Description and Evaluation of the Aerosol Component, based on NASA's GOCART2G, in the Latest Prototype of the Unified Forecast System: Application to the NOAA Global Ensemble Forecast System version 13

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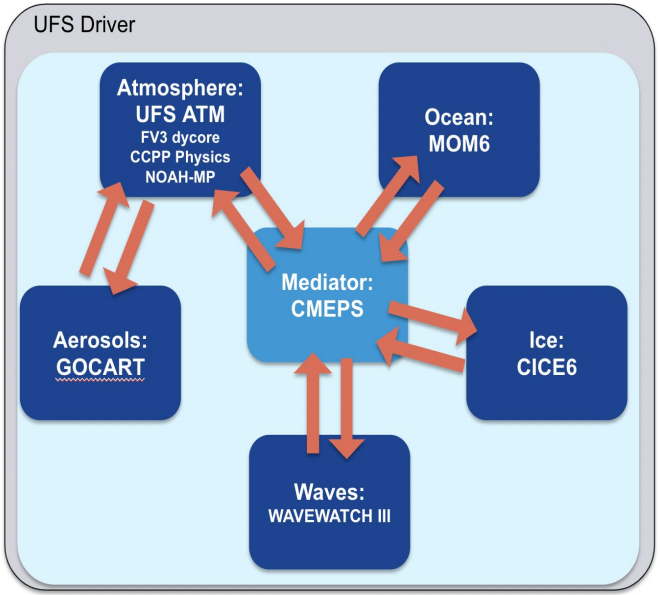
Background

One of the NOAA Unified Forecast System (UFS) modeling applications currently in development is a coupled model for global predictions of weather to seasonal time scales, targeting NOAA/NCEP operational Medium Range (**GFS v17**), Subseasonal (**GEFS v13**), and Seasonal (**SFSv1**) forecasting systems.

In the **Global Coupled UFS development phase**, discrete system prototypes were defined and evaluated within a fixed benchmark framework. Evaluation findings were used to inform subsequent development.

Target configuration (GFSv17, GEFSv13, SFSv1)



ufs-weather-model https://github.com/ufs-community/ufs-weather-model

Atmosphere
- FV3 dynamical core
- GFS Physics with Thompson microphysics
- CCPP physics driver
- C384 (~25km), 127 levels

Ocean
- MOM6 Modular Ocean Model
- ¼ degree tripolar grid, 75 hybrid levels
- OM4 Set up [Adcroft, 2019]

Waves
- WAVEWATCH III
- ½ degree regular lat/lon grid
- ST4 Physics [Ardhuin, 2010]

Ice
- CICE6 Los Alamos Sea Ice Model
- ¼ degree tripolar grid (same as ocean)
- 5 thickness categories
- Mushy thermodynamics on (P7 onward)

Aerosols
- NASA GOCART2G
- Emissions: CEDS-2019 (SO2, PSO4, POC, PEC), QFED biomass burning, FENGSHA dust, GEOS-5 sea salt, marine DMS
- Sulfate, Organic Carbon, Black Carbon, Dust, Sea Salt, Nitrogen
- MERRA2 ICs

Driver/Mediator
- NEMS driver
- CMEPS mediator

EP5: Anthropogenic Emission Forcing

Surface Emissions

- A Community Emissions Data System (CEDS): OC, BC, SU (primary emissions - retrospective representative years: 2019 latest available year | currently used in production)
- MERRA2 DMS climatology (SO_2 production | updated version currently used in production)
- MEGANv2.1 Biogenic Emissions: ISOP, LIMO, MTPA, MTPO (small OC effect)

Aviation Emissions: three elevated levels

- HTAPv2: OC, BC, SU (currently used in production)

Biomass Burning

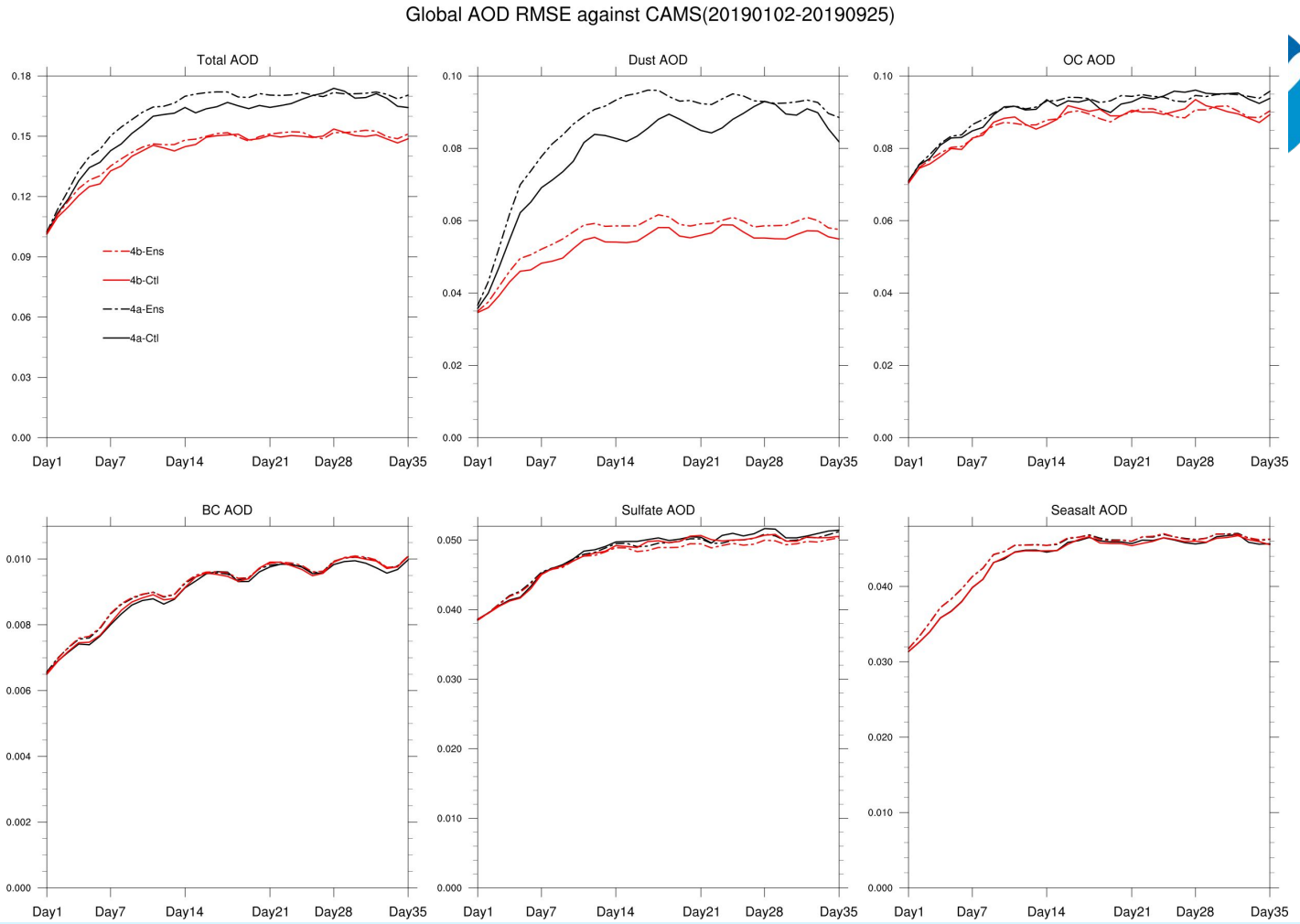
- QFED/HFED (For Reforcast: OC, BC, SU
- Blend fire emissions to climatology after 5 days
- GBBEPx (For NRT)
    - Blend fire emissions to climatology after 5 days

FENGSHA Dust inputs

- Drag Partition derived from NESDIS VIIRS BRDF Albedo climatology:
- BNU Soil Dataset: Clay, Sand
- ML Derived threshold friction velocity (ARL Developed)

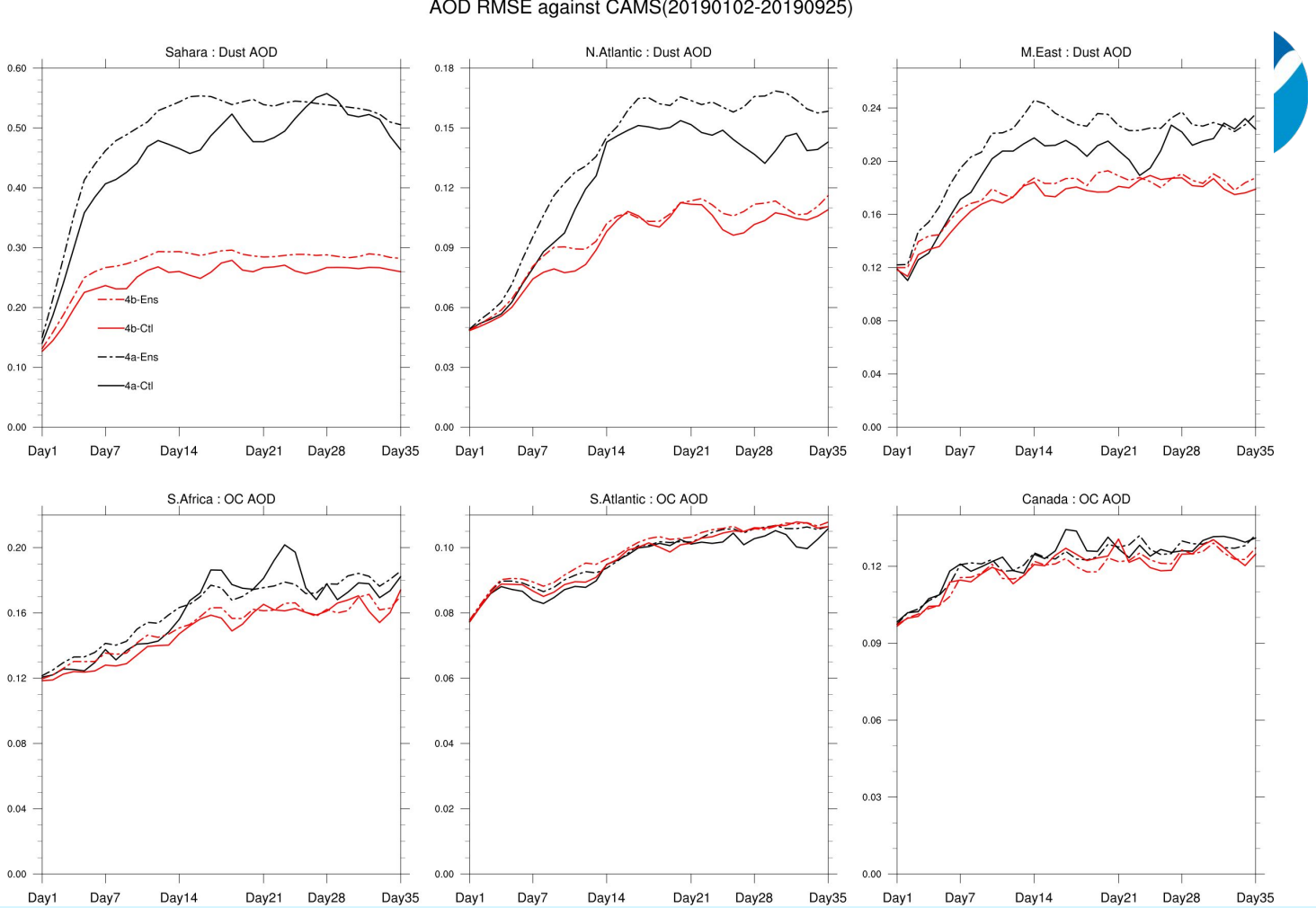
EP4b

Preliminary results from ensemble experiment



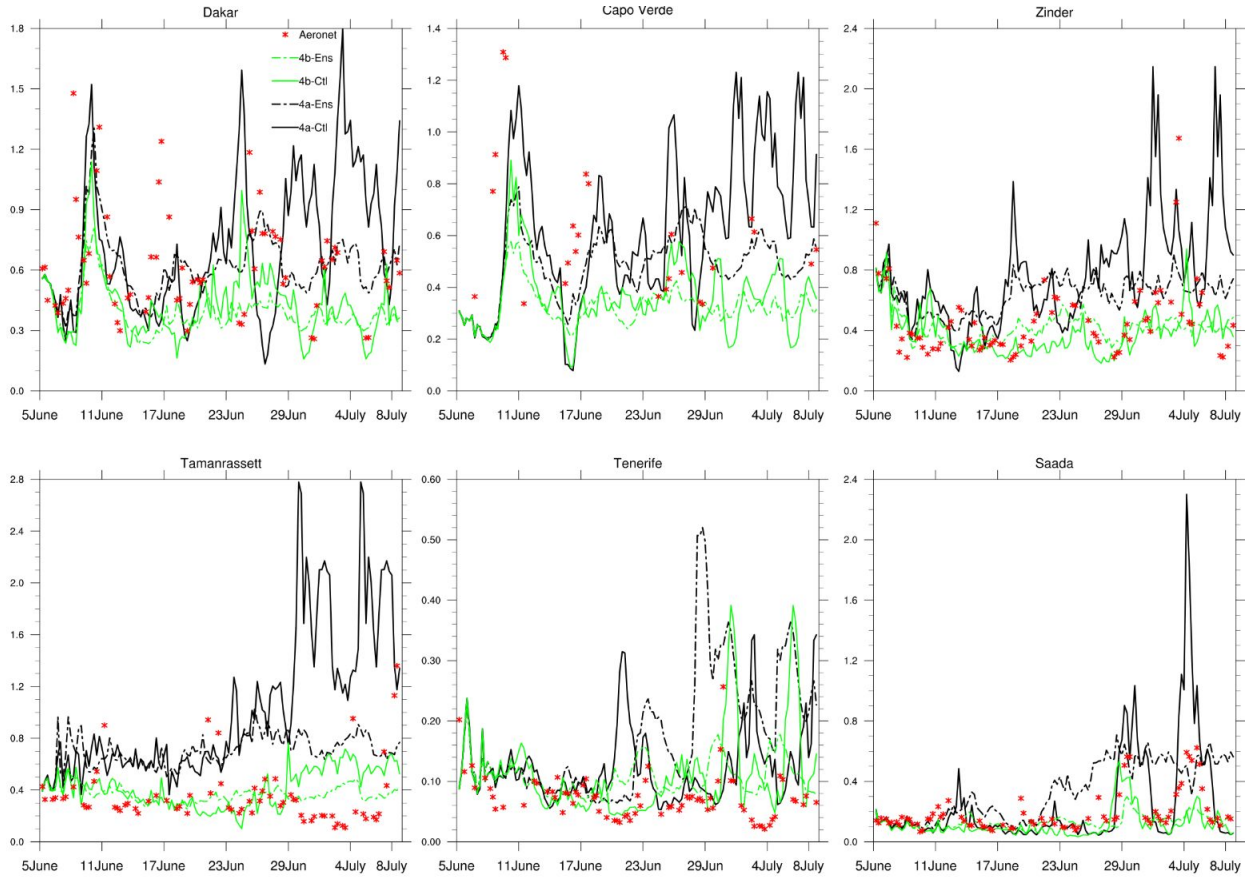
EP4b

Preliminary results from ensemble experiment



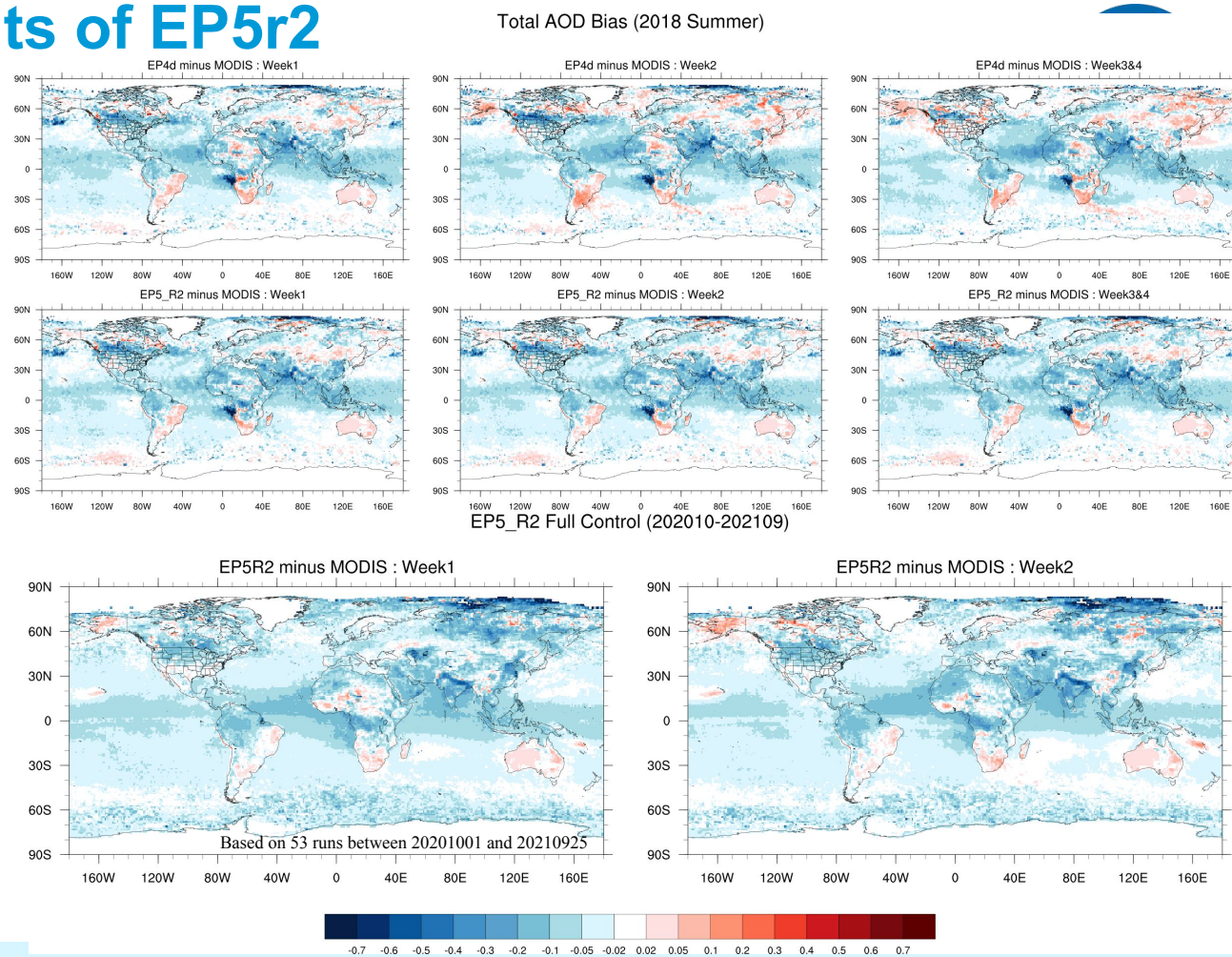
EP4b – Preliminary results (control)

Example of Sahara stations



Preliminary Results of EP5r2

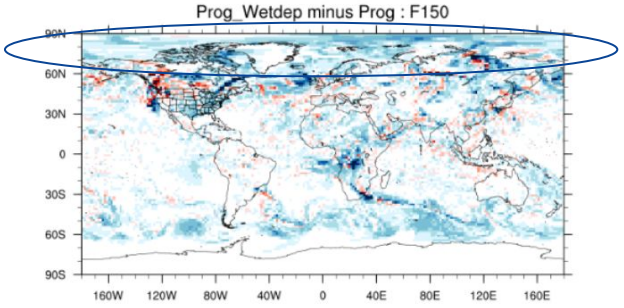
EP5r2 decreased AOD bias along the majority of dust regions. Seasalt AOD is largely unchanged between the experiments while there were improvements predominantly in the biomass burning boreal forest regions

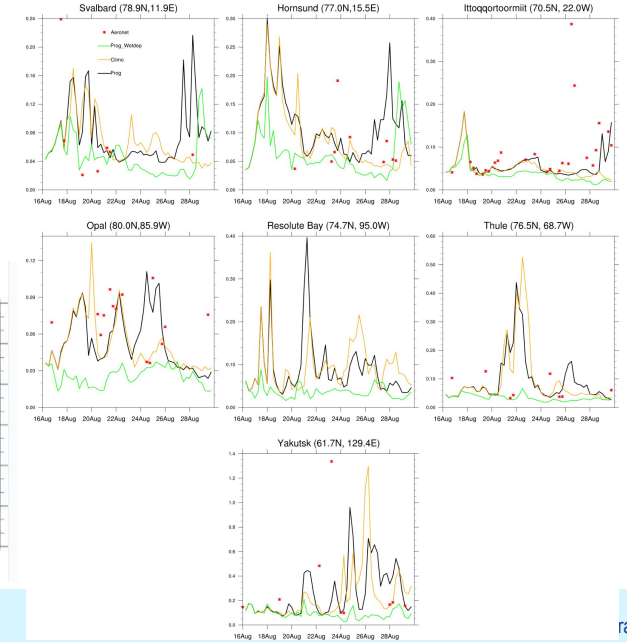


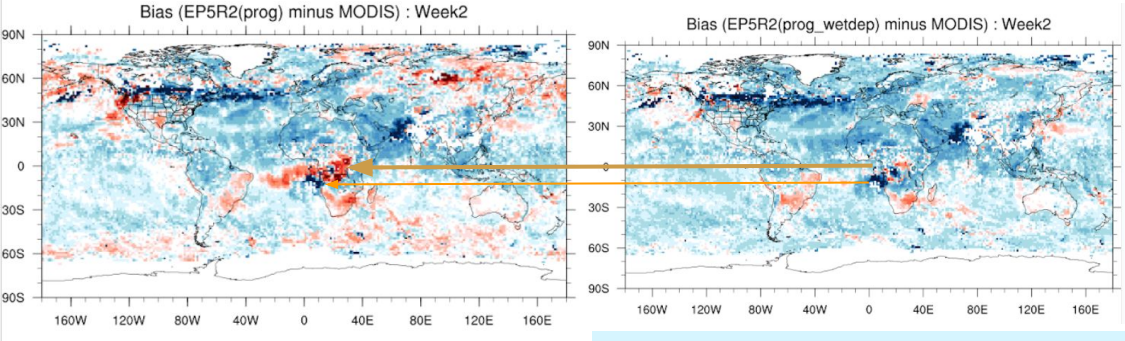
Addressing Accumulation - Wet Deposition

Summary:

- Overall the over prediction of aerosols (ie the accumulation) in high latitudes was corrected with the new implementation.
- Much of the over prediction over central Africa was removed. However, in week 2 there is still large portions of underprediction off the south central coast of African biomass burning transport likely due to fire emissions and weather patterns.
- May reduce dust LS wet deposition to help with long range transport of dust.







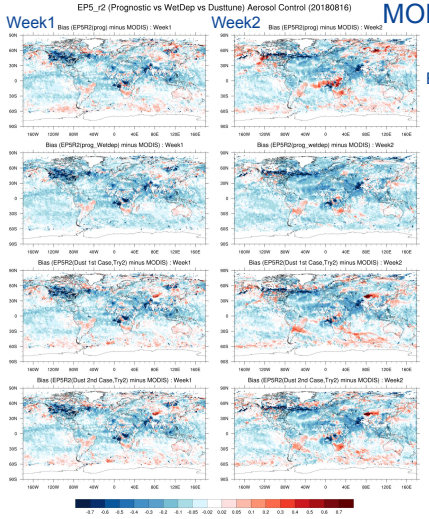
Improving Dust Emission Processes

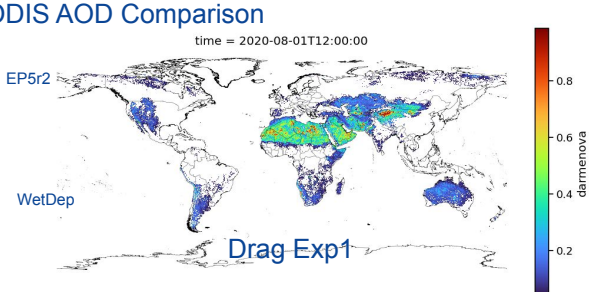
Summary:

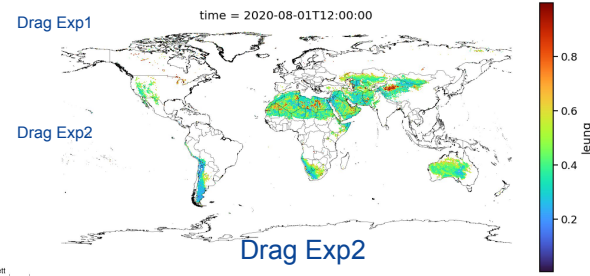
A new drag partition for bare surfaces is developed to address a few biases in the current FENGSHA dust emission model adapted from Marticorena et al. 2004.

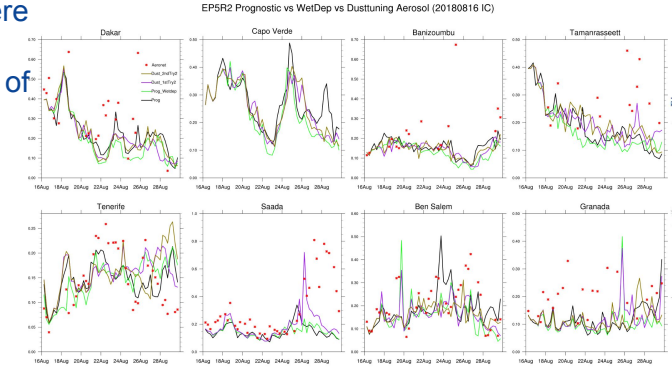
Two drag partitions are developed based off of this with Exp1 - based on Darmenova et al. 2009 and Exp2 (based on Leung et al. 2023).

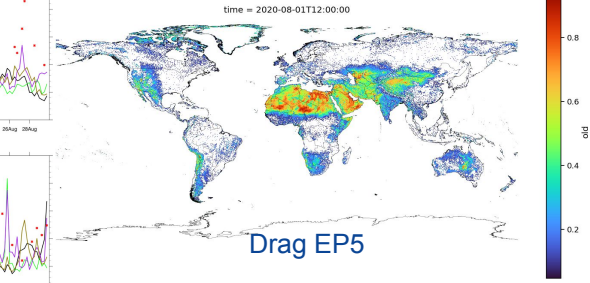
Both show increased emissions in areas where we saw over predictions (ie western china) while also decreasing emissions off the Horn of Africa where the previous experiments saw a general over prediction.











Comparison vs AERONET Dust