



# NASA Health and Air Quality Applied Sciences Teams: *an EPA Success Story*

Barron H. Henderson

US Environmental Protection Agency

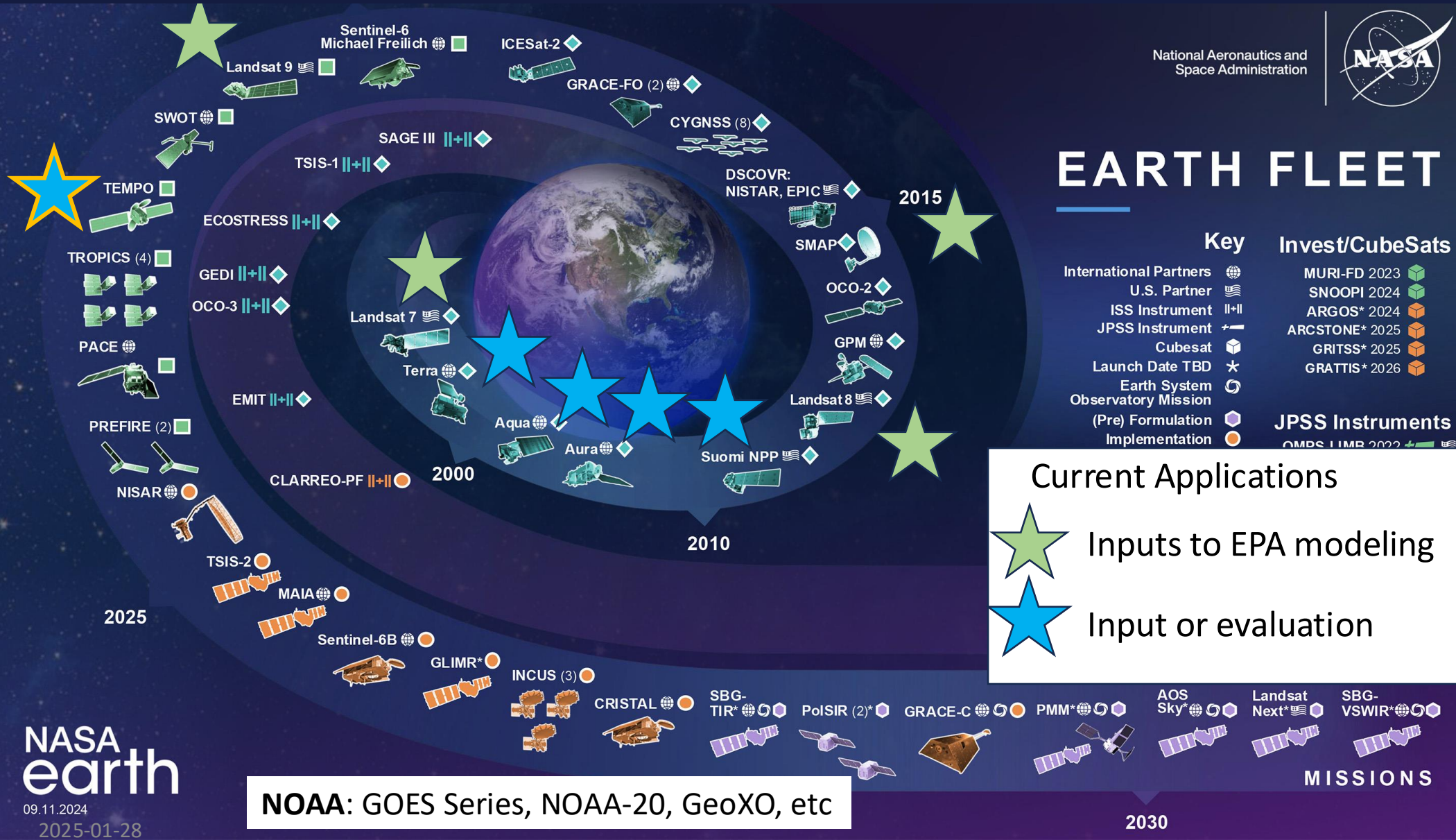
Thanks to all the contributors and NASA HAQAST Tiger Teams!

***Disclaimer:*** The views expressed in this presentation are those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.



# How could EPA use more satellite data?

<https://science.nasa.gov/earth-science/missions/>



**NASA**  
**earth**

09.11.2024  
2025-01-28

# EPA partners with NASA and academics via HAQAST



- What does it mean for EPA to be partner with HAQAST:
  - EPA collaborates on several core-funding projects with specific groups,
  - EPA participates on 12 “Tiger Teams” that address stakeholder needs,
  - EPA participates on Rapid Response Teams addressing topical areas, and
  - Ten minutes is far too short to discuss them all!
- ***3 Applied science collaborations and their impacts for EPA***
  - EPA assimilated satellite nitrogen dioxide for its 2019 Multipollutant Assessment.
  - EPA’s on-line mapping tools have nitrogen dioxide for the first time.
  - EPA’s AirNow system now has near real-time satellite particulate matter.

Program Manager



John Haynes

Team Lead



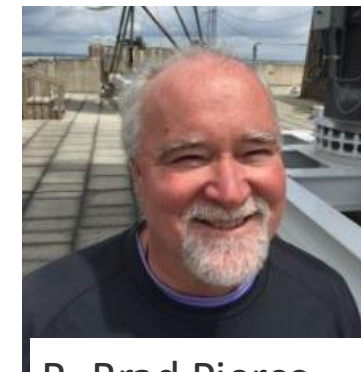
Tracey Holloway

# HAQAST helps EPA assimilate satellite NO<sub>2</sub>!



- HAQAST Team helped EPA to assimilate OMI or TropOMI satellite observations.
- Assimilation is conceptually pushing the model to be more like the observations.
- Assimilated results informed updates to the emissions used for other countries.
- **Updated modeling results were the first assimilation results used in the national air toxics assessment.**

## Team Leads



R. Brad Pierce



Daniel Tong

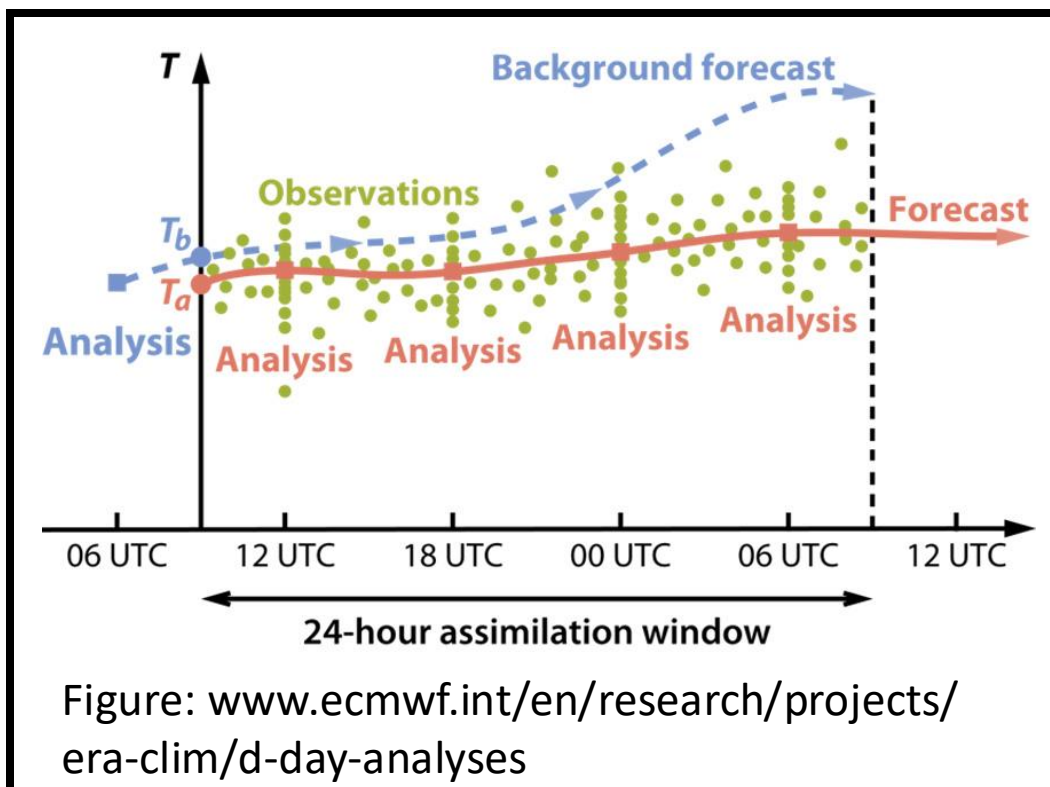
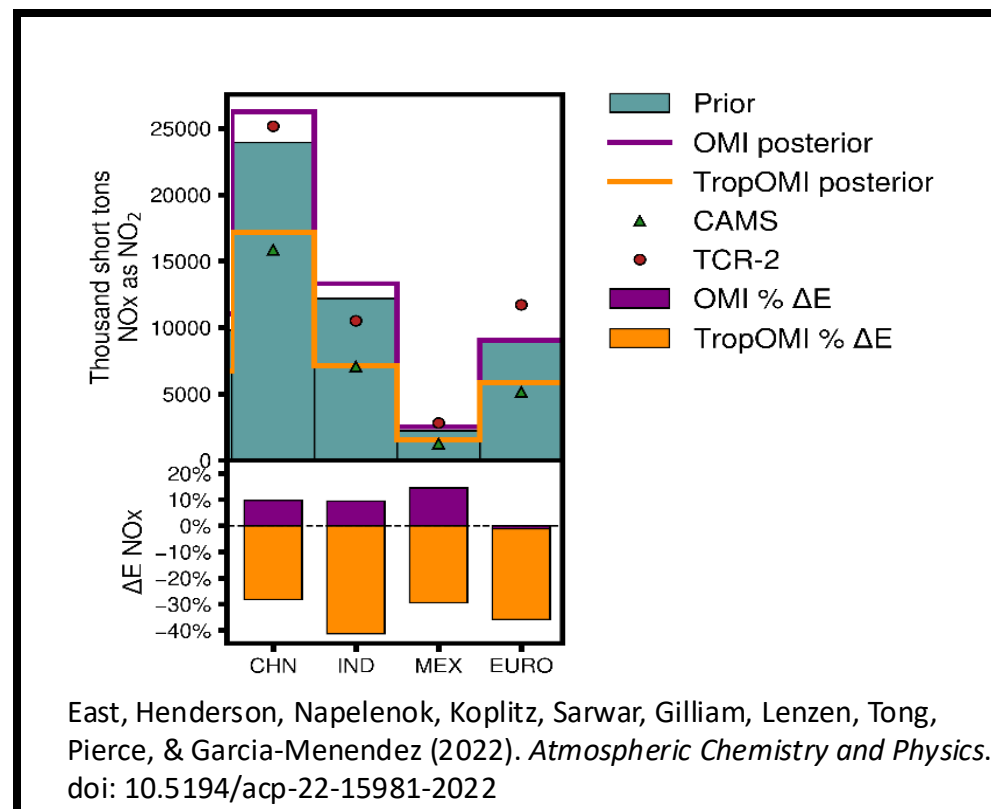


Figure: [www.ecmwf.int/en/research/projects/era-clim/d-day-analyses](http://www.ecmwf.int/en/research/projects/era-clim/d-day-analyses)



East, Henderson, Napelenok, Koplitz, Sarwar, Gilliam, Lenzen, Tong, Pierce, & Garcia-Menendez (2022). *Atmospheric Chemistry and Physics*. doi: 10.5194/acp-22-15981-2022





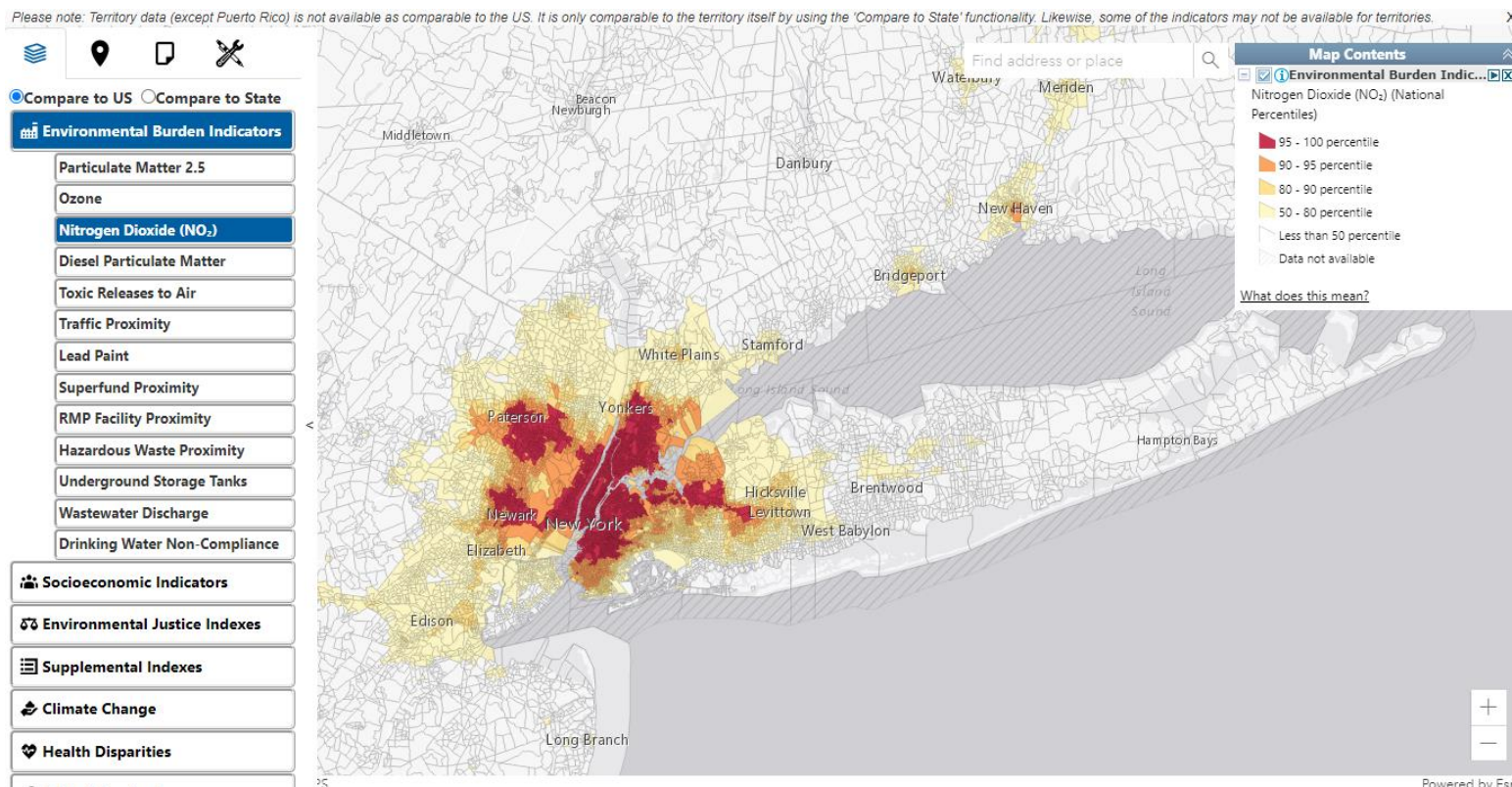
Susan Anenberg



Qian Xiao

# HAQAST benefits EPA mapping tool

- EPA has pollutant screening/mapping tools publicly available since 2015.
- EPA collaborated with HAQAST Team to evaluation/inter-comparison[1] of satellite NO<sub>2</sub> product[2] the United States.
  - Evaluation against surface monitors.
  - Evaluation by rural, urban, and near-road.
  - Comparison to EPA's data products.
- HAQAST Team helped enable two firsts in version 2.3 (released July 2024):
  - A track-level nitrogen dioxide estimate!
  - A satellite-derived product[1]
- Mapping tool received the FY23 Gold Medal Honor Award!



[1] Kerr, G. H., Goldberg, D. L., Harris, M. H., Henderson, B. H., Hystad, P., Roy, A., & Anenberg, S. C. (2023). *Environmental Science & Technology*, 57(48), 19532-19544.

[2] Anenberg, S. C., Moheg, A. et al. (2022). *The Lancet Planetary Health*, 6(1), e49-e58.



# HAQAST benefits AirNow

**Team Lead:** HAQAST investigator Pawan Gupta

**Partners:** Phil Dickerson and Barron Henderson with the US Environmental Protection Agency (EPA), and Shobha Kondragunta with the National Oceanic and Atmospheric Administration (NOAA)

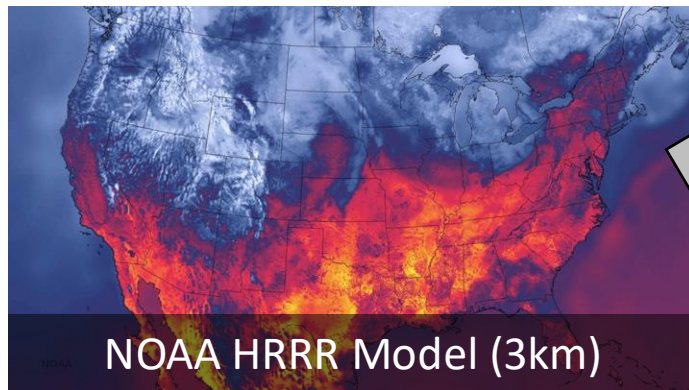
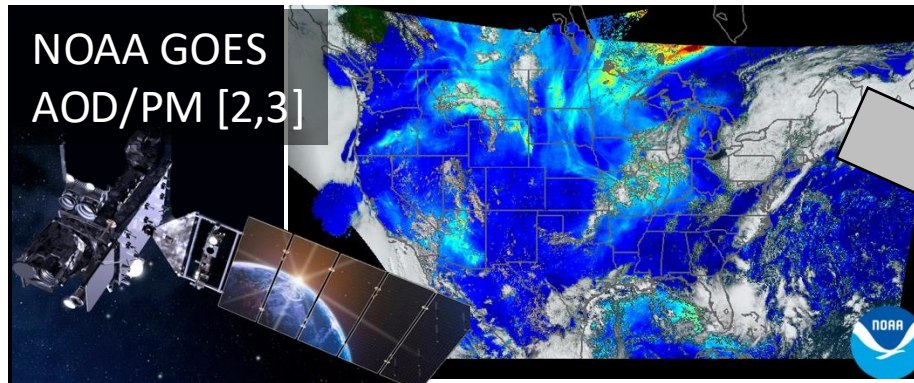
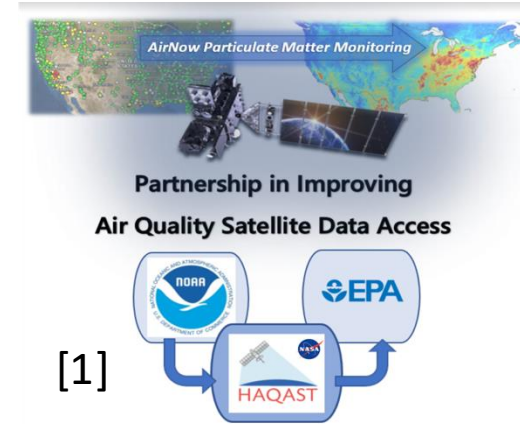


Pawan Gupta

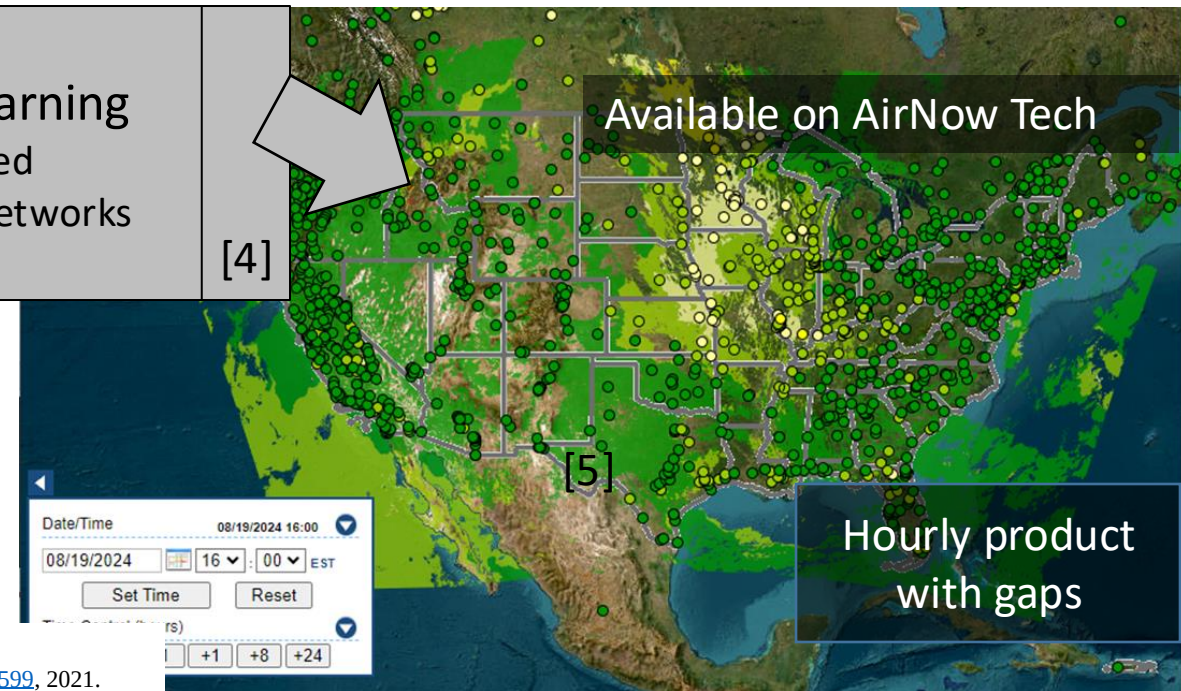


Yang Liu

*2024 Team led by Yang Liu*



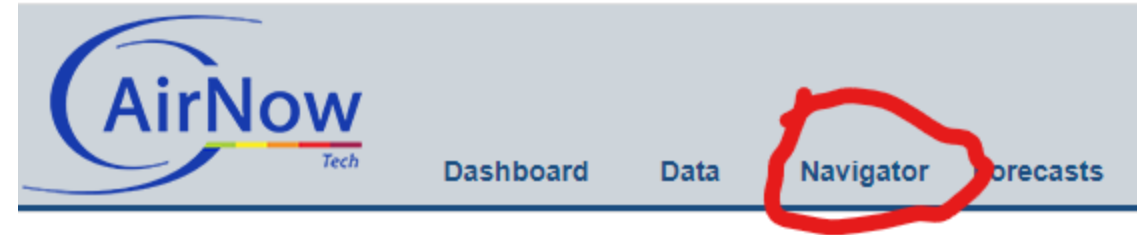
Machine Learning  
14 Blended  
Deep Neural Networks  
[4]



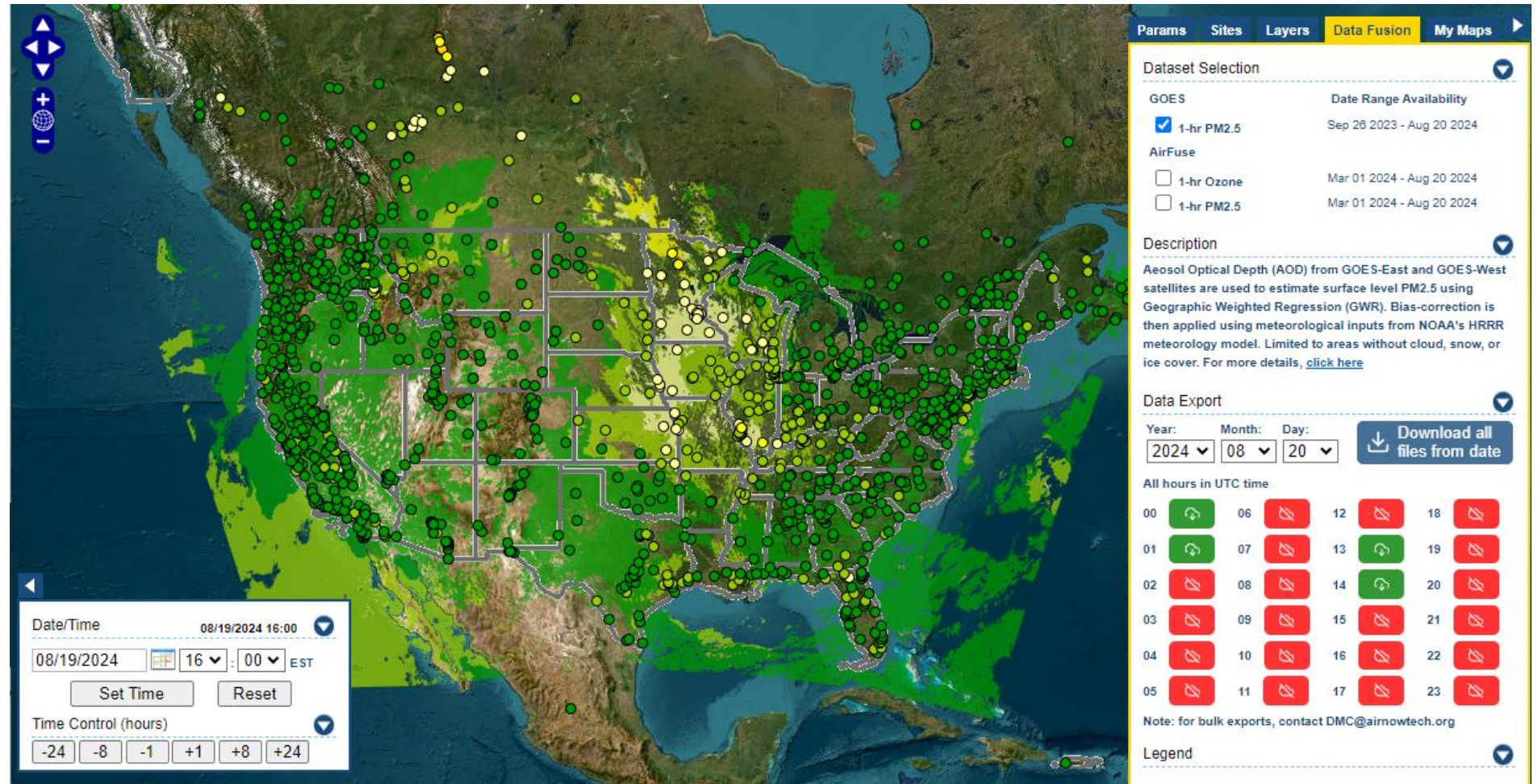
1. Bratburd et al.: Air Quality Data When You Need It: Incorporating Satellite Data Updates into AirNow, [EM Plus](#), 2022.
2. Zhang and Kondragunta.: Daily and Hourly Surface PM2.5 Estimation From Satellite AOD, Earth Space Sci, 8, doi: [10.1029/2020EA001599](#), 2021.
3. Zhang et al.: Nowcasting Applications of Geostationary Satellite Hourly Surface PM2.5 Data. Weather and Forecasting, 37(12), 2313-2329, 2022. doi: [10.1175/WAF-D-22-0114.1](#)
4. Sayeed et al. GOES-R PM2.5 Evaluation and Bias Correction: A Deep Learning Approach. [https://doi.org/10.22541/essoar.172857960.01252938/v1](#)
5. O'Dell et al.: Public Health Benefits from Improved Identification of Severe Air Pollution Events with Geostationary Satellite Data, *GeoHealth*, 2023.



# GOES-PM25 in <https://airnowtech.org/>

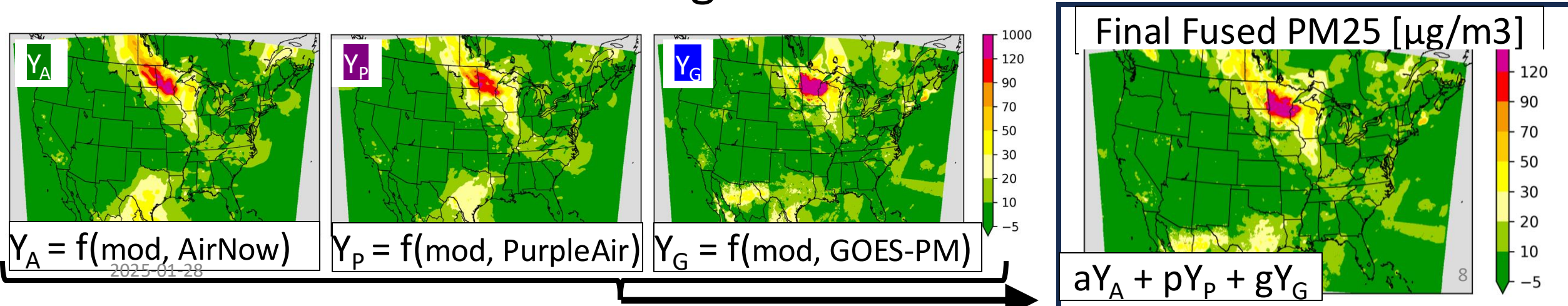


- GOES-PM25 product is on EPA's AirNow suite because of HAQAST collaborations
- Example of HAQAST catalyzing federal agency cooperation



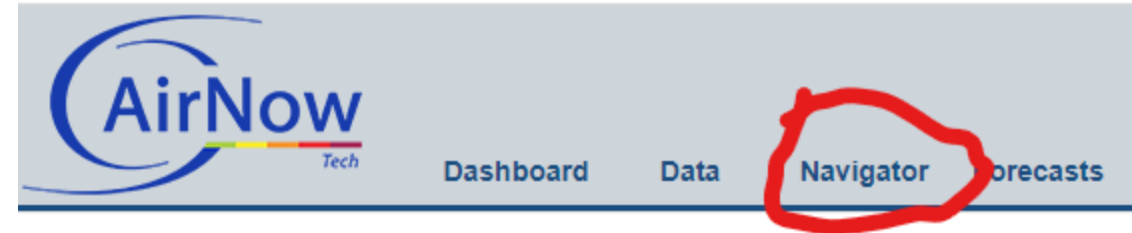
# AirFuse: Bias Correction Ensemble

- Did you notice the gaps due to cloud gaps on the last slide?
- HAQAST collaboration included EPA developing a method to fuse satellite and surface data.
- AirFuse “corrects” the NOAA air quality forecast (NAQFC)
  - Using AirNow monitor ( $Y_A$ ) **observations**:
  - Using low-cost sensors (PurpleAir,  $Y_P$ ) **observations**:
  - Using GOES-PM25 ( $Y_G$ ) “**observations**”
- Combines them all into a single best estimate!

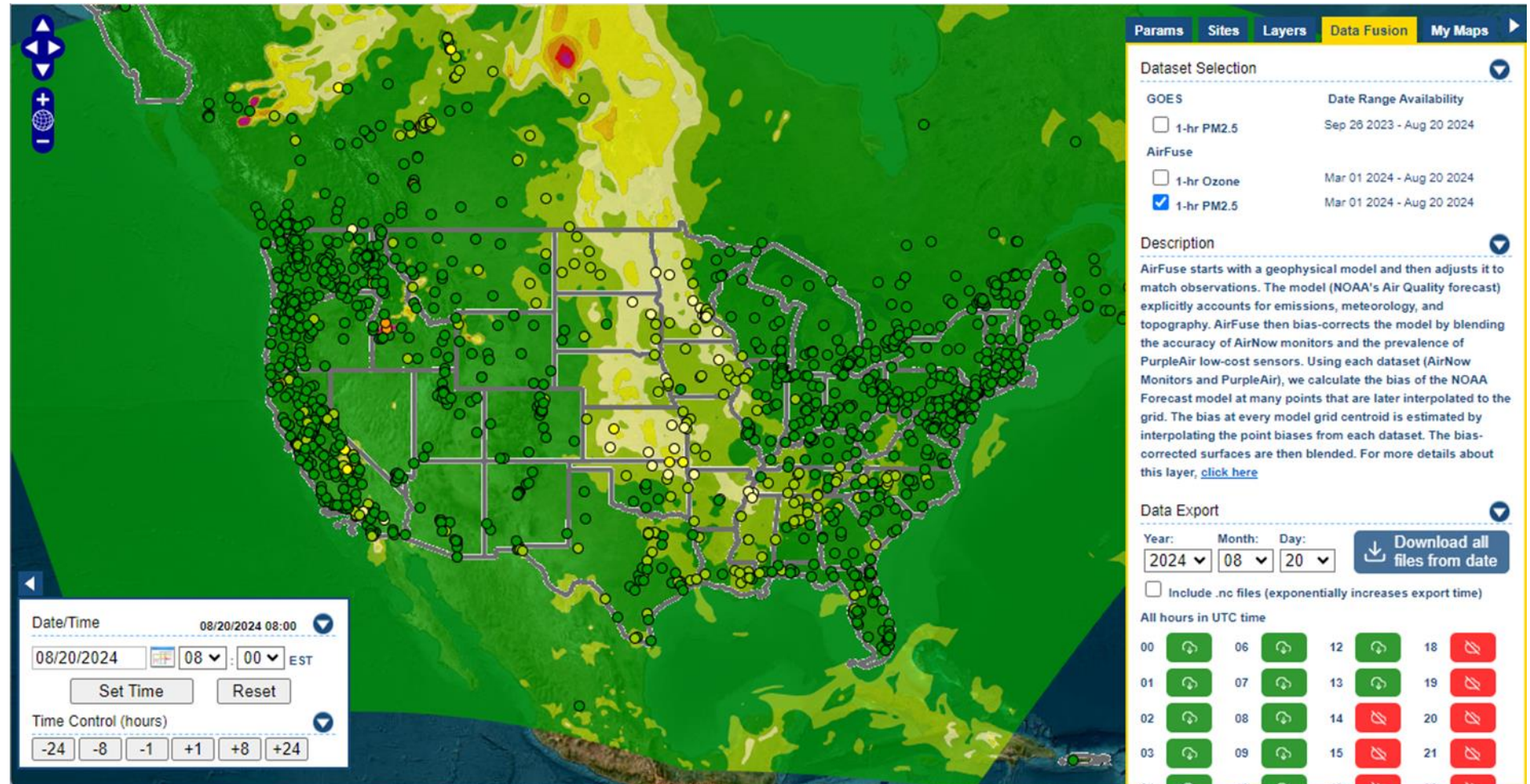




# AirFuse in <https://airnowtech.org/>



- HAQAST motivated new data products
- AirFuse:
  - Currently uses NAQFC, AirNow and PurpleAir only
  - GOES-PM25 incorporation still under development



# Conclusion: HAQAST collaborations are great!

- Satellite data is currently underutilized and HAQAST guides us forward
- HAQAST helped:
  - EPA utilize robust satellite data to improve estimates of pollution entering the US.
  - EPA utilize robust satellite nitrogen dioxide columns to inform exposure.
  - AirNow take a major step forward to with near-real-time satellite derived PM25.
- Too short a time to discuss many other HAQAST projects in any detail!
- NASA Health and Air Quality Applied Science Team collaborations produce
  - Tangible benefits to EPA and our stakeholders.
  - Intangibles like researcher connections that will lead to future advances.