



Partner



**GMAO**



# Satellite data in Air Quality Operations new capabilities, challenges, & opportunities

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# Don't Forget the Basics: satellite imagery of sources & impacts

## Satellites support situational awareness of:

- Thermal Anomalies
- Smoke Plumes
- Dust Clouds
- Prevailing winds
- Burn Scars
- Ship Tracks

## NASA Worldview

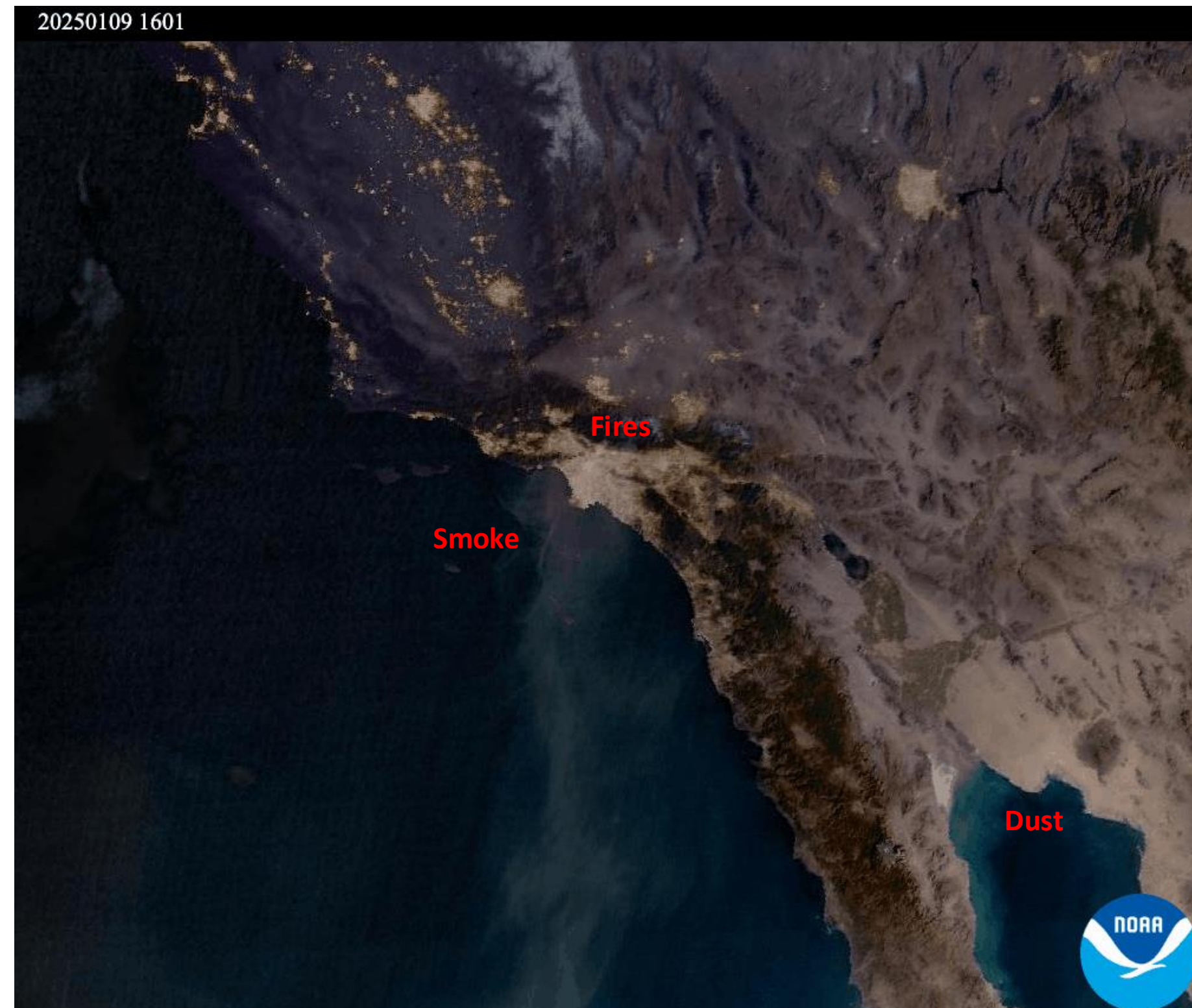
<https://worldview.earthdata.nasa.gov/>

- Aqua & Terra MODIS
- SNPP, NOAA-20, NOAA-21 VIIRS
- PACE OCI
- Landsat 8, Landsat 9 OLI

## NOAA Aerosol Watch

<https://www.star.nesdis.noaa.gov/smcd/spb/aq/AerosolWatch/>

- GOES-East, GOES-West ABI



Source: NOAA Aerosol Watch, <https://www.star.nesdis.noaa.gov/smcd/spb/aq/AerosolWatch/>





# New Capabilities



# Tropospheric Emissions Monitoring of Pollution (TEMPO)

**Launched 7 April 2023**

Part of a constellation of similar instruments with GEMS (launched 2020) and Sentinel-4 (Launched 2025).

Hourly temporal resolution.  
2 x 4.75 km spatial resolution.

Primary AQ data products:

- NO<sub>2</sub>
- HCHO
- **NEW** 0-2 km O<sub>3</sub> product
- **NEW** Surface PM<sub>2.5</sub>  
(integrated with GOES ABI)



Source: NASA SVS  
<https://svs.gsfc.nasa.gov/5142/>



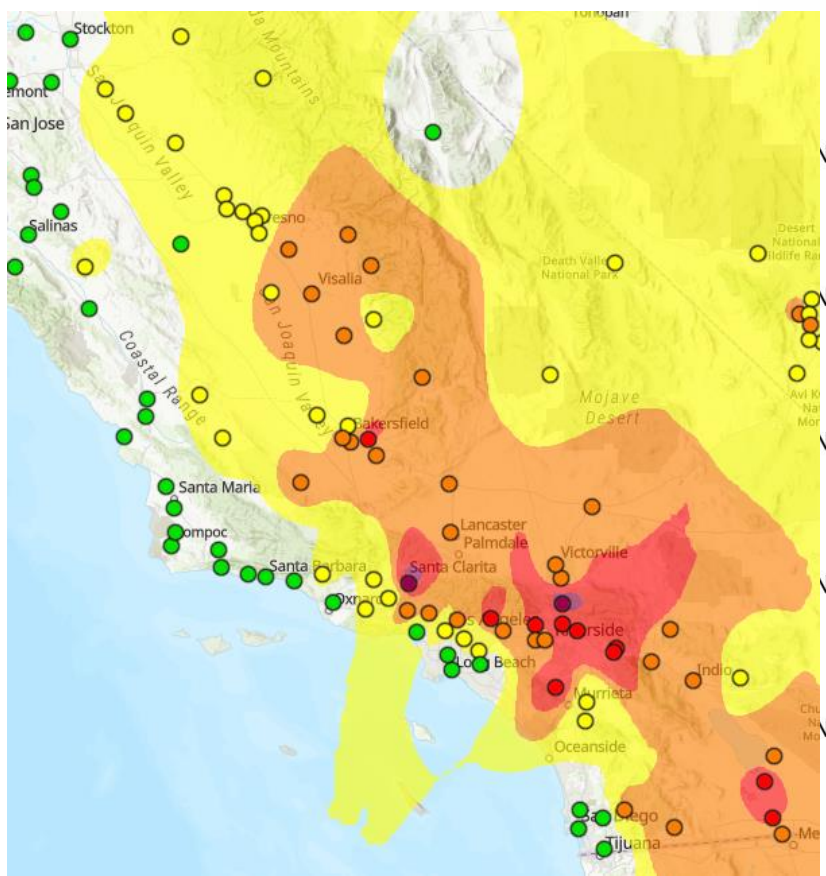


# TEMPO near-surface Ozone, PM<sub>2.5</sub> Products

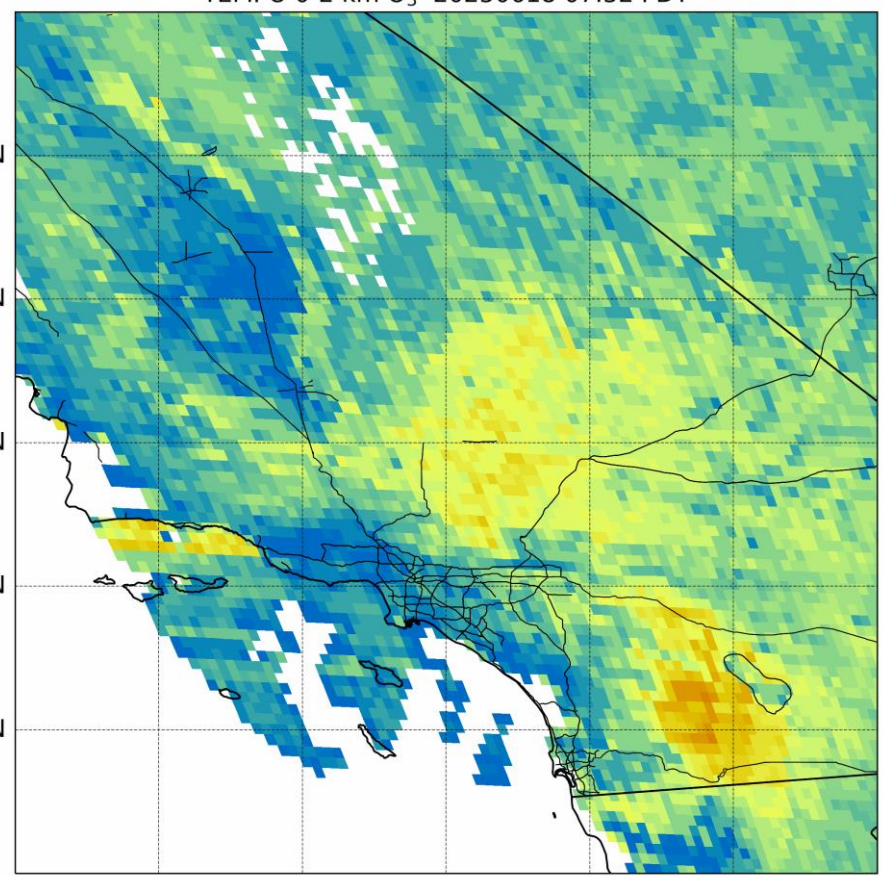
June 18, 2025

July 26, 2024

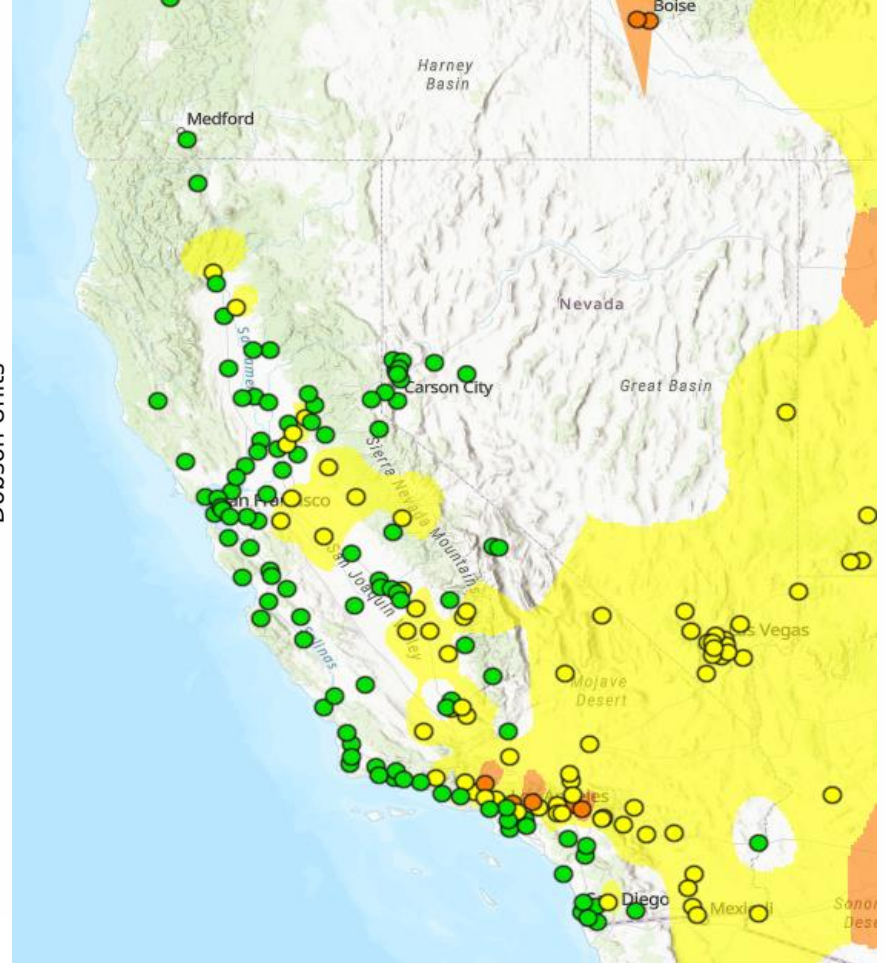
AirNow O<sub>3</sub> Monitors



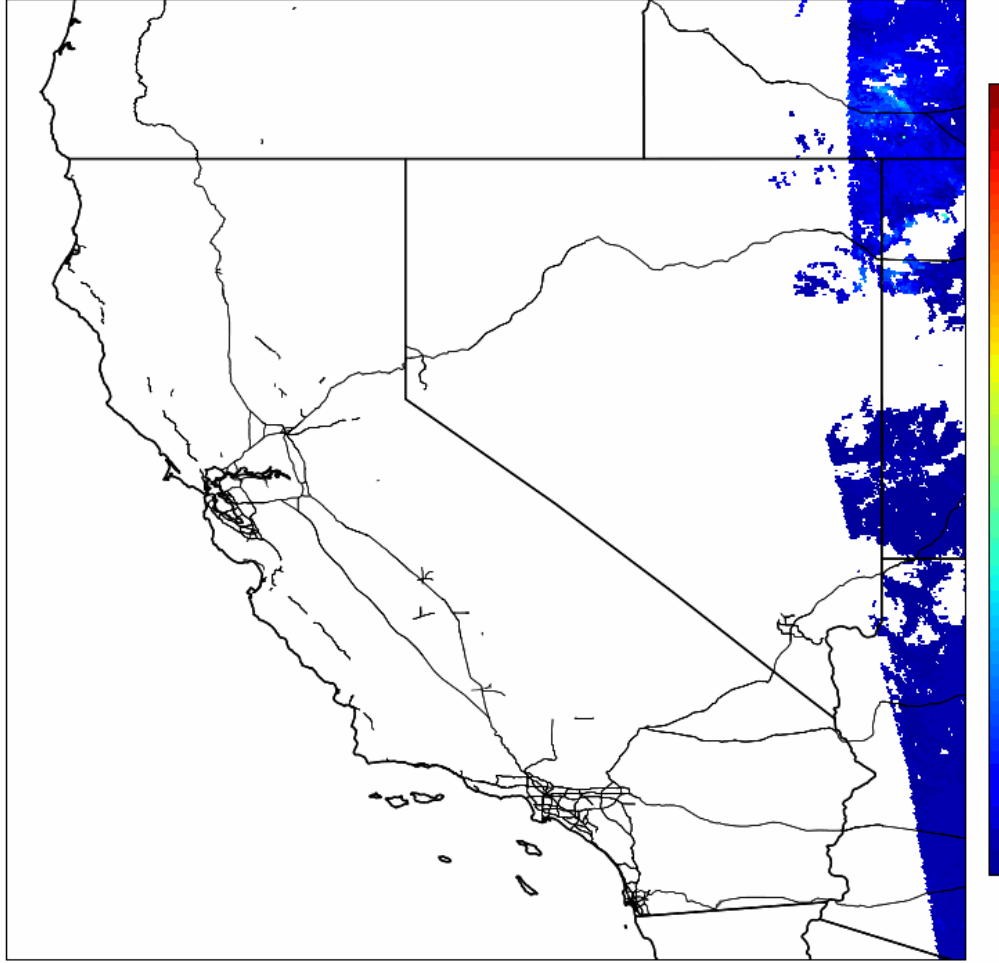
TEMPO 0-2 km O<sub>3</sub>



AirNow PM<sub>2.5</sub> Monitors



TEMPO Surface PM<sub>2.5</sub>



TEMPO Ozone Profile Product  
Version 4, BETA status  
Undergoing validation, available via NASA Earthdata

TEMPO-GEOS Synergistic Aerosol Products  
Geographic weighted regression, including aerosol layer height info  
Undergoing production by NOAA, test data available on request

Source: ARSET Training "[Introduction to Geostationary Satellite Observations for Air Quality Applications in the Western U.S.](#)"





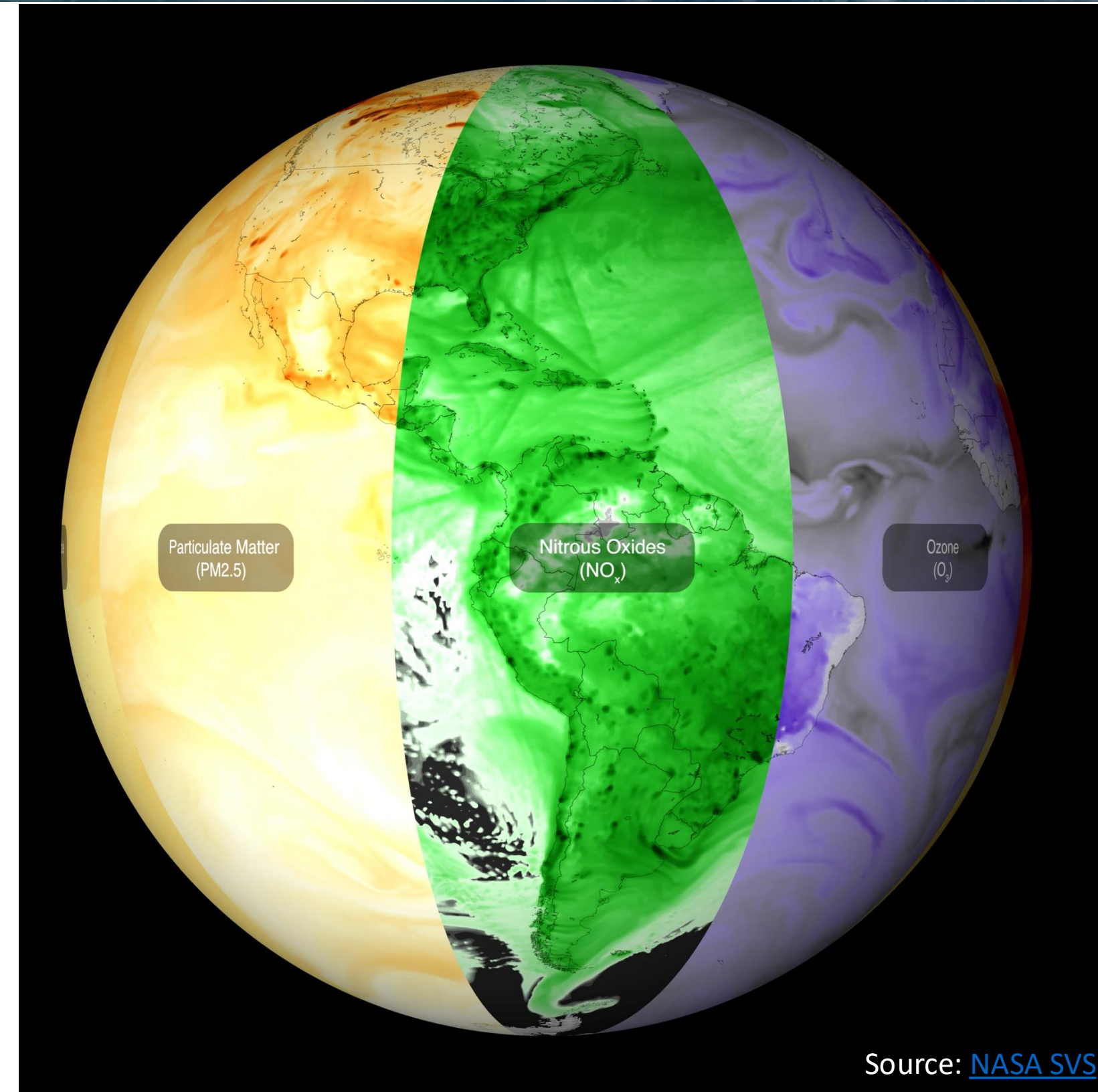
# Goddard Earth Observing System Composition Forecast

## GEOS-CF

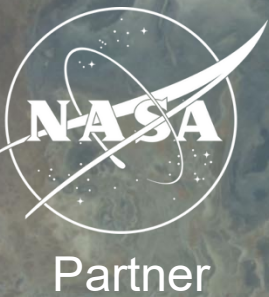
- combines GEOS numerical weather prediction with GEOS-Chem chemistry simulation
- generates 3D gridded continuous datasets of atmospheric constituents for research & applications
- run daily
- 5 day forecast
- 0.25° (~25km) grid resolution
- **Version 2 updates (Jan 2026): improved emissions, assimilation of satellite Ozone columns & profiles**

Keller, C. A., Knowland, K. E., et al. (2021). Description of the NASA GEOS composition forecast modeling system GEOS-CF v1.0. *Journal of Advances in Modeling Earth Systems (JAMES)*, 13, e2020MS002413. <https://doi.org/10.1029/2020MS002413>

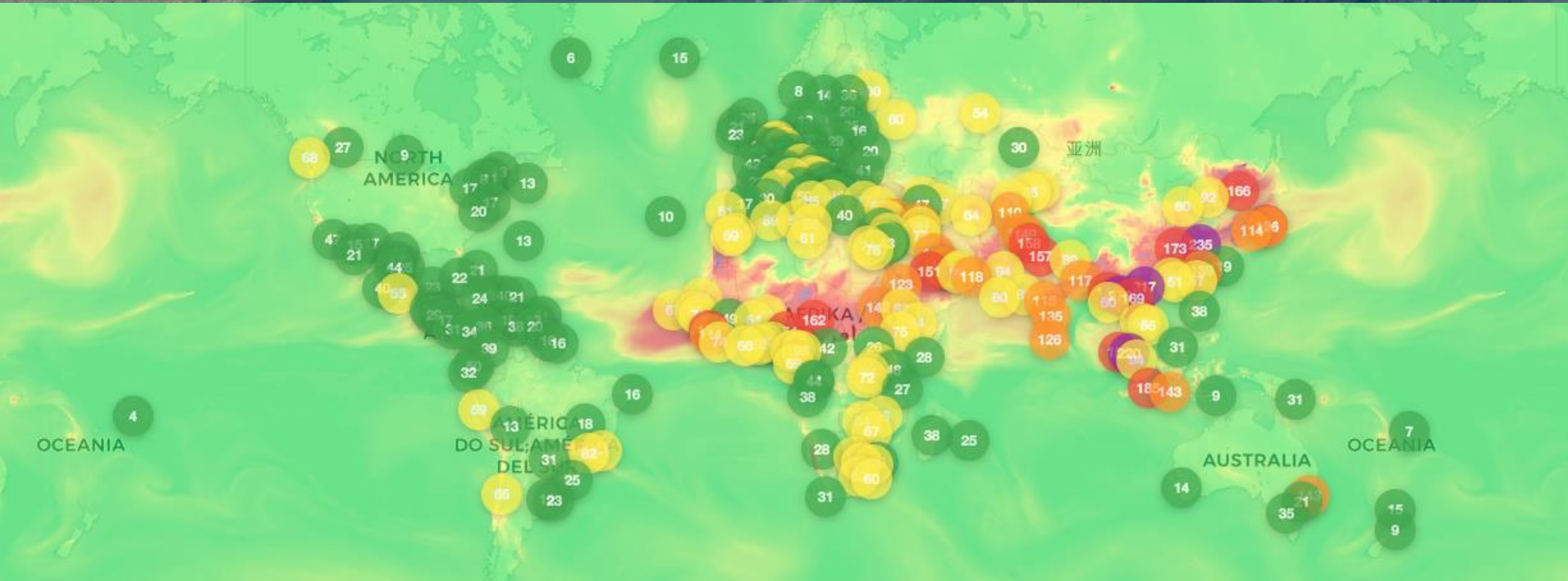
Knowland, K. E., Keller, C. A., et al. (2022). NASA GEOS Composition Forecast Modeling System GEOS-CF v1.0: Stratospheric Composition. *JAMES* <https://doi.org/10.1029/2021MS002852>



Source: [NASA SVS](https://svs.gsfc.nasa.gov/)



# GEOS-CF Applications – Locally-Corrected Forecasts



SNWG Air Quality Forecasts



Source: Lazrak, N., "SNWG Localized Forecasts". [https://geos-esm.github.io/SNWG\\_Localized\\_Forecasts/](https://geos-esm.github.io/SNWG_Localized_Forecasts/)

HAQAST - Madison 2026

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# GEOS-CF Applications – City-Scale Forecasts

## Earth Engine Apps

This application visualizes hourly NO<sub>2</sub> and PM<sub>2.5</sub> concentration forecasts for Rio de Janeiro. Forecasts are generated daily for the next day using the NASA GEOS-CF forecast, satellite retrievals from the TROPOMI and MAIAC AOD instruments, and ground-level air quality measurements from reference-grade monitors and low-cost sensors. Reference-grade monitor data are shown with purple squares, while low-cost sensors are shown using green circles. All times are displayed in the local timezone.

To get started, select a parameter, forecast product, and datetime from the dropdown menus below. Once a forecast is selected, an animated gif will appear in the bottom right for that forecast type. You can minimize the window using the "Show/Hide Forecast Animation" button in the top-right. Map layers may be turned on or off in the "Layers" drop-down in the top-right. This application is still under development; any data shown are still preliminary.

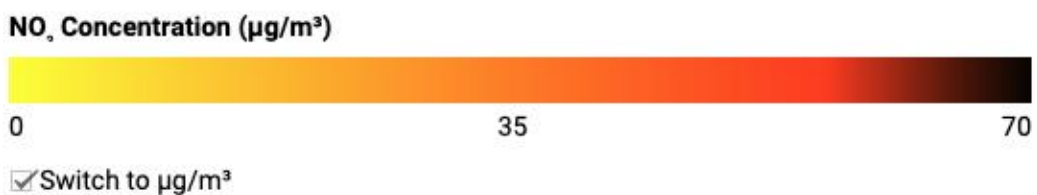
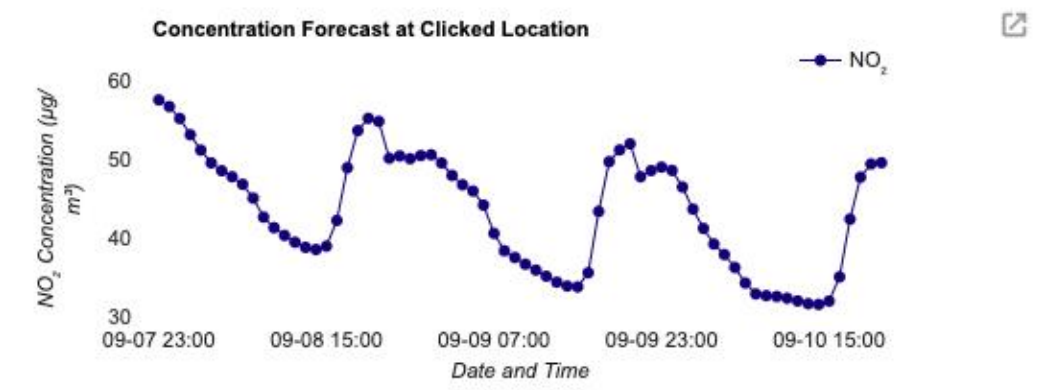
To generate a time series of forecasted NO<sub>2</sub> or PM<sub>2.5</sub>, click on any point to retrieve the hourly forecasted NO<sub>2</sub>/PM<sub>2.5</sub> concentrations for the selected date and time at that specific location.

### Select the parameter, input data, and time of interest to view forecasts

NO<sub>2</sub> ▾

Model, satellite, and interpolated ground monitors ▾

Forecast time (local):  
2024-09-08 19:00 ▾



Search places

Layers

Show/Hide Forecast Animation

Animated Forecast

2024-09-07 23:00

Keyboard shortcuts | Map data ©2024 Google | 5 km | Terms



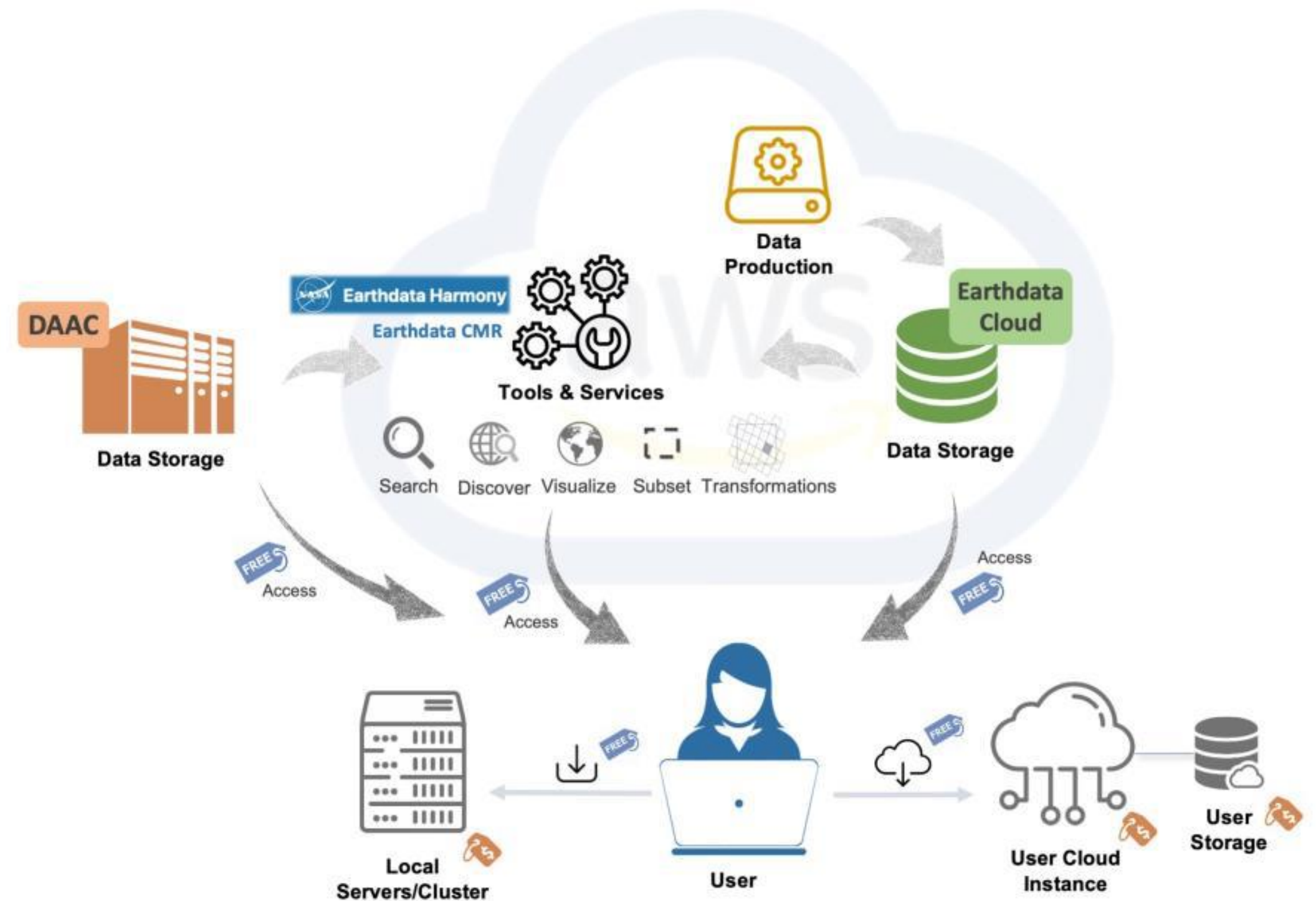
# Challenges & Opportunities

## NASA Earthdata “on the cloud”

- Earthdata Common Metadata repository  
Enable programmatic search options for automated routine data access
- Earthdata Harmony Subsetter  
Filter, subset, and transform data on the cloud prior to download

*Example:* TEMPO Level 2 NO<sub>2</sub>,  
State of Colorado, September 2025

- Download all files: 334 files, 160MB Each, **52.2 GB**
- Earthdata Harmony Subsetting: 1 file, **51.6 MB**



Source: <https://www.earthdata.nasa.gov/news/feature-articles/harmony-subset-regrid-reproject-data-cloud>



# Near-Real-Time Data Visualization NASA Worldview

[worldview.earthdata.nasa.gov](https://worldview.earthdata.nasa.gov)

interactive interface for browsing full-resolution, global, daily satellite imagery

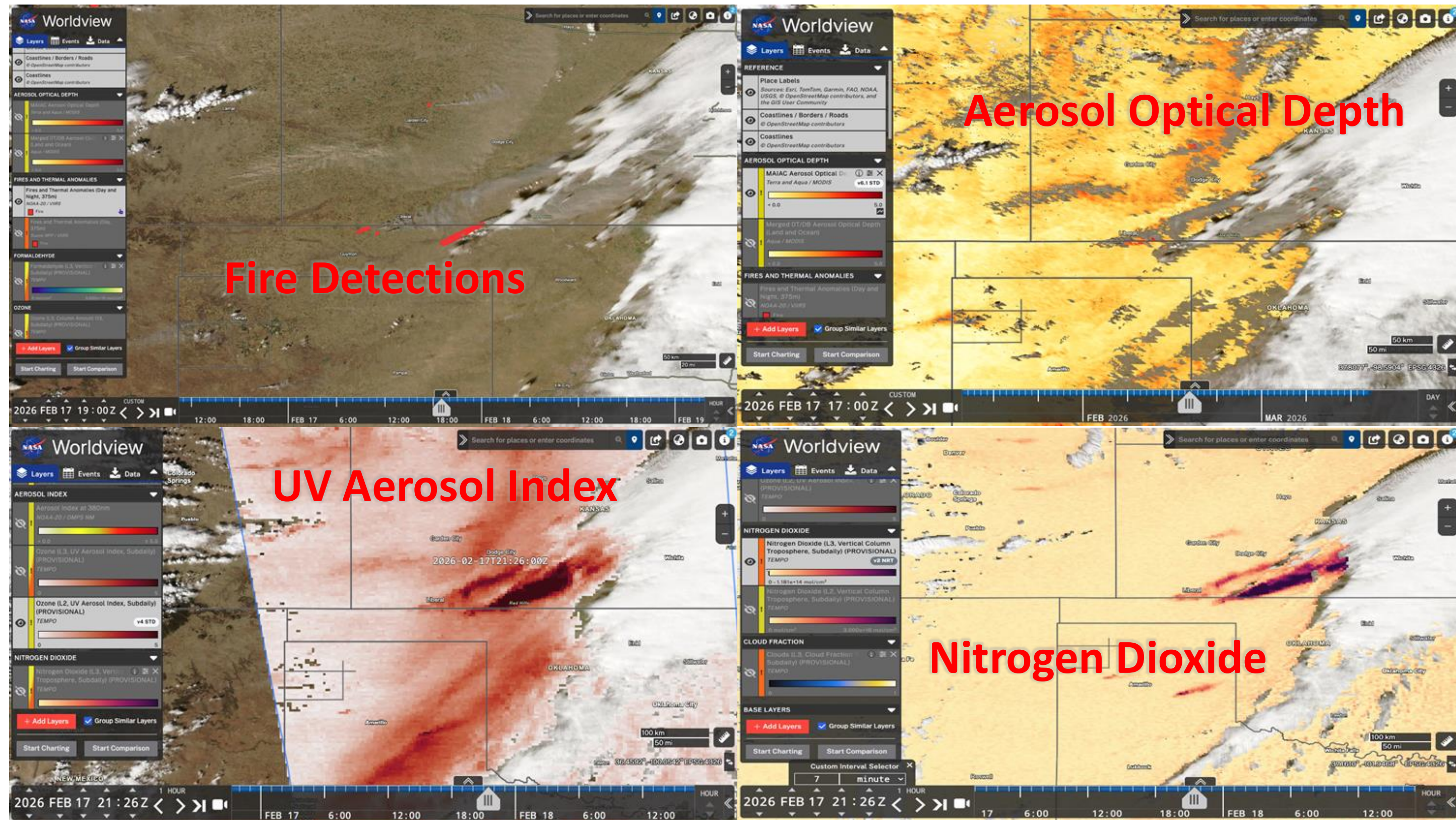
Over 1,200 global imagery layers, updated within hours

Full-resolution satellite imagery covering the entire Earth, from 2000 to present

Supports wildfire, air quality and flood management & more

Animate, compare, share images

Fully browser-based, no software needed

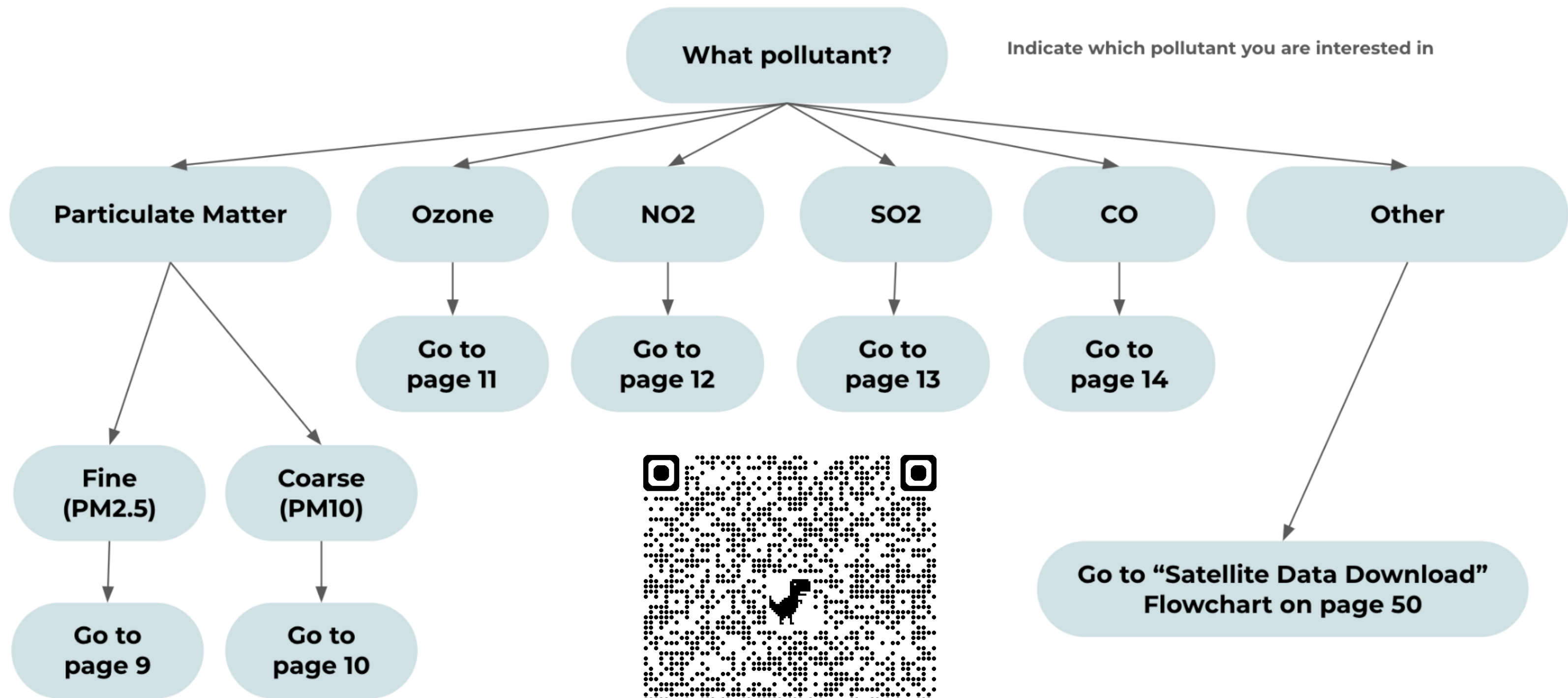


Source: ARSET Training "NASA Satellite Observations and Tools for Fire and Smoke Monitoring"  
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# HAQAST Flowchart of Resources and Data Products





# Applied Remote Sensing Training (ARSET)

<https://www.earthdata.nasa.gov/data/projects/arset>

**ARSET provides accessible, relevant, and cost-free training on remote sensing satellites, sensors, methods, and tools.**

Our trainings are:

- Online and in-person
- Open to everyone
- Live, instructor-led, or self-guided
- Provided at no cost, with materials and recordings available from our website
- Often multi-lingual
- Tailored to those with a range of experience in remote sensing, from **introductory** to **advanced**



## Training Themes



AGRICULTURE



CLIMATE & RESILIENCE



DISASTERS



ECOLOGICAL CONSERVATION



HEALTH & AIR QUALITY



WATER RESOURCES



# ARSET Workshops for Air Quality Managers

## Introduction to Geostationary Satellite Observations for Air Quality Applications in the Western US; Fort Collins, CO, August 5-7, 2025

3 Days In-Person  
Intermediate Level  
34 US Participants  
19 Organizations  
11 US States

### Collaborative Effort

- ARSET
- TEMPO Applications
- ASDC
- WESTAR
- EPA
- NOAA
- SCAQMD



Photograph courtesy of Shawn McClure





# Air-quality Information Resource for the United States (AIR4US)

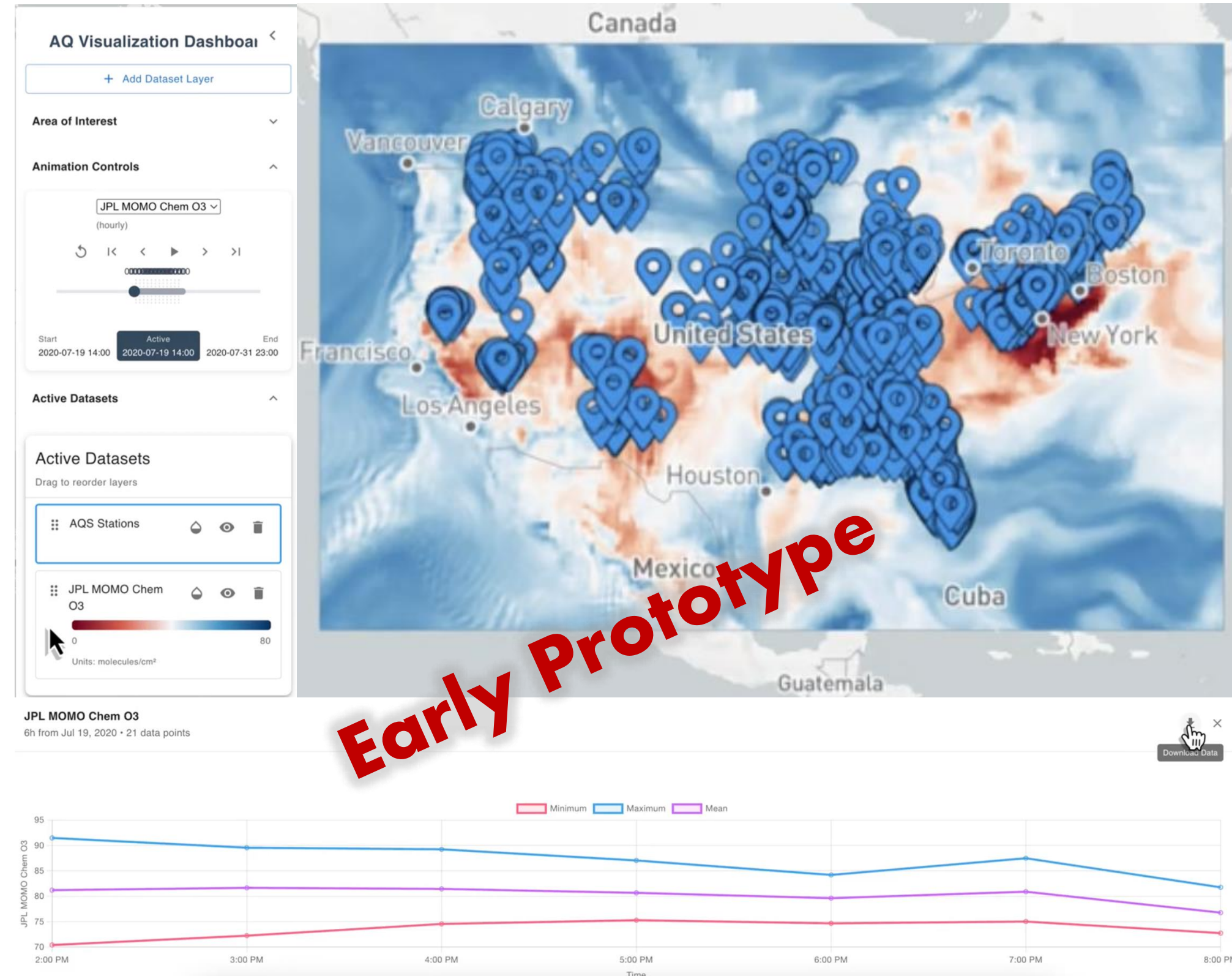
## Multi-agency joint effort

Integrate diverse air quality information datasets (in-situ monitoring, remote sensing, modeling)

Enable intercomparison and analysis

Support US air quality management decision-making at federal to local levels

Anticipated beta release late 2026





# AIR4US Early Adopters Program

## [HAQAST Tiger Team Activity 2026-2027](#)

- Monthly meetings with future AIR4US users
- ***Prioritize AIR4US datasets & capabilities to meet user needs***
- “beta testing” of new features
- Online & in-person orientation workshops
- Peer-to-peer learning & shared case studies

Join the  
AIR4US Early Adopters  
Email List





**Thank You!**  
Questions?