Enrich and Enhance the Application of TEMPO and GEOS Data Products for Regional Air Quality and Public Health Management under Smoke Conditions

Jun Wang, Megan Christiansen, Lorena Castro Garcia

University of Iowa

April 23, 2024

NASA HAQ Team

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Project Summary

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- Enrich and Enhance the Application of TEMPO and GEOS Data Products for Regional Air Quality and Public Health Management under Smoke Conditions
- FireAQ
- Jun Wang
- Solication: NNH21ZDA001N-HAQ
- Project Summary
  - The proposed project will first make the TEMPO AOCH research algorithm operational so the AOCH and AOD products from TEMPO can be ported to a new website for Fire and Air Quality (FireAQ) in NRT.
  - The proposed efforts will bridge application needs and TEMPO's operational data production. Published machine-learning tools will be used to provide NRT estimates of surface PM2.5 forecast bias corrections, with inputs from TEMPO AOCH and AOD data, as well as GEOS-FP meteorological and aerosol fields.
- US CONUS

Project Partners/Collaborators

List project Co-Investigators, collaborators, and other partners

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Role	Name	Affiliation	Organization Type
PI	Jun Wang	University of Iowa	University
Co-I	Daven Henze	University of Colorado Boulder	University
Co-I	Xiong Liu	Harvard Smithsonian Observatory	University
Co-I	Melanie Follette-Cook	NASA GSFC	Federal
Postdoc/Stakeholder engagement	Megan Christiansen	University of Iowa	University
Collaborator/Stakeholder	Scott Epstein	South Coast Air Quality Management District, CA	State agency
Collaborator/Stakeholder	Zac Adelman	Lake Michigan Air Directors Consortium	Air quality research and planning
Collaborator/Stakeholder	Martha Webster	ME Dept. of Environmental Protection	State agency
Collaborator/Stakeholder	Daniel Welsh	CO Dept. of Public Health & Environment	State agency
Collaborator/Stakeholder	Ryan Biggerstaff	OK Dept. of Environmental Quality	State agency
Collaborator/Stakeholder	Christoph Keller	Universities Space Research Association	Data/Domain Scientist

Project End-users & Stakeholders

List organization names and organization types

Organization Name	Organization Type	Decision Making Activity
South Coast Air Quality Management District, CA	State Agency	Air quality forecasting/ exceptional event analysis
Lake Michigan Air Directors Consortium	Air quality research and planning	Air quality forecasting/ exceptional event analysis
ME Dept. of Environmental Protection	State Agency	Air quality forecasting/ exceptional event analysis
CO Dept. of Public Health & Environment	State Agency	Air quality forecasting/ exceptional event analysis
OK Dept. of Environmental Quality	State Agency	Air quality forecasting/ exceptional event analysis
Universities Space Research Association	State Agency	Air quality forecasting/ exceptional event analysis

Engagement plan and recent updates

Meet with stakeholders on a quarterly basis to discuss project progress, website developments, and future needs for the AQPH agencies.

FireAQ weekly air quality briefings: 2023 summary

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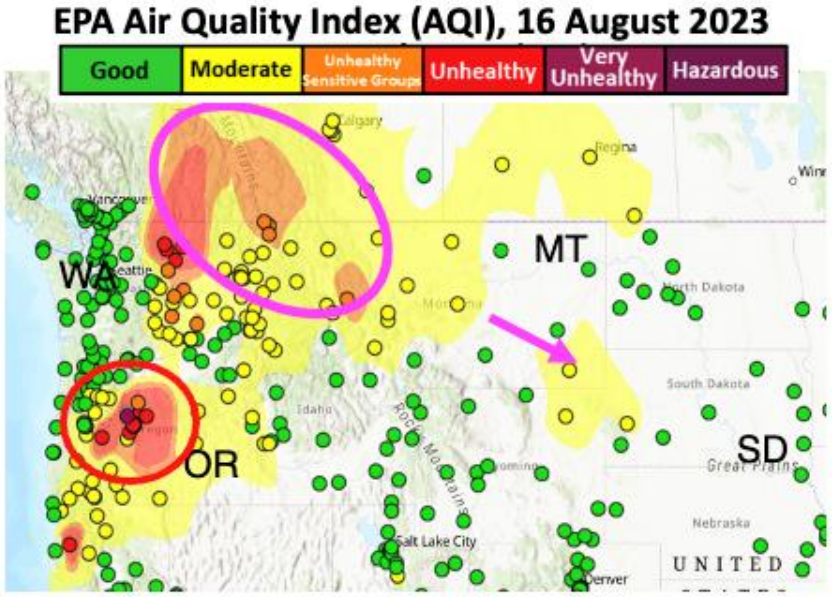

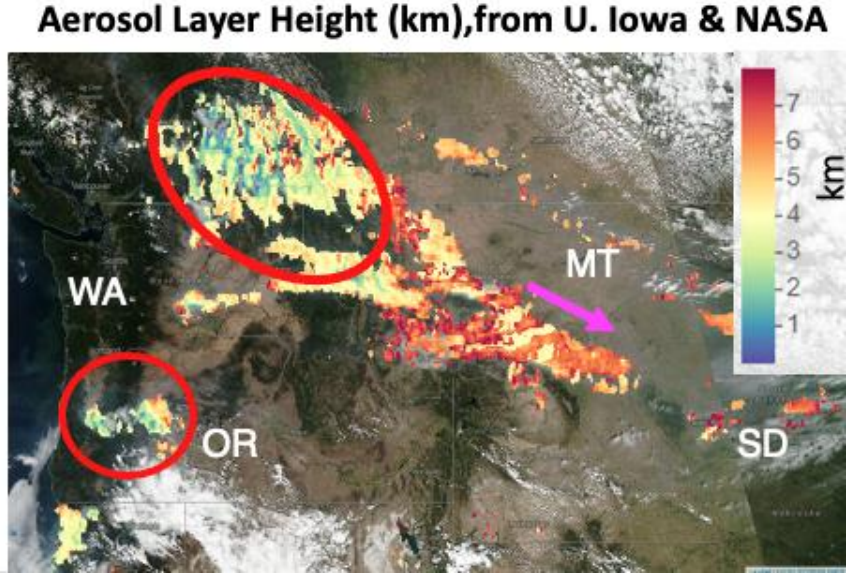

A retrospective analysis of AQ the week back and outlook a week ahead during US “fire season”

AIM: engage with the scientific community and end user organizations

Occurred: Weekly from July – October 2023

Meeting attendees, and email subscribers, represented **21 groups** across universities, federal organizations, and state agencies.

Briefing slides are archived:
http://fireaq.uiowa.edu/briefings.php

Improvements to the FireAQ website design

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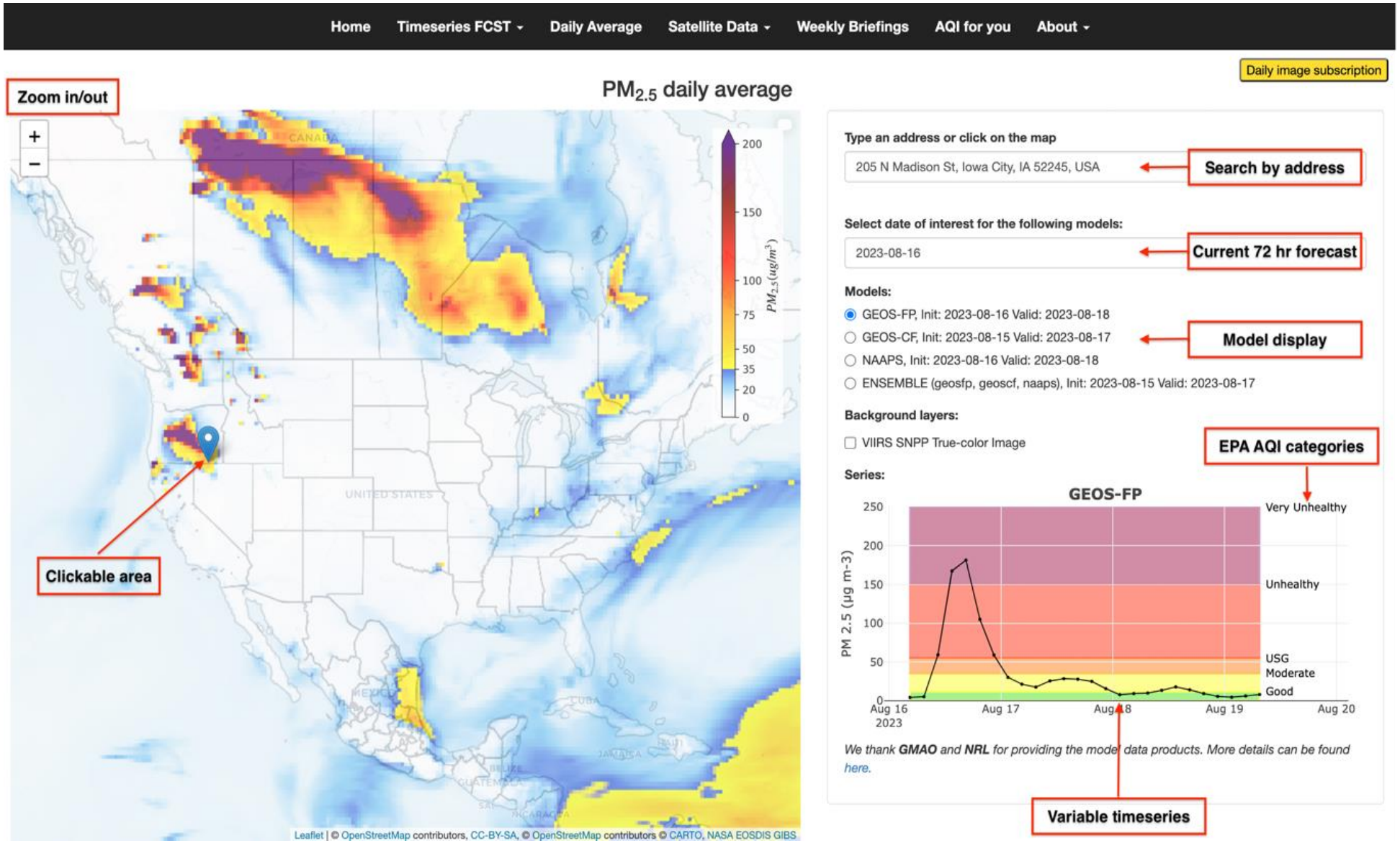

Example of $PM_{2.5}$ daily average page

Aerosol Optical Centroid Height can help to constrain AOD Case Study: August 16, 2023

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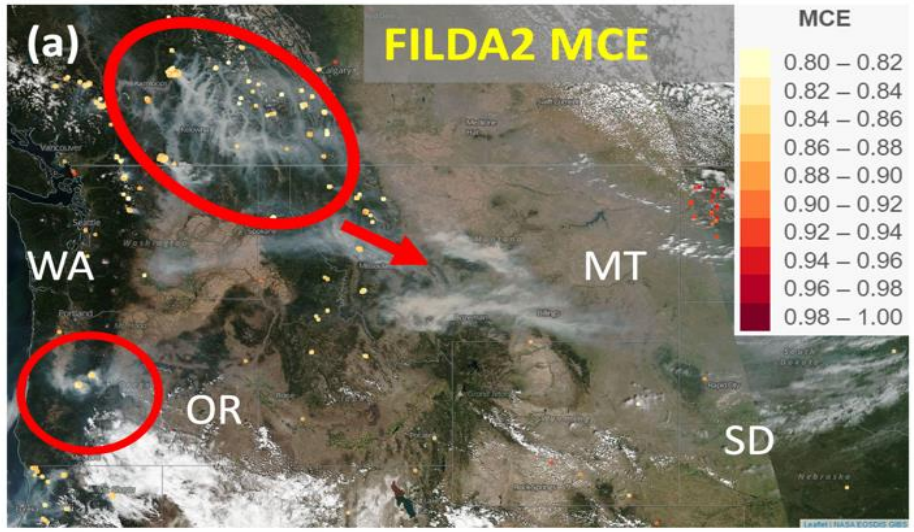

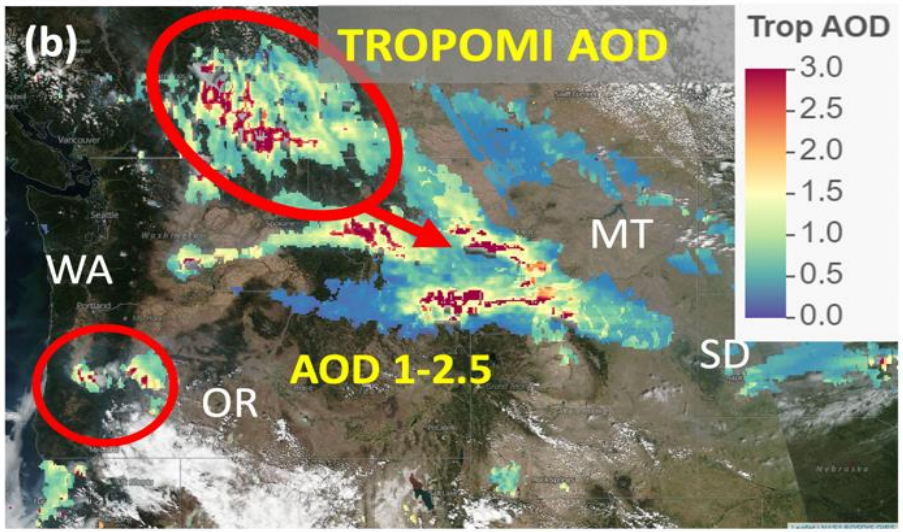

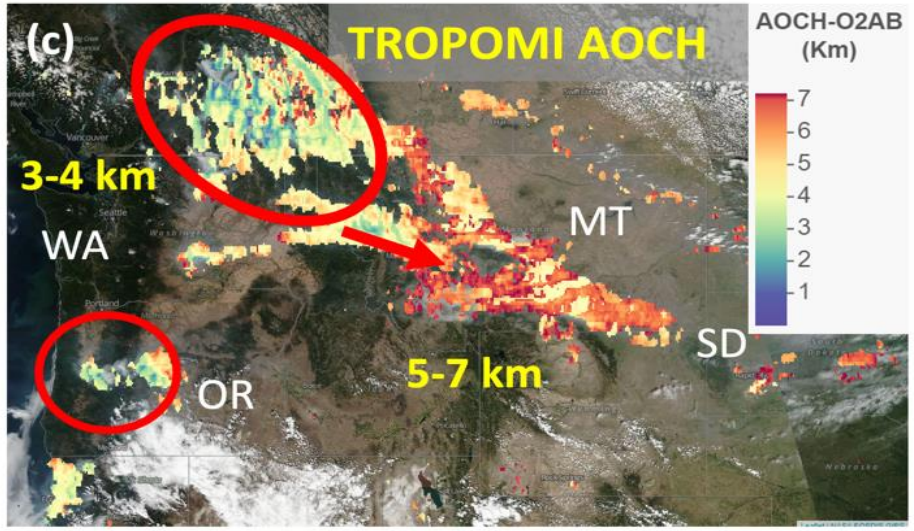

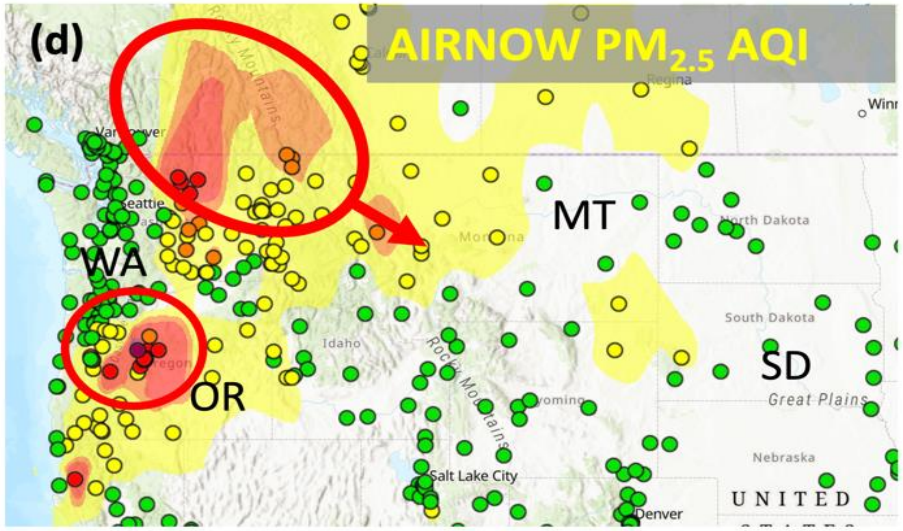

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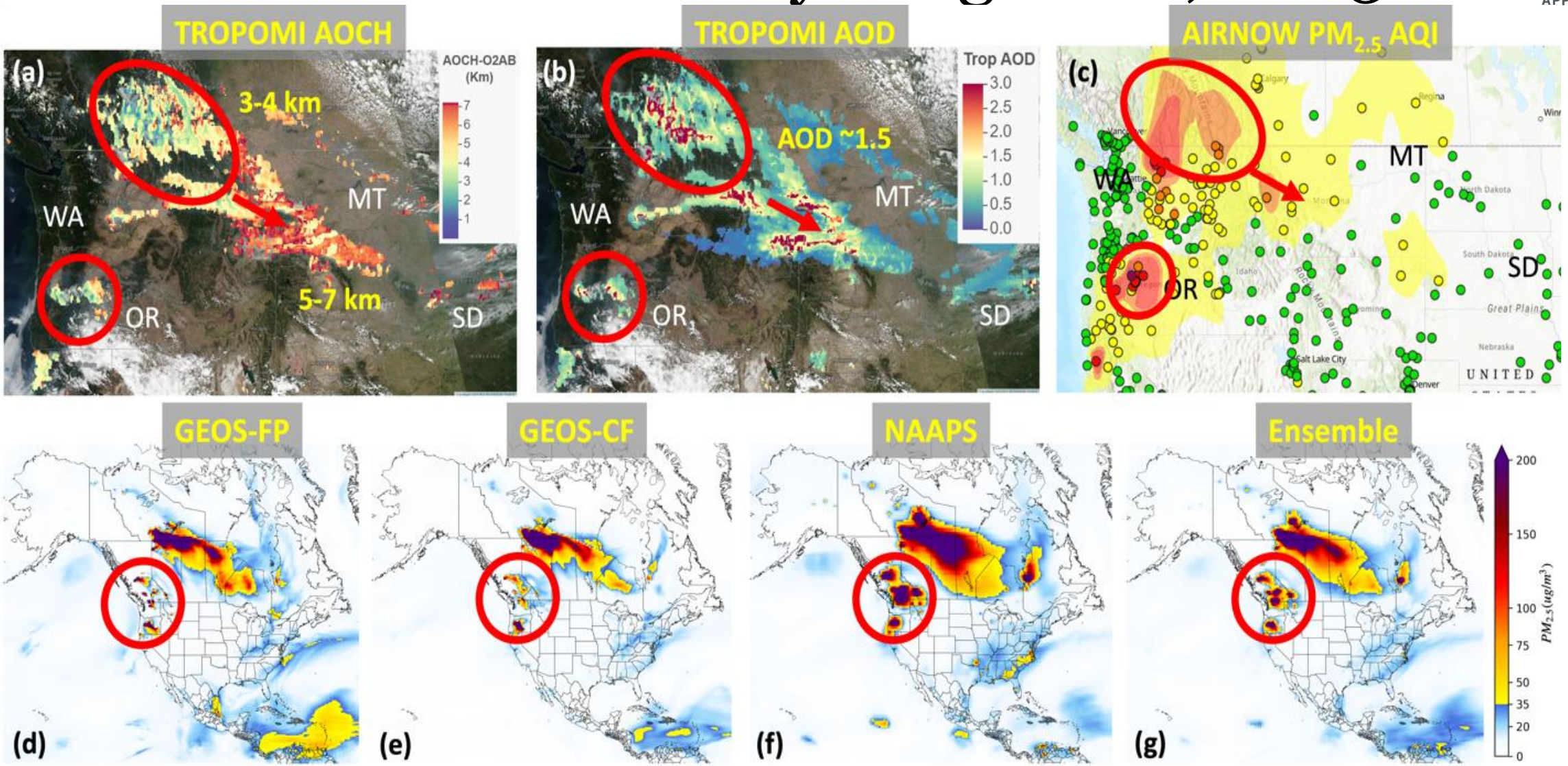

Potential use during exceptional event analyses
Smoke Event: Day 2, June 27, 2023

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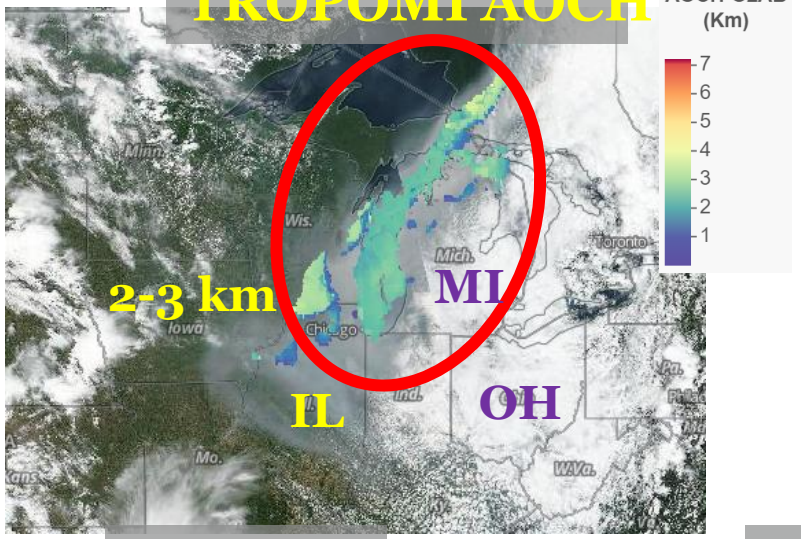
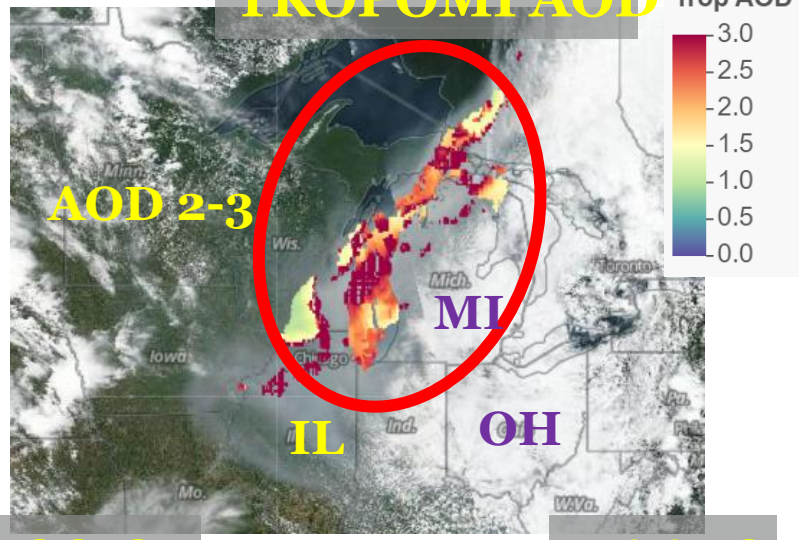
TROPOMI AOCH

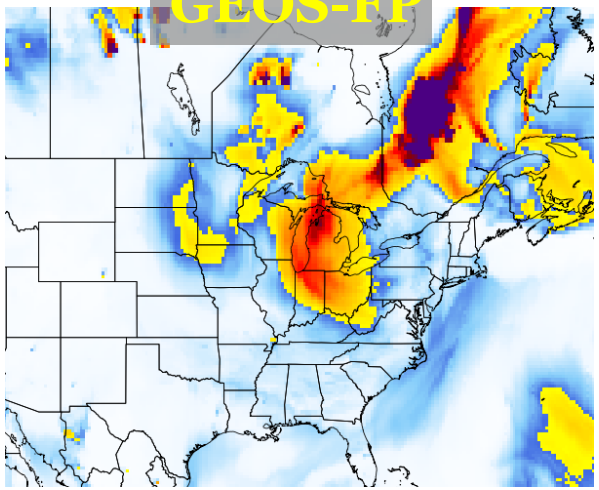


TROPOMI AOD

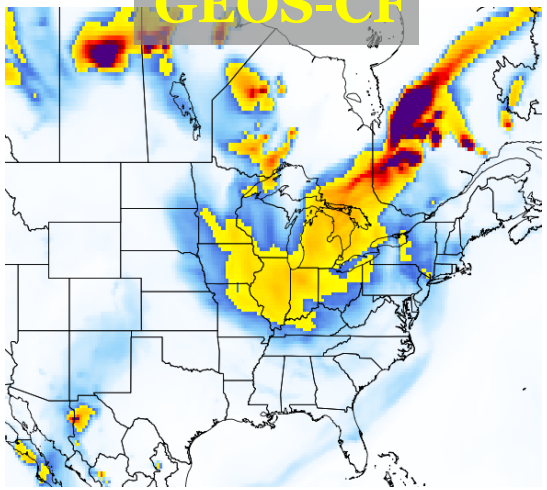


AIRNOW $PM_{2.5}$ AQI

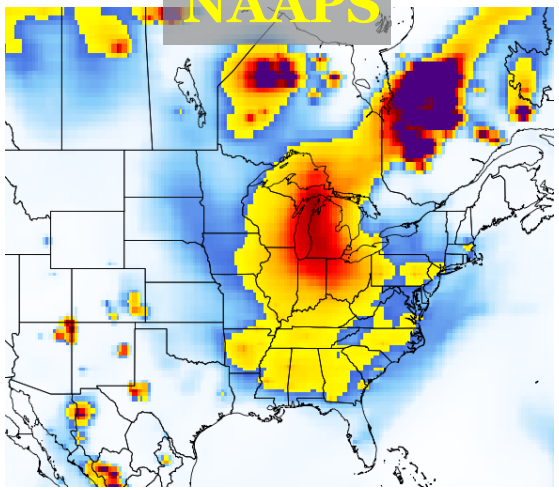
GEOS-FP



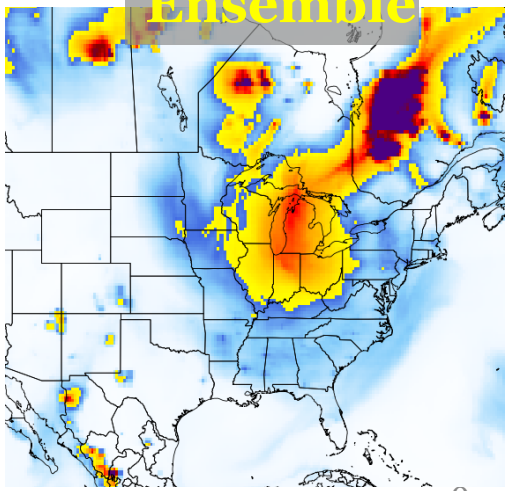
GEOS-CF



NAAPS



Ensemble



Multi model and satellite bias correction ensemble approach: Kalman Filter

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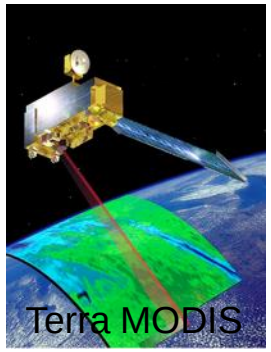
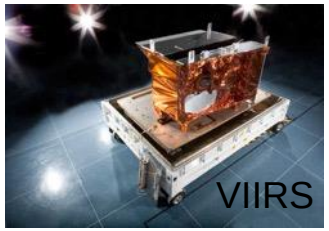
GMAO products
- GEOS FP
- GEOS CF

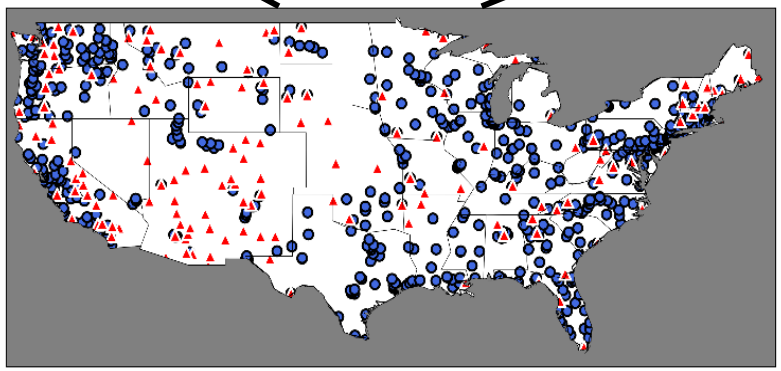
NRL model
- NAAPS

Models





Satellites



Ground observations

Developed under a NASA HAQAST project for smoke forecast in Alaska

Preliminary results KF bias correction for FireAQ domain

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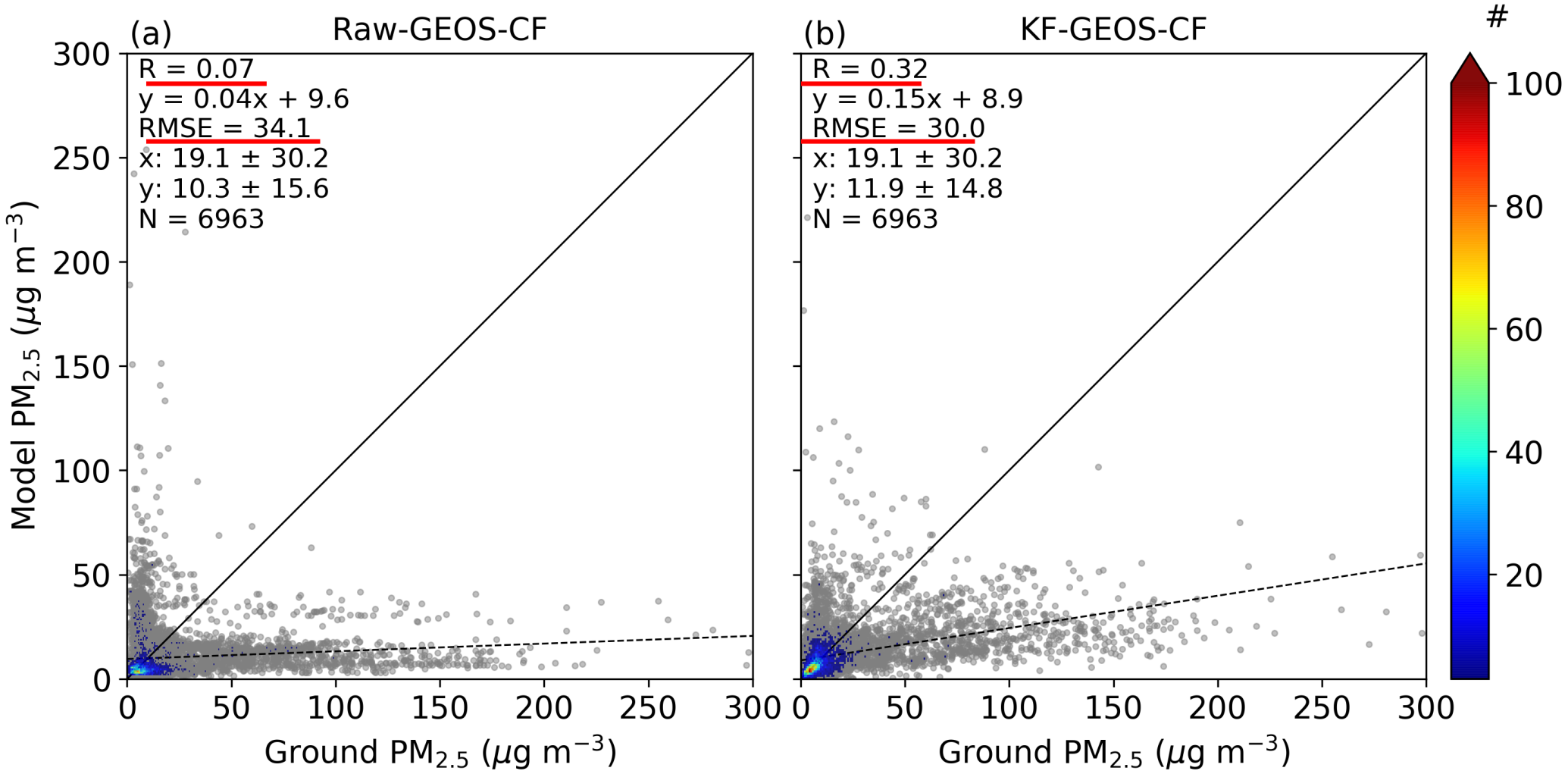
Smoke Event: June 25-30, 2023



Preliminary $PM_{2.5}$ bias correction results employing MultiLayer Perception Neural Network

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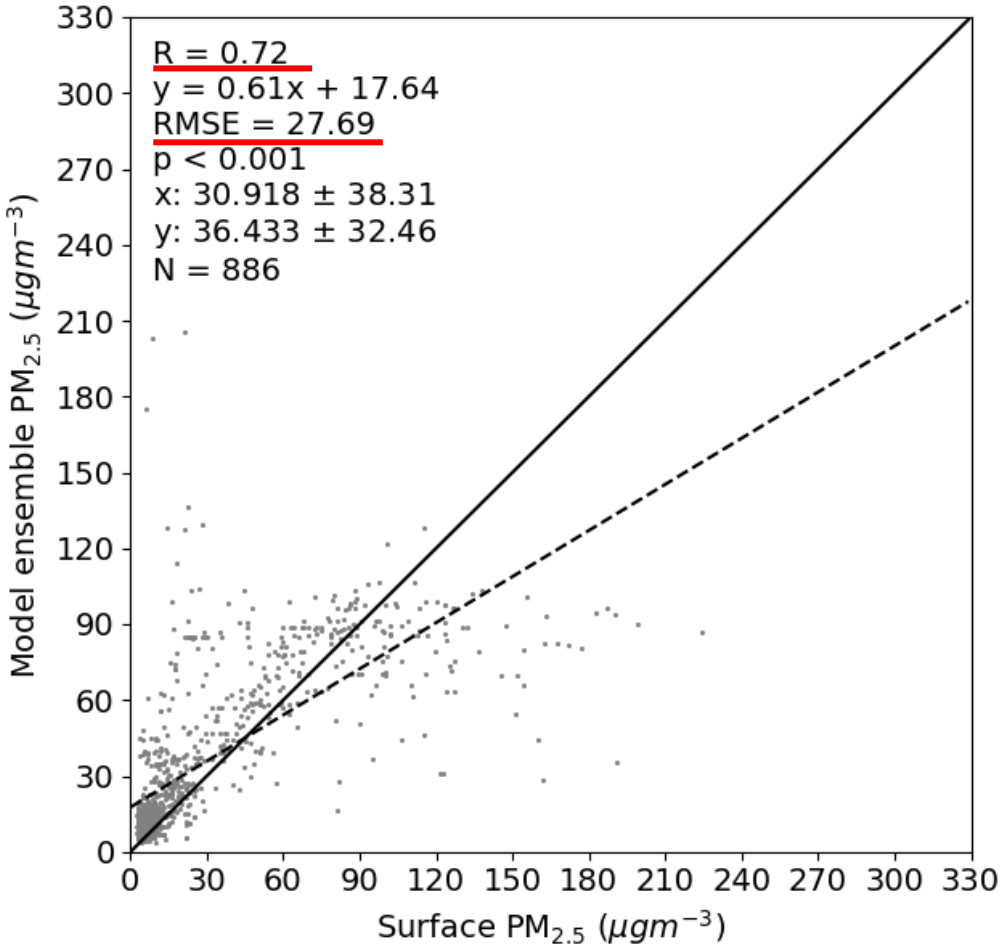
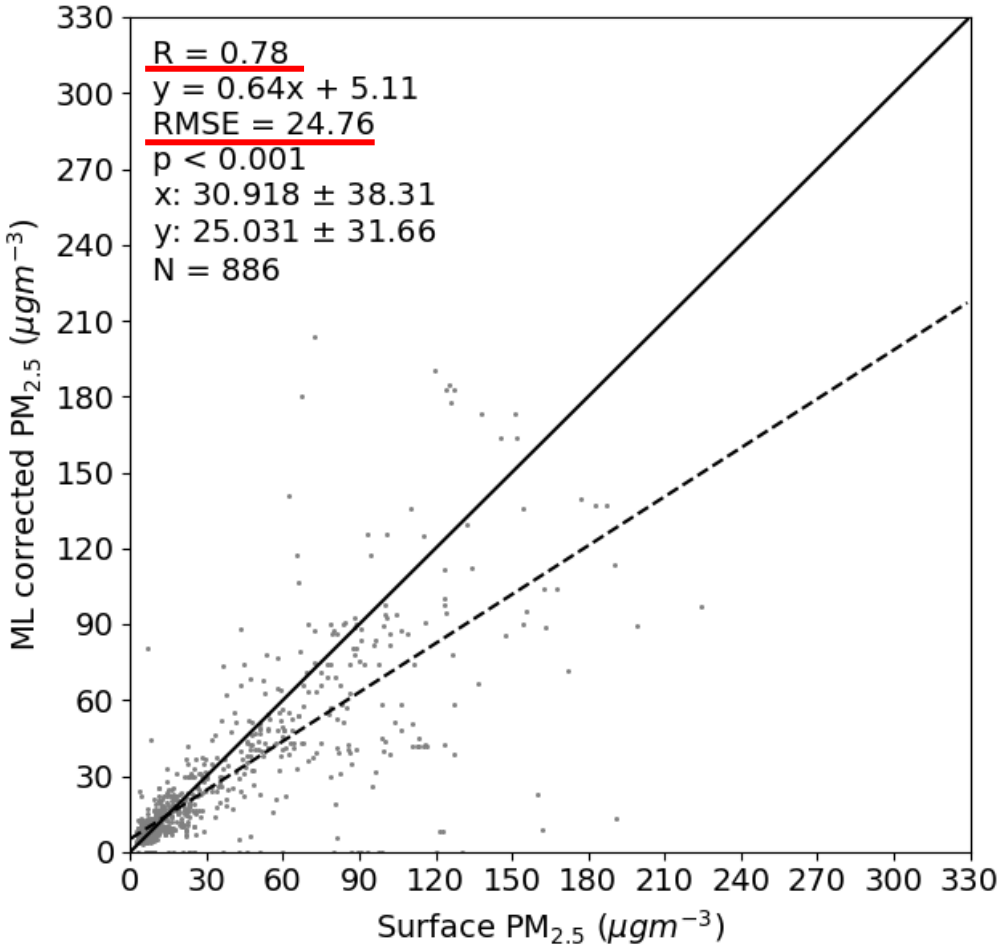
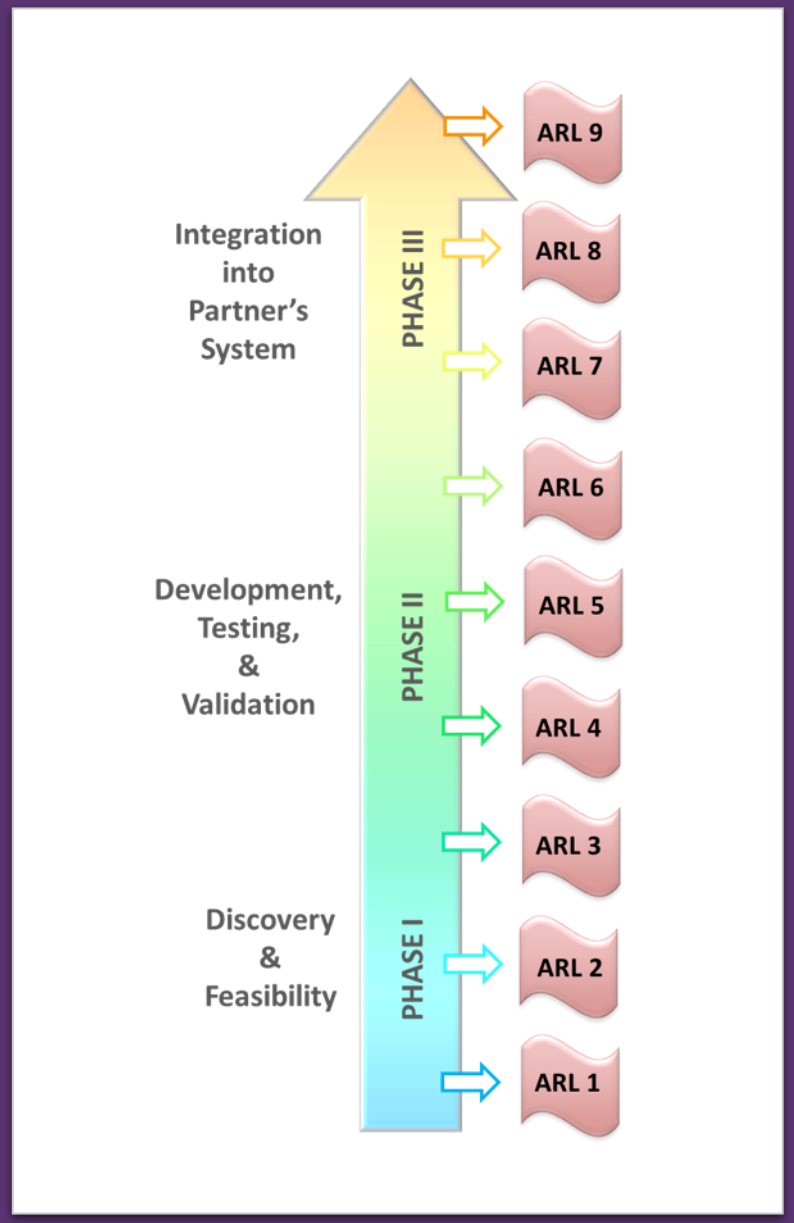
Test Day:
June 29, 2023

Original Ensemble



MLP - Ensemble





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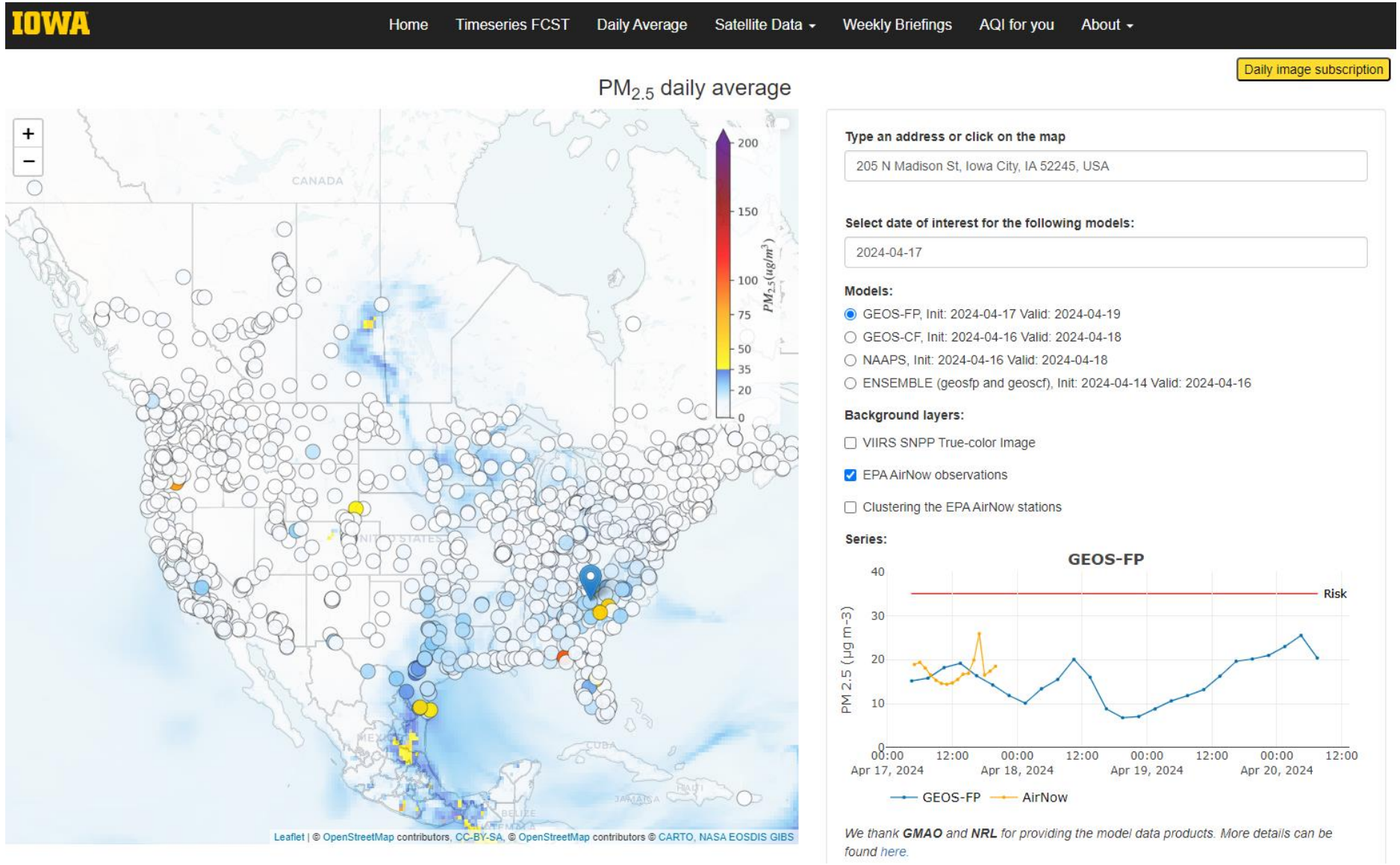
ARL Performance

- Start-of-Project ARL = 2-3 *(August 2022)*
  - AOCH/AOD algorithm tested with Tropomi and documented
- Goal ARL = 8
- Current ARL = 7 *(April 2024)*
  - Web portal developed and live (documented workflow)
  - Model and satellite data visualization operational
  - Preliminary ML bias correction tested

Current ARL-Supporting Evidence



Addition of current Airnow PM2.5 observations to landing page

Current ARL-Supporting Evidence

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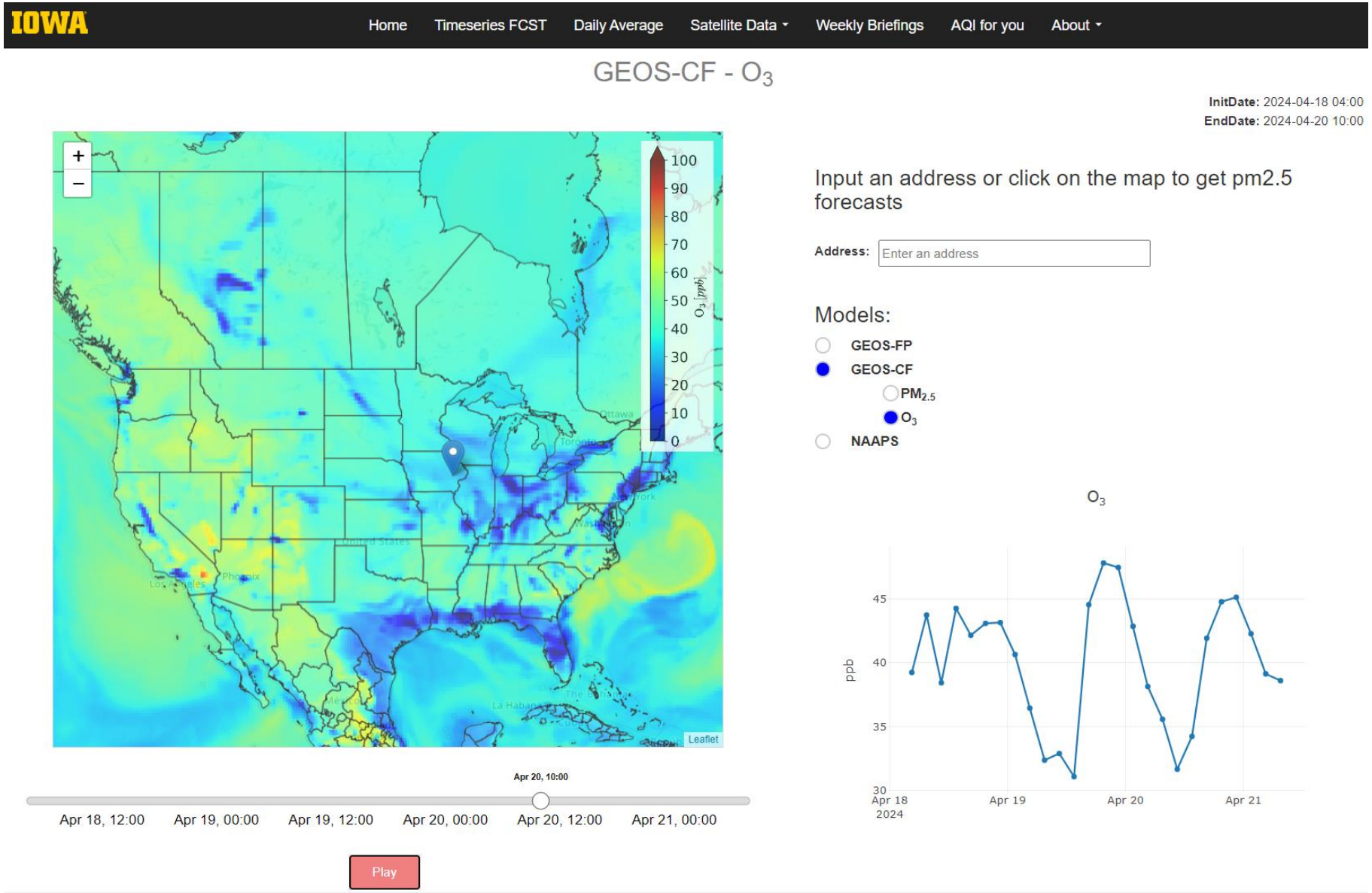
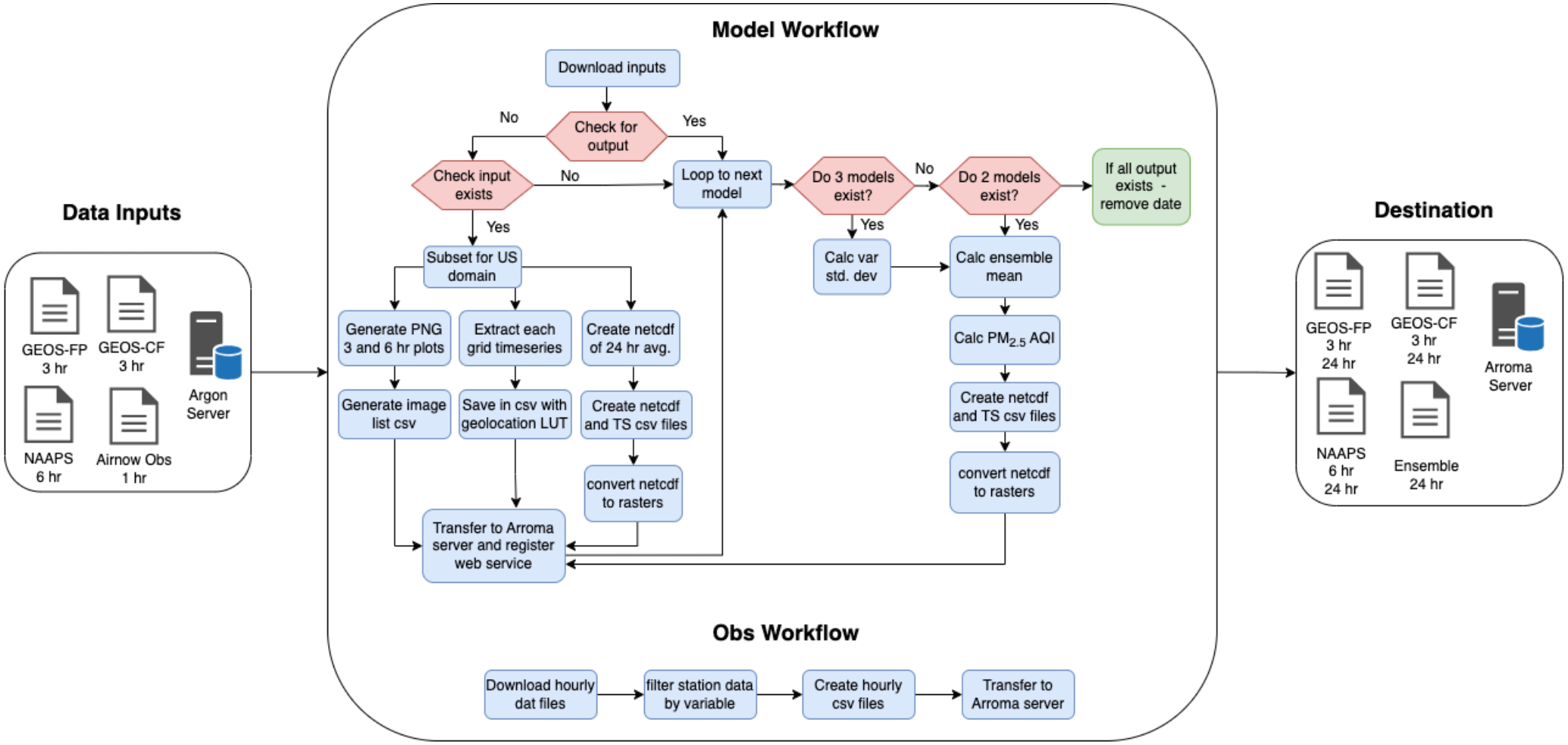


User friendly time-series webpage and inclusion of GEOS-CF ozone forecast

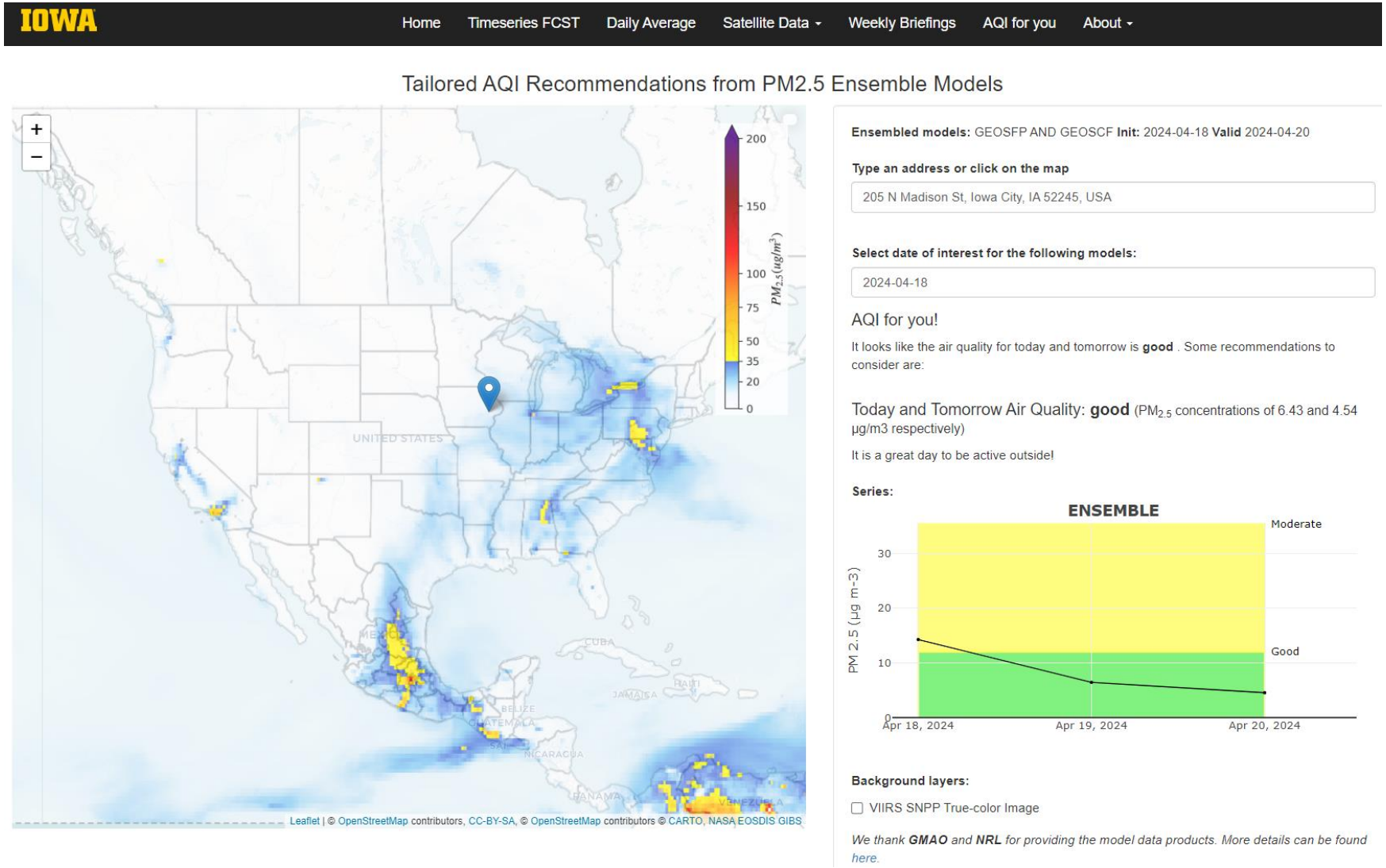
Current ARL-Supporting Evidence

- Workflow for operational model visualization from download to published online
- Includes PM2.5 calculation for GEOS-FP, ensemble mean, and Airnow observations



Highlight Image – Overlay Prototype

AQI for You webpage based on Ensemble mean daily forecast



Accomplishments Summary

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- Hold quarterly meetings with state agency collaborators in support of stakeholder engagement
  - Feedback summarized and included in report
- Website Design:
  - User friendly improvements to data web pages and inclusion GEOS-CF ozone and Airnow PM2.5 visualizations
- Began testing MLPNN for PM2.5 bias correction

Questions?