Development of an Ensemble-Variational Data Assimilation System for Global Aerosol Forecasting at NOAA

Bo Huang∗†1,2, Mariusz Pagowski2,3, Cory Martin4, Samuel Trahan1,2, Dan Holdaway5,6, Andrew Tangborn7, Daryl Kleist8, and Shobha Kondragunta9

1Cooperative Institute for Research in Environmental Sciences, CU Boulder – 216 UCB, Boulder, CO 80309, United States
2NOAA Earth System Research Laboratory/GSL – 325 Broadway, Boulder, CO 80305-3337, United States
3Cooperative Institute for Research in Environmental Sciences, CU Boulder – 216 UCB, Boulder, CO 80309, United States
4RedLine Performance Solutions at NCEP/EMC – 2275 Research Blvd STE 500, Rockville, MD 20850, United States
5Joint Center for Satellite Data Assimilation – UCAR FOOTHILLS LAB 4, 3300 MITCHELL LANE, BOULDER, CO 80301, United States
6NASA Global Modeling and Assimilation Office – Goddard Space Flight Center, Greenbelt, MD 20771 USA, United States
7I. M. Systems Group Inc. (IMSG) at NCEP/EMC – 5825 University Research Ct, College Park, MD 20740, United States
8NOAA National Centers for Environmental Prediction – 5830 University Research Court, College Park, MD 20740, United States
9NOAA National Environmental Satellite, Data, and Information Service – 1335 East-West Highway, SSMC1, 8th Floor Silver Spring, MD 20910, United States

Abstract

A hybrid ensemble-variational (EnVar) aerosol data assimilation (DA) system is being developed within the Joint Effort for Data assimilation Integration (JEDI) to improve global aerosol forecasting in the NOAA’s operational Global Ensemble Forecast System - Aerosols (GEFS-Aerosols) model. The GEFS-Aerosols model adopts the Finite-Volume Cubed-Sphere (FV3) dynamical core and the aerosol parameterization is based on the Goddard Chemistry Aerosol Radiance and Transport (GOCART) model. In the variational solver, the ensemble background covariances updated by the Local Ensemble Transform Kalman Filter (LETKF) are blended with static background covariances. Aerosol optical depth (AOD) retrievals at 550 nm derived from the Visible/Infrared Imager Radiometer Suite (VIIRS) instruments are assimilated. AOD forward operator is calculated using NASA lookup tables. Stochastically-perturbed emissions are developed and implemented in the GEFS-Aerosols model to reduce

∗Speaker
†Corresponding author: bo.huang@noaa.gov
model bias and alleviate ensemble spread deficiency. Cycled experiments show that assimilation of AOD retrievals reduces bias and root-mean-square error of simulated AOD, and improves agreement of global aerosol analyses and forecasts with aerosol reanalyses from NASA and ECMWF. Experimentation of leveraging ensemble forecasts at varying valid times to populate background ensemble suggests enhanced background ensemble error-spread consistency and further improves global aerosol analyses and forecasts.

**Keywords:** EnVar, Data assimilation, AOD