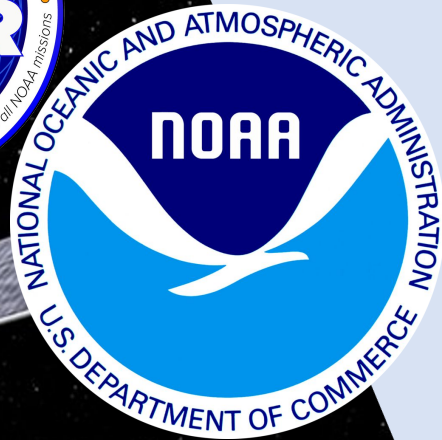




Session 4: Air Quality Research, Applications, and Products
48th Annual Climate Diagnostics and Prediction Workshop (CDPW)
21st Annual Climate Prediction Applications Science Workshop (CPASW)
March 26, 2024



National Environmental Satellite,
Data, and Information Service

NOAA Satellite Data for Wildfire Smoke: A Case Study of the Historic Early June 2023 Canadian Wildfire Smoke Intrusion

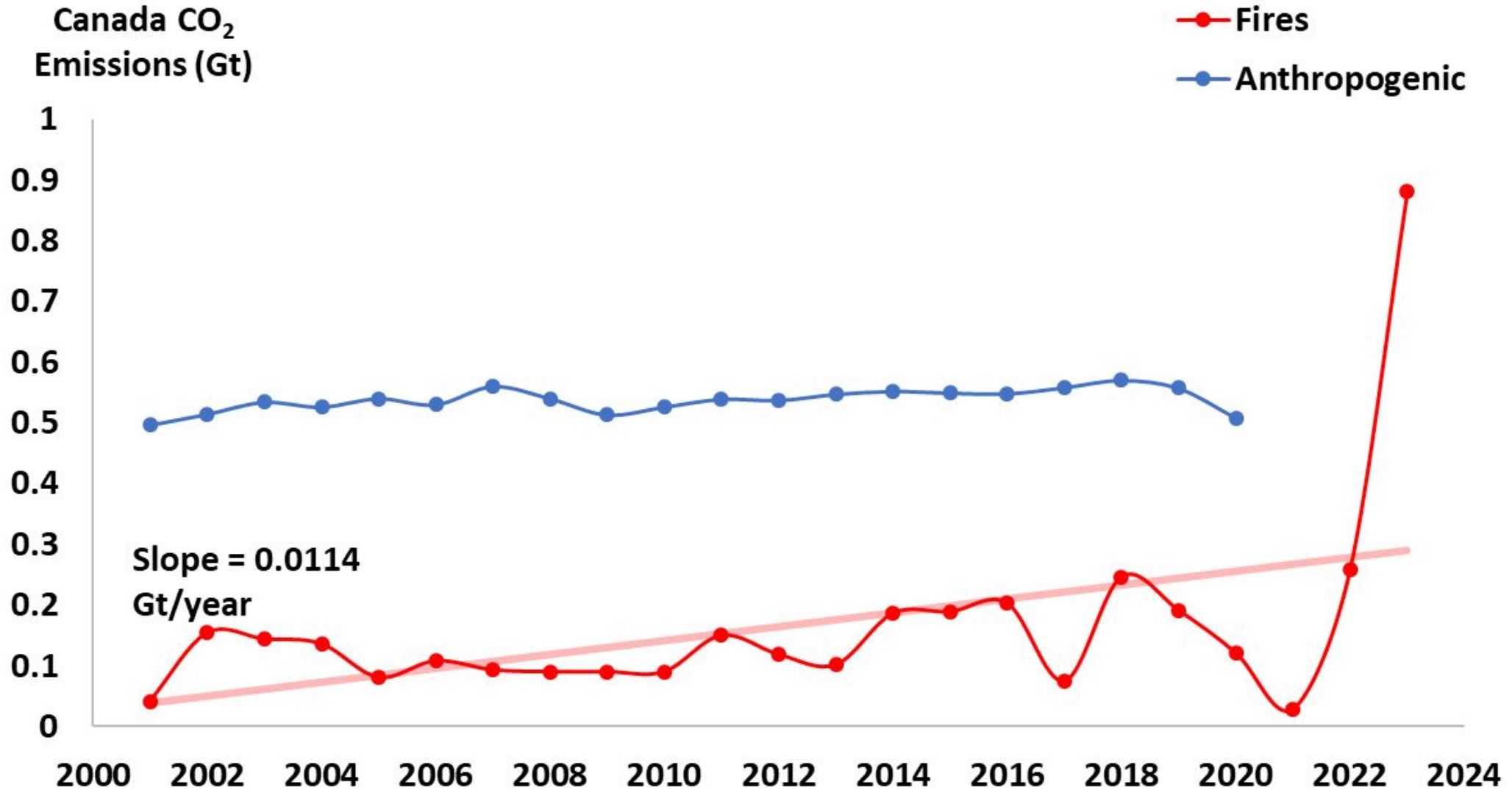
Amy K. Huff¹,
Shobha Kondragunta² and Joel Dreessen³

¹IMSG at NOAA/NESDIS/STAR

²NOAA/NESDIS/STAR

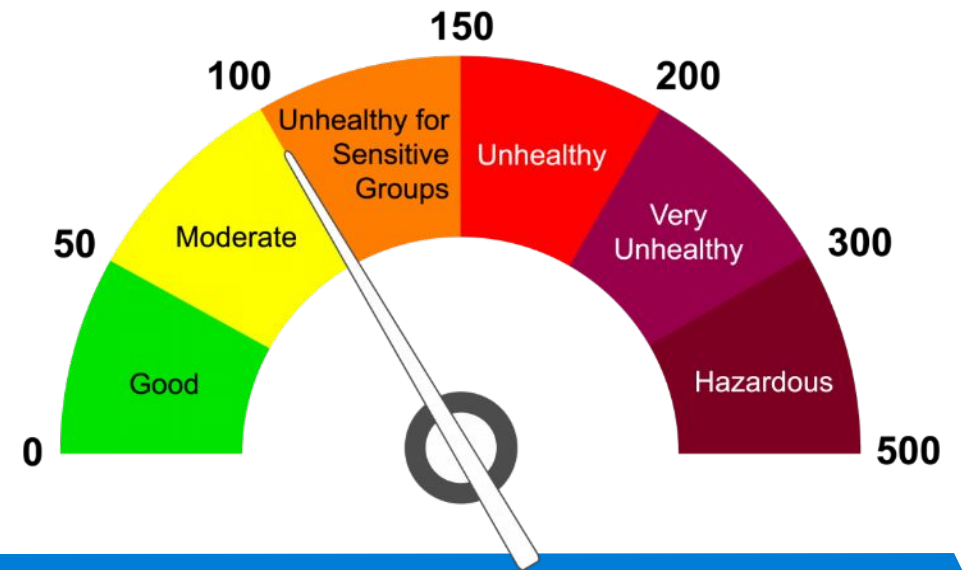
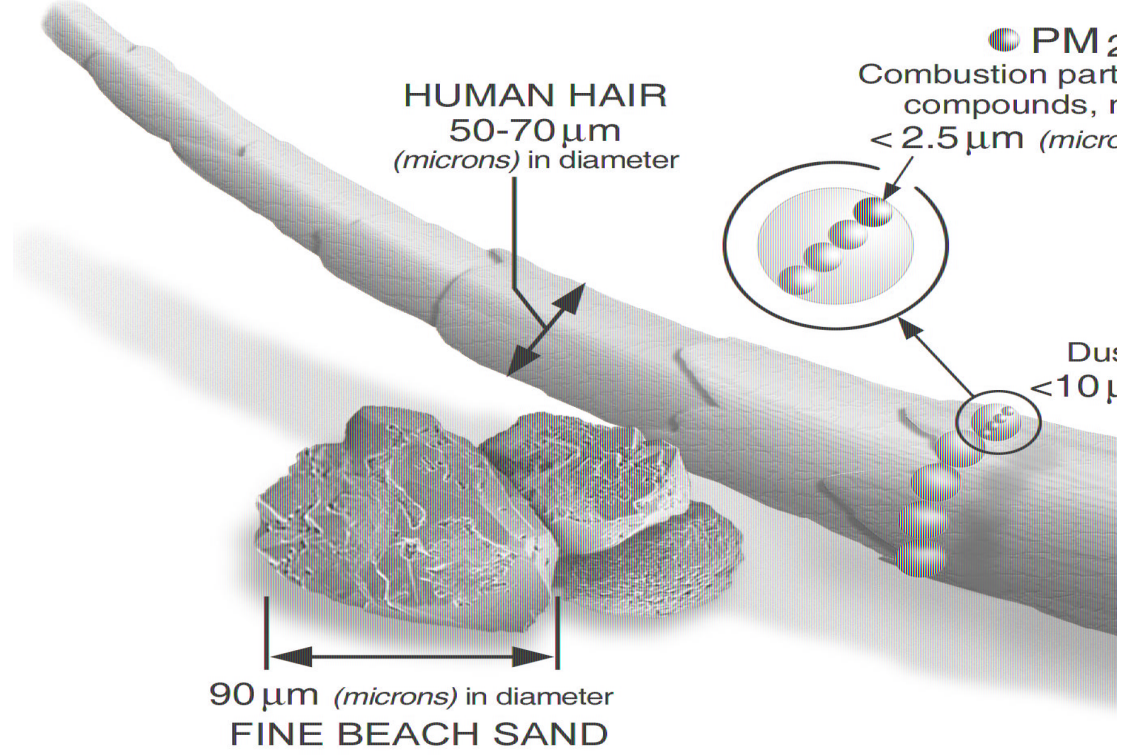
³Maryland Department of the Environment

2023 Canadian Wildfires Were Record-Breaking



Smoke Contains PM_{2.5}

- **PM_{2.5} (fine particulate matter):** very small aerosols, diameter $\leq 2.5\mu\text{m}$
 - Solid, liquid, and mixed phase particles
 - Wide variety of natural & man-made sources
- PM_{2.5} is harmful to human health
 - Particles are so small they penetrate deep into lungs & pass into bloodstream
 - **Sensitive Groups** are at greatest risk: children, seniors, people with existing respiratory or cardiovascular diseases
- US EPA's **Air Quality Index (AQI)** communicates PM_{2.5} concentrations
 - **Code Orange or higher:** take action to limit exposure!

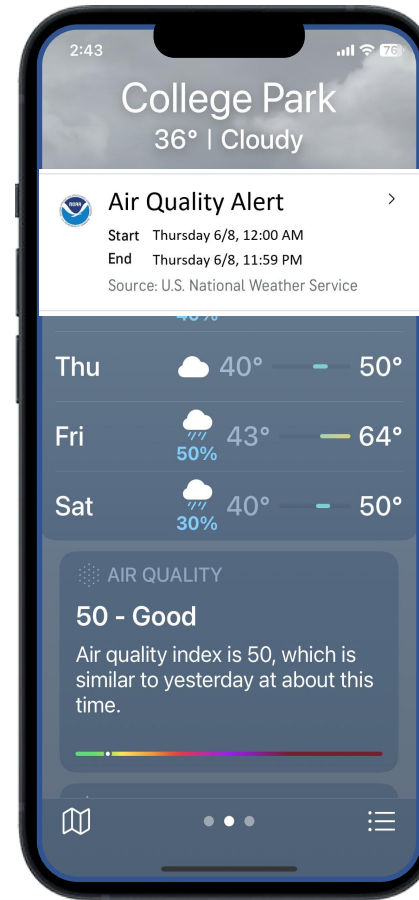


Images credit: [US EPA](#)



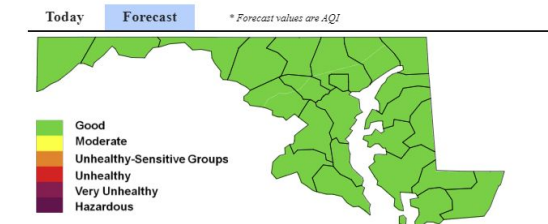
Air Quality Forecasts Protect Public Health

- Issued by **state/county government agencies** (e.g., Maryland Department of Environment)
 - Like a weather forecast, but for expected maximum AQI of chemical pollutants (e.g., O₃, PM_{2.5}, PM₁₀)
 - Find on US EPA’s [AirNow.gov](https://www.airnow.gov), state air quality websites, [EnviroFlash emails](#)
- **Air Quality Alert** issued when pollutant levels expected to exceed US daily National Ambient Air Quality Standards (NAAQS)
 - Like a Winter Storm Warning or Flood Warning
 - Typically triggered by **Code Orange or higher** forecast
 - People can take action to limit their exposure
- **Accurately predicting the impacts of wildfire smoke on PM_{2.5} air quality is a major challenge!**



Air Quality Forecast

Air Quality Forecast



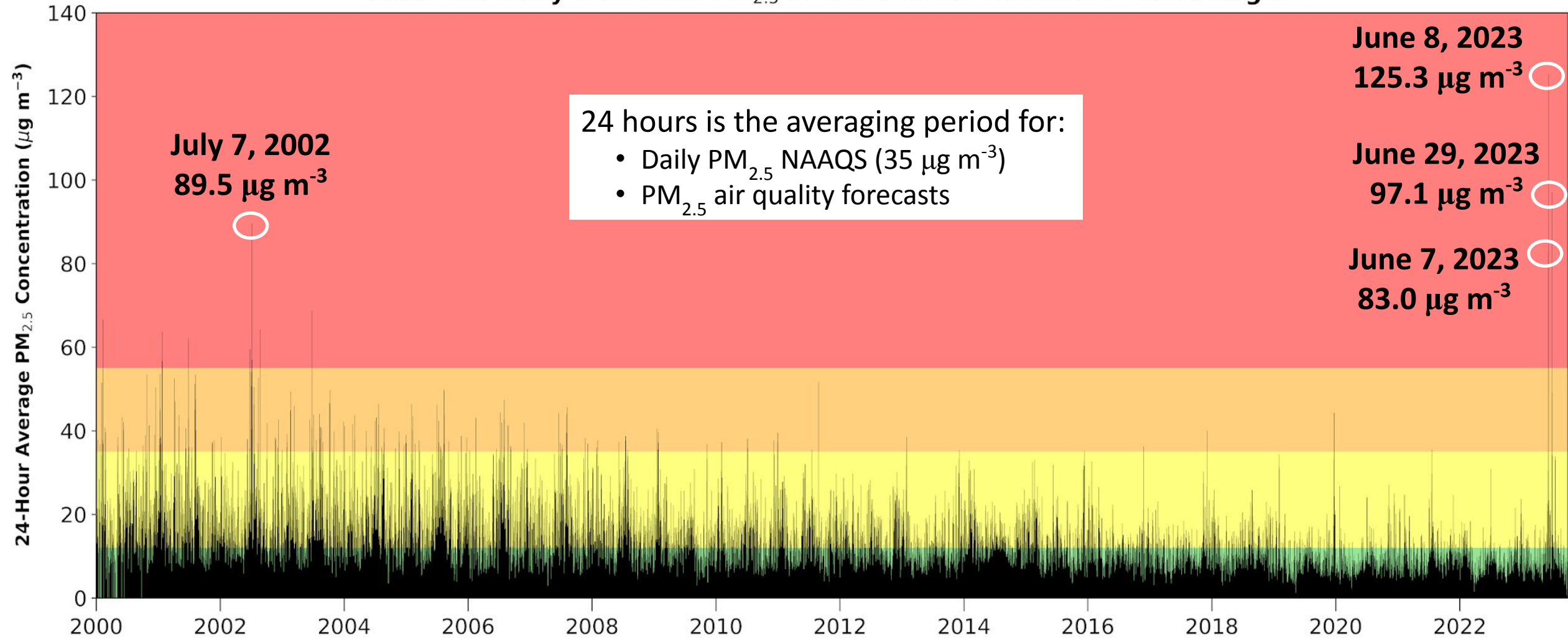
Air Quality Forecast Discussion

Winds turn southerly and weaken Thursday. Good air quality should persist for the daily average for most areas Thursday, but the air mass will steadily degrade through the day towards Moderate range AQI concentrations. Then overnight Thursday into Friday morning, lighter winds over persisting snowpack will foster inversion development, trapping local pollution and creating a jump in fine particle concentrations. As a result, Moderate AQI due to fine particles is expected Friday for most areas, ahead of and during additional expected light snowfall. Precipitation is expected to be too light to scour accumulated particle pollution. Winds notably increase on Saturday, ushering another blast of cold, but clean Canadian air resulting in Good air quality. For the latest air quality information, please visit our website [here](https://www.mde.state.md.us). -MDE

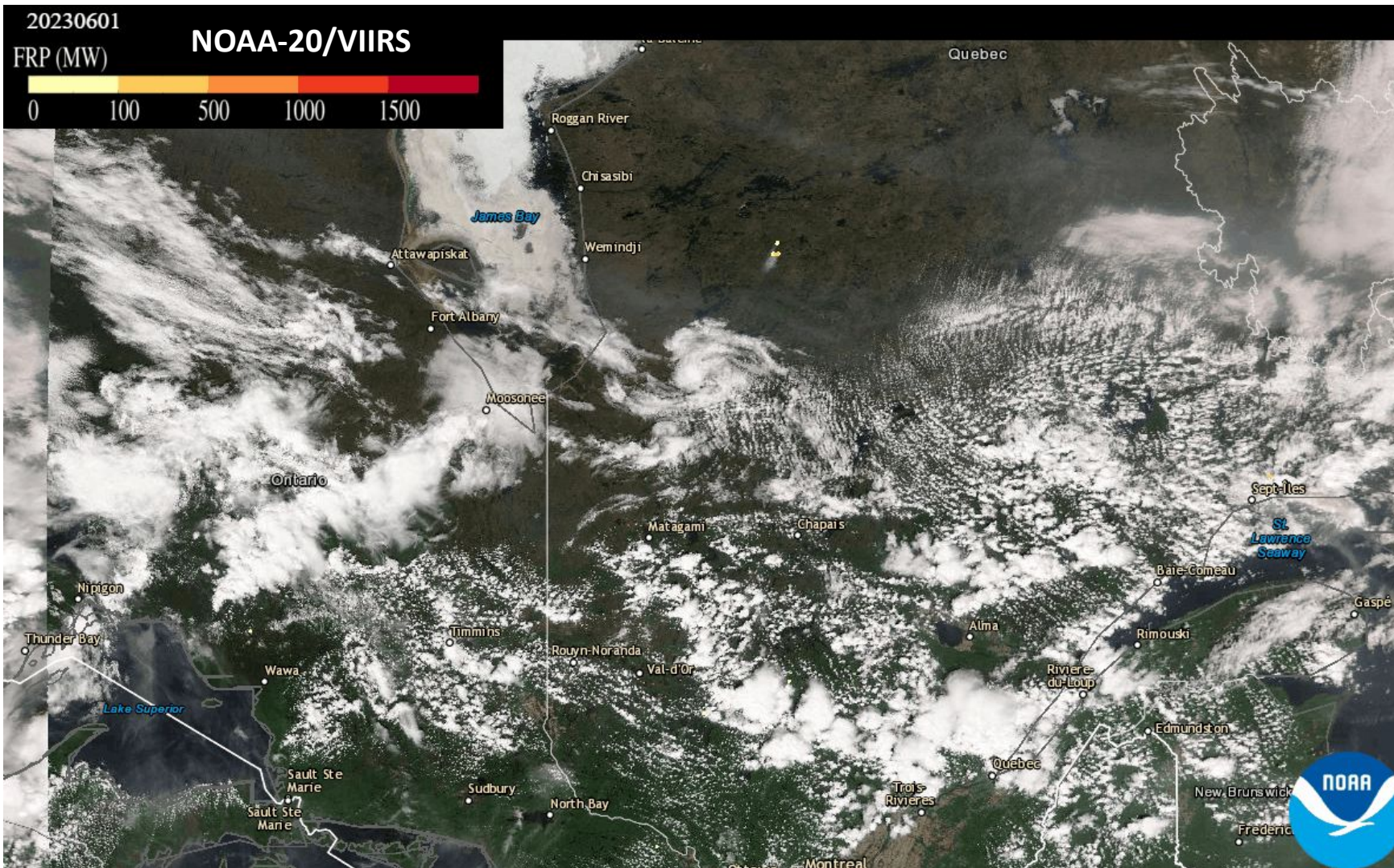


June 2023 Canadian Wildfire Smoke Caused Historic Air Quality

Observed Daily Maximum PM_{2.5} in the Greater Baltimore Metro Region



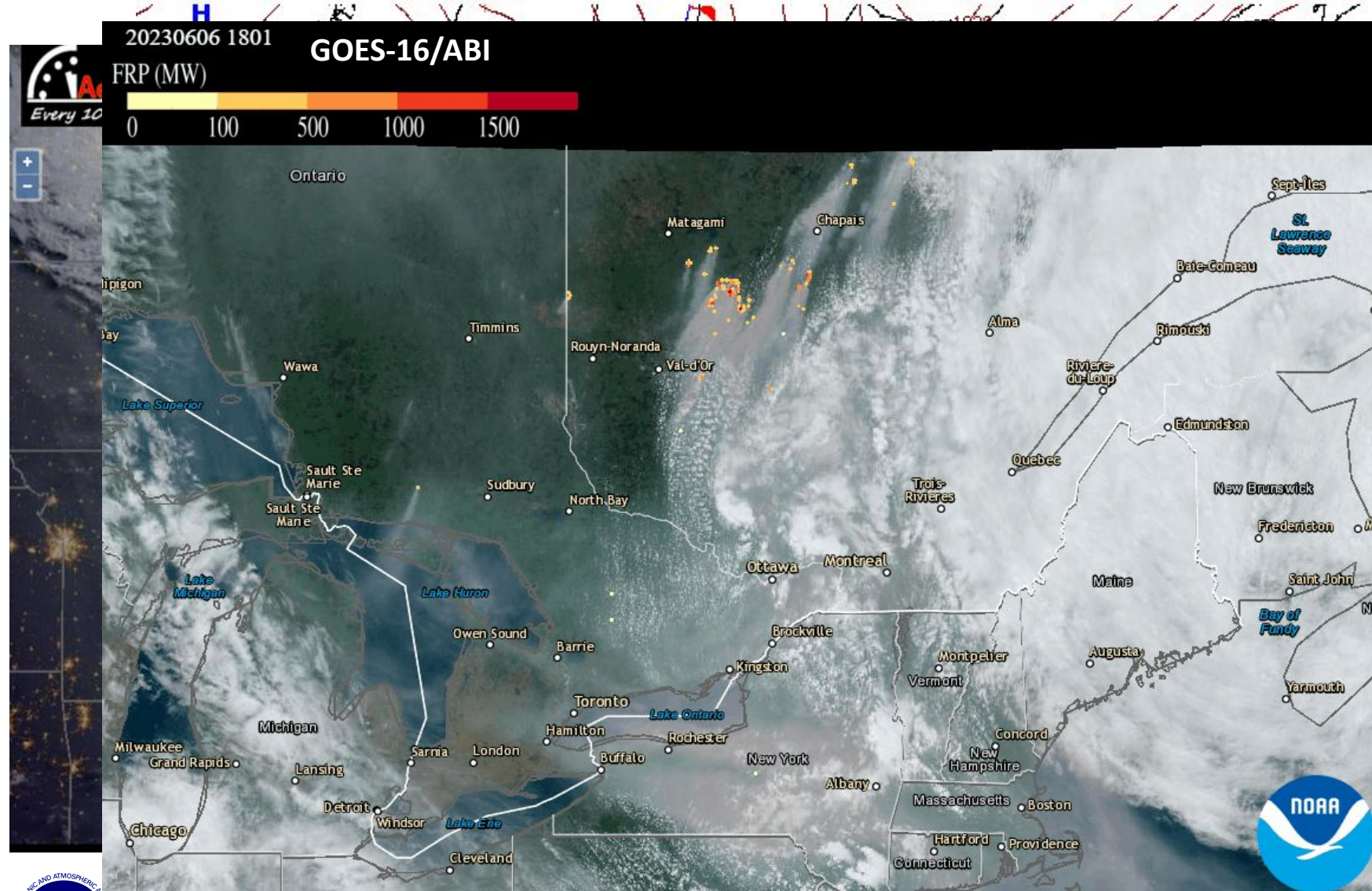
Wildfires Erupt in Québec & Ontario on June 2-3



- Air quality forecasters view **NOAA satellite imagery** daily to monitor fires & smoke
- June 2-3: **NOAA-20/VIIRS** captured the explosive growth of wildfires in Québec & Ontario
 - True color RGB imagery
 - Fire Radiative Power (FRP)
- Wildfires started mainly by lightning
- Released huge plumes of thick brown/grey smoke

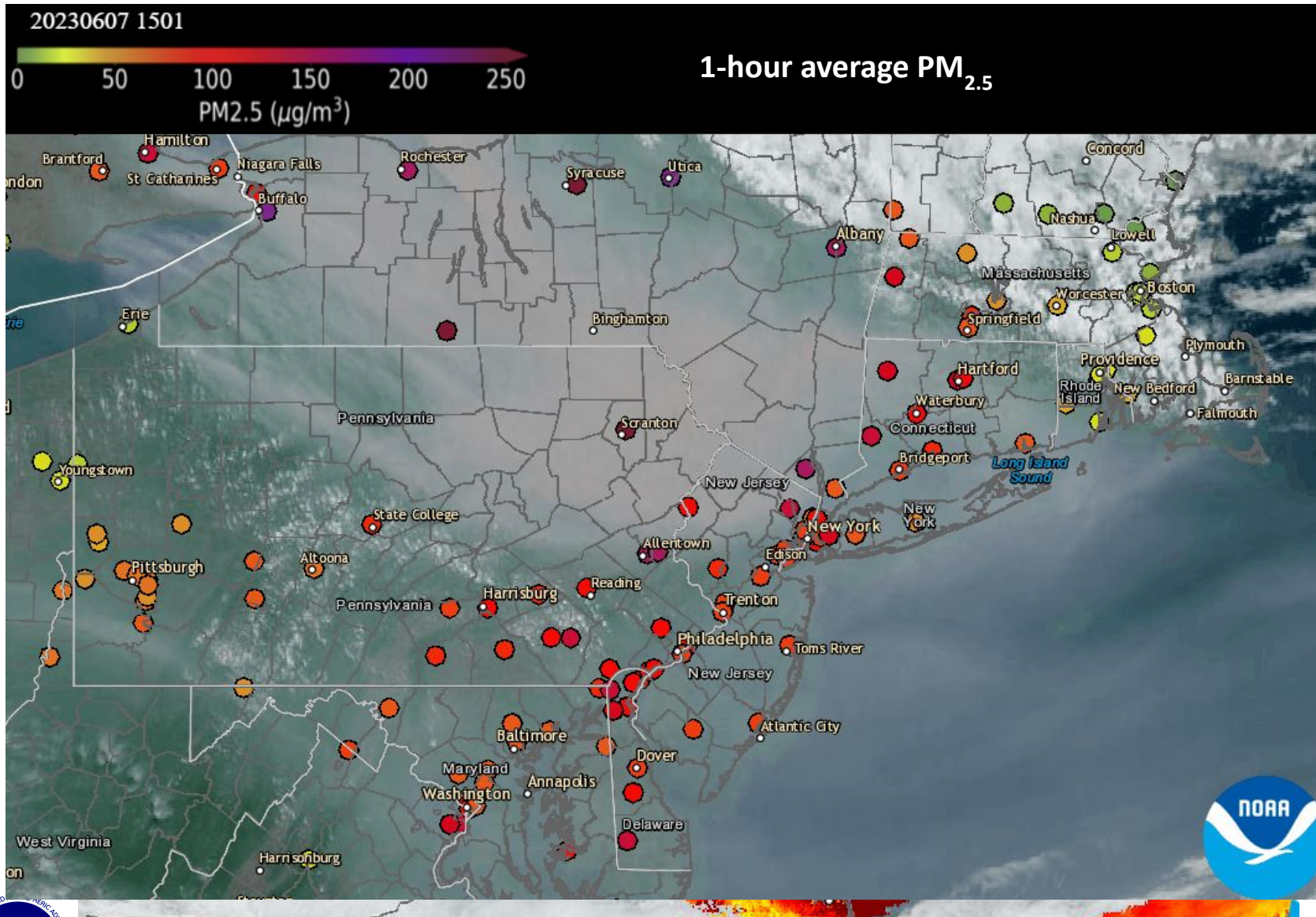


“Wall of Smoke” Moves Southward on June 6



- June 6: **GOES-16/ABI** imagery showed very thick smoke moving into the Northeast US
 - **GeoColor RGB** imagery
 - **Fire Radiative Power (FRP)**
- Satellite imagery conveyed the historic nature of the event to forecasters
- Smoke transport driven by a Low pressure system over Canadian Maritimes
 - Northerly winds on the western periphery of the Low
 - “Funneled” thick smoke southward

Very Thick Smoke Reaches Maryland on June 7



- June 7: **GOES-16/ABI Aerosol Optical Depth (AOD)** showed embedded pulse of very thick smoke
 - Dark red shading, AOD >1
 - Smoke steadily moving southward
- PM_{2.5} monitors (colored dots) confirmed smoke was reaching the surface & impacting air quality
- **NOAA satellite imagery** helped forecasters track the smoke's:
 - Magnitude
 - Timing
 - Progress

Accurate Code Red PM_{2.5} Forecasts Issued for Baltimore on June 7-8

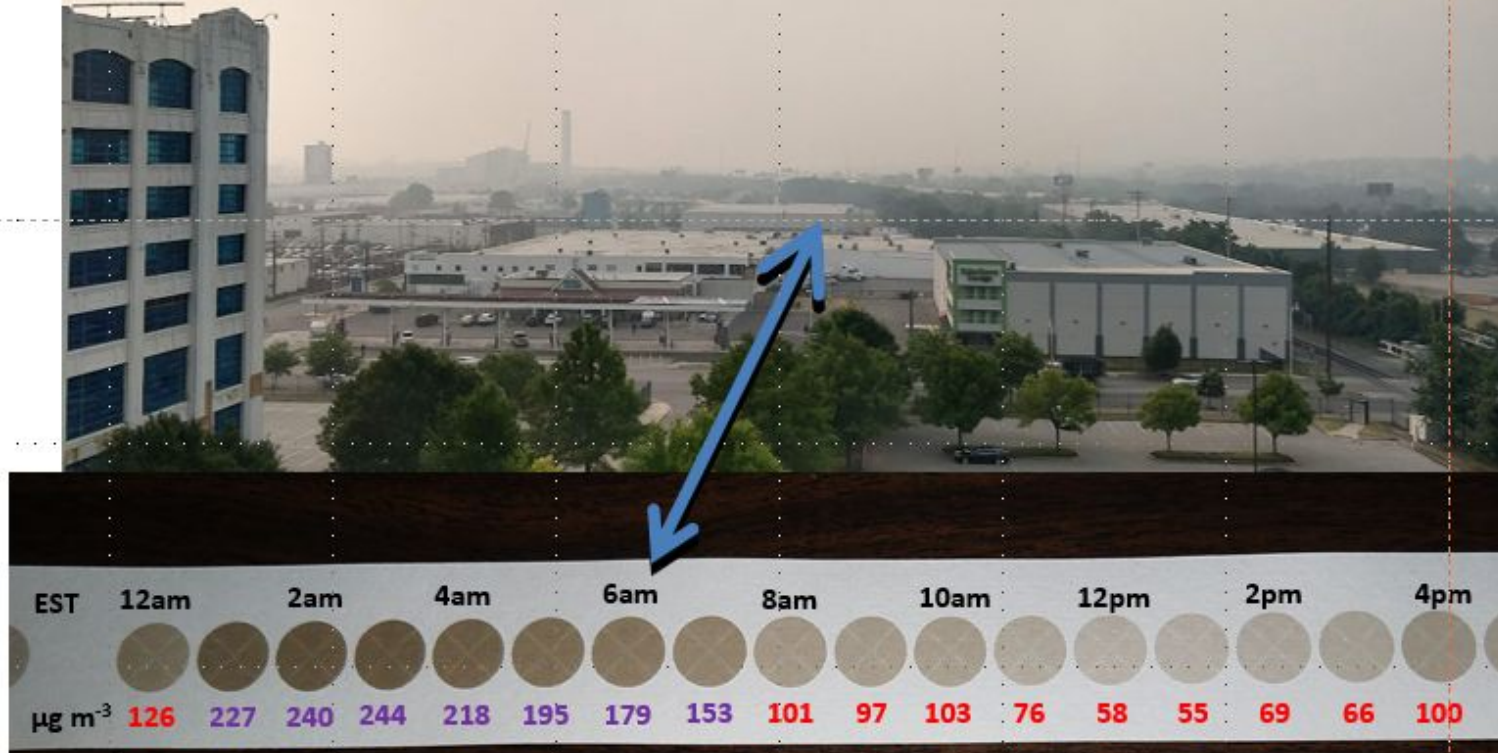
Observed

June 8, 2023
7:00 am EDT

1-hour PM_{2.5} = 179 $\mu\text{g m}^{-3}$

View from MDE Office in downtown Baltimore, MD

- **Code Red PM_{2.5} Air Quality Alerts** for Baltimore on June 7-8
 - Extremely rare!
 - Never before issued by current forecasters, going back to 2013
 - Forecasts verified!
- **NOAA satellite imagery facilitated the accurate PM_{2.5} forecasts!**
- Highest observed daily PM_{2.5} in history in Baltimore on June 8: **125.3 $\mu\text{g m}^{-3}$** for 24-h average
 - Tape from PM_{2.5} regulatory monitor (BAM₂)
 - Darker grey = higher PM_{2.5} concentrations from smoke aerosols



- NOAA satellite imagery provides critically vital observations during smoke transport events
 - Helps operational air quality forecasters issue accurate alerts to public
 - Allows people to take action to minimize exposure to harmful conditions
- Air quality forecasters use NOAA's **AerosolWatch** website!
 - Designed to meet the needs of the operational air quality community
- Near real-time aerosols & fire satellite imagery
 - 2km resolution GOES-East & -West imagery updated every 10 minutes
 - 750m resolution SNPP & NOAA-20 VIIRS imagery for Exceptional Events
 - Archive back to January 2018
- Coming soon: Hourly PM_{2.5} estimated from GOES-East & -West AOD
 - Fills gaps in PM_{2.5} monitor network, especially in rural areas
- Follow us on X (formerly Twitter) for news & updates



CONUS Full Disk

▼ GOES-East Layers

- GeoColor
- + Dust RGB
- + Fire RGB
- + AOD
- + AOD Composite
- + Smoke Dust Mask
- + Fire

▼ GOES-West Layers

▼ VIIRS Layers (SNPP)

▼ VIIRS Layers (NOAA-20)

▼ TROPOMI Layers

▼ PM2.5 Layers

- + Daily AOD-estimated PM2.5
- + Hourly PM2.5
- + Daily PM2.5

▼ Labels Layer