

Support PM_{2.5} Exceptional Events Demonstration in Smoke and Dust Plumes using Aerosol Optical Centroid Height (AOCH) Observations



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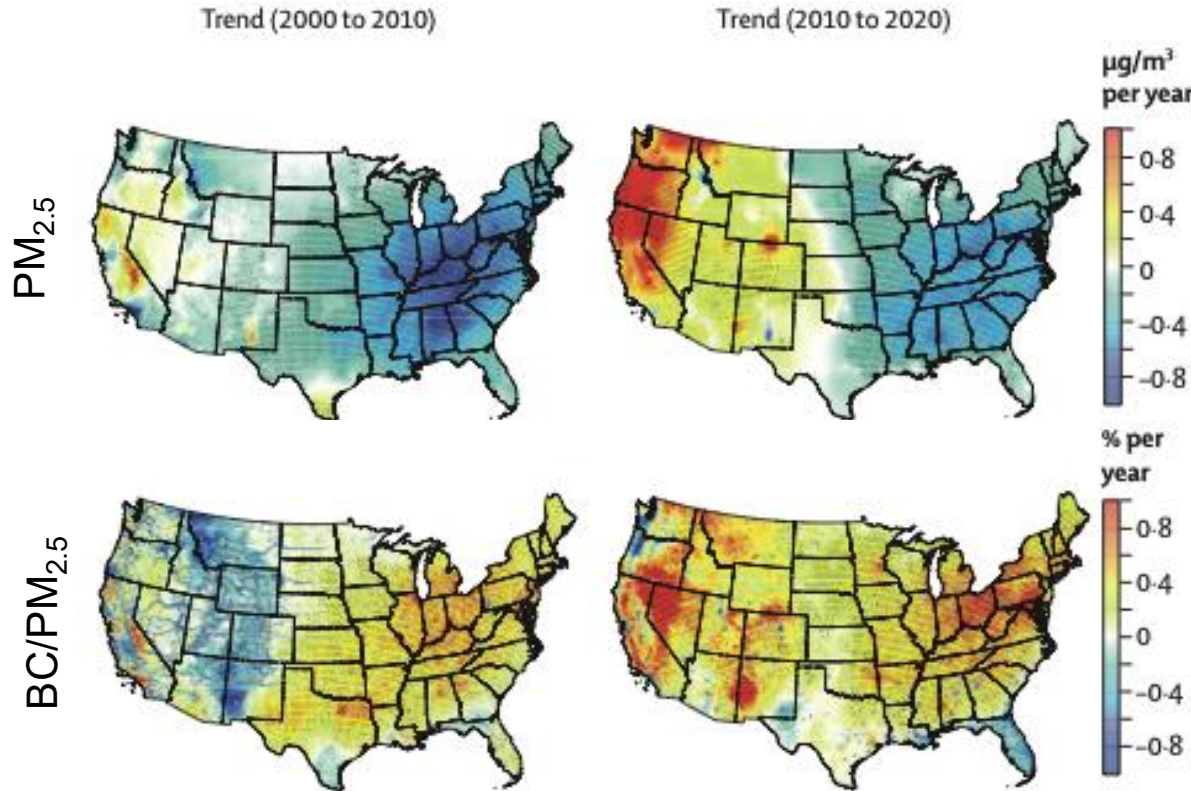


CONUS PM_{2.5} pollution influenced by smoke/dust plumes

Exceptional events trigger heavy PM_{2.5} pollution

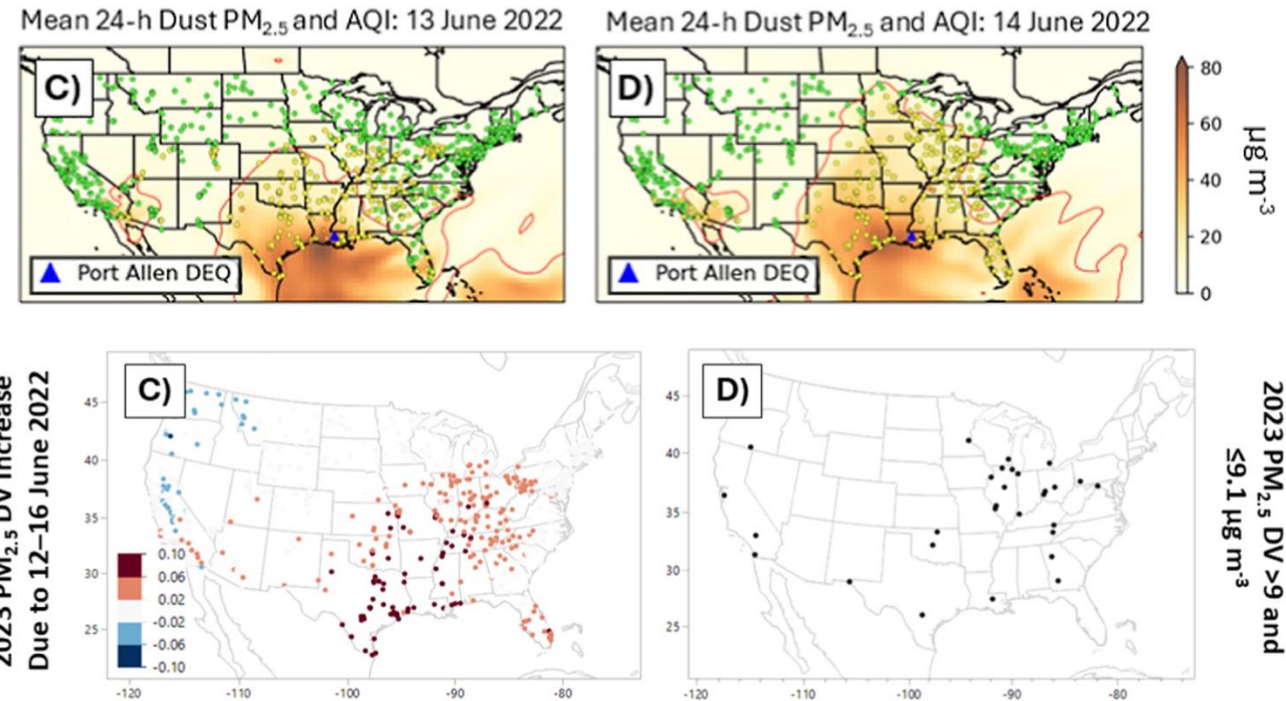
- Increasing wildfire emissions reverse BC&PM_{2.5} trend:

- Saharan dust outbreak increases US PM_{2.5}:



The BC to PM_{2.5} mass ratio increasing trend across the USA, mainly due to increasing wildfire emissions in the western USA.

(Wei et al., *The Lancet Planetary Health*, 2023)



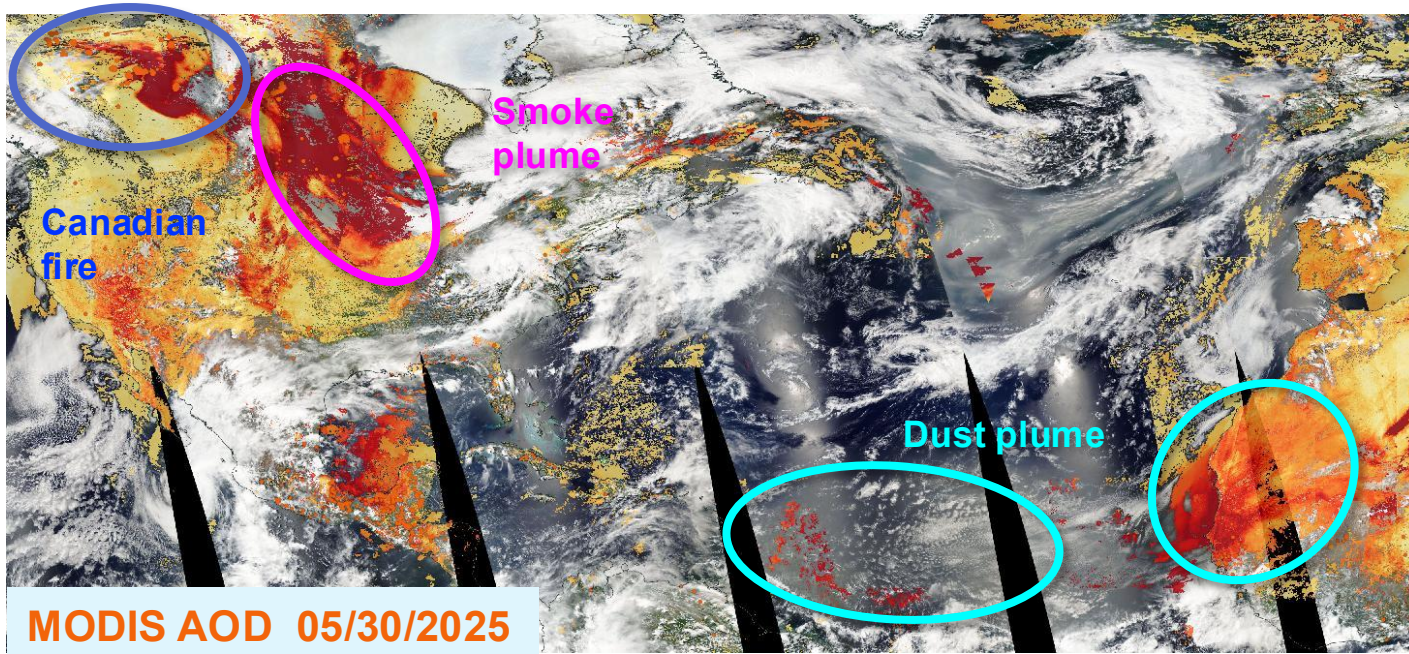
A June 2022 trans-Atlantic Saharan dust outbreak single-handedly elevated the 2022 mean annual PM_{2.5} by $> 0.5 \mu\text{g}/\text{m}^3$ for some Gulf Coast communities and pushed the 2023 design value (DV) for at least two sites above the $9 \mu\text{g}/\text{m}^3$ NAAQS.

(Miller et al., *Environmental Science & Technology*, 2025)

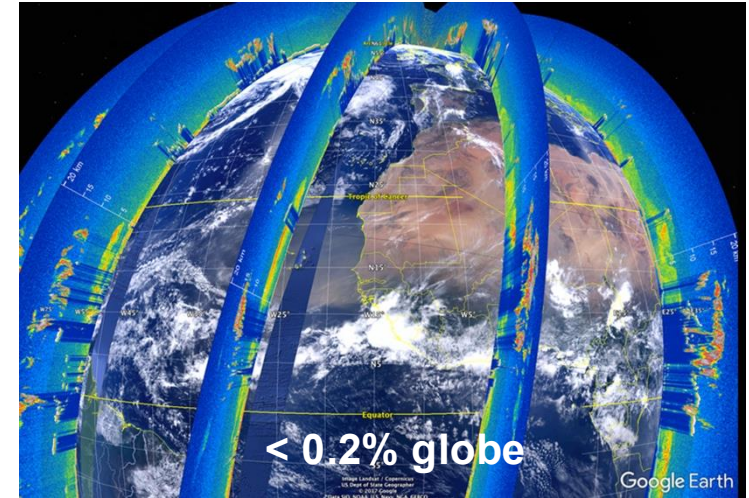
Challenges of PM_{2.5} pollution demonstration using EO

Uncertainty in smoke/dust plume vertical distribution

- Satellite observes column aerosol loading (AOD):



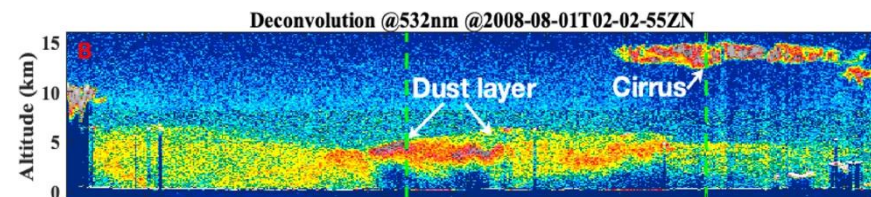
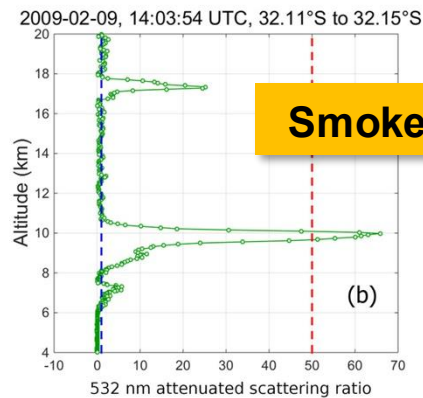
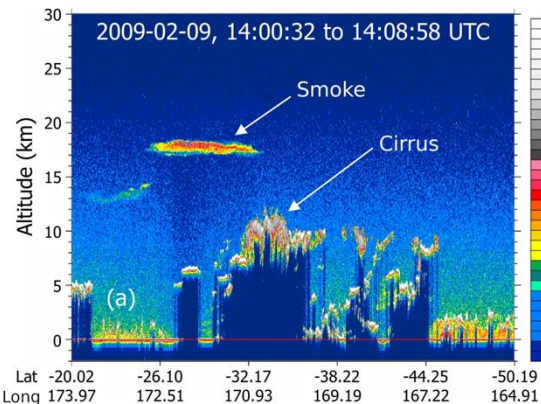
- Limited spatial coverage from lidars:



Total column aerosol burden

Surface PM_{2.5} concentration

Vertical distribution



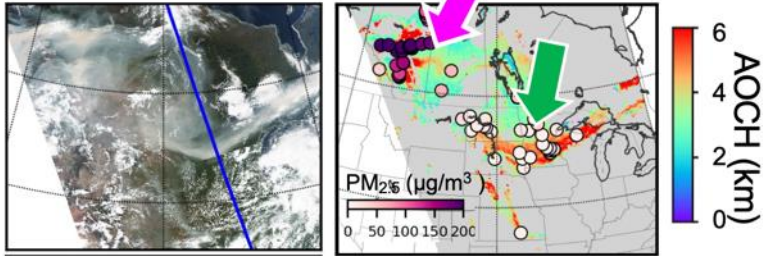
New passive satellite AOCH measurements

From EPIC, TROPOMI to TEMPO with high temporal and spatial resolution

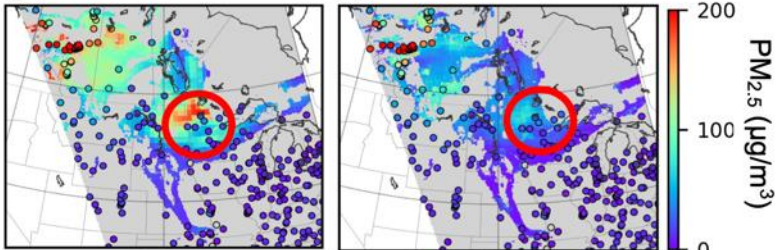
- Aerosol optical centroid height (AOCH) from O_2 absorption bands:

- Multiple AOCH products:

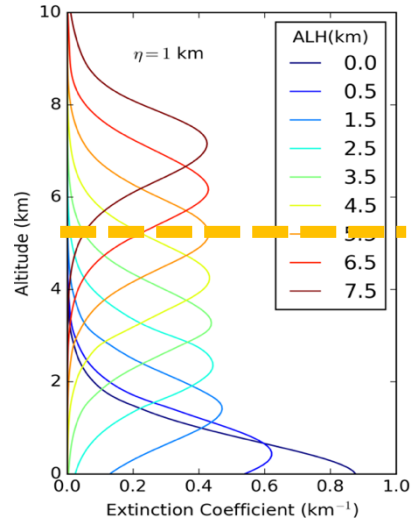
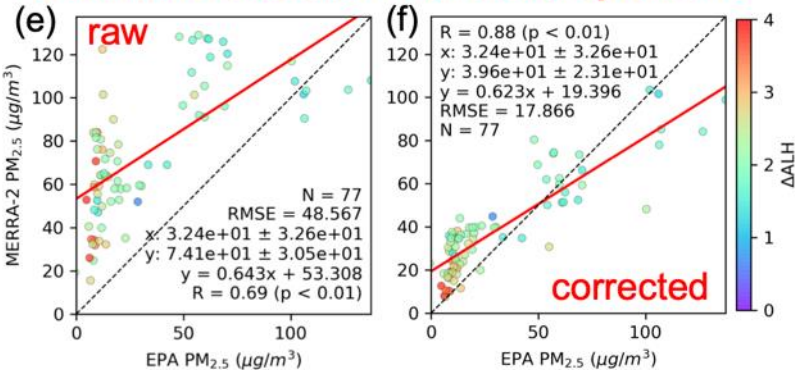
(a) 08-17-2018 (b) TROPOMI AOCH



(c) raw MERRA-2 (d) corrected MERRA-2

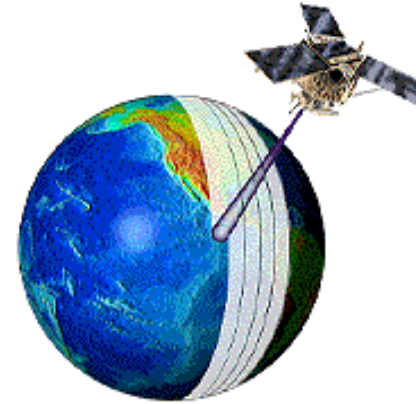


MERRA-2 false alarm corrected by ACH!



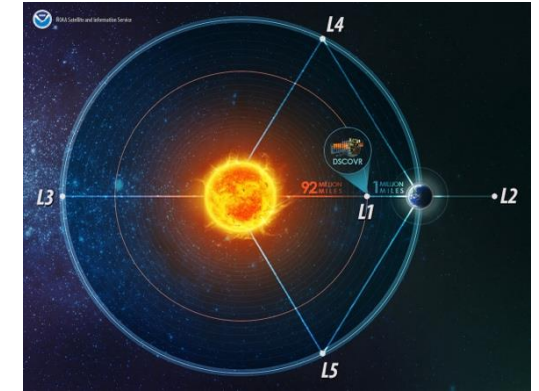
AOCH

(Chen. et al., 2021, RSE)

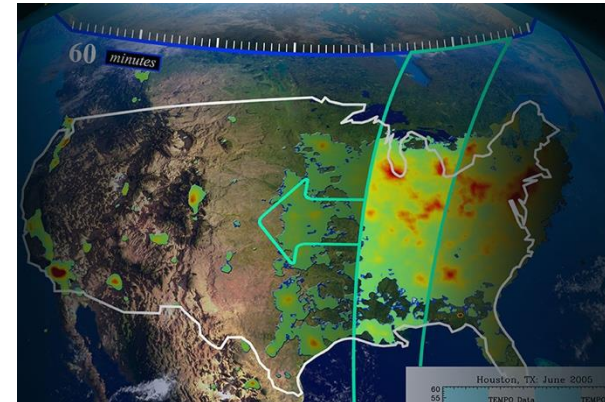


TROPOMI: Daily, global

EPIC/DSCOVR: Hourly, global



TEMPO (CONUS, hourly)

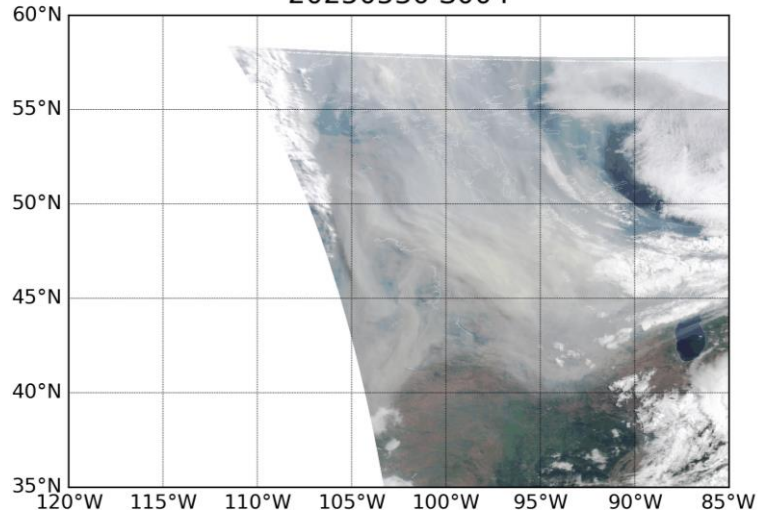


We have made efforts to develop our own ACH product using O_2 A and/or B bands.

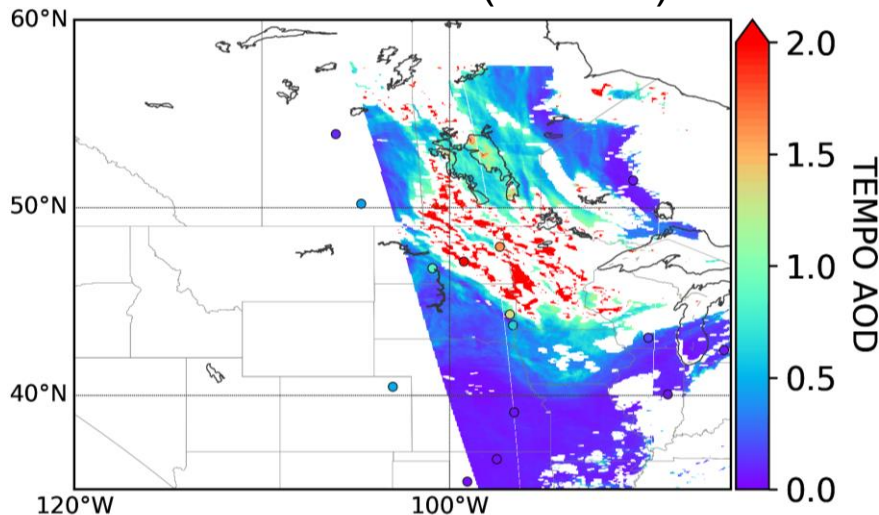
Smoke plume demonstration

AOCH and AOD from TROPOMI and TEMPO

20250530 S004

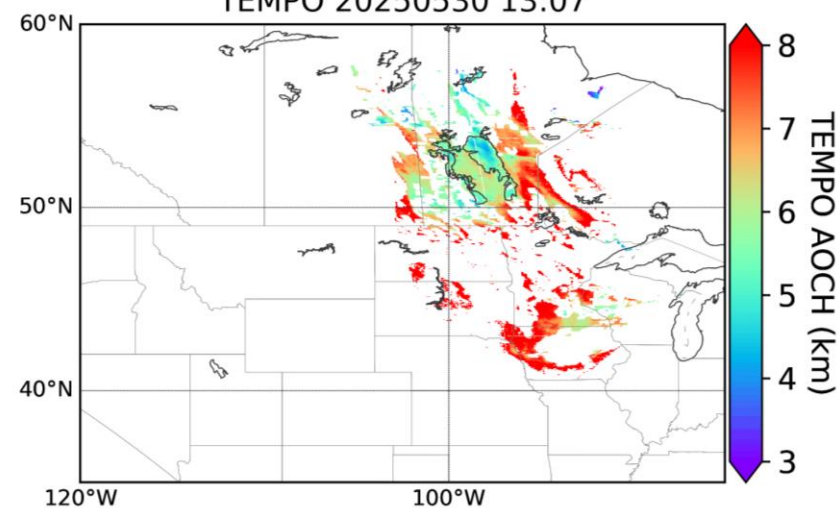


TEMPO AOD (680 nm)

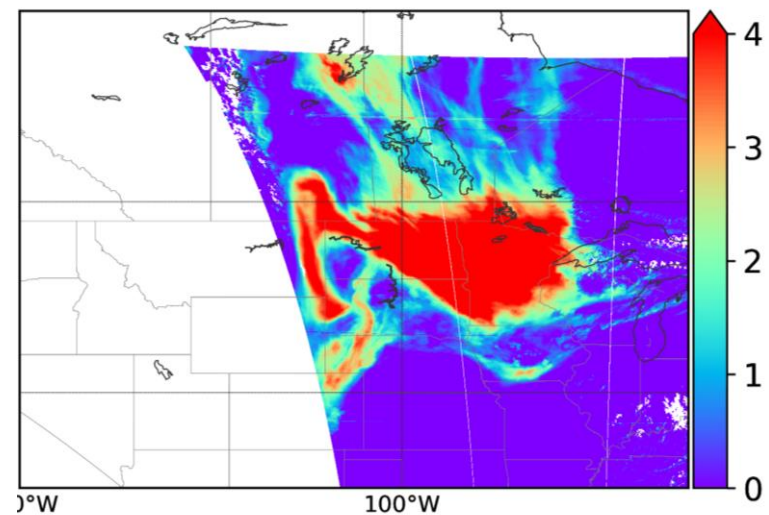


AOCH

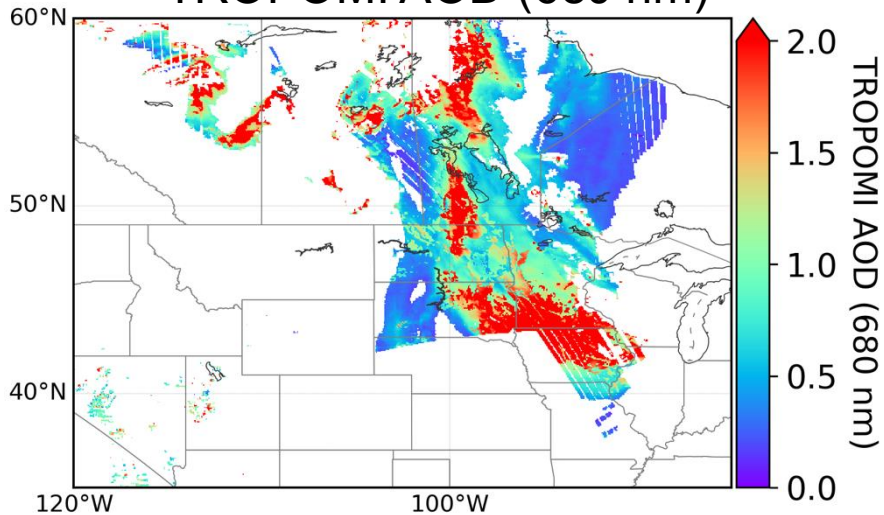
TEMPO 20250530 13:07



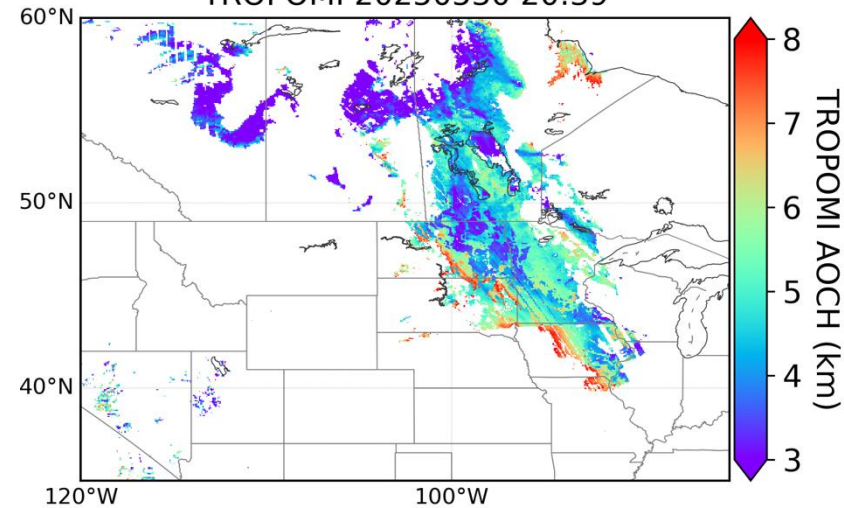
TEMPO UVAI



TROPOMI AOD (680 nm)



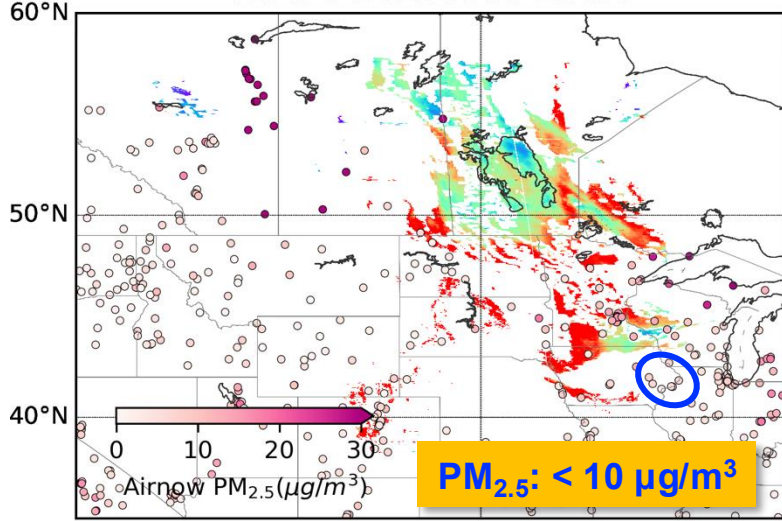
TROPOMI 20250530 20:39



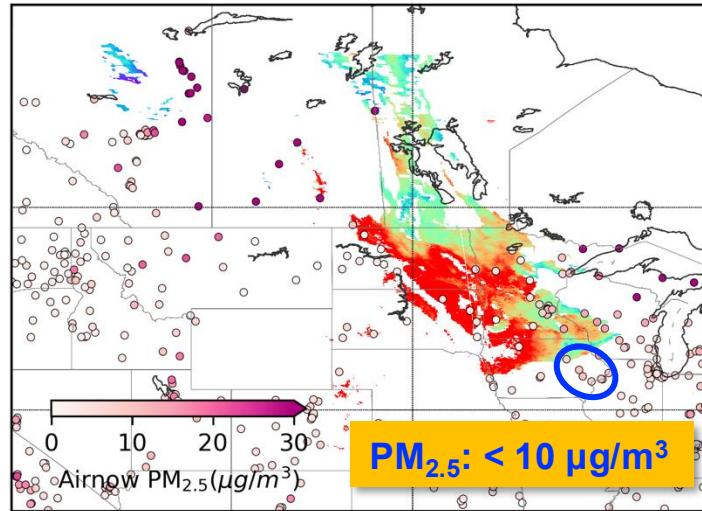
Dependence of PM_{2.5} on smoke AOC

Descending of smoke plume enhances PM_{2.5} pollution

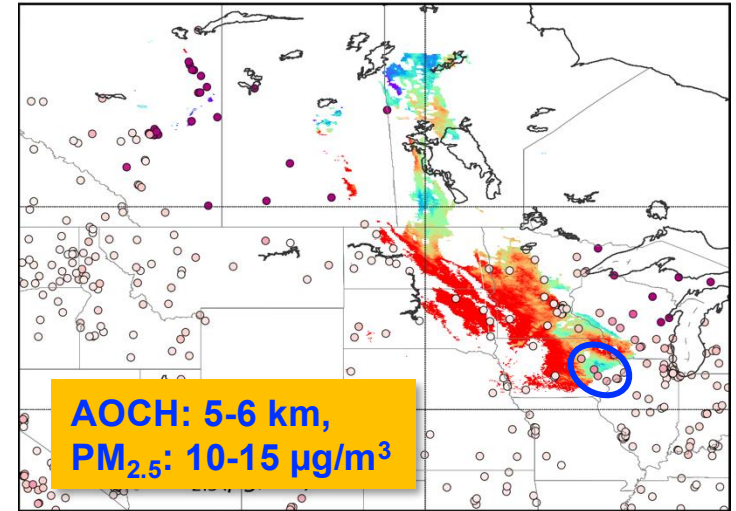
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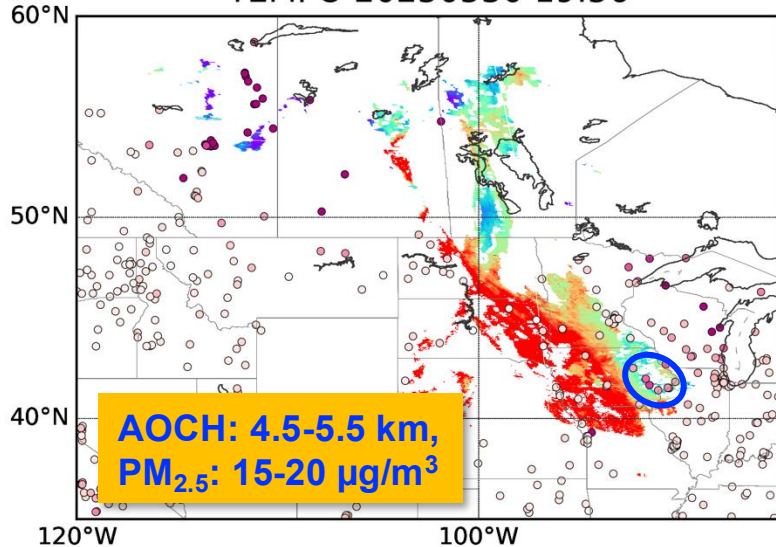
TEMPO 20250530 15:55



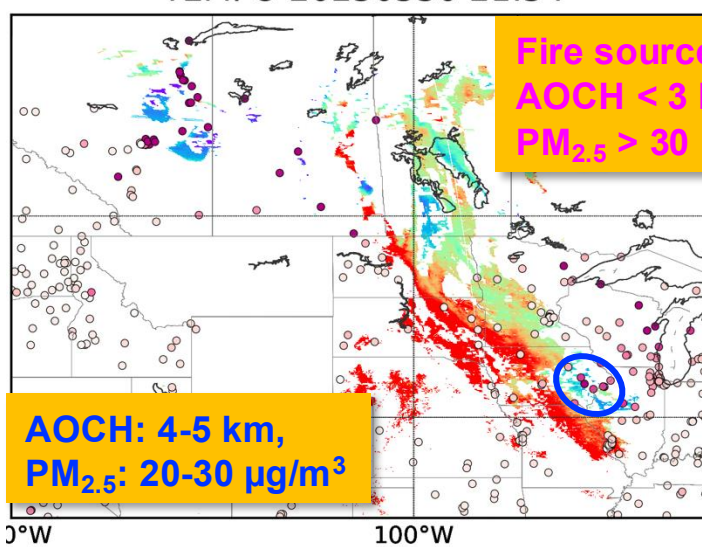
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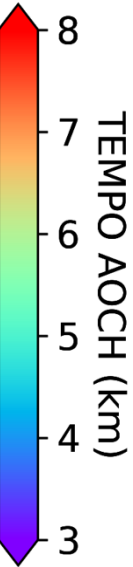
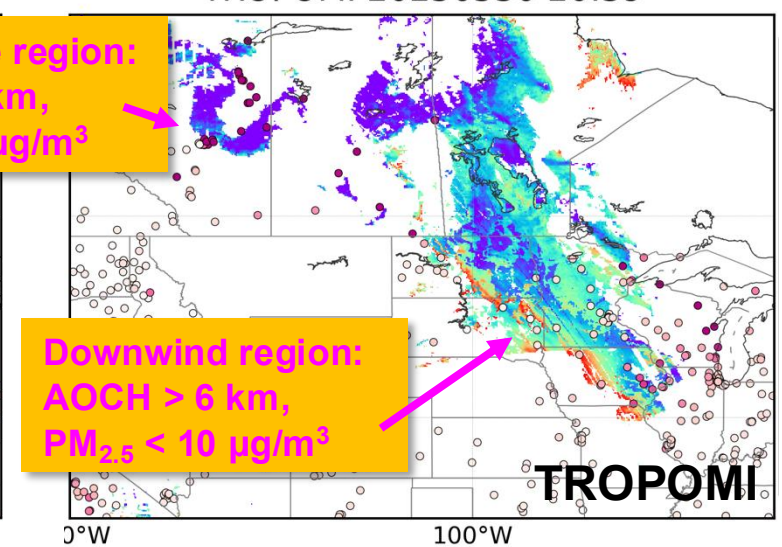
TEMPO 20250530 19:56



TEMPO 20250530 21:54



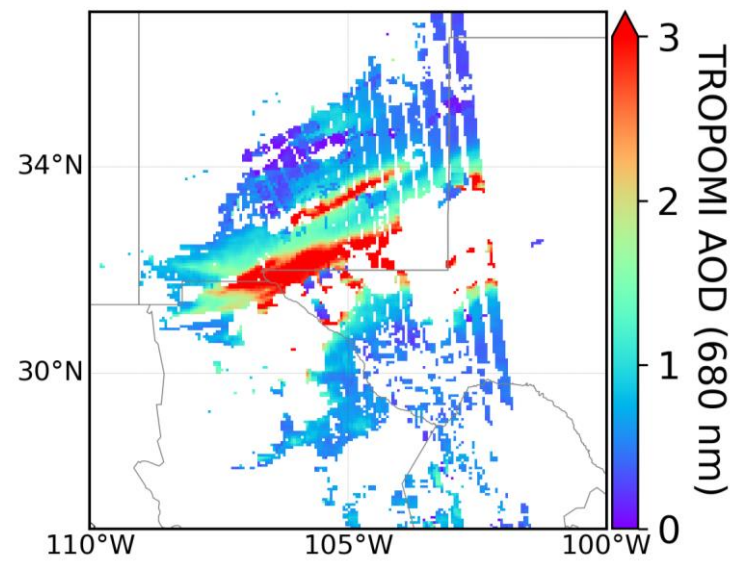
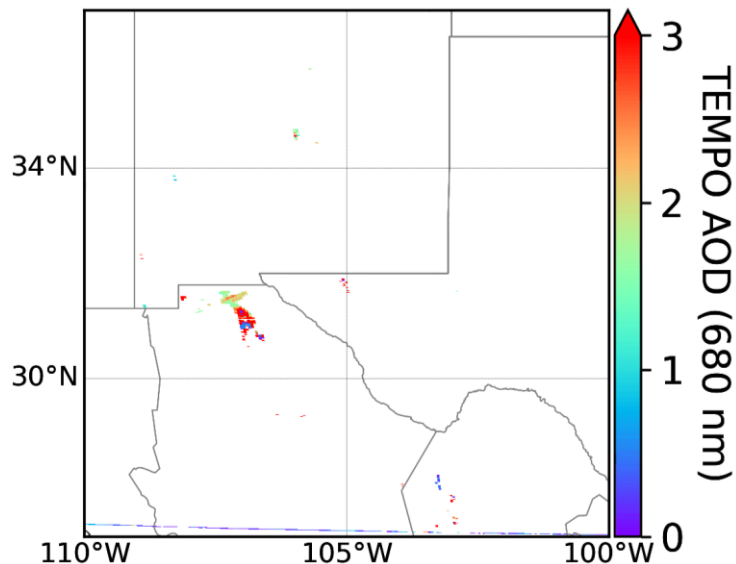
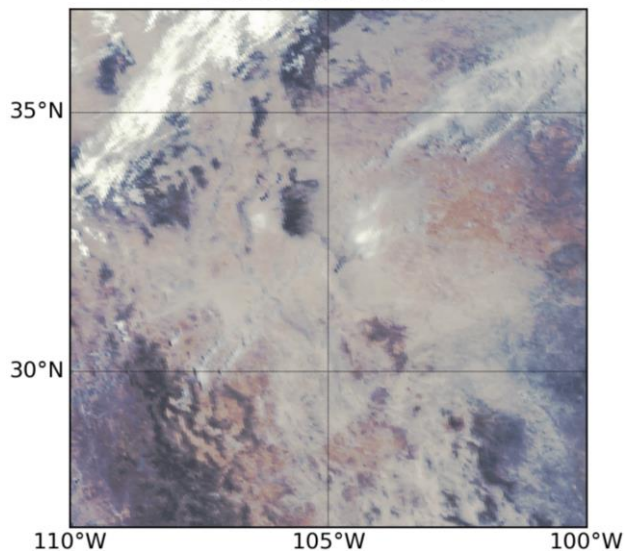
TROPOMI 20250530 20:39



Dust plume demonstration

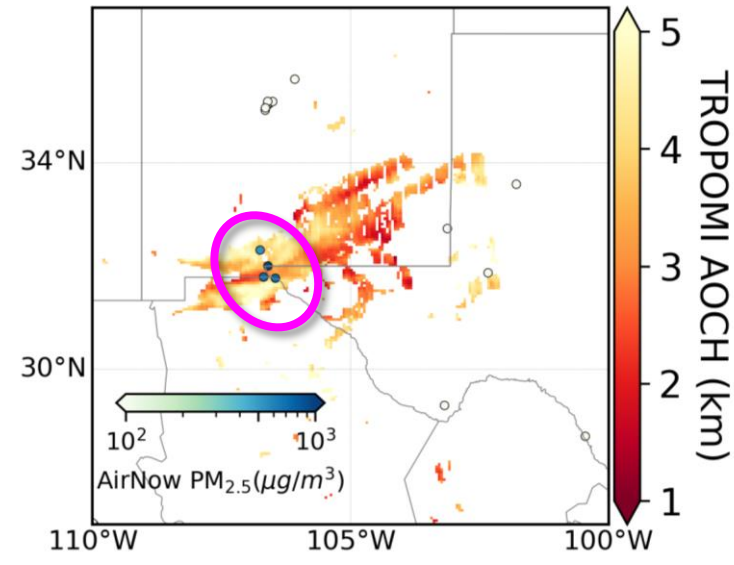
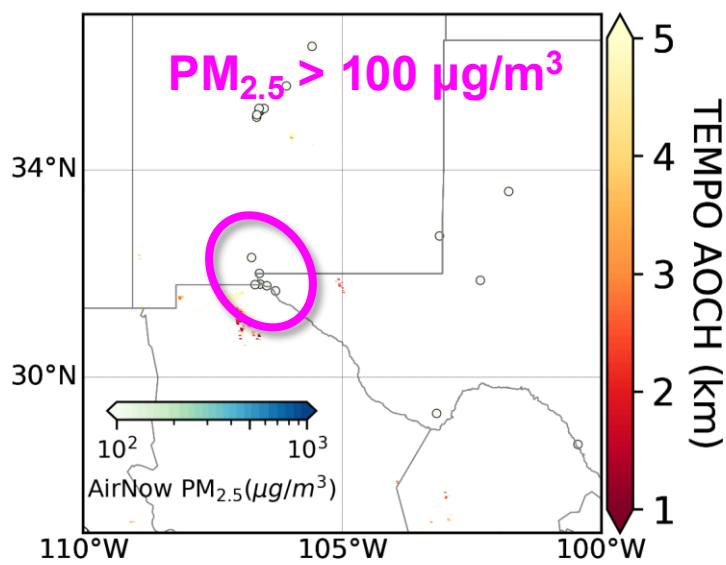
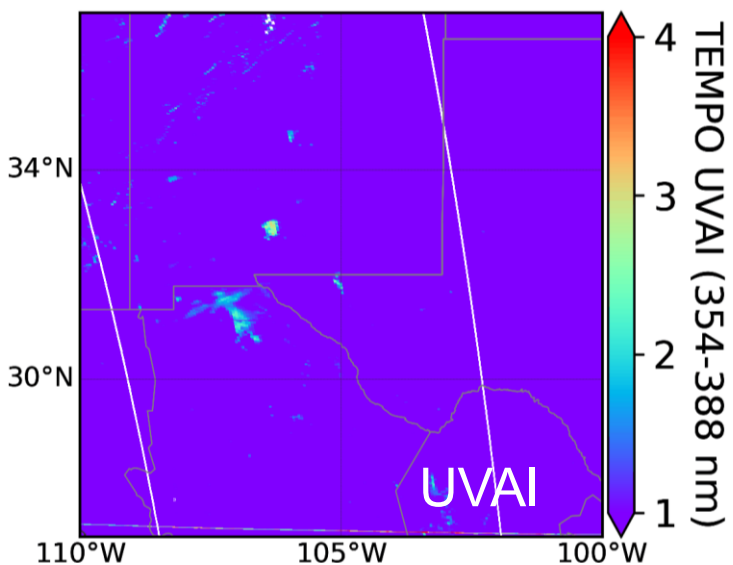
Fast dust storm formation and transport

20250318 S007



TEMPO 20250318 16:57

TROPOMI 20250318 20:36



FireAQ: Monitoring Fire and Air Quality Forecasts

A decision support system including NRT satellite measurements

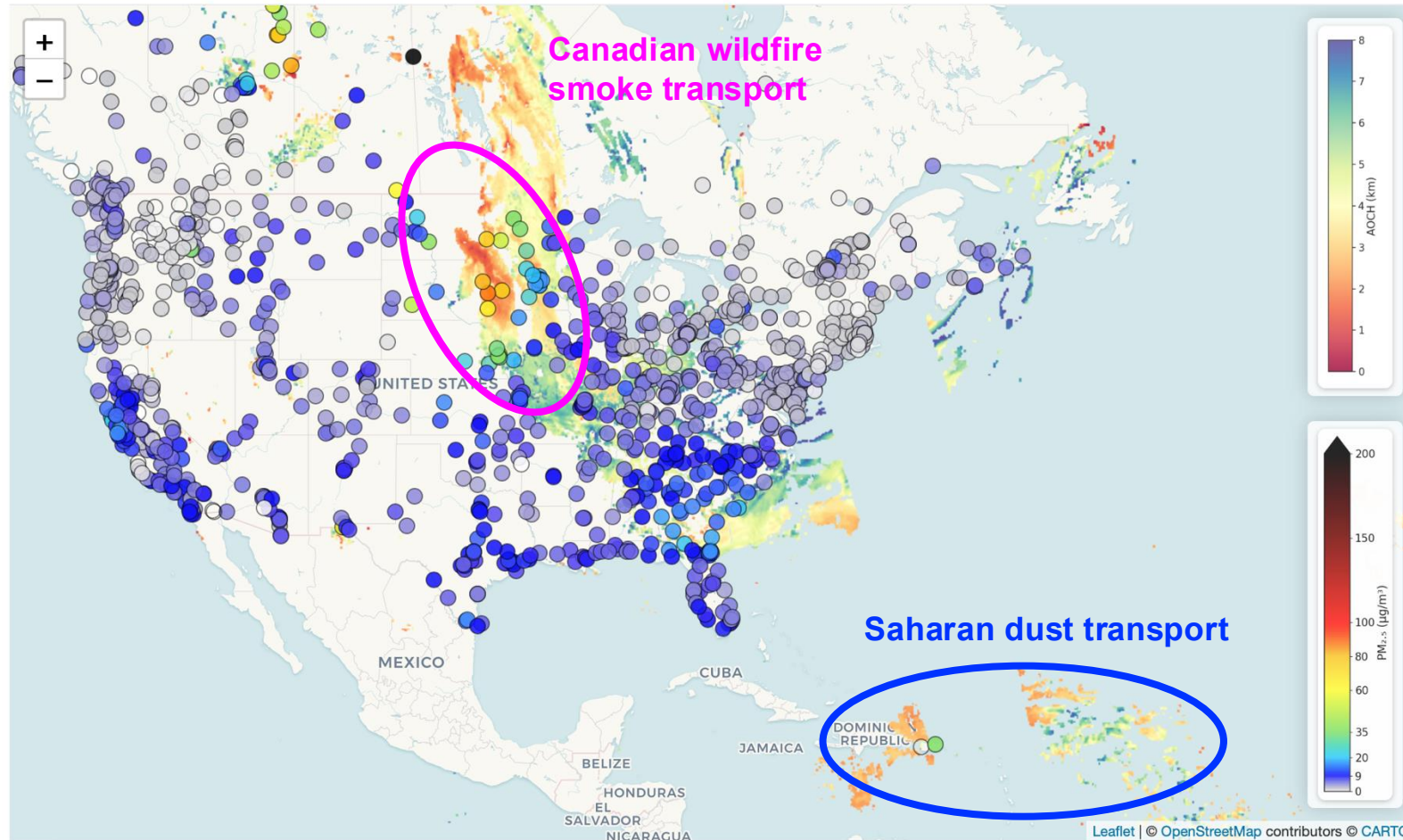
- **NRT satellite and AirNow measurements:**

IOWA Home Timeseries FCST Daily Average Satellite Data Weekly Briefings AQI for you About

TROPOMI AOCHE with AirNow PM_{2.5}

AOCHE retrievals displayed with surface PM_{2.5} observations from EPA AirNow.

https://fireaq.uiowa.edu/apps/tropomi_aoch_pm25/



Select Date to Explore:
2025-06-01
< Previous Next >

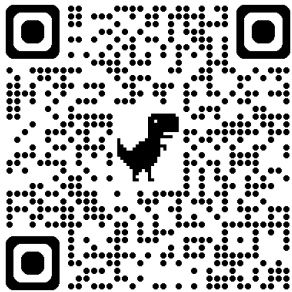
Select Variable
✓ AOCHE Aerosol Optical Centroid Height
None Hide satellite layer

Observations
✓ AirNow PM_{2.5} observations

Background map layers
 VIIRS SNPP True-color Image

Note: rectangle over the map represents the retrieval domain

QR code:



Host weekly meetings during fire seasons engaged with stakeholders to analyze the exceptional wildfire smoke events and predict their influence on PM_{2.5} in CONUS.

Thanks for your attention!

Acknowledgement

