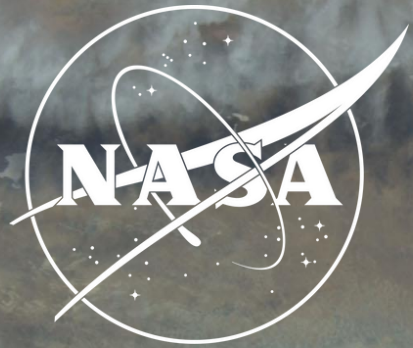




Partner



GMAO



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

Carl Malings

Morgan State University & NASA Goddard Space Flight Center





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

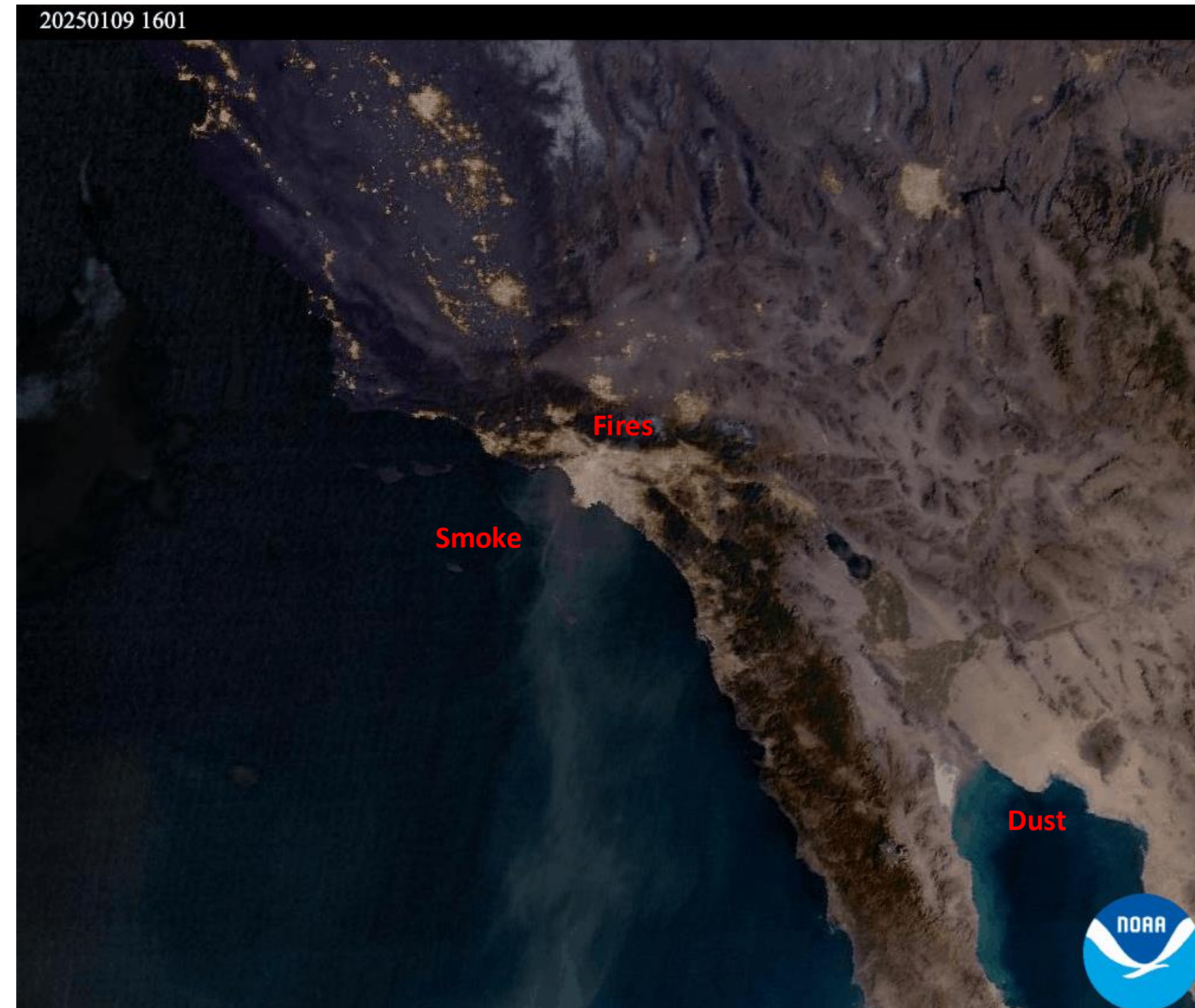
<https://worldview.earthdata.nasa.gov/>

- 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/>



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:

- NO₂
- HCHO
- **NEW** 0-2 km O₃ product
- **NEW** Surface PM_{2.5}
(integrated with GOES ABI)

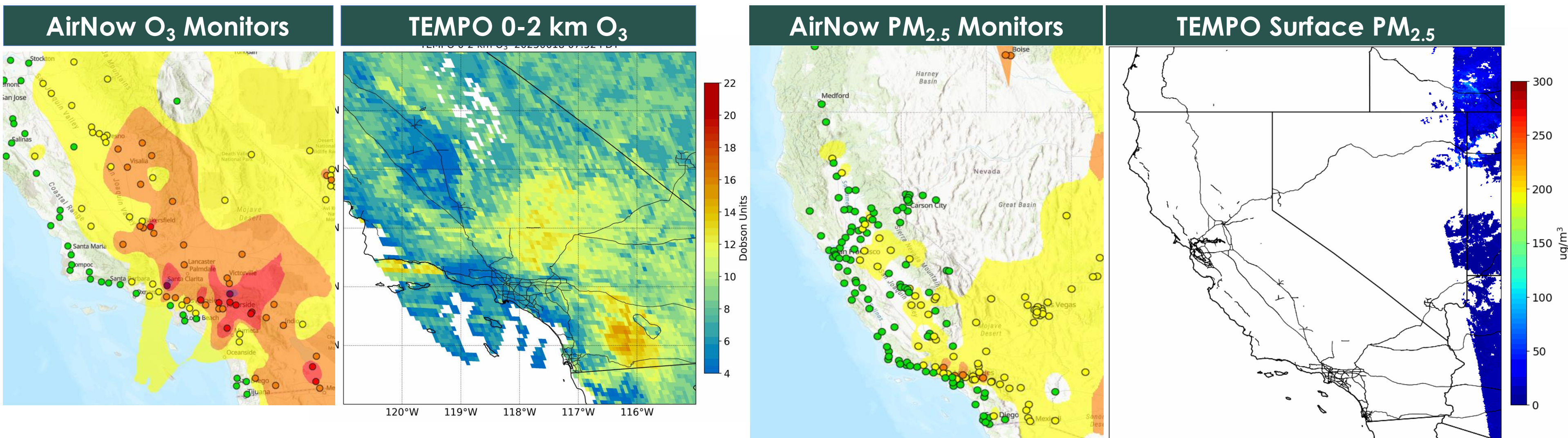


Source: NASA SVS

<https://svs.gsfc.nasa.gov/5142/>

June 18, 2025

July 26, 2024



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.](#)”

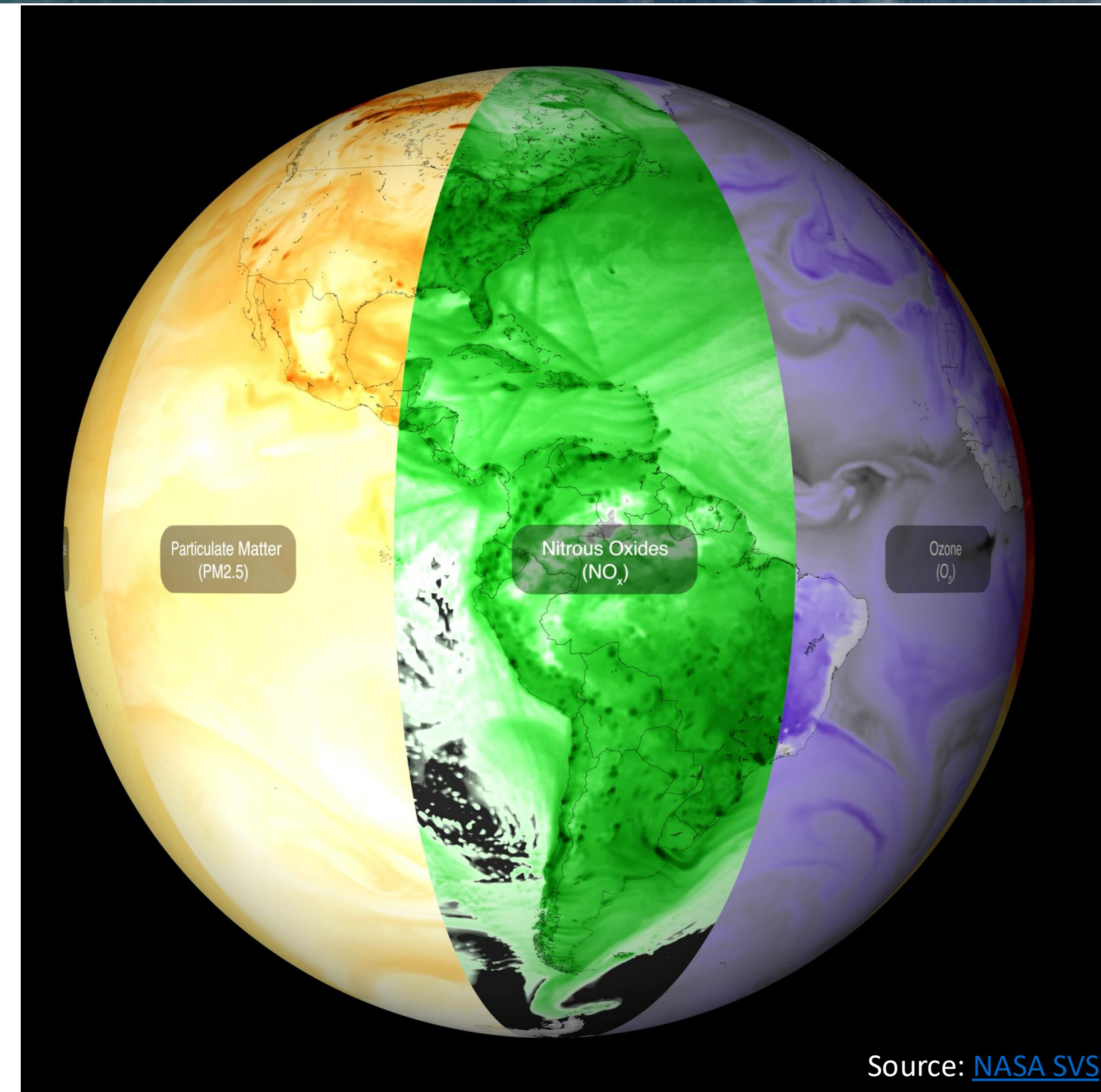
Goddard Earth Observing System Composition Forecast

GEOS-CF

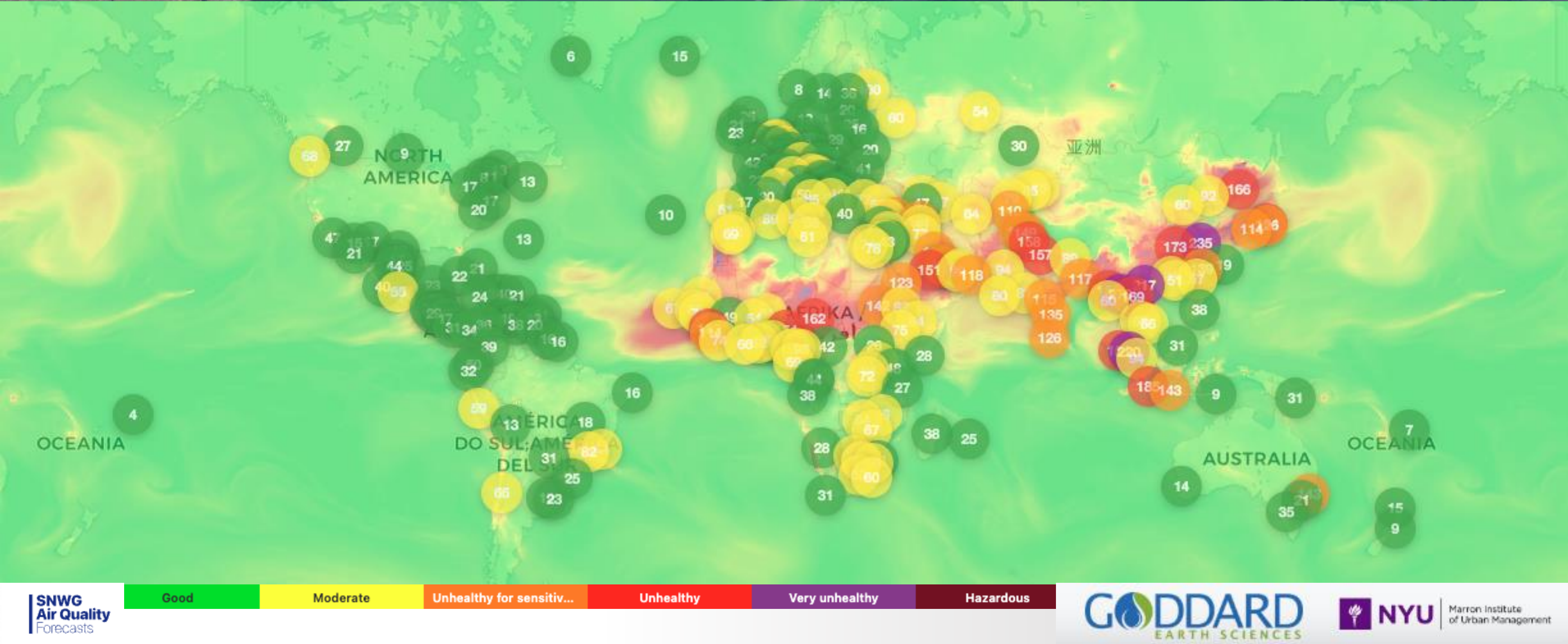
- combines GEOS numerical weather prediction with GEOS-Chem chemistry simulation
- generates 3D gridded continuous datasets of atmospheric constituents for research & applications
- run daily
- 5 day forecast
- 0.25° (~25km) grid resolution
- **Version 2 updates (Jan 2026): improved emissions, assimilation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

Earth Engine Apps

Search places

This application visualizes hourly NO_2 and $\text{PM}_{2.5}$ 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_2 or $\text{PM}_{2.5}$, click on any point to retrieve the hourly forecasted NO_2 / $\text{PM}_{2.5}$ concentrations for the selected date and time at that specific location.

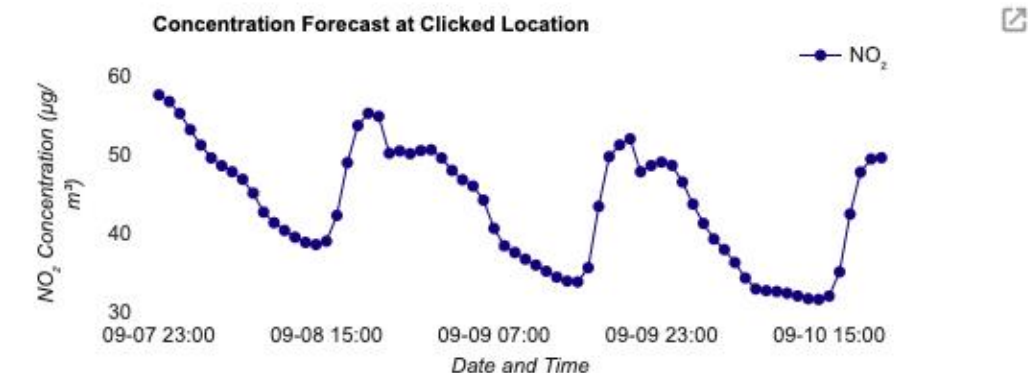
Select the parameter, input data, and time of interest to view forecasts

NO_2

Model, satellite, and interpolated ground monitors

Forecast time (local):

2024-09-08 19:00



NO_2 Concentration ($\mu\text{g}/\text{m}^3$)



Switch to $\mu\text{g}/\text{m}^3$

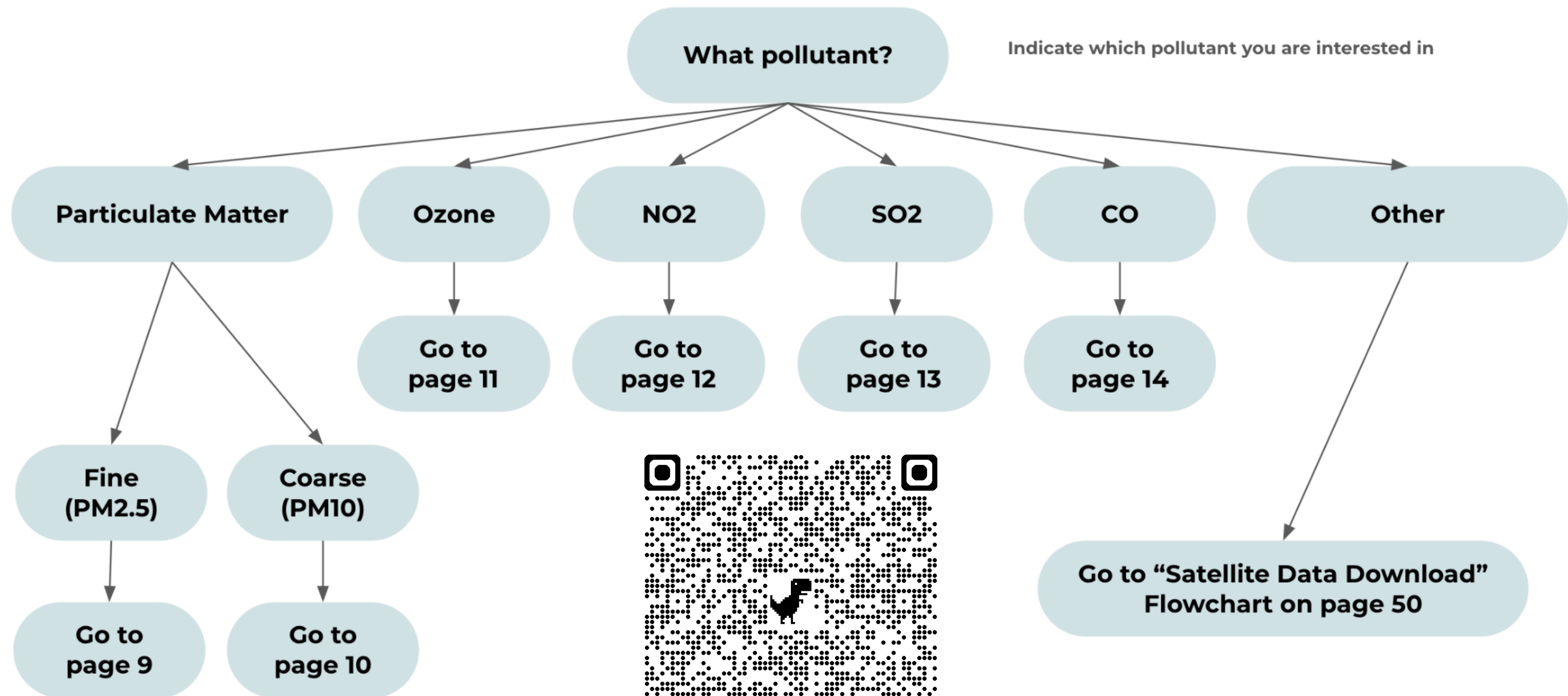


HAQAST - Madison 2026

carl.a.malings@nasa.gov



HAQAST Flowchart of Resources and Data Products





Partner

Near-Real-Time Data Visualization NASA Worldview

worldview.earthdata.nasa.gov

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

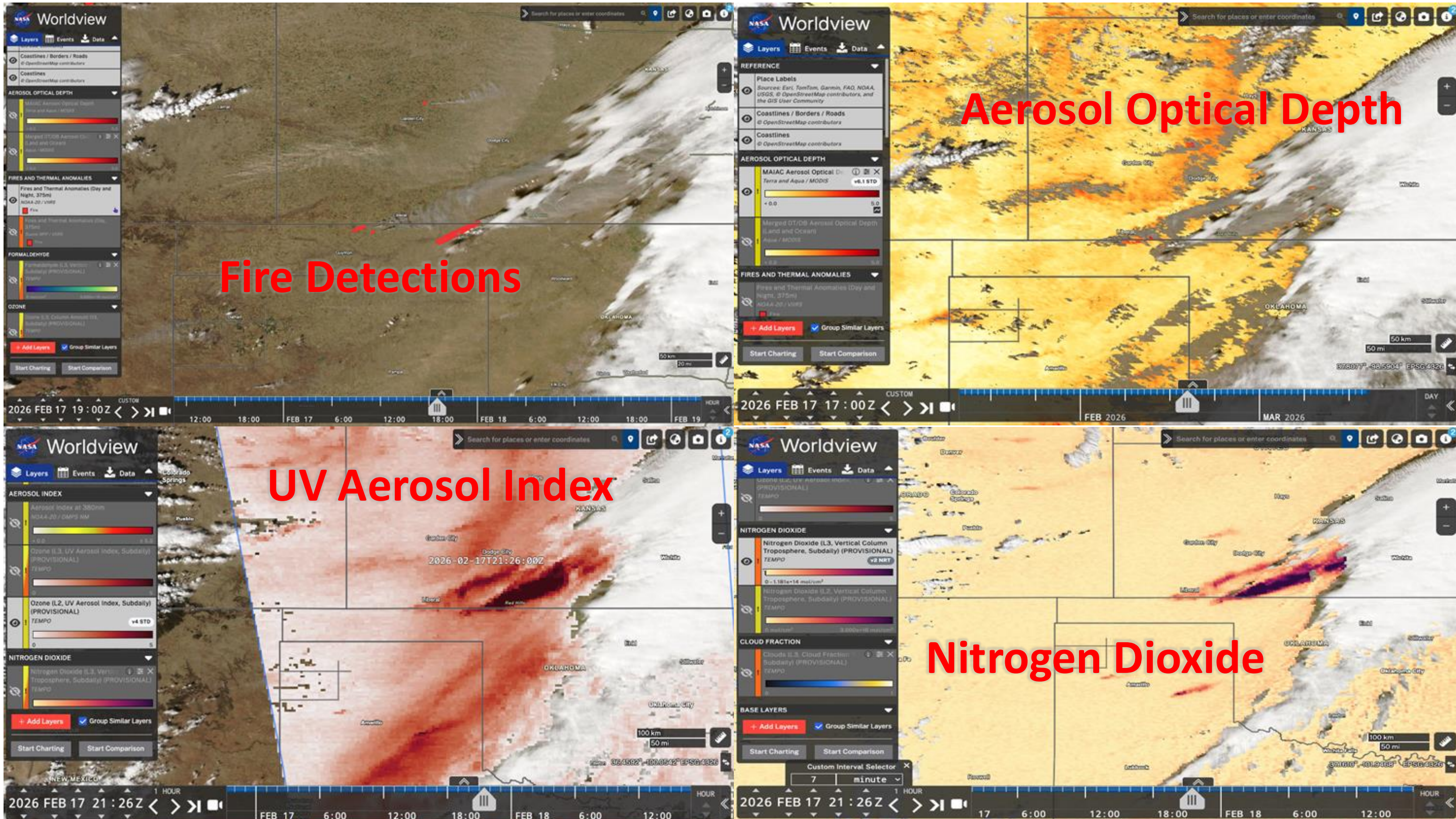
Over 1,200 global imagery
layers, updated within hours

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



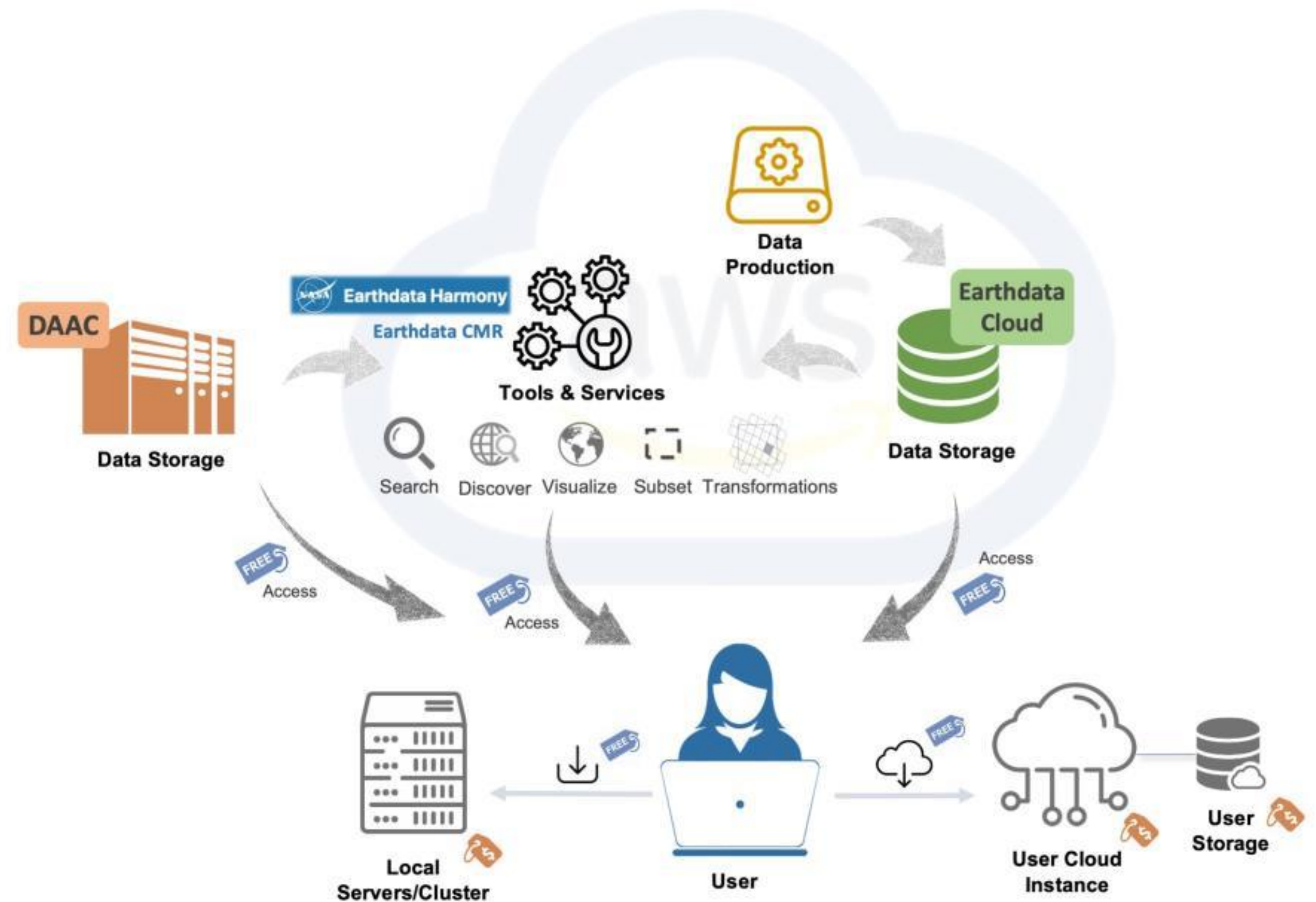
Data Access & Processing – opportunities for cloud computing

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 NO₂,
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>



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

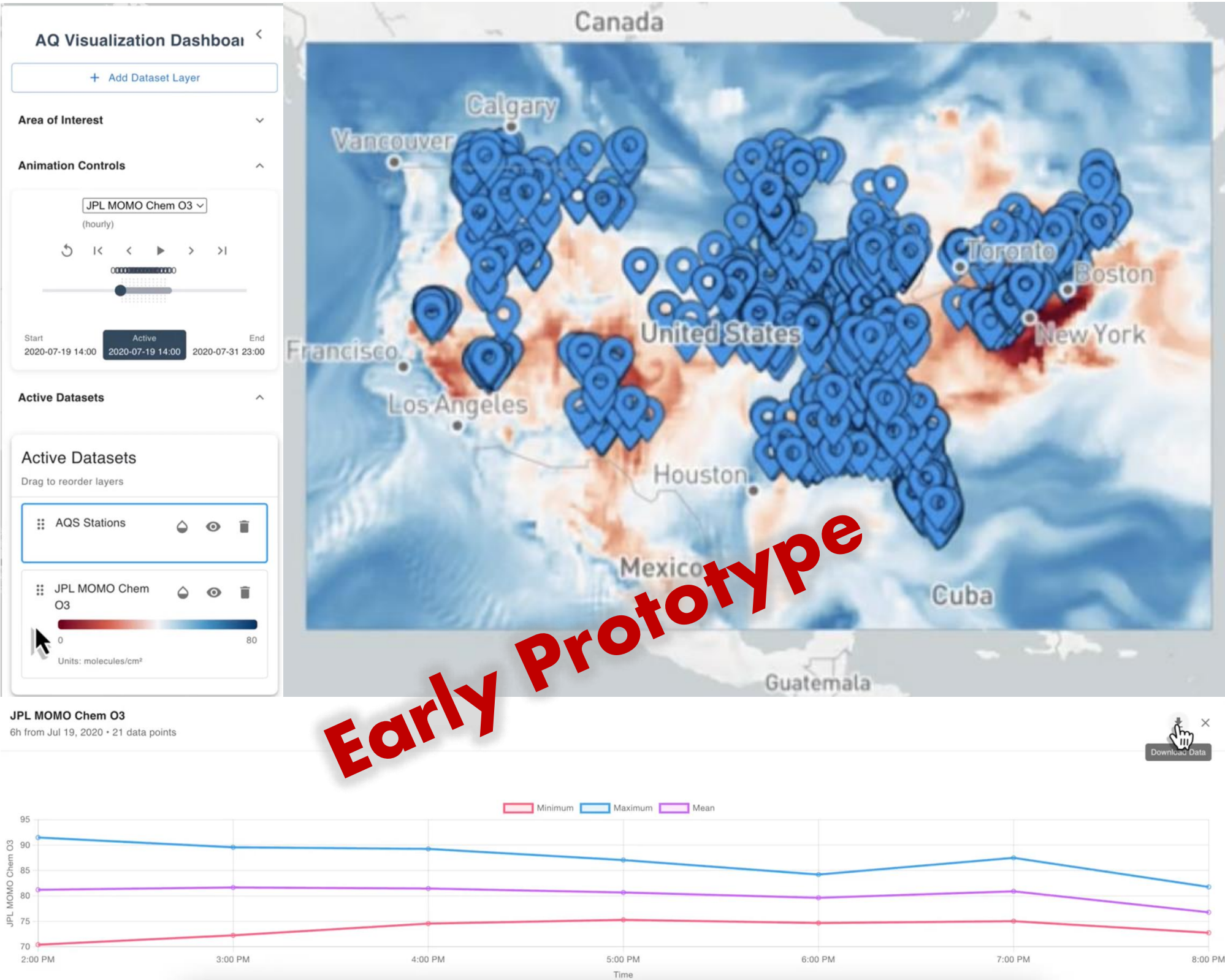
Multi-agency joint effort

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?