

**U.S. NAVAL
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NAAPS

updates from NRL- Monterey

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ICAP
8-9 November 2023

In This Talk

- NAAPS components and status
- NAAPS as a platform for science
- One interesting result: forecast smoke vs forecast meteorology

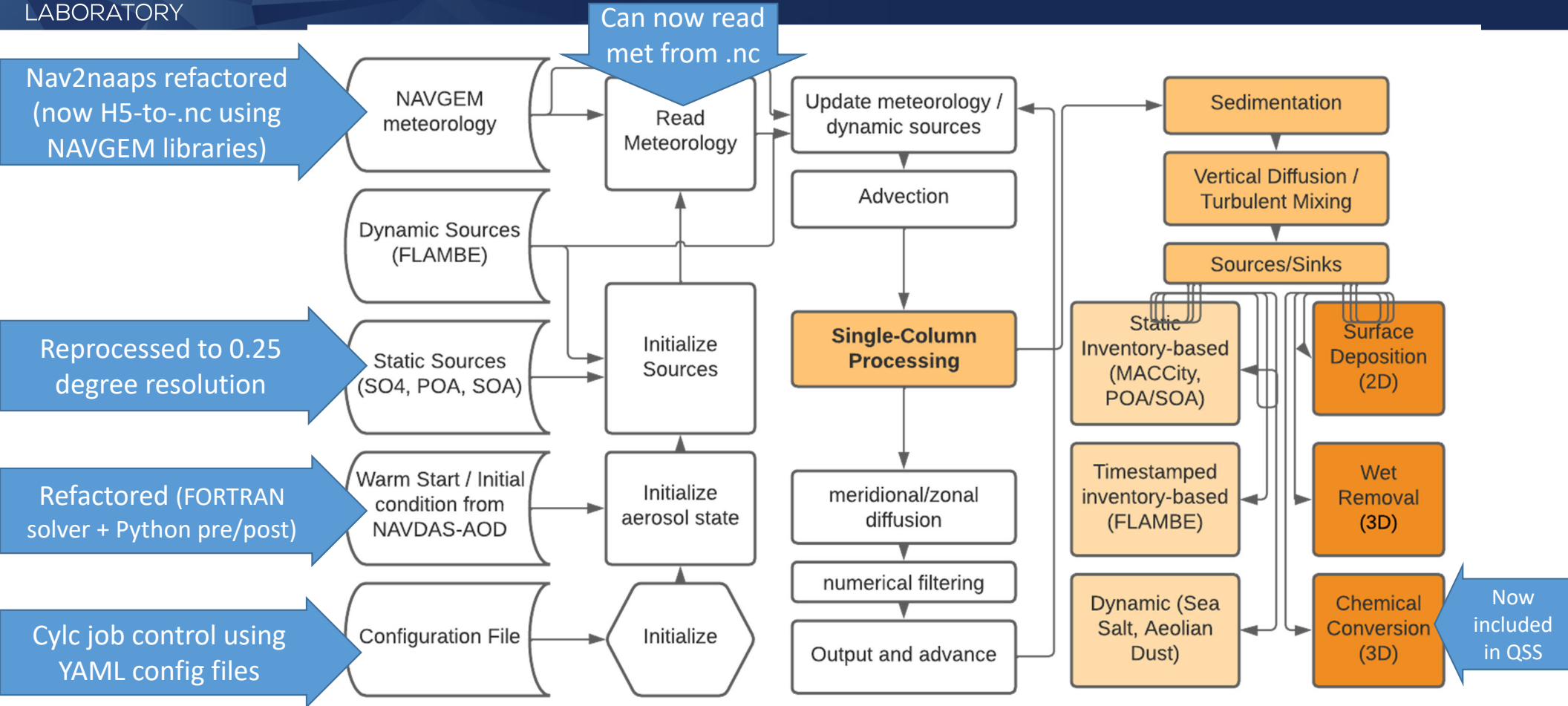
The Navy forecasts global aerosol transport to support tactical operations and decision-making

1. *Can you tell us when this is coming?*
2. *How long until we can see again?*

- *Global forecasts 4x/day*
- *1/3-degree spatial resolution*
- *35 vertical levels from surface to 100hPa*
- ***Operational NAAPS now uses NAVGEM 2.1, otherwise unchanged from previous ICAP***

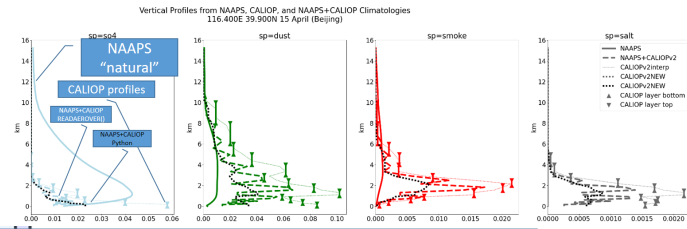
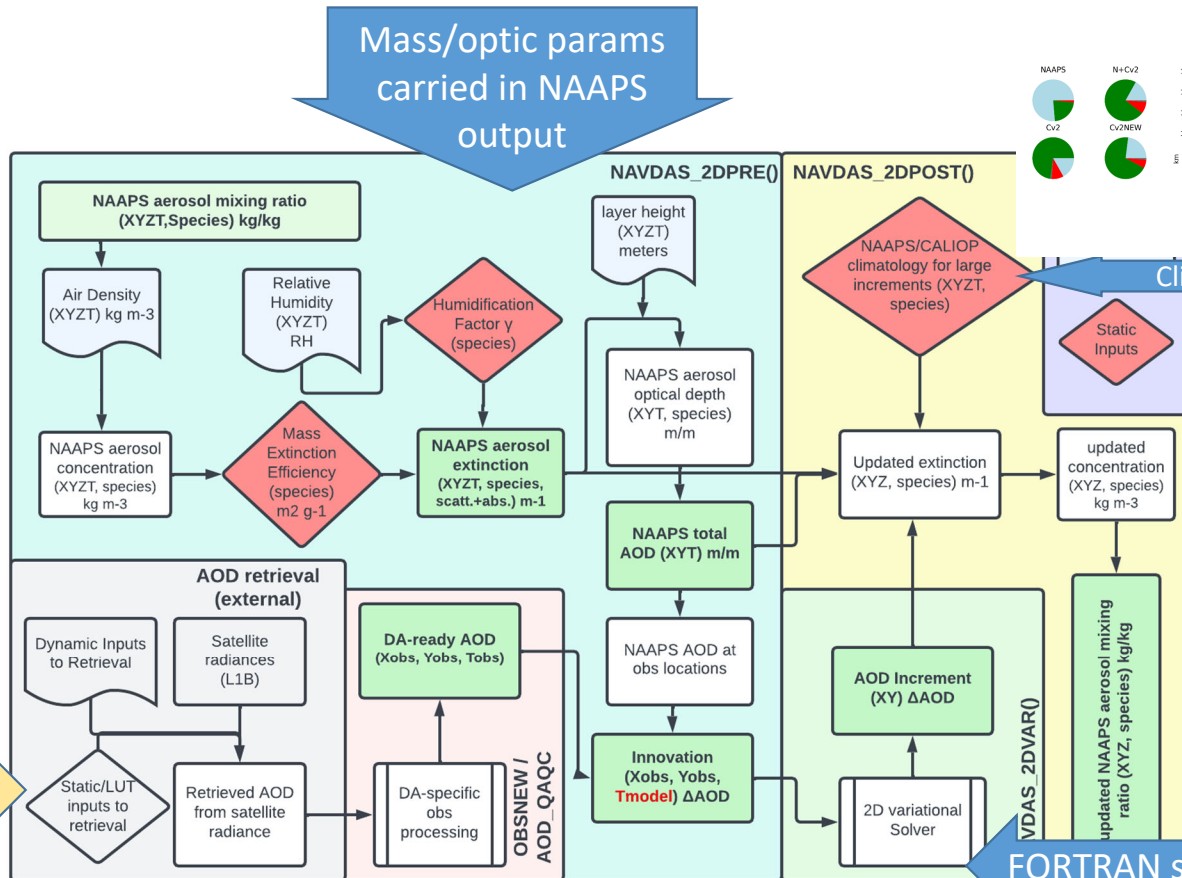


NAAPS2 Updated System



NAVDAS-AOD new Python implementation

Mass/optic params
carried in NAAPS
output

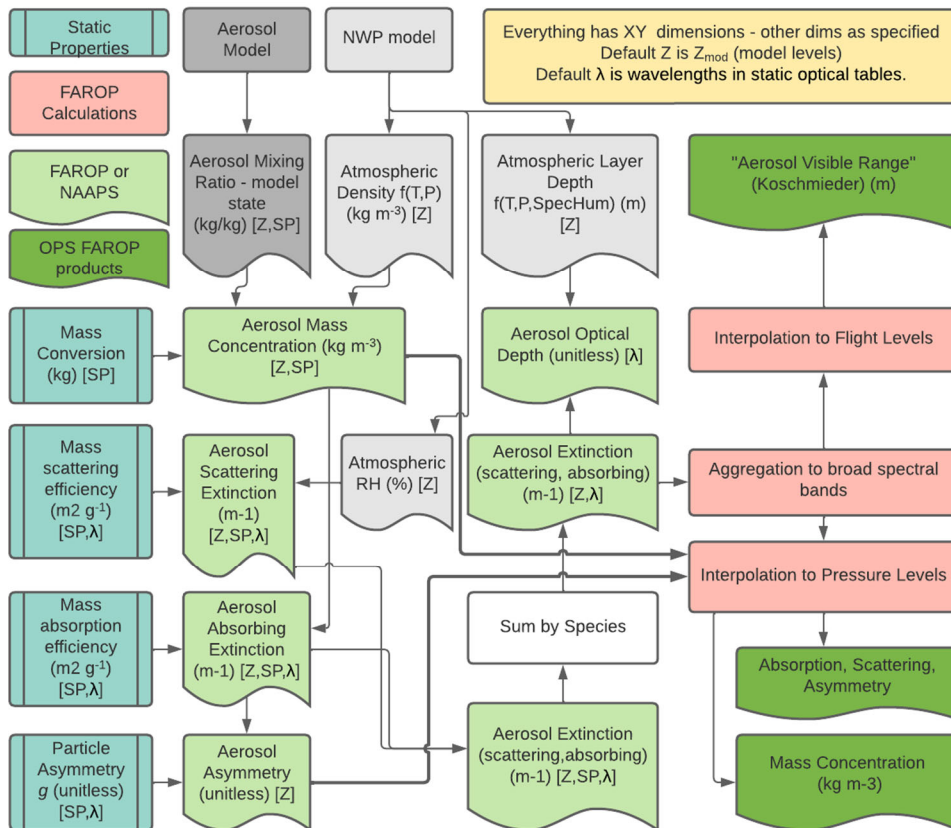


Climo reprocessed to remove aliasing

IN PROGRESS:
Updated OBS
processing via
GeOIPS

FORTRAN sandwich on Python bread

Post-processing now pure Python



- Complete refactor of NAAPS post-processor
 - 100% Python
- Output products are what actually gets used:
 - Aerosol visible range
 - Extinction/Scattering
 - Mass concentration
- Easy access to modify all ancillary data, format details

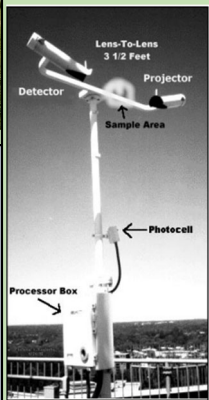
NAAPS2 will become operational in 2024

Verification vs applications

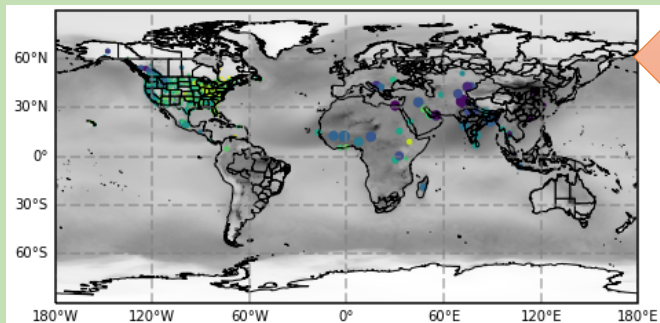
Aerosol Robotic Network (AERONET):
300+ stations measuring spectral solar and lunar occultation to retrieve spectral aerosol optical depth and other properties



Integrated Surface Dataset (ISD): more than 14,000 stations report hourly including visibility (measures fwd scatter, calibrated to 550nm extinction)



AirNow: 1200+ stations (95% in USA) measuring hourly mass concentration of particulate (PM2.5/PM10)



AOD: direct verification for e.g. solar power; indirect for most other applications

Surface visibility: direct verification for e.g. aviation, tourist applications; indirect for e.g. slant path visibility

Surface PM: direct verification for health and air quality

For diagnosing and understanding model behavior: everything!

NAAPS as a tool for science

- NAAPS has always been a tool for science
- Recent updates greatly simplify setup for many experiments
 - Adding tracers is now easy:
 - Select source type (gridded monthly source or dust erodibility or hourly point source)
 - Select optical properties and hygroscopicity
 - Select/construct climo for NAVDAS-AOD
 - Update pointers to ancillary files
 - Run NAAPS (no recompile required)
 - NAAPS now accepts met. inputs in (CF-compliant) NetCDF format
 - Easy to generate workflows to test modified/post-processed/alternate met. fields
 - NAVDAS-AOD is now a plug-and-play tool, to easily test
 - Different OBS
 - Modified climatology data and settings
 - 2D control variable
- NOTE: NAAPS is not a community model
 - Code is not publicly releasable at this time
 - NRL welcomes collaboration to test new approaches, datasets, methods!
 - Requires agreement between institutions

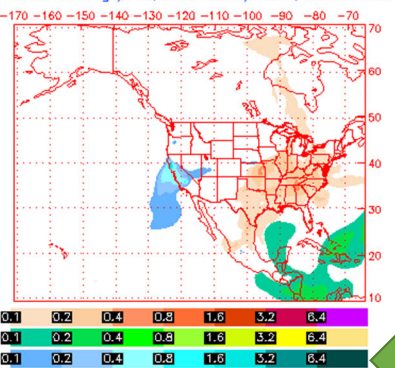
NAAPS Status 2023:
**An improving
 model, and also
*a model that
 makes it easy to
 implement, test,
 and verify
 improvements!***

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Part 2: An experiment about prognostic smoke

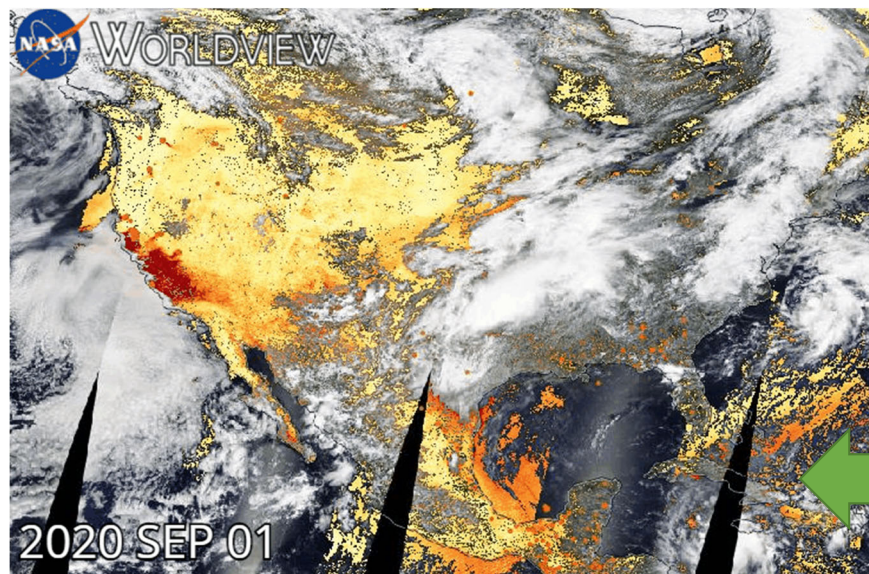
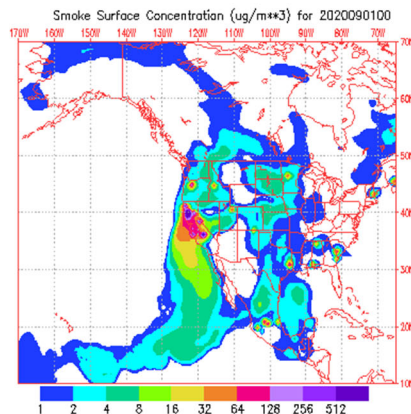
Gigafire September 2020 – a continental-scale air quality event

NAAPS Total Optical Depth for 00:00Z 01 Sep 2020
Sulfate: Orange/Red, Dust: Green/Yellow, Smoke: Blue



NAAPS
speciated AOD
(blue = Smoke)

NAAPS surface
smoke
(orange=32 $\mu\text{g m}^{-3}$)



MODIS
MAIAC
AOD +
MODIS-
Terra RGB

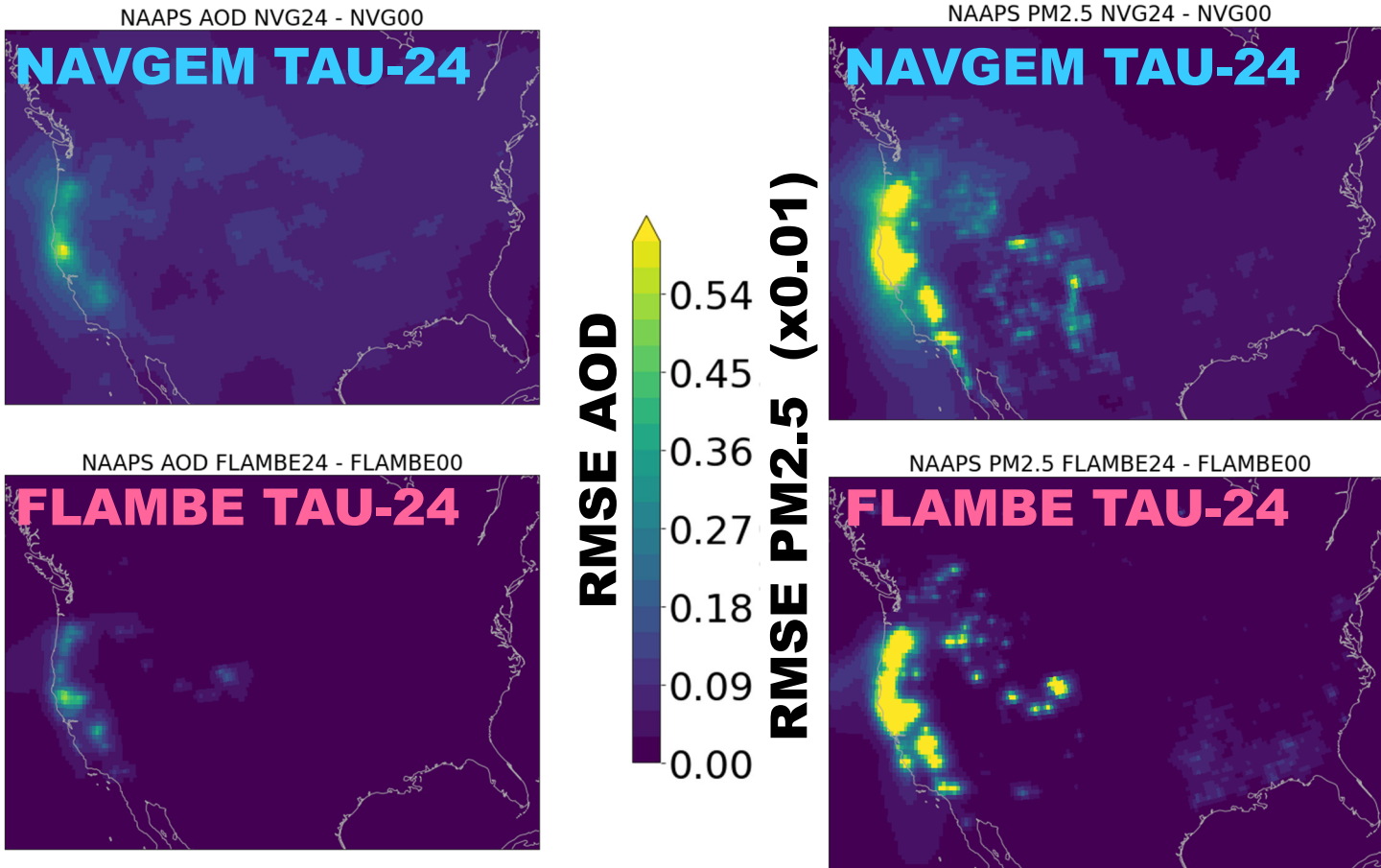
- Largest fires were in CA
- Smoke went every direction

Which is the more significant error for smoke prediction: meteorology or smoke emissions?

- ***A controlled experiment to compare persistence fire vs forecast meteorology errors***
- **BASELINE:** This is a “cycling re-forecast” NAAPS run
- The run is initialized from the OPS analysis at 2020080100. NAVGEM forecast fields are used to run from T to T+36, and the T+6 forecast is combined with MODIS AOD via aerosol data assimilation to create initial conditions for the next forecast. **All FLAMBE inputs are based on the “final” analyzed files for each valid time; no persistence forecast is used.**
- **DELAY:** This run is configured like the BASELINE, but uses FLAMBE files dated forward 24 hours. **This is equivalent to a run using a 24-hour persistence forecast of smoke.**

- BASELINE tau-0 vs BASELINE tau-24 shows effects of NAVGEM forecast meteorology
- BASELINE tau-0 vs DELAY tau-0 shows effects of FLAMBE persistence forecast

Results: How big is the effect?

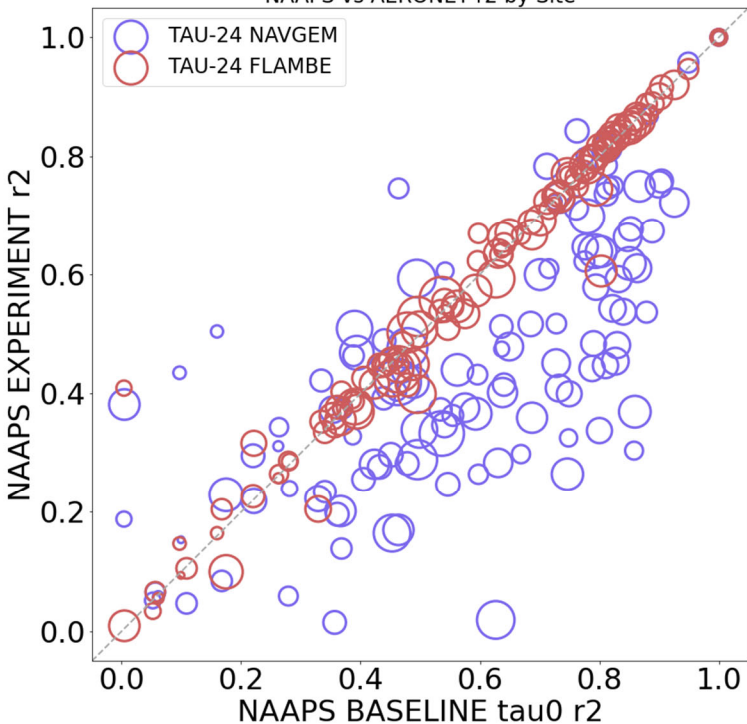


- Near fires, emissions forecast has impact comparable to met forecast
- Met. forecast effects more prevalent downwind

Results: How does met forecast vs emissions forecast effect verification stats?

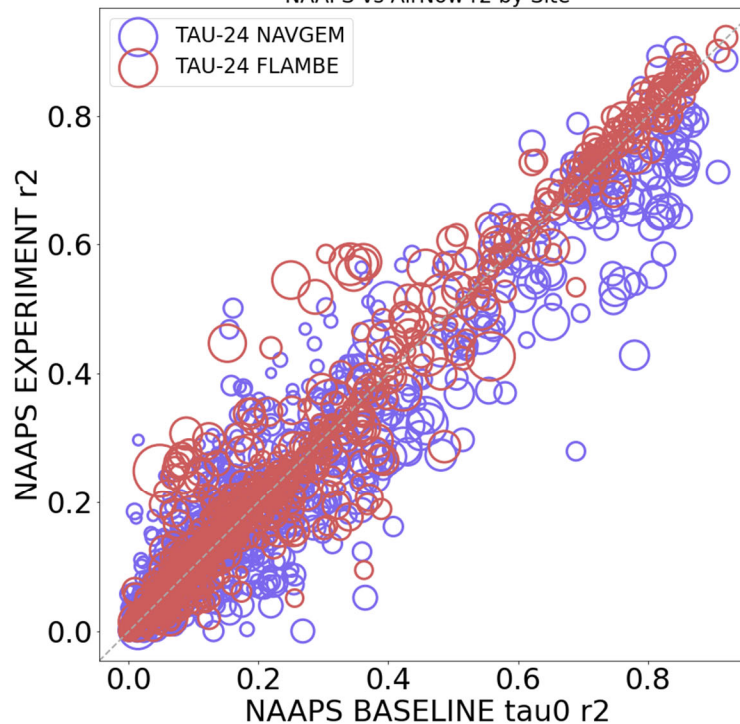
VS AERONET AOD

NAAPS vs AERONET r2 by Site



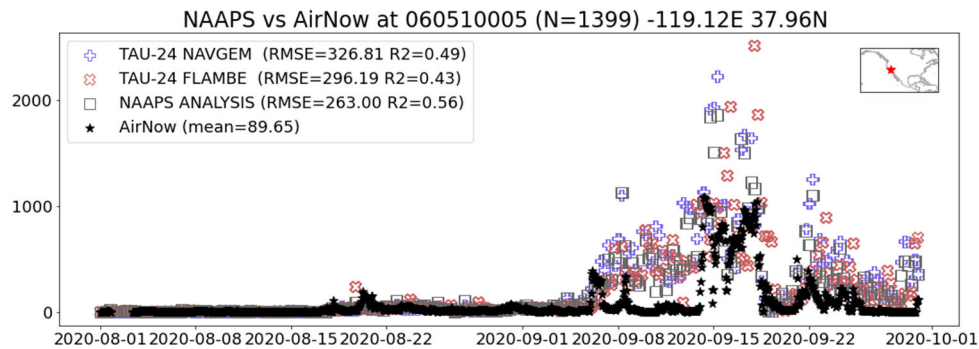
VS AIRNOW PM

NAAPS vs AirNow r2 by Site

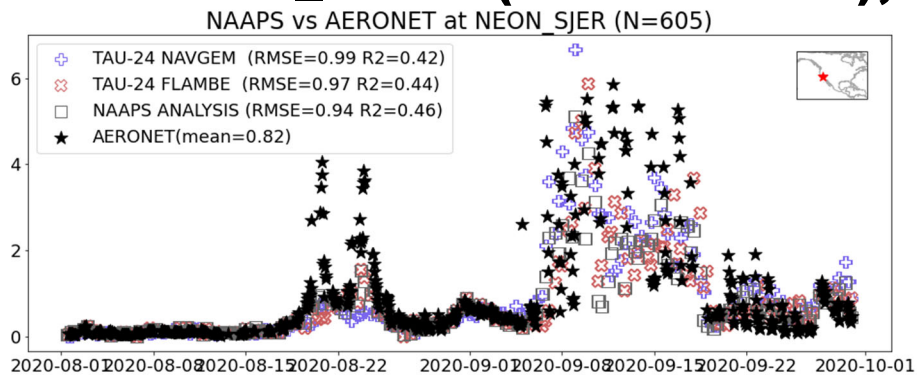


- Sensitivity to **FLAMBE forecast** clearly greater for surface PM
- Sensitivity to **NAVGEM forecast** is large for column-integrated AOD
- AirNow correlations are low at many sites

AirNow: Lee Vining (near Mono Lake), CA

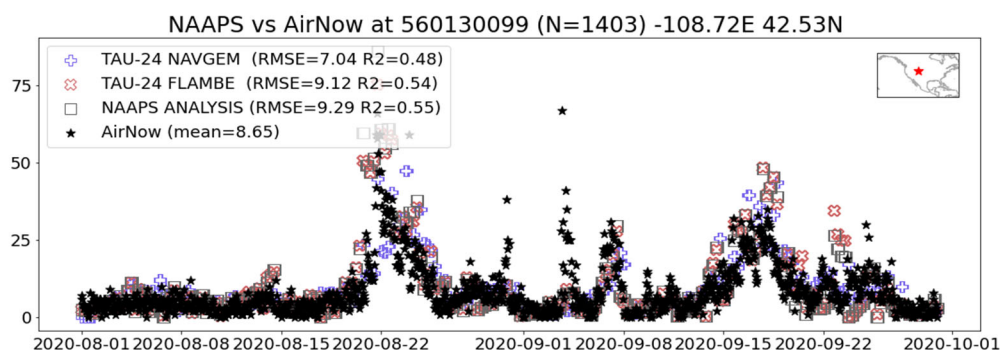


AERONET: NEON_SJER (near Fresno), CA

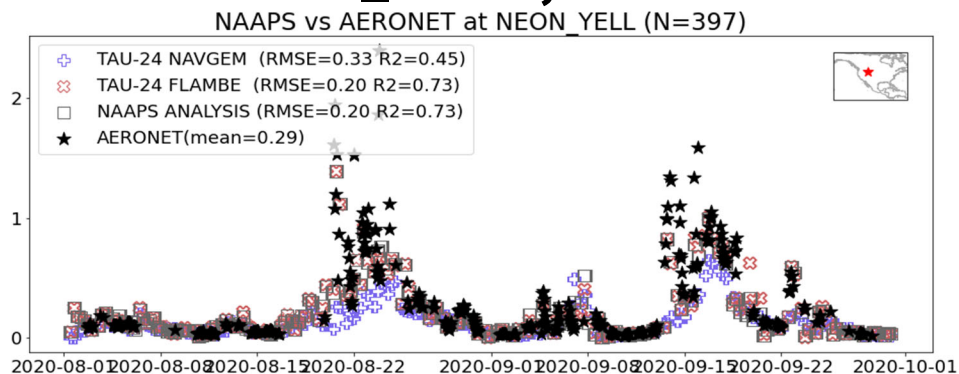


- Model tends to overestimate near source
- FLAMBE persistence is still generally a minor factor
- NAVGEM forecast error generally less significant closer to sources

AirNow: South Pass, Riverton, WY



AERONET: NEON_YELL, Yellowstone NP



- Far downwind, influence of FLAMBE persistence forecast is very small
- Influence of NAVGEM forecast errors is variable

- Timeliness of fire data is a skill factor for smoke prediction
- Users of model products should be aware of the latency of fire observations informing the forecasts
- Experimental results:
 - For predictions of smoke impacts near fires (<200 km), persistence forecast of smoke emissions causes error in smoke forecast that is comparable in magnitude to NWP forecast error
 - Farther from fires, NWP errors dominate
 - NWP errors generally dominate column-integrated verification

- NRL APES
- R&D Sponsors: ONR, FNMOC
- Patient Audience!



THANK YOU!

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