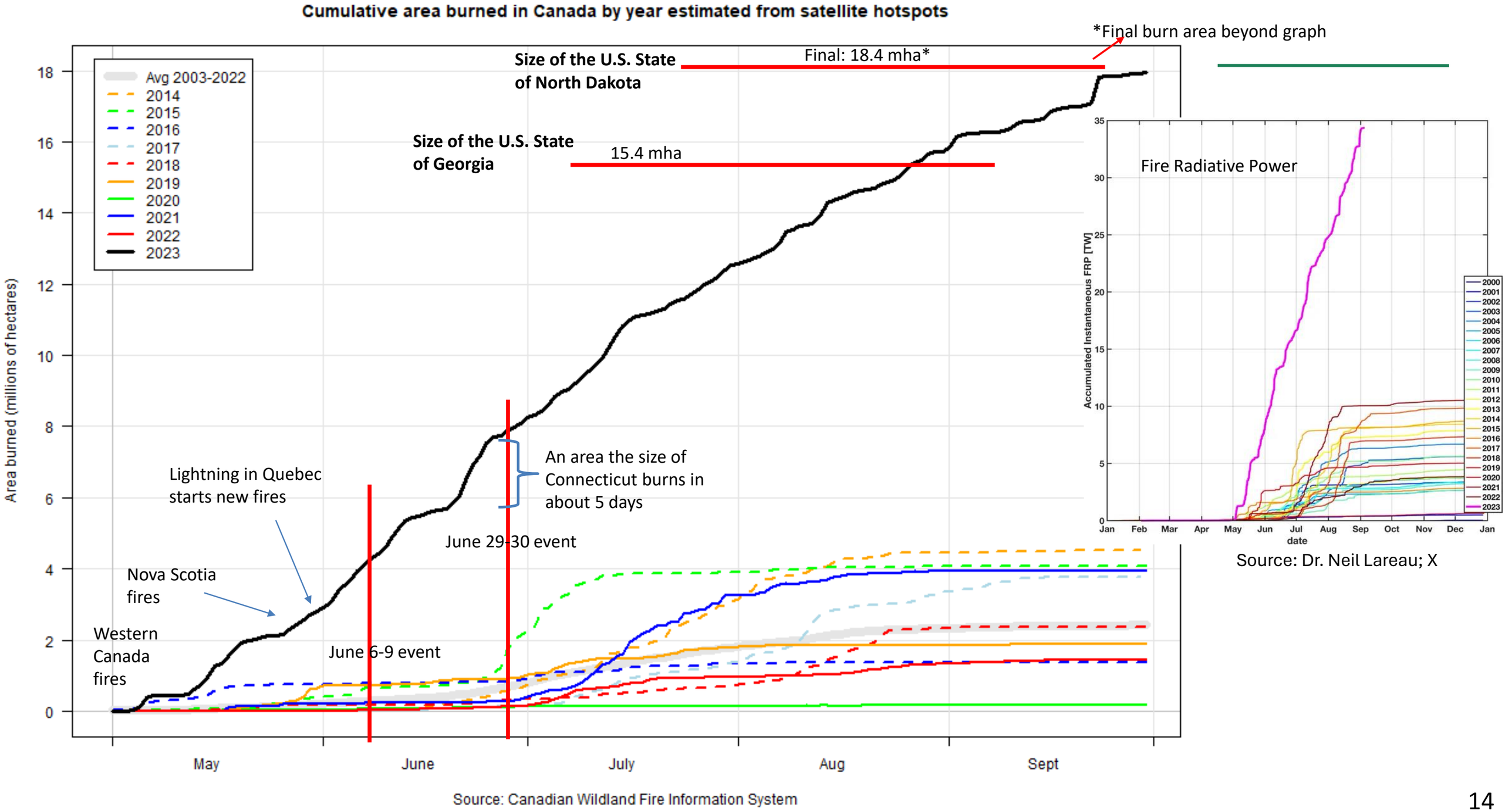
**3x** worse than 2020-2022 period!

*3x worse @ 12 µg $m^{-3}$ exposure threshold

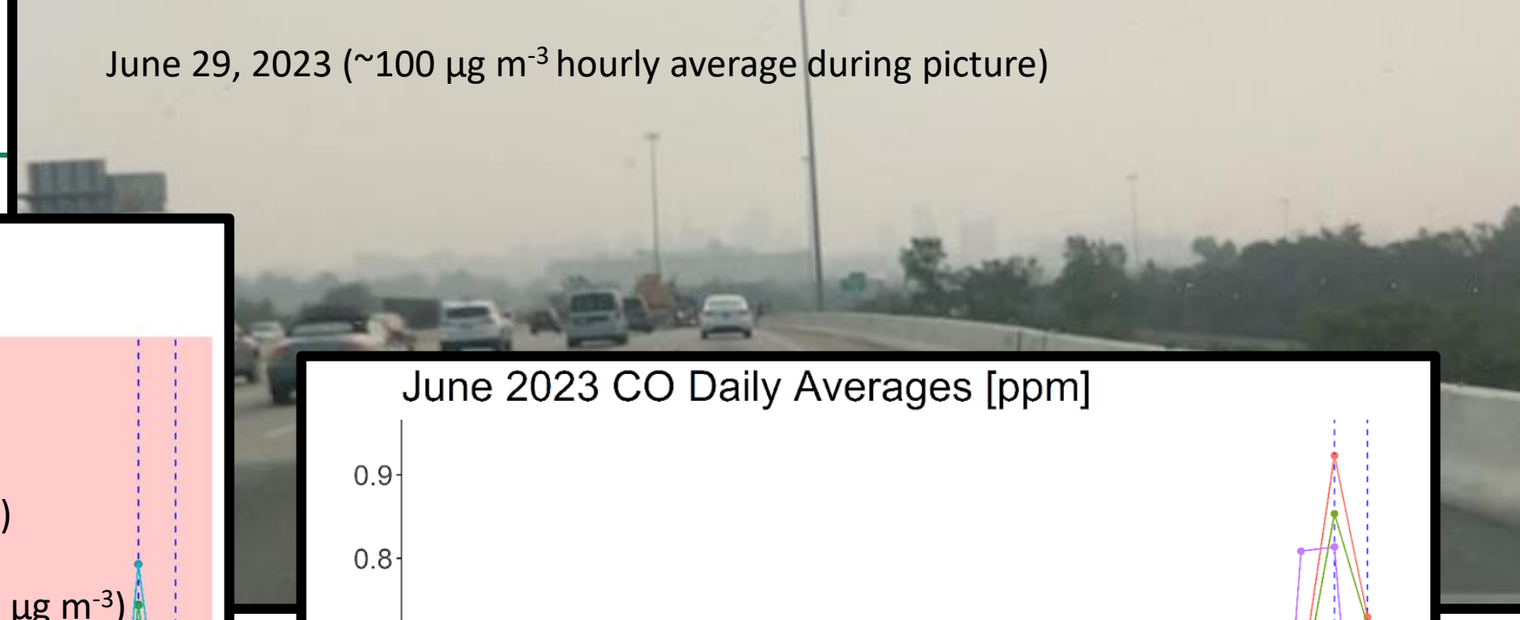
# More Broadly, What Do States [Maryland] Need/Face?

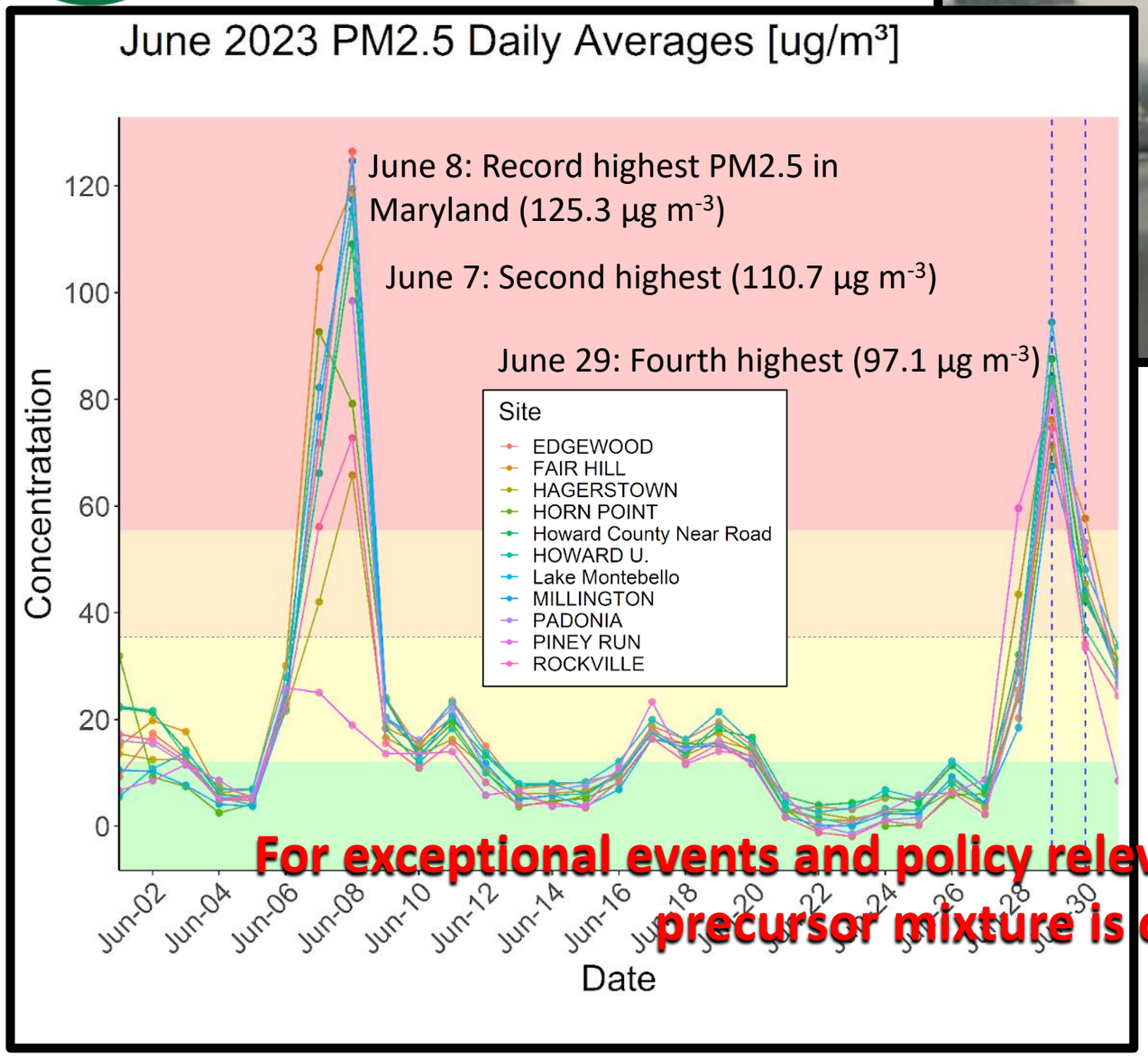
- Quantify all fire attribution to ozone
- Keep giving us those great ready-to-use graphics and tools to respond to environmental events
- Quantify the health impacts of events
  - Short-term vs long-term impacts and communication (hourly metrics??)
  - Forecasters
  - Policy Development
- Environmental Justice and Sensor Tech
- Continued Collaboration
  - Please reach out!
  - From a state agency perspective, ask us what our current challenges are.

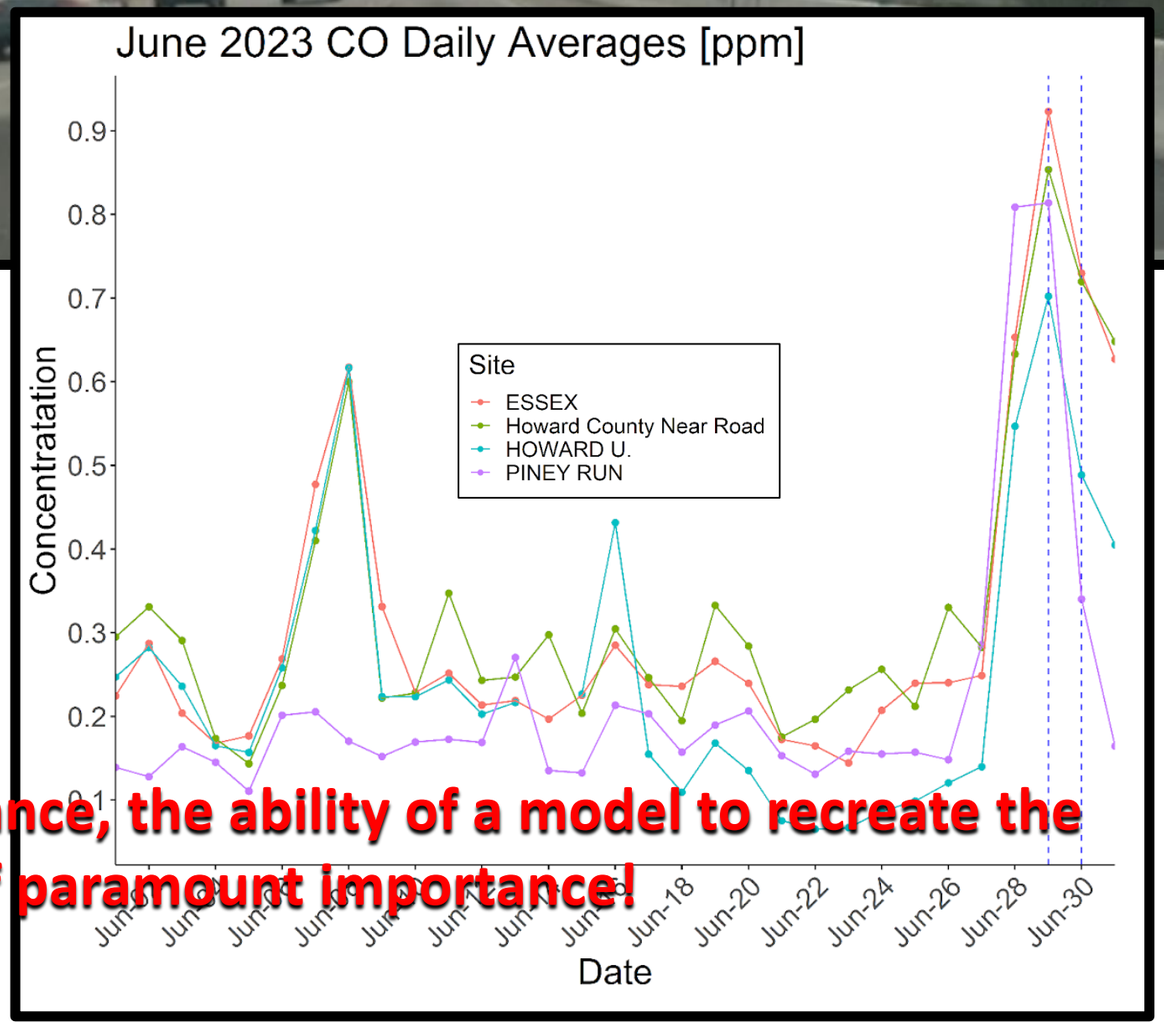



Cumulative area burned in Canada by year estimated from satellite hotspots
*Final burn area beyond graph
Size of the U.S. State of North Dakota
Final: 18.4 mha*
Size of the U.S. State of Georgia
15.4 mha
Avg 2003-2022
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Area burned (millions of hectares)
Lightning in Quebec starts new fires
An area the size of Connecticut burns in about 5 days
June 29-30 event
Nova Scotia fires
Western Canada fires
June 6-9 event
May
June
July
Aug
Sept
Source: Canadian Wildland Fire Information System
Fire Radiative Power
Accumulated Instantaneous FRP [TW]
date
Source: Dr. Neil Lareau; X

# June 2023



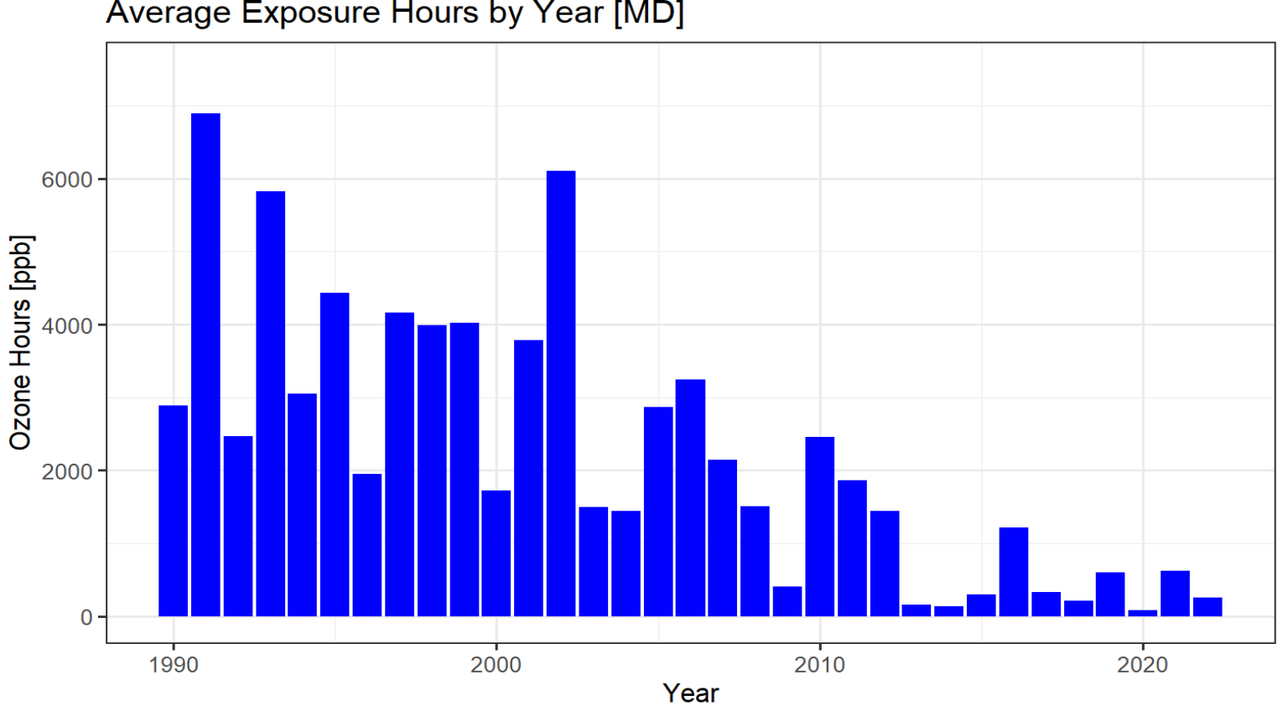



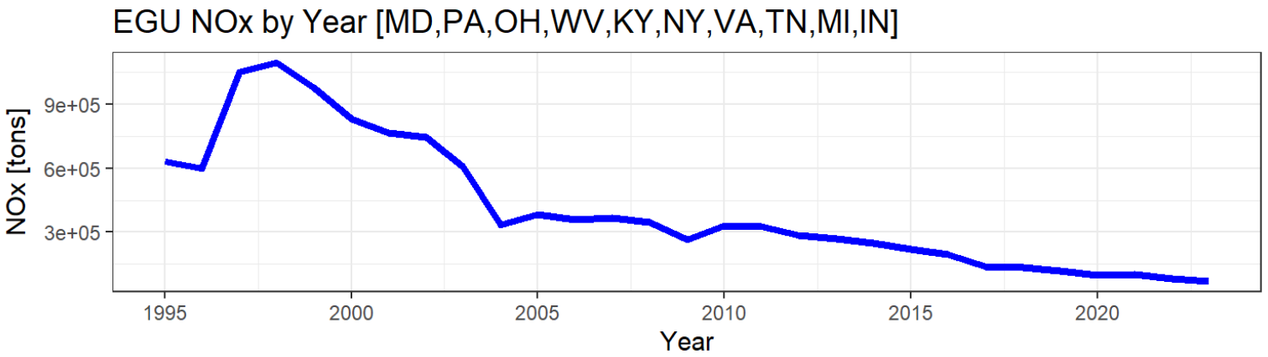



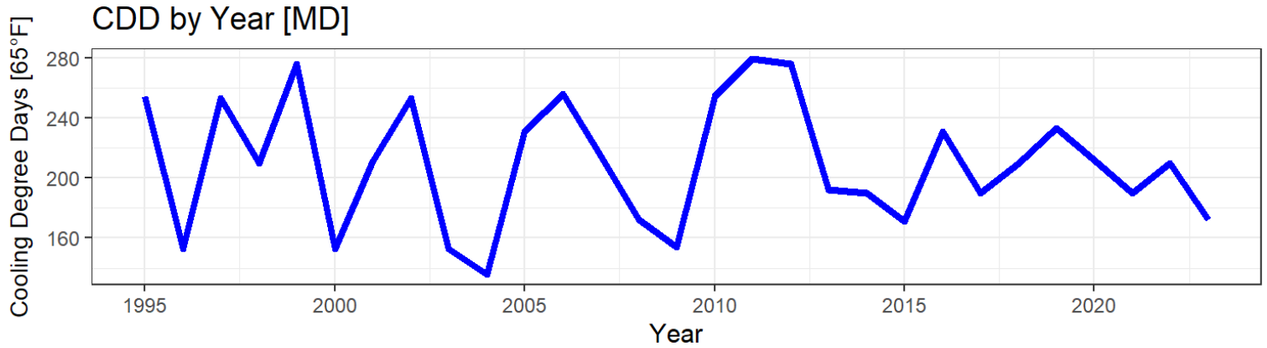

**For exceptional events and policy relevance, the ability of a model to recreate the precursor mixture is of paramount importance!**

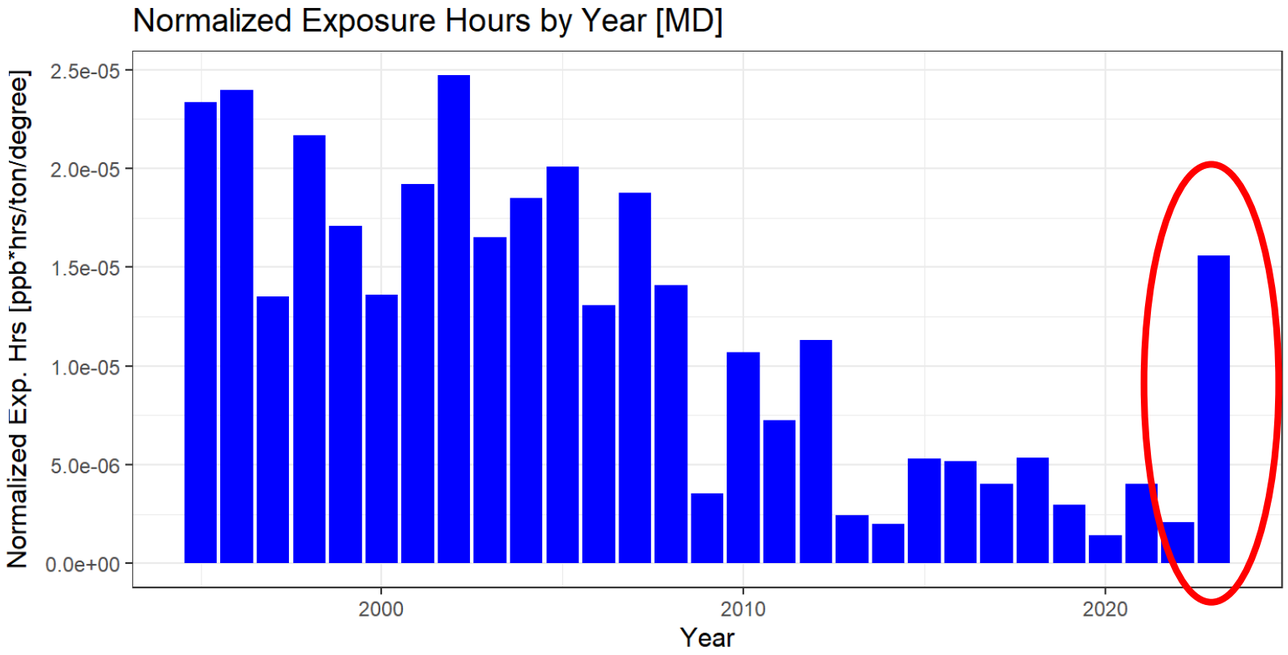
**Same fire region, different results; Modest ozone on June 7-8; Record highest ozone on the eastern half of the country on June 29**

# 2023 Exp. Hrs. Normalized



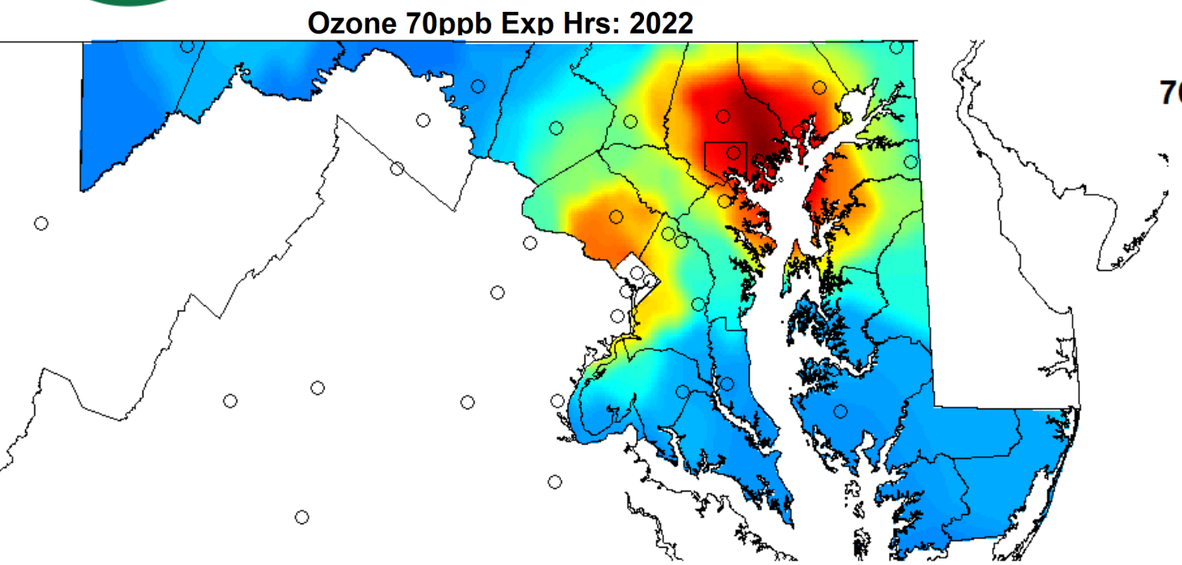



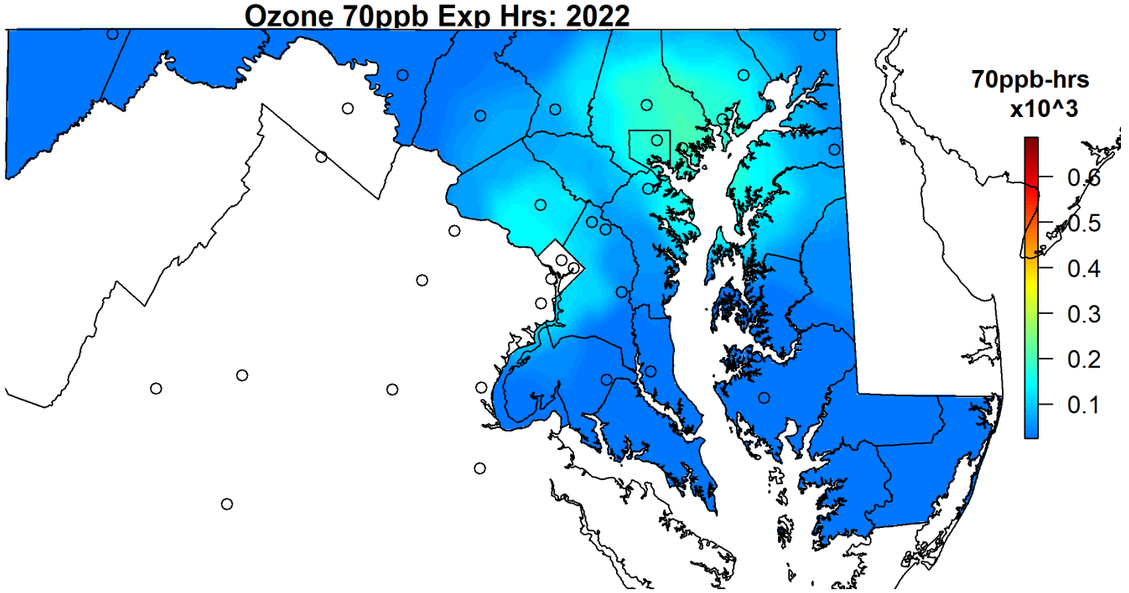



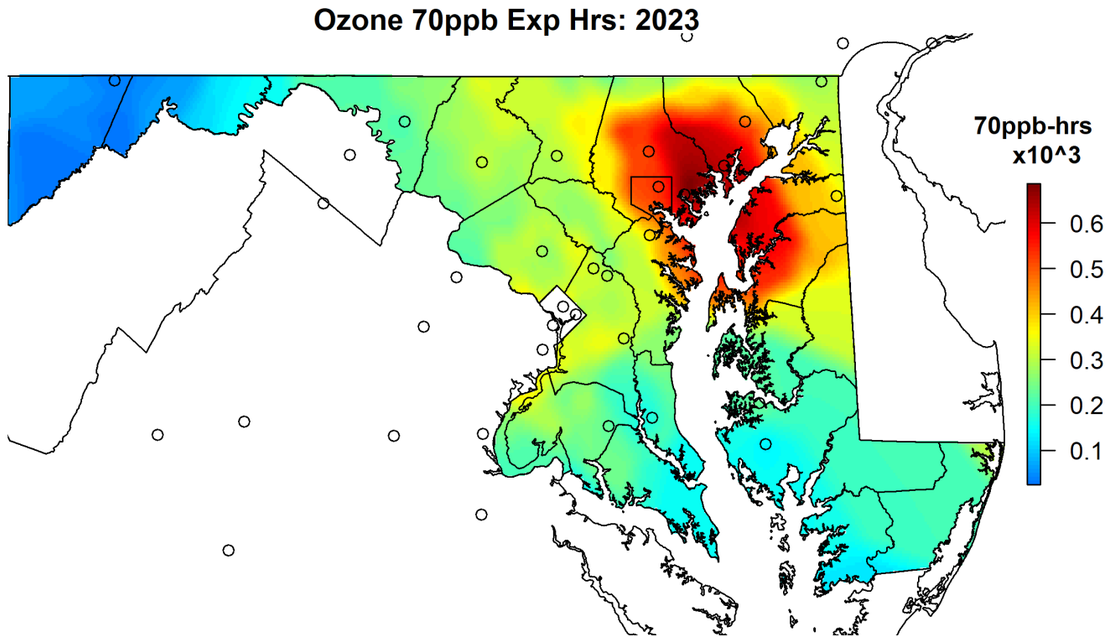




- Normalized Exposure Hours by regional EGU NOx and Cooling Degree Days in Maryland show 2023 was the highest year since 2007
- Accounting for season temperature and changes in NOx indicate 2023 was as effective at “making” or sustaining ozone above 70 ppb as 2 decades ago.

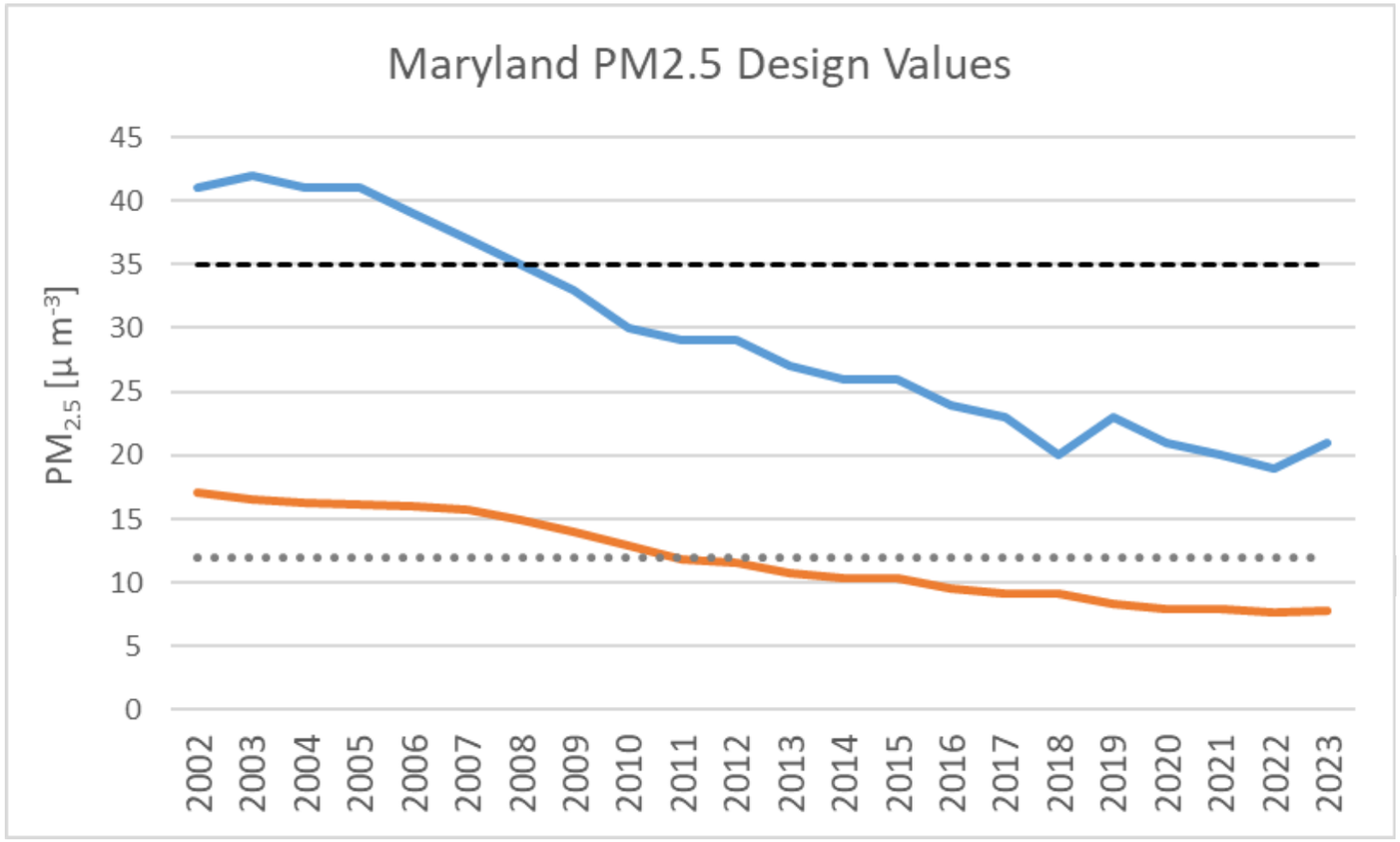
# Ozone Exposure Hours @ 70ppb: 2023

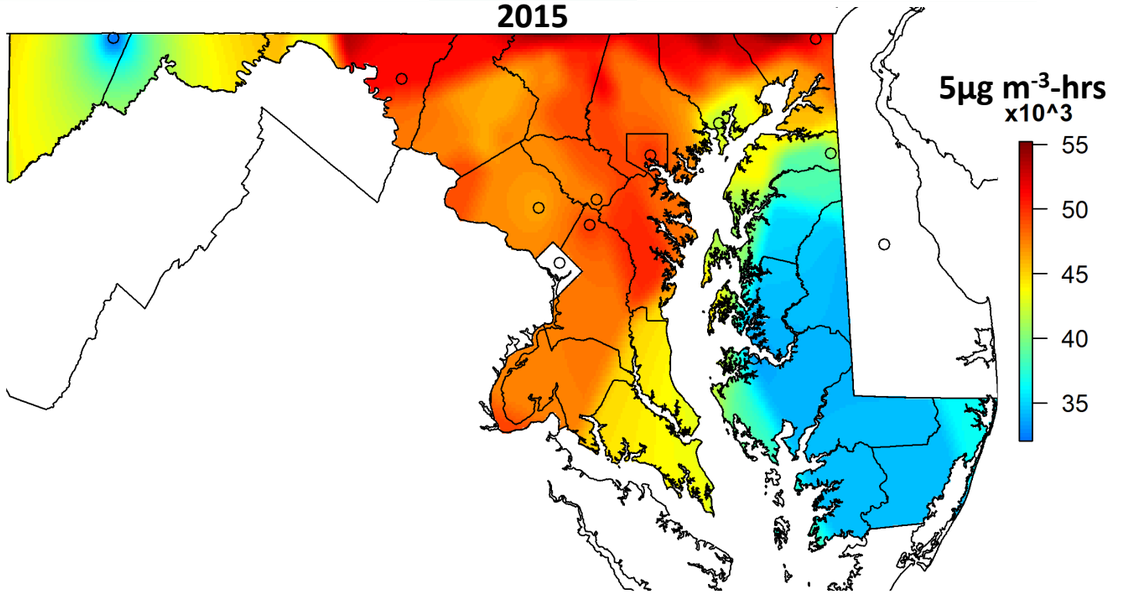


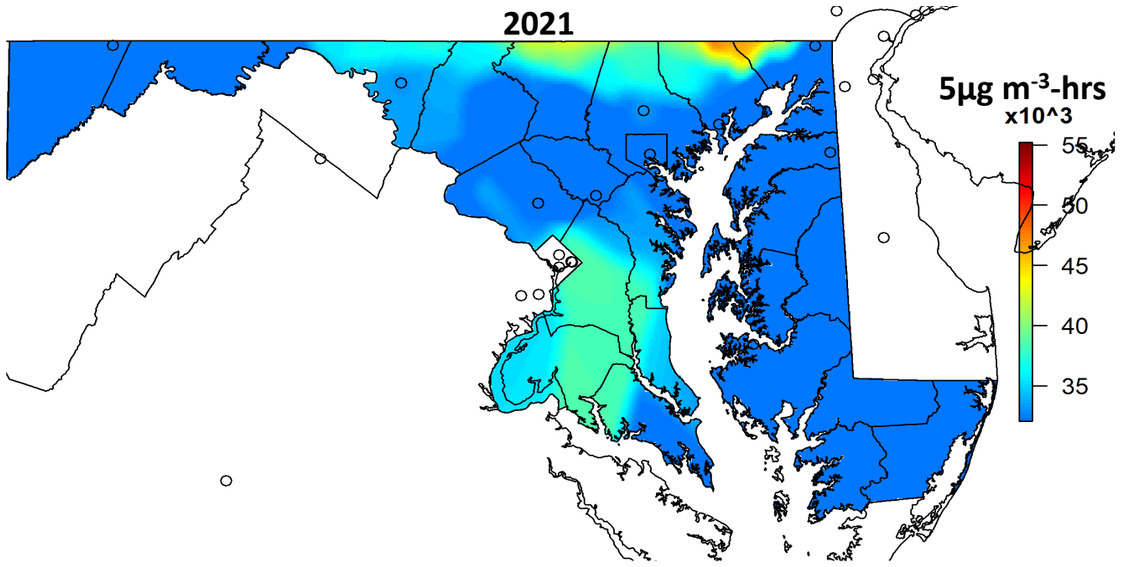



# Decades of Progress: DVs & $PM_{2.5}$ Exposure Hours @ 5 µ $m^{-3}$



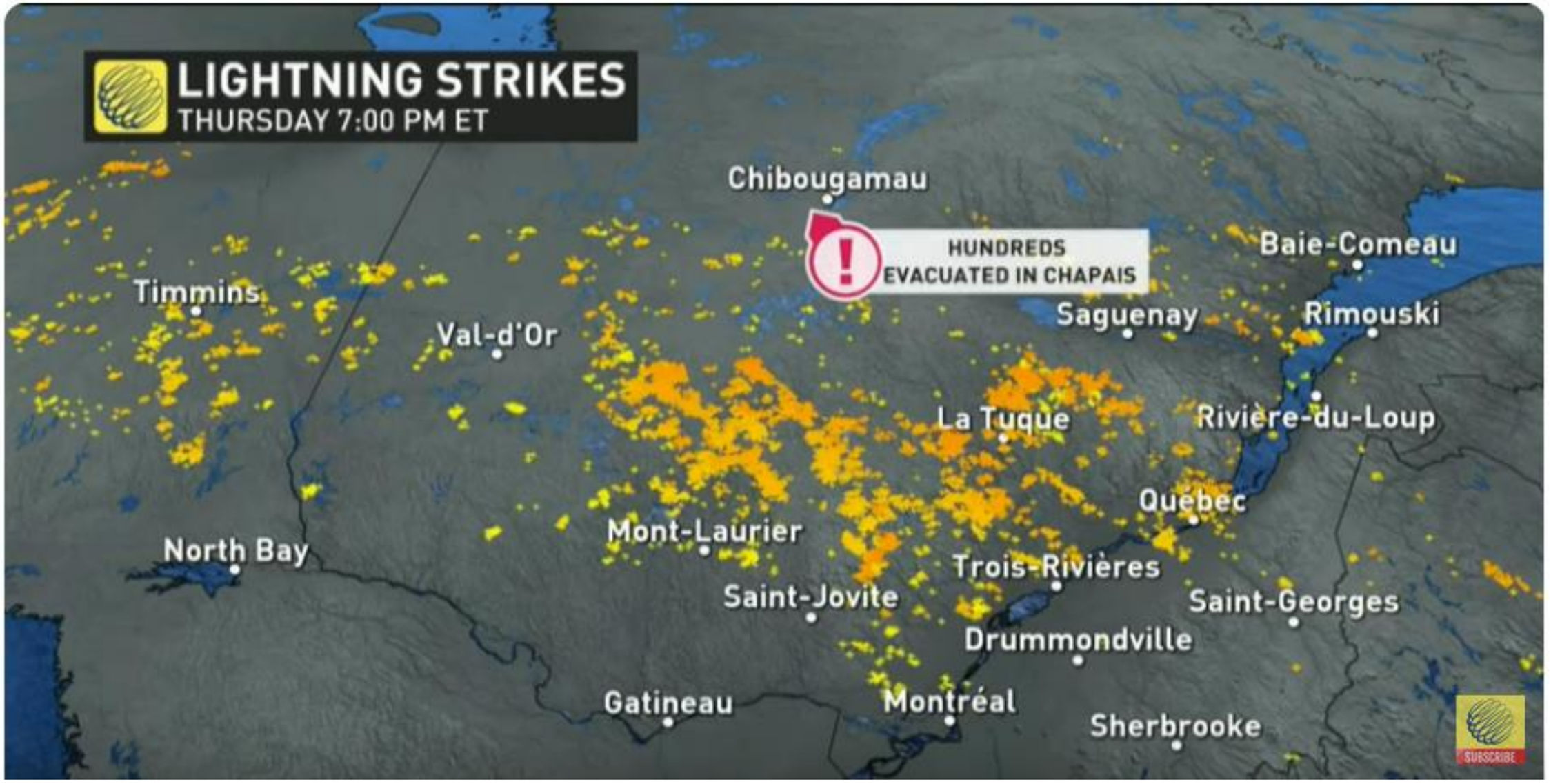




Maryland has also improved fine particle pollution ($PM_{2.5}$) exposure.

Maryland has met the standards for $PM_{2.5}$ since 2011.

# Lightning Strikes – Thursday, June 1, 2023




https://www.youtube.com/watch?v=CDYkr3QS3lY