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

Bo Huang*†[1,2], Mariusz Pagowski[2,3], Cory Martin[4], Samuel Trahan[1,2], Dan Holdaway[5,6], Andrew Tangborn[7], Daryl Kleist[8], and Shobha Kondragunta[9]

[1]Cooperative Institute for Research in Environmental Sciences, CU Boulder – 216 UCB, Boulder, CO 80309, United States

[2]NOAA Earth System Research Laboratory/GSL – 325 Broadway, Boulder, CO 80305-3337, United States

[3]Cooperative Institute for Research in Environmental Sciences, CU Boulder – 216 UCB, Boulder, CO 80309, United States

[4]RedLine Performance Solutions at NCEP/EMC – 2275 Research Blvd STE 500, Rockville, MD 20850, United States

[5]Joint Center for Satellite Data Assimilation – UCAR FOOTHILLS LAB 4, 3300 MITCHELL LANE, BOULDER, CO 80301, United States

[6]NASA Global Modeling and Assimilation Office – Goddard Space Flight Center, Greenbelt, MD 20771 USA, United States

[7]I. M. Systems Group Inc. (IMSG) at NCEP/EMC – 5825 University Research Ct, College Park, MD 20740, United States

[8]NOAA National Centers for Environmental Prediction – 5830 University Research Court, College Park, MD 20740, United States

[9]NOAA 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