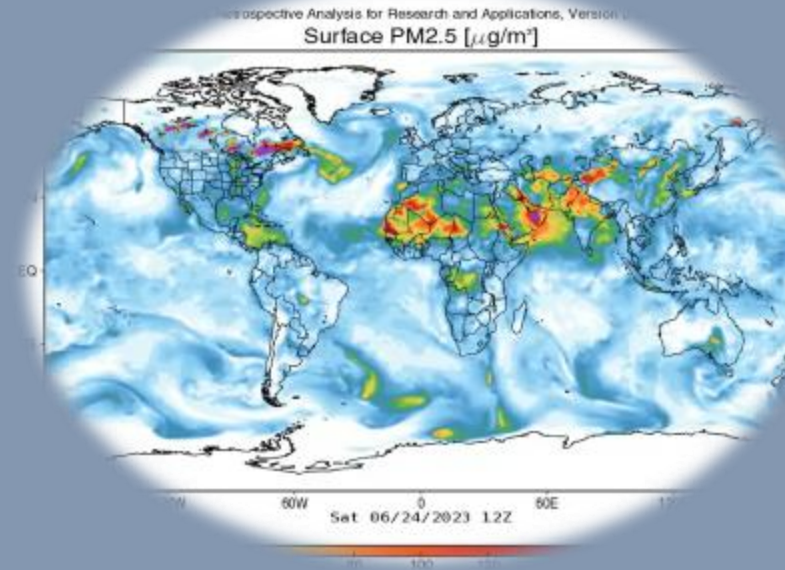
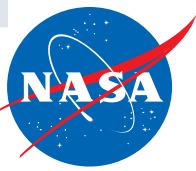




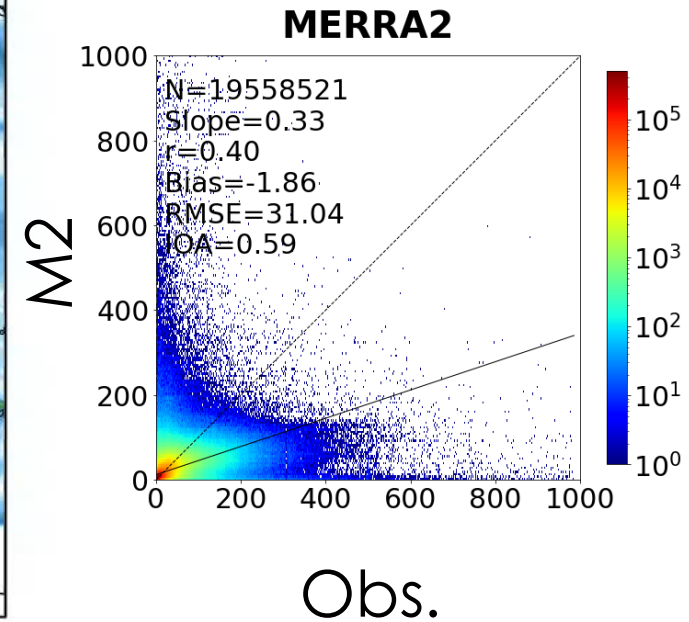
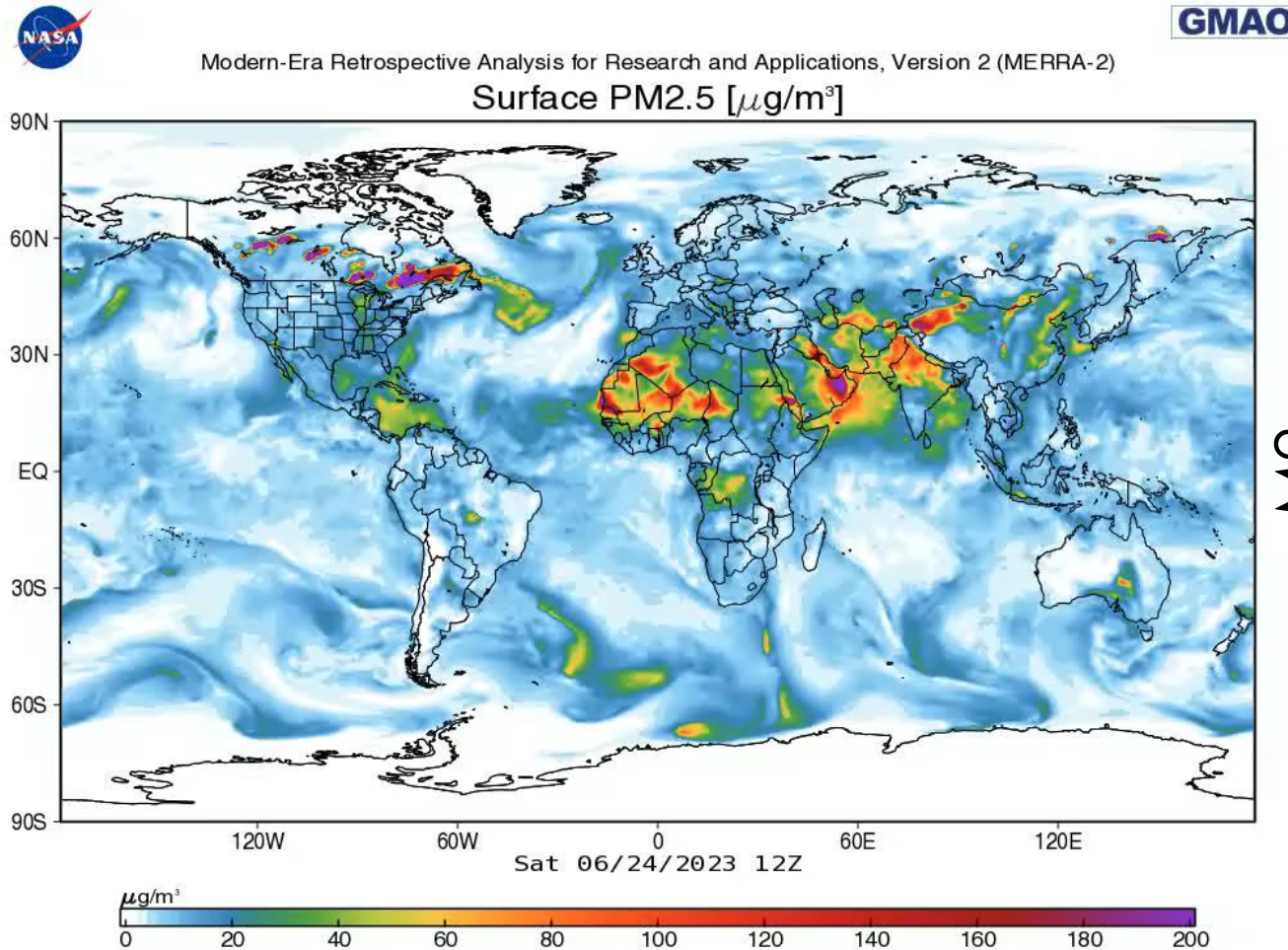
Reanalysis, Satellites, Machine Learning and New Opportunities

Pawan Gupta (NASA GSFC) - pawan.gupta@nasa.gov

HAQAST, Salt Lake City, Utah, October 18-19, 2023

Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA2) – 1980 – Current

long-term global reanalysis to assimilate space-based observations of aerosols and represent their interactions with other physical processes in the climate system



Regional Success Story – Hourly & Daily Data

MERRA2 /GEOS
(Aerosol +
Met.)



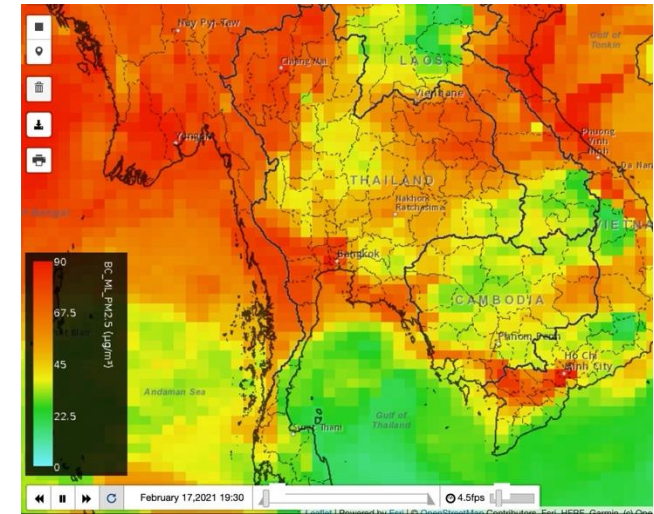
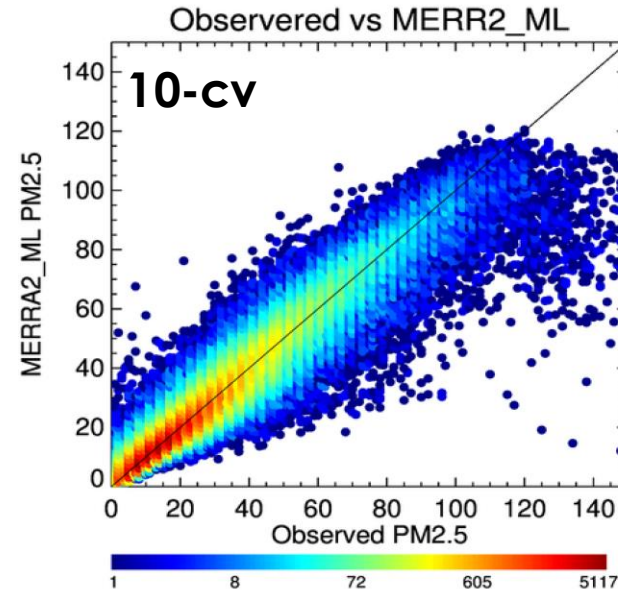
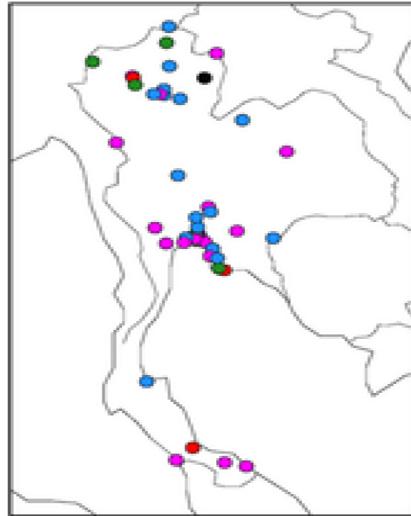
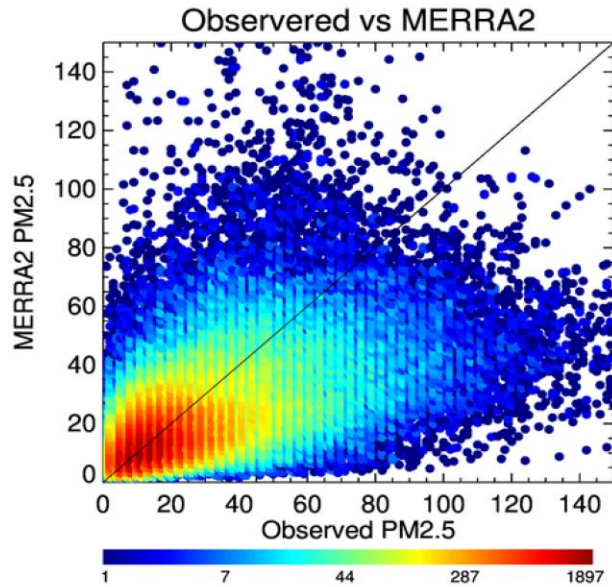
Surface PM2.5



MLA/DLA

Historical PM2.5

Forecasted
PM2.5

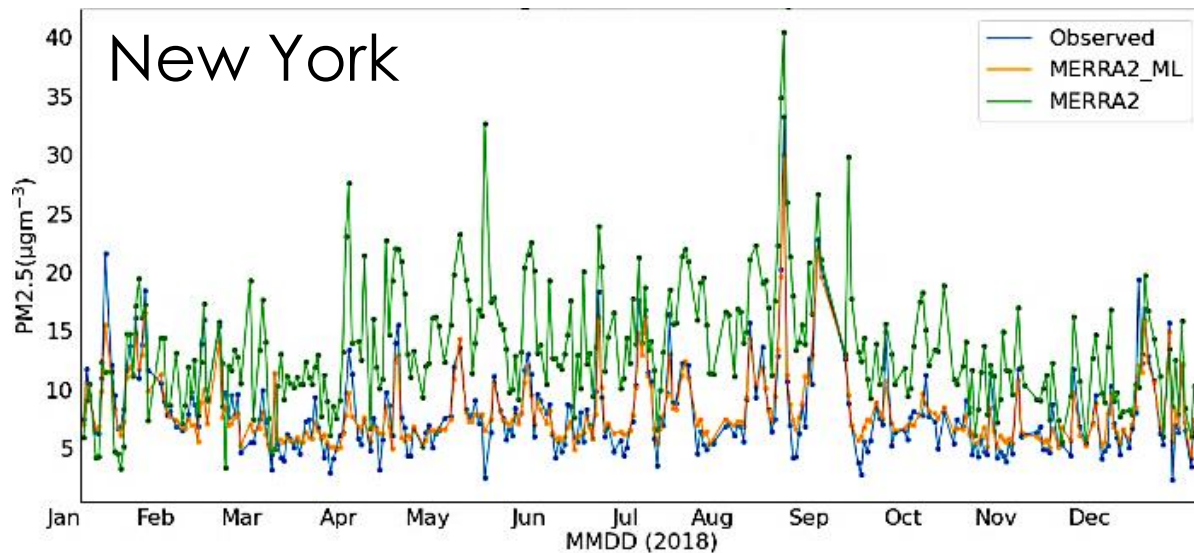
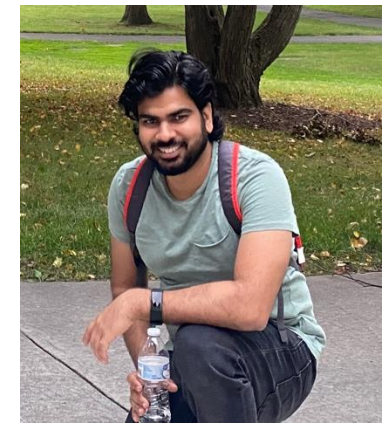


<https://aqatmekong-servir.adpc.net/en/>

Partnership between NASA-SERVIR and TPCD

Gupta et al., 2021, <https://aaqr.org/articles/aaqr-21-05-oa-0105>

Hourly Data for US



Data will be available through NASA GES-DISC – An HAQAST Partnership

AGU ADVANCING EARTH AND SPACE SCIENCE

Earth and Space Science

RESEARCH ARTICLE
10.1029/2022EA002375

Special Section:
Applications of Machine Learning Algorithms in Modeling Atmospheric Aerosols, Clouds, and Radiation

Key Points:

- Machine learning (ML) model to estimate grid-wise $PM_{2.5}$ from Modern-Era Retrospective analysis for Research and Applications version 2 meteorology and aerosols was developed
- ML model was successful in estimating $PM_{2.5}$ when compared with surface measurements
- Regional ML models performed better than the overall ML model

Supporting Information:
Supporting Information may be found in the online version of this article.

Correspondence to:
A. Sayeed,

Hourly and Daily $PM_{2.5}$ Estimations Using MERRA-2: A Machine Learning Approach

Alqamah Sayeed^{1,2}, Paul Lin¹, Pawan Gupta^{1,2}, Nhu Nguyen Minh Tran³, Virginie Buchard^{4,5}, and Sundar Christopher³

¹Universities Space Research Association (USRA), Huntsville, AL, USA, ²NASA-Marshall Space Flight Center, Huntsville, AL, USA, ³The University of Alabama in Huntsville, Huntsville, AL, USA, ⁴University of Maryland Baltimore County, Baltimore, MD, USA, ⁵NASA Goddard Space Flight Center, Greenbelt, MD, USA

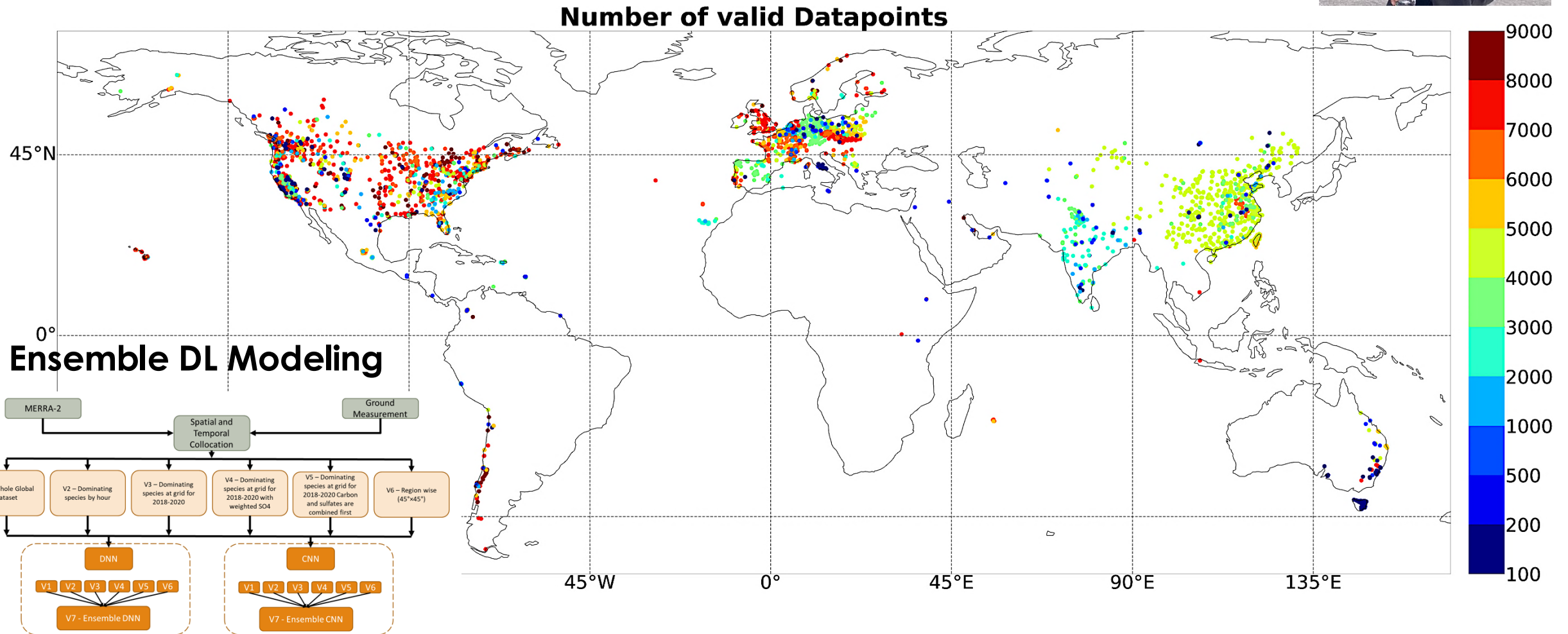
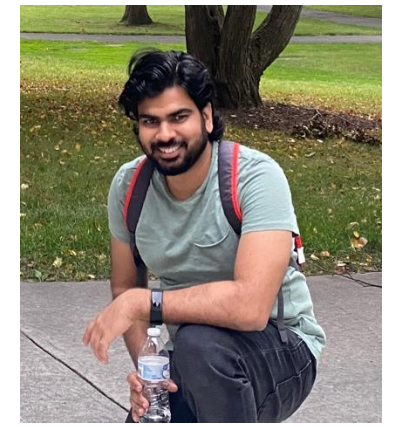
Mean Bias ($\mu g m^{-3}$)

Sayeed et al., 2022

<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2022EA002375>

Going Global – Available Ground Network

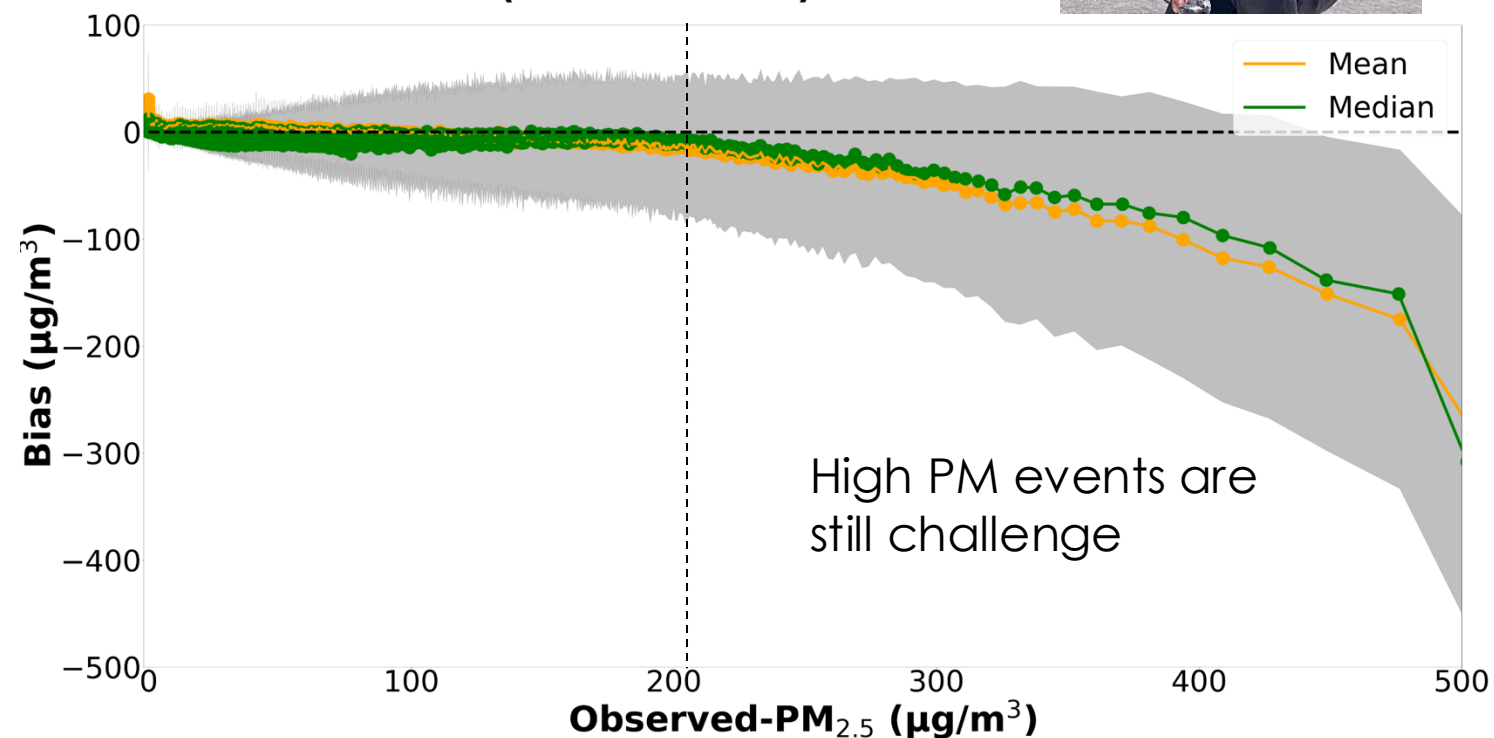
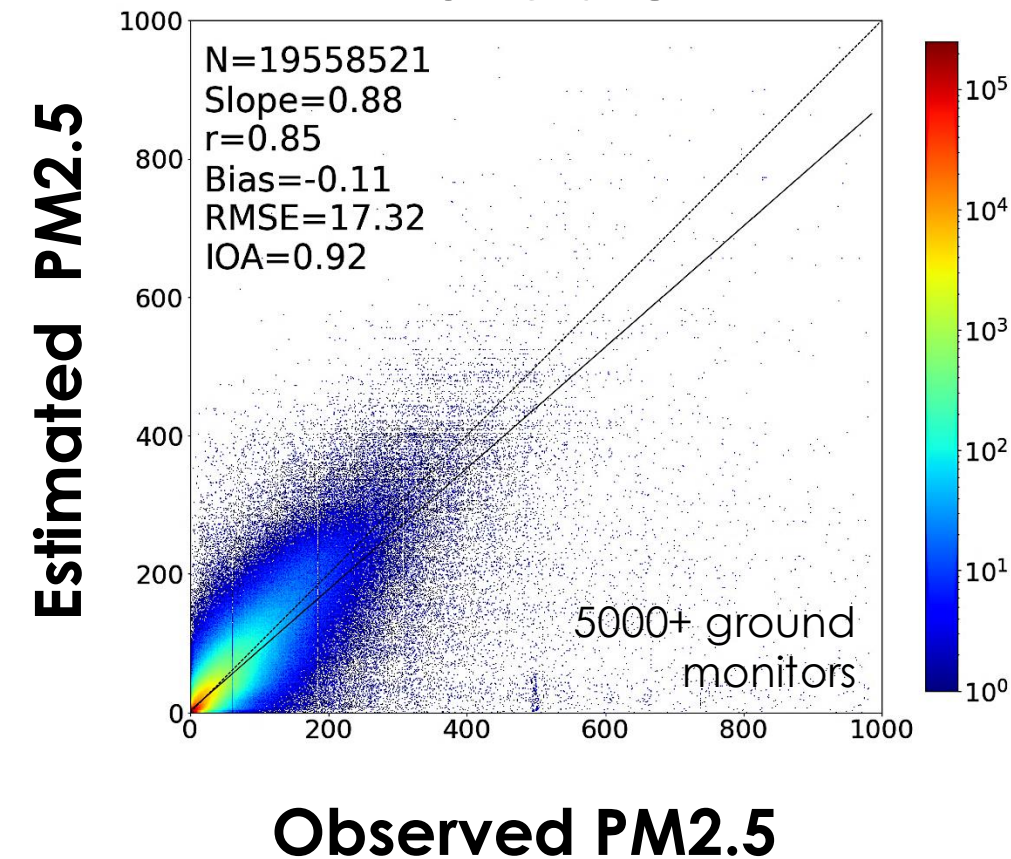
- ❑ ML Training and Testing - 2018 -2019
- ❑ Independent Data Evaluation – 2020-2022
- ❑ Deep Neural Network (DNN) & Convolutional Neural Network (CNN)



Global Estimates – Validation of Hourly Data



10-fold CV



Sayeed et al., 2023, in prep

Data Availability

NASA Data Center


EARTHDATA Find a DAAC 

GES DISC
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11
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Atmospheric Composition, Water & Energy Cycles and Climate Variability
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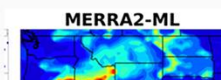
HAQAST: Global Daily PM_{2.5}

[Introduction](#)
[Data](#)
[Characterization](#)

Introduction

Hourly and daily mean PM_{2.5} mass concentration for 2000 to 2020 based on Machine Learning model. The models were trained for the Continental United States (CONUS), Alaska, Puerto Rico, and Hawaii. The reanalysis data was obtained from MERR-2 for hourly averaged meteorology and aerosol components for 2018.

The Goddard Earth Observing System Model (GEOS) data assimilation system operated by NASA's Global Modeling and Assimilation Office (GMAO) creates meteorological and aerosol analyses and forecasts in real-time (<https://gmao.gsfc.nasa.gov>). The aerosol products are derived from an online version of the Goddard Chemistry Aerosol Radiation and Transport (GOCART) aerosol model, including organic carbon, black carbon, sulfate, nitrate, dust,



MERRA2-ML

Google Earth Engine

Mapbox

Search places and datasets...

NASA_GSFC_... Get Link Save Run Reset Apps

```

1 var dataset = ee.ImageCollection('NASA/GSFC/MERRA/aer/2')
2   .filter(ee.Filter.date('2022-02-01', '2022-02-01'))
3 var black_carbon_column_u_wind_mass_flux = dataset.select('TSPM')
4 var bccVis = {
5   min: 0.0,
6   max: 1.0,
7   palette: ['001137', '01abab', 'e7eb05', '620500']}
8 };
9 Map.setCenter(-95.62, 39.91, 2);
10 Map.addLayer(black_carbon_column_u_wind_mass_flux, bccVis);
11 
```

Inspector Console Tasks

Use print(...) to write to this console.

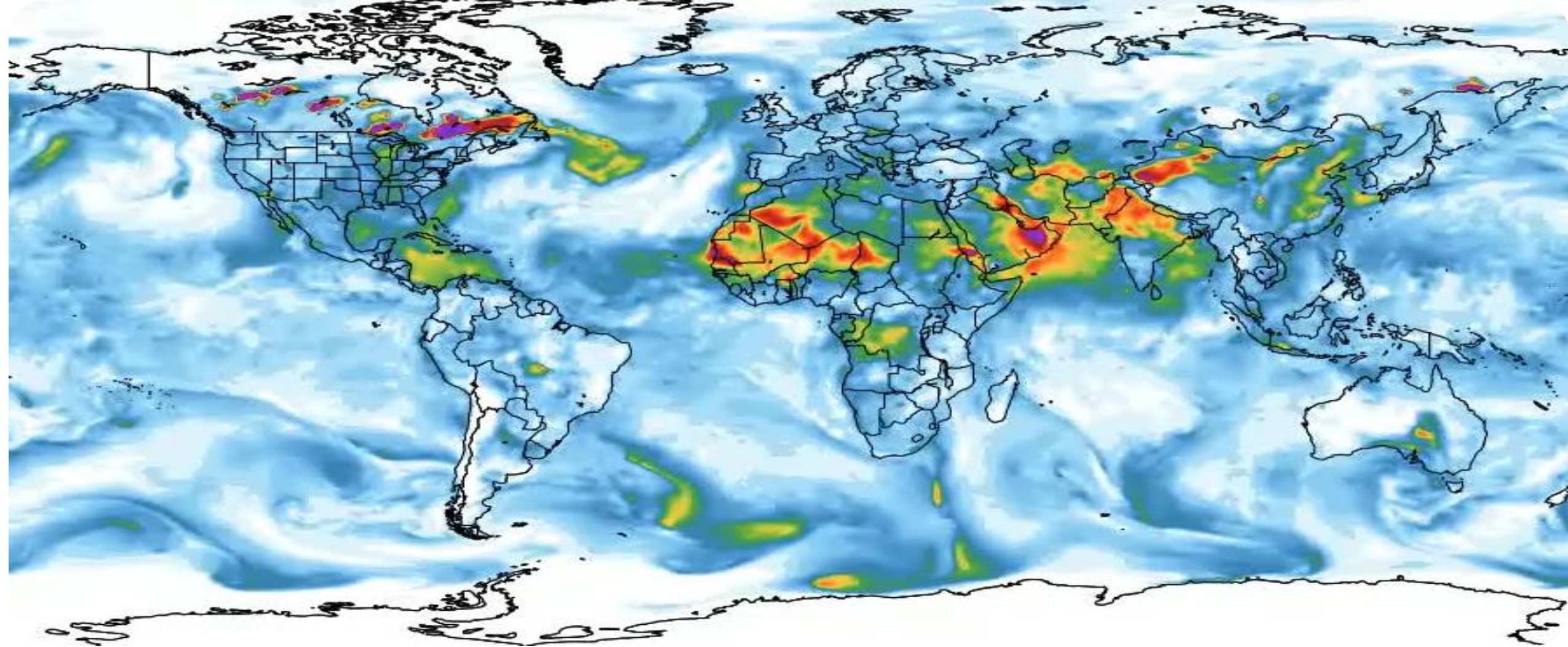
Cannot read properties of undefined

. Click Refresh to check again.

blic_Imagery

RH

The map displays global black carbon column concentration. High concentrations (red/orange) are concentrated over North America, Europe, and parts of Asia, particularly over India and China. Lower concentrations (blue/green) are seen over the oceans and some southern landmasses. The map includes labels for major countries and oceans.

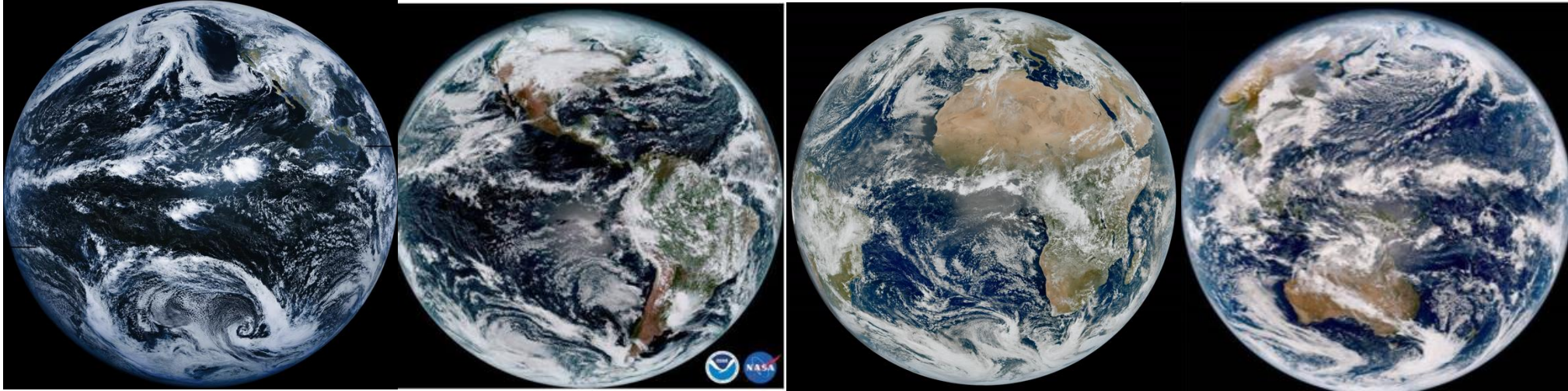


Upcoming Opportunities

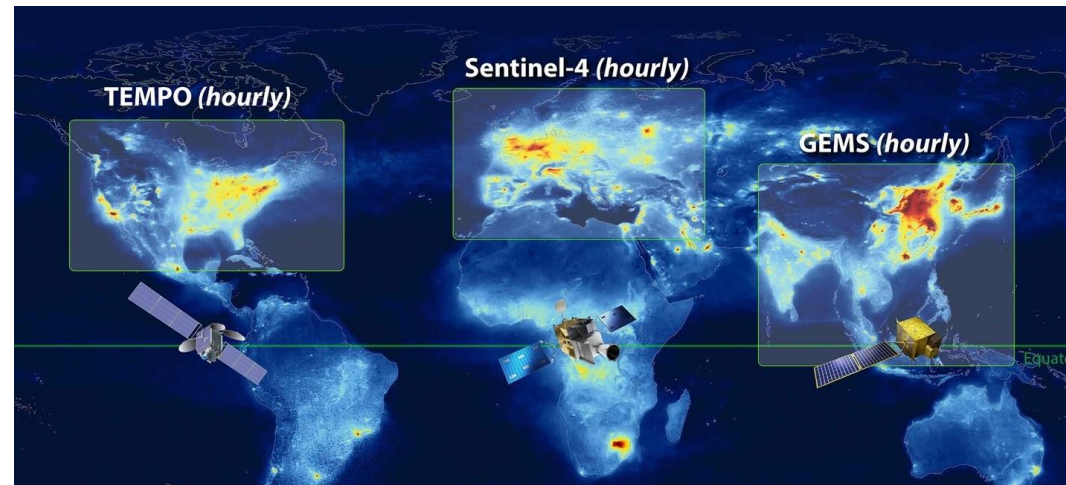
Geostationary Constellations

Visible-IR Sensors

Every 10 minutes Aerosol Observations

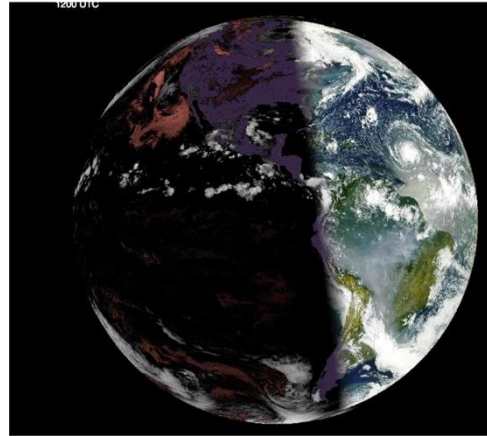


UV-VIS Sensors – Hourly Trace Gases

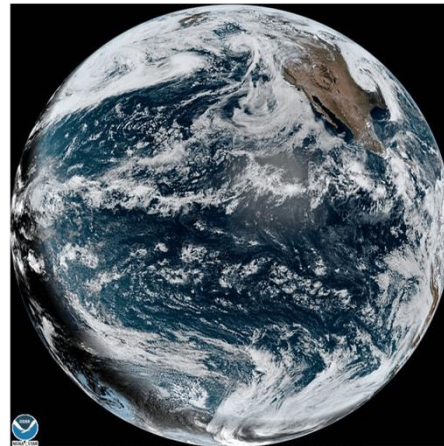


GOES-R Data in AirNow

GOES-East



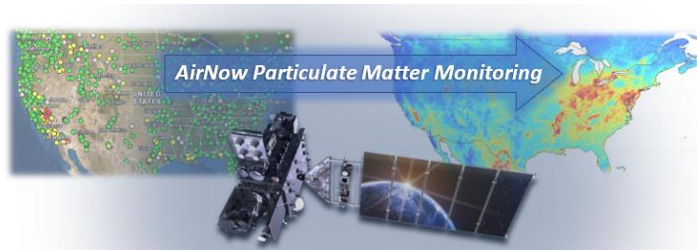
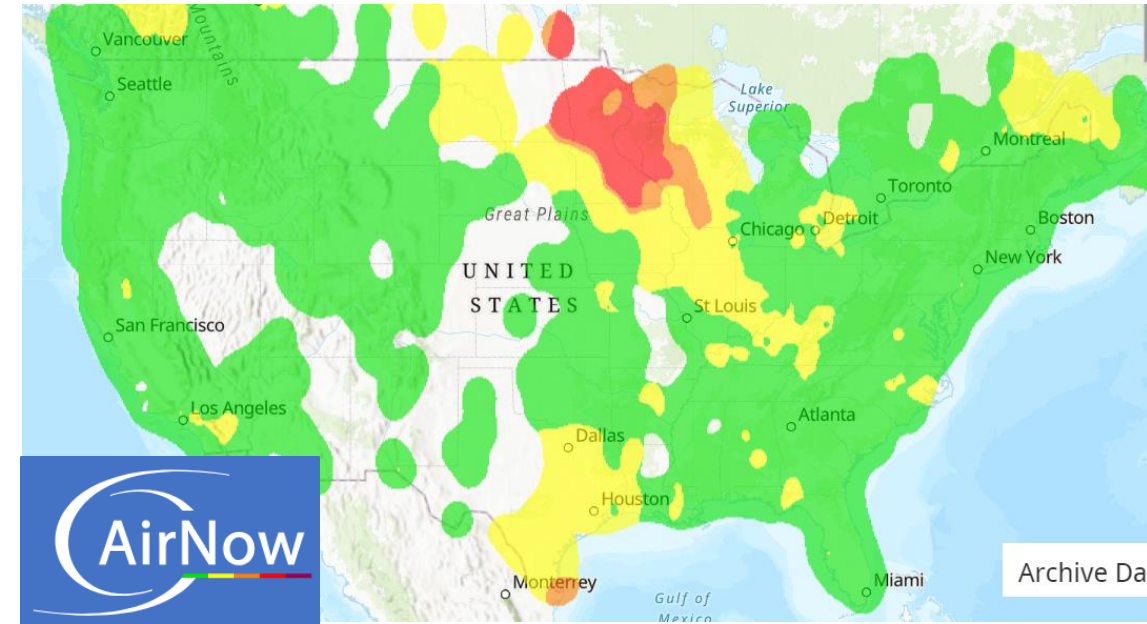
GOES-West



26 May 2022 19:30Z NESDIS/STAR GOES-West GEOCOLOR

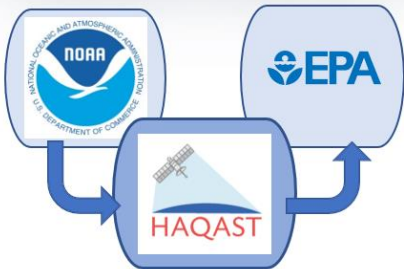


HAQAST Tiger Team – 2020/21

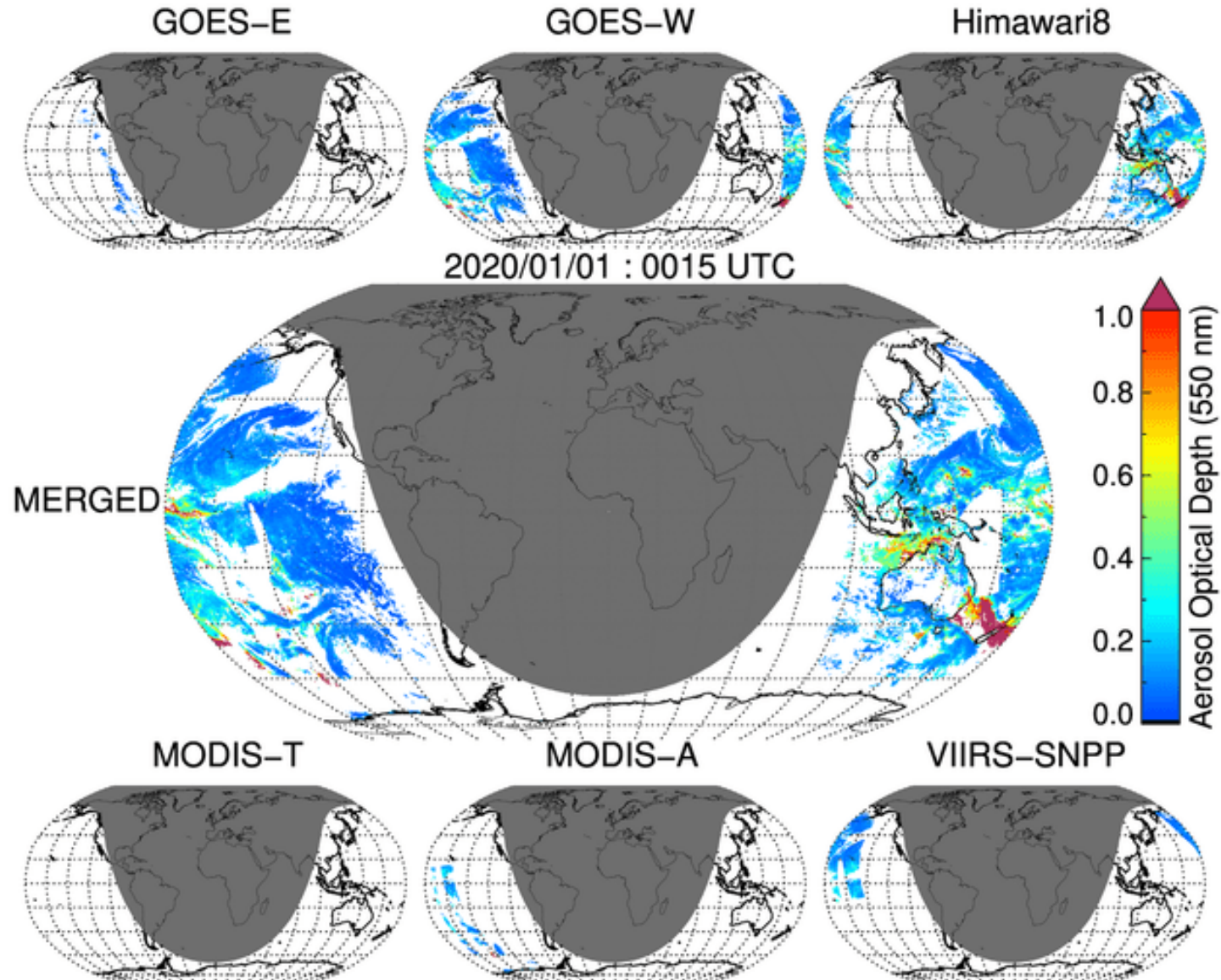


AirNow Particulate Matter Monitoring

Partnership in Improving
Air Quality Satellite Data Access



Looking into the future: Synergy of LEO & GEO



30 minutes loop Jan 1 to Jan 5, 2020