Preliminary Evaluation of NOAA's GEFS-Aerosol Model

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The National Centers for Environmental Prediction (NCEP) has partnered with NOAA/ESRL Global Systems Laboratory (GSL), Chemical Sciences Laboratory (CSL), NOAA/OAR Air Resources Lab (ARL), the NOAA/NESDIS Center for Satellite Applications and Research (STAR) and NASA Goddard Space Flight Center to develop a global aerosol model that will replace the current NEMS GFS Aerosol Component (NGAC) (Wang et al., 2018). The new model will be a single member named GEFS-Aerosol in Version 12 of the Global Ensemble Forecast System (GEFS). The meteorology of this new model is based on the operational Global Forecast System (GFS v15) and most of the aerosol modules are from the Goddard Chemistry Aerosol Radiation and Transport (GOCART) (Colarco et al., 2010). Recent updates and additions include the biomass burning plume rise module added from WRF-Chem; tracer convective transport and wet scavenging implemented in the Simplified Arakawa-Schubert (SAS) convection scheme; the FENGSHA dust scheme implemented and developed by ARL (Dong et al., 2016); biomass-burning emission calculations based on the Blended Global Biomass Burning Emissions Product (GBBEPx V3) emission, and Fire Radiative Power (FRP) data provided by NESDIS (Zhang et al., 2012). Once implemented operationally, GEFS-Aerosol will provide a 5-day forecast of total aerosol as well as component dust, organic and biomass carbon, sea-salt and sulfate aerosol at a global horizontal resolution of ~0.25 by 0.25 degrees, and 4 times per day (at 00, 06, 12 and 18 Coordinated Universal Time (UTC). It will also provide Particulate Matter (PM 2.5 & PM10) forecasts along with 3-dimensional mixing ratios of aerosol species at 64 model vertical levels.

A nearly one-year retrospective run has been conducted using GEFS-Aerosol to provide multi-species forecasts of Aerosol Optical Depth (AOD) and other aerosol properties. AOD observation from satellites, International Cooperative for Aerosol Prediction Multi-Model Ensemble (ICAP-MME) and reanalysis from NASA MERRA2-Aerosol are used to extensively evaluate model results. Figure 1 shows daily day-1 AOD forecasts at the 550-nm wavelength from GEFS-Aerosol compared against operational NGACv2 and MERRA2 over different global aerosol regions. The results show that GEFS-Aerosol has made remarkable improvement across all aerosol regimes compared to NGACv2. Over North Africa dust AOD dominates (from the Sahara dust source region and downwind sides) in the boreal summer, whereas the Amazon forest fire season starts from late August. Both natural and anthropogenic aerosols contribute to the other three regions in the figure. GEFS-Aerosol has shown improvement in model forecasts and in reducing forecast bias over biomass burning areas and over some of the anthropogenic aerosol dominated regions (mainly over India, Southeast Asia and East Asia).

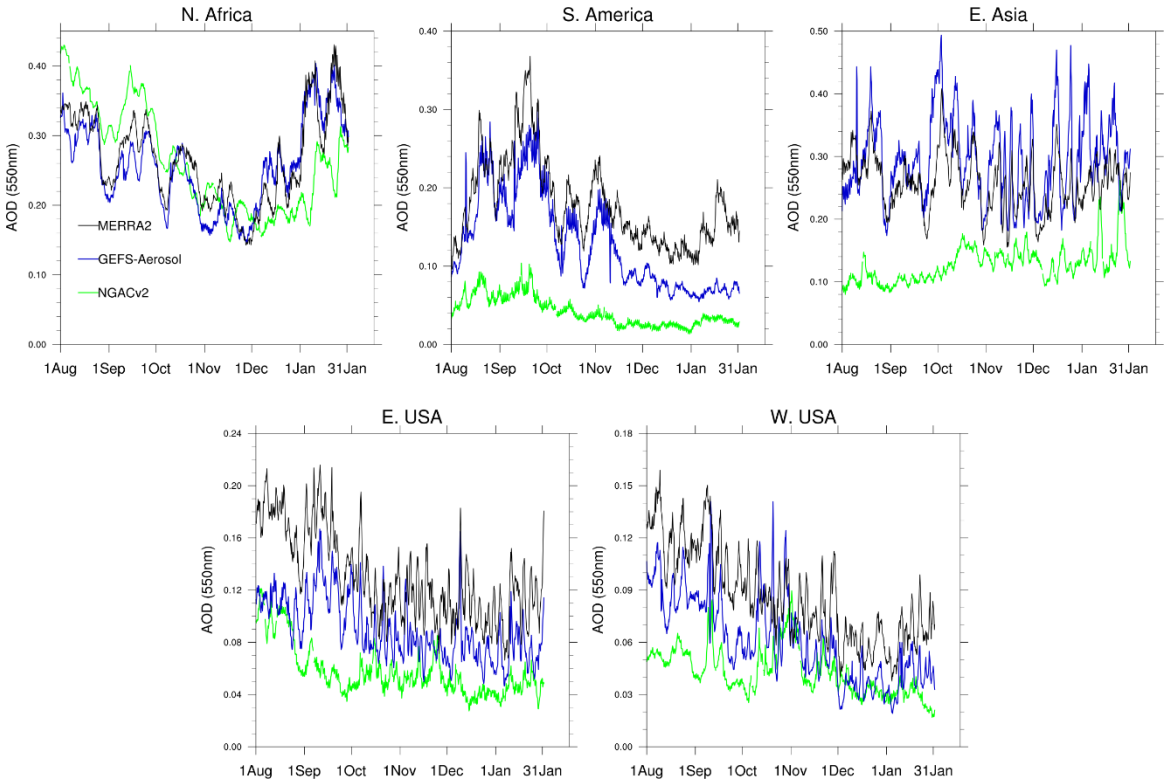

Figure 1. Daily day-1 GEFS-Aerosol model forecasts over five global regions compared against NGACv2 and MERRA2-reanalysis for six months between August 2019 and January, 2020. Latitude and longitude bounds to compute area averages are North Africa (0°-35°N, 18°W-30°E), South America (0°-35°S, 35°-80°W), East Asia (20°-48°N, 100°-140°E), Eastern USA (25°-48°N, 68°-95°W) and Western USA (25°- 48°N, 95°-125°W).

References

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