

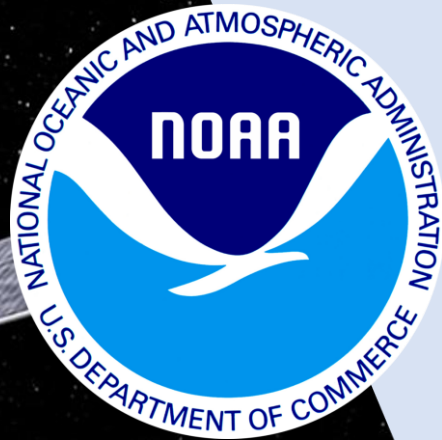
Smoke Exposure Hazards from Wildfires

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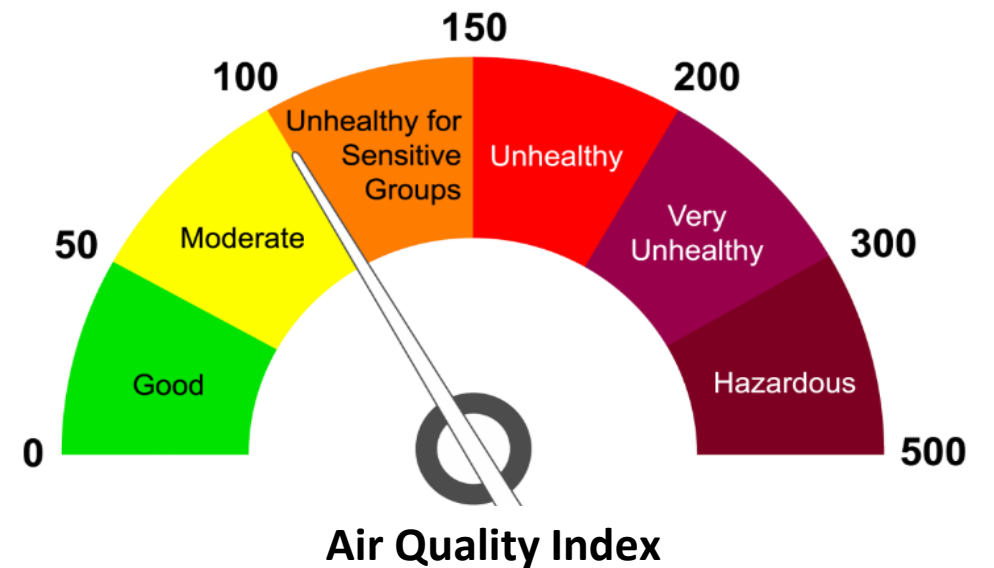
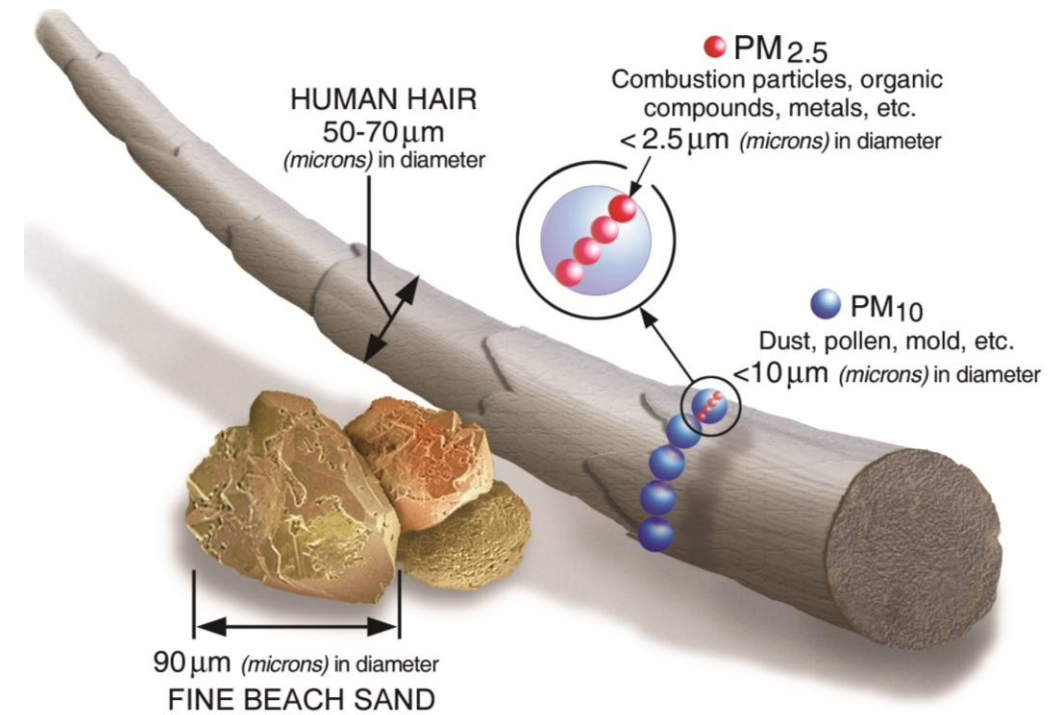


National Environmental Satellite,
Data, and Information Service

Presentation 5.7
Fire and Smoke Session
AC-VC-22
June 3, 2026

Wildfire Smoke Contains PM_{2.5}

- PM_{2.5} (fine particulate matter): very small aerosols, diameter $\leq 2.5\mu\text{m}$
 - 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
- **Daily (24-hour average) PM_{2.5} National Ambient Air Quality Standard (NAAQS): $35\mu\text{g}/\text{m}^3$**
- US EPA's Air Quality Index (AQI) communicates PM_{2.5} concentrations
 - Unitless scale, 0-500
 - Code Orange or higher (AQI ≥ 100): take action to limit exposure



Early June 2023 Wildfire Smoke

- June 3-9, 2023
- Explosive growth of wildfires in southern Québec & eastern Ontario
- Low pressure system moved over the Canadian Maritimes
- Winds on western periphery of low:
 - Initially blew smoke into Great Lakes region, June 3-5
 - Winds shifted, funneling thick smoke southward into Northeast US June 6-8

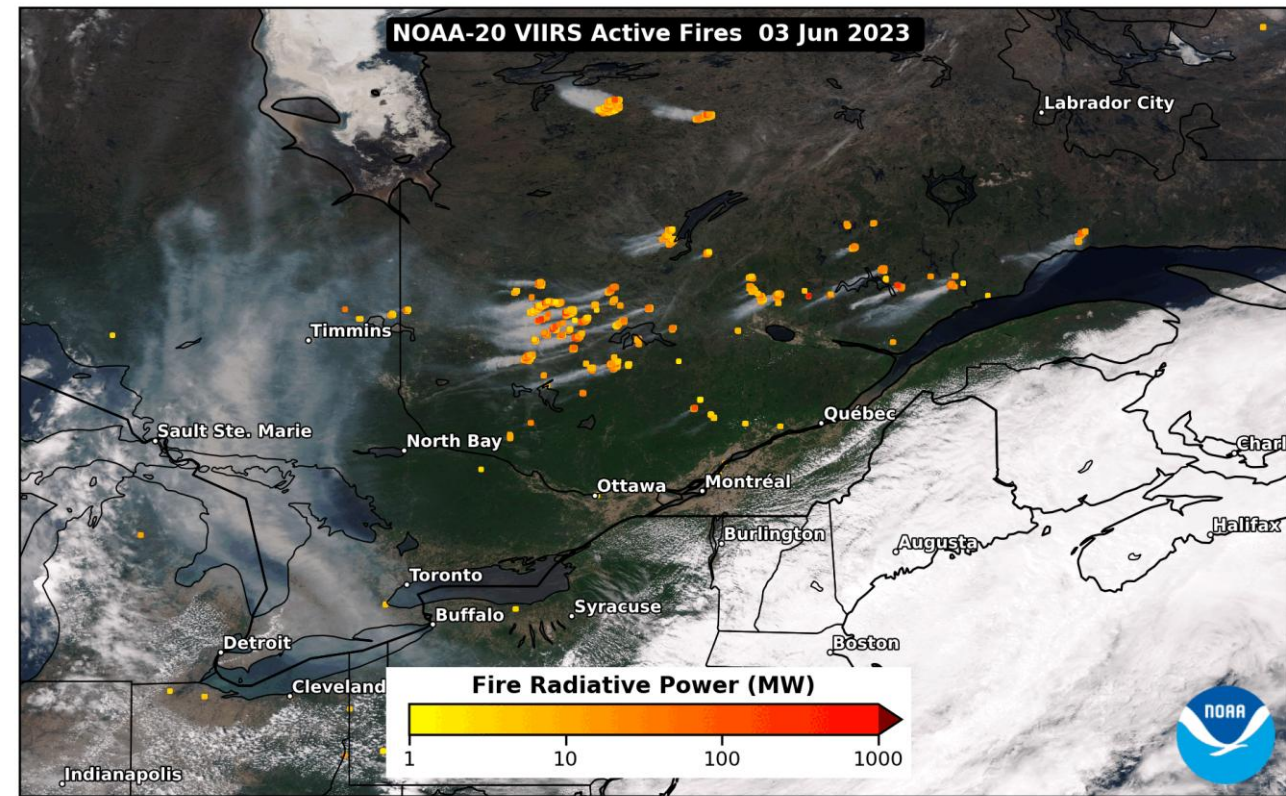


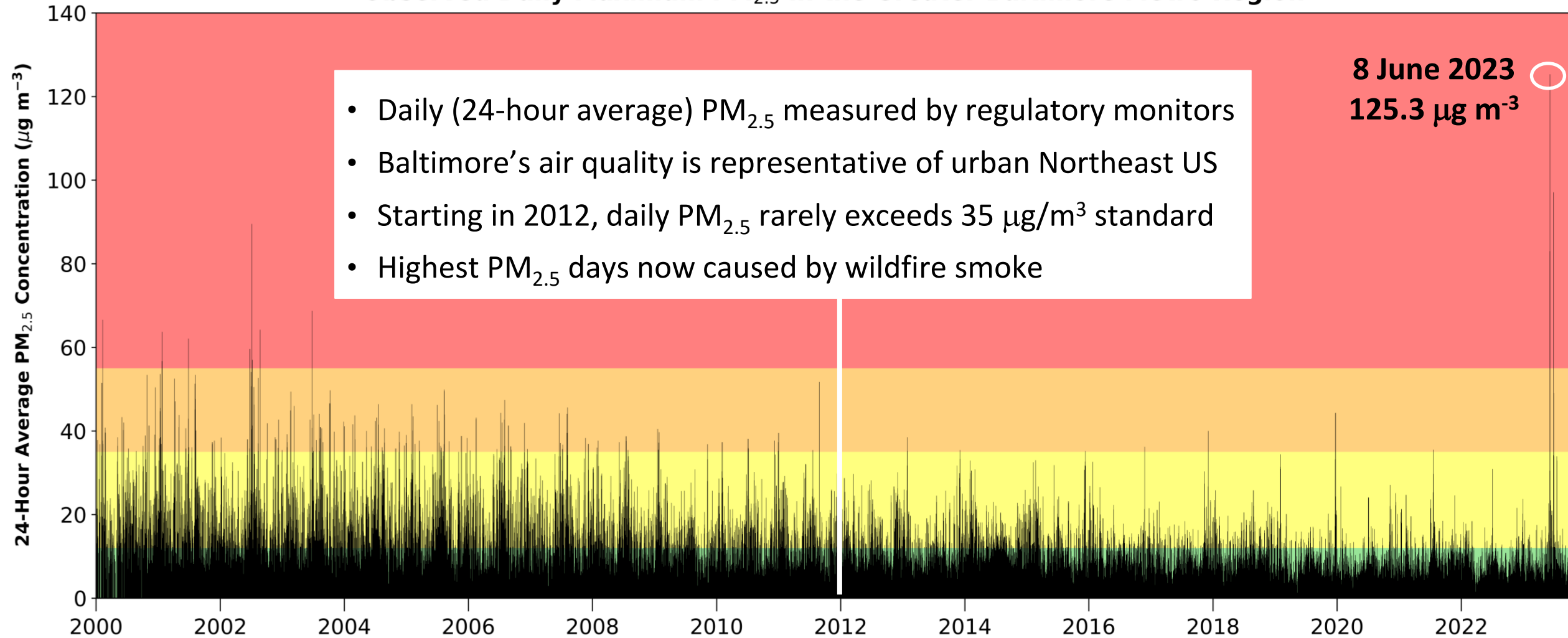
Photo: Dave Sanders for The New York Times

The New York Times Smoky Air Disrupts Life in the Northeast

A hazy plume from Canadian wildfires delayed flights and prompted the cancellation of three big New York theater productions and two Major League Baseball games. Gov. Kathy Hochul of New York called the worsening air quality “an emergency crisis.”

Wildfire Smoke Responsible for Highest PM_{2.5} in Northeast US

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



Calculating Population Exposure to PM_{2.5}

- Datasets:

- [Gridded Population of the World \(GPW\)](#)

- Global population count in 2020
 - Number of persons per grid cell
 - ~4.6 km resolution

- Daily (24-hour average) surface PM_{2.5} estimated from VIIRS aerosol optical depth (AOD)

- [Algorithm](#) developed by Hai Zhang uses PM_{2.5} measured by regulatory monitors and satellite AOD in a geographically weighted regression (GWR) model
 - Captures temporal and spatial variations in the satellite AOD/surface PM_{2.5} relationship
 - 4 km resolution; covers the CONUS, southern Canada, northern Mexico

Center For International Earth Science Information Network-CIESIN-Columbia University. Gridded Population of the World, Version 4 (GPWv4): Population Count, Revision 11. 4.11, Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC), 2018, doi:10.7927/H4JW8BX5

- Approach:

- Regrid satellite PM_{2.5} data to the GPW grid
 - Treat population grid as the fixed reference frame
 - Subset both datasets to geographic region of interest
 - Sum number of people corresponding to each AQI PM_{2.5} concentration range

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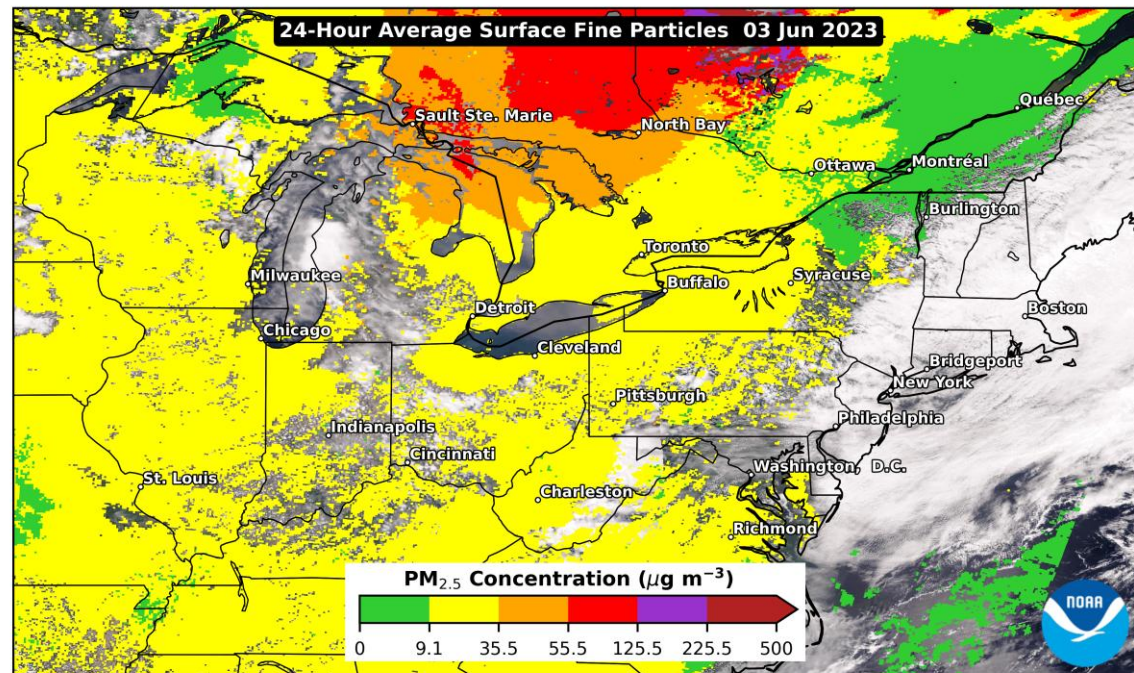
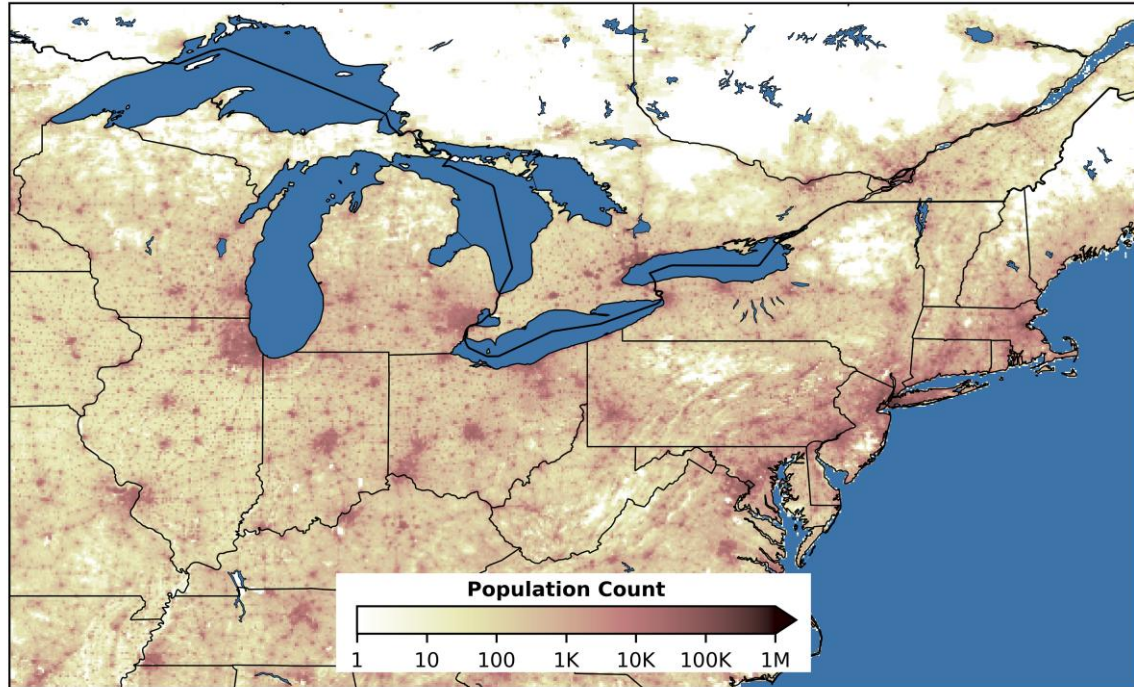
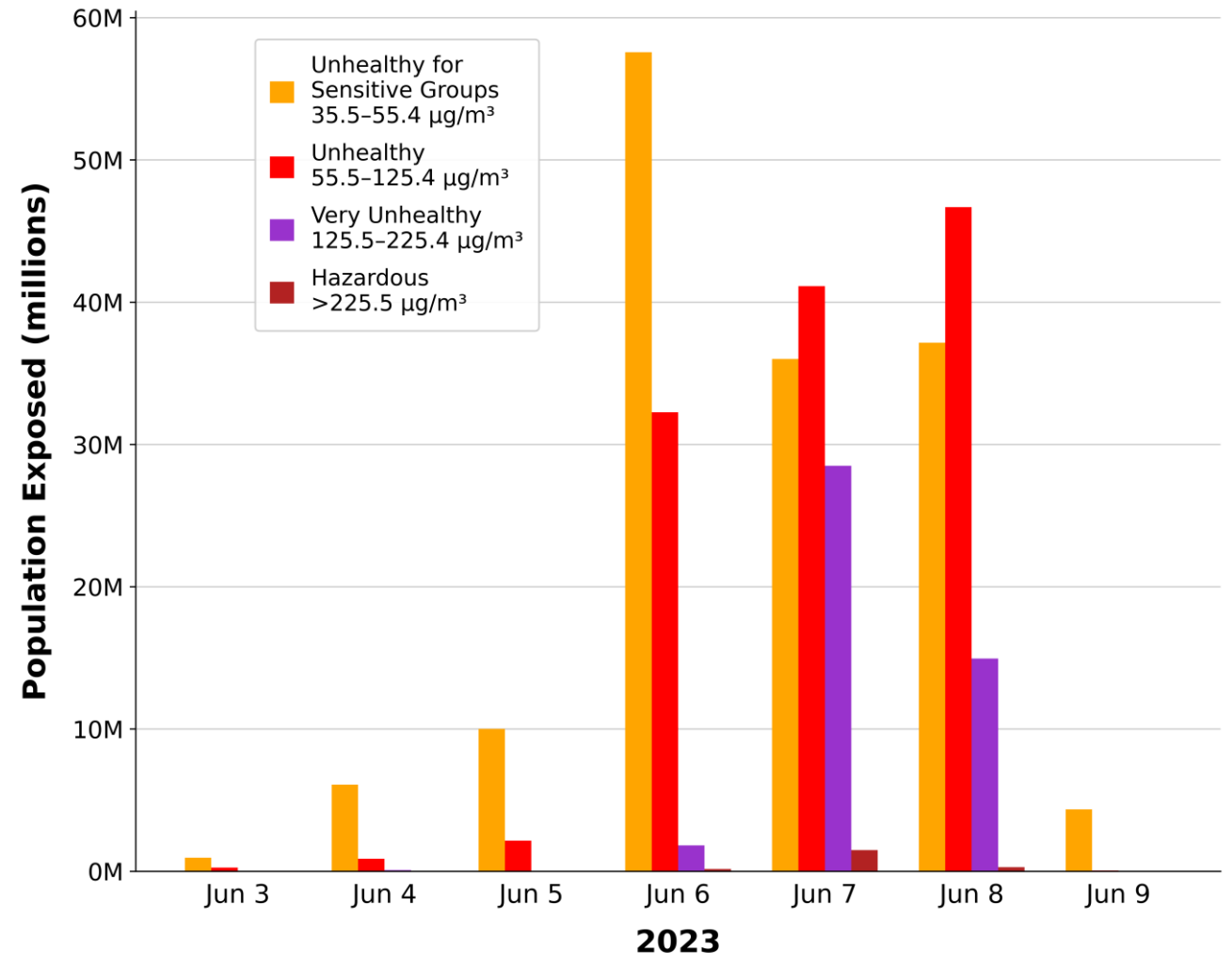
Daily and Hourly Surface PM_{2.5} Estimation From Satellite AOD

Zhang, H., & Kondragunta, S. (2021). Daily and hourly surface PM_{2.5} estimation from satellite AOD. *Earth and Space Science*, 8, e2020EA001599. <https://doi.org/10.1029/2020EA001599>



Population Exposed to PM_{2.5} Each Day of Smoke Event

- Millions of people exposed to the harmful AQI categories of PM_{2.5}, exceeding the daily NAAQS (PM_{2.5} >35 µg/m³)



Population Exposed to Maximum PM_{2.5} during Event

- Highest daily PM_{2.5} AQI concentration at each pixel during the 7-day smoke event, June 3-9
- Millions of people exposed to the worst PM_{2.5} at their location during the event
 - Densely populated metro regions in Northeast US (New York City, Philadelphia, Washington DC) experienced highest PM_{2.5}, very high exposure
 - Highest PM_{2.5} also in rural areas of Québec & Ontario near fires, but few people live there so low exposure
- **Straightforward method to quantify air quality health hazards from exposure to wildfire smoke**
 - Relies on satellite data
 - Leverages US federal guidance on PM_{2.5} health effects
 - Assumes all high PM_{2.5} due to smoke (true for this region)
 - Limitation: no satellite PM_{2.5} for cloud-covered locations

