Performance Evaluation of the JEDI-Based Data Assimilation System for the NOAA Global Chemistry and Aerosol Forecast System (GCAFS)

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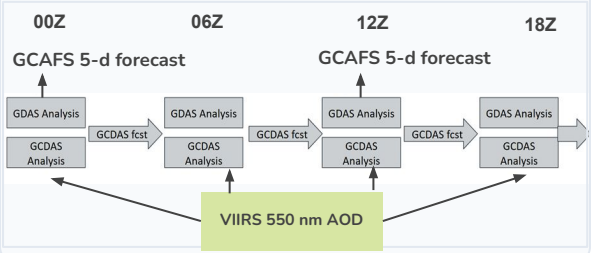
1. CCAFS & GCDAS

The GCAFS is the next-generation operational global aerosol forecast system developed at the NOAA/NWS/OMD. This study evaluates its core data assimilation component, the **Global Constituent Data Assimilation System** (GCDAS), with the Joint Effort for Data Assimilation Integration (**JEDI**) infrastructure.

GCAFSv1 employs the **FV3** core and **GOCART** module for ~25 km global forecasts. GCDAS generates analysis of aerosol tracers by assimilating **550 nm Aerosol Optical Depth (AOD) from VIIRS** satellite utilizing a **3DVar-FGAT** algorithm and **flow-dependent error covariance** matrix.

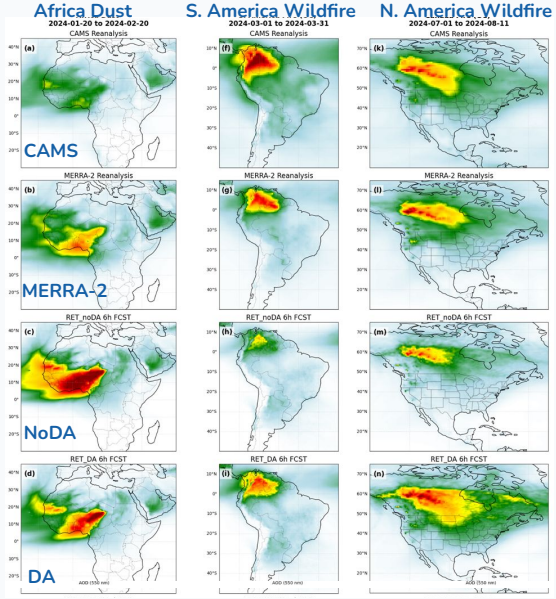


2. Retrospective Experiments Design

- QCed 550 nm AOD from VIIRS (S-NPP, NOAA-20, NOAA-21).
- Background B diagonal estimated from STDV of neighboring grids; SABER diffusion operator for spatial correlation.
- Nine-month long retrospective experiments (**Dec 2023 - Sep 2024**) **with** and **without** (w/o) data assimilation.

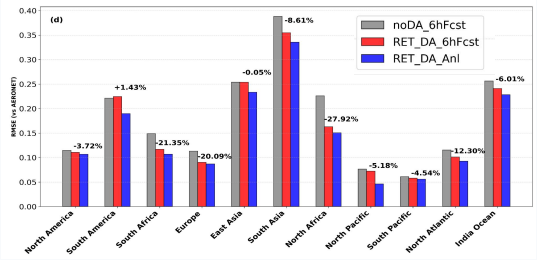
3.1 Evaluation against Reanalysis

Mean 6-h dust and OC AOD at 550 nm from DA and noDA verified against ECMWF CAMS and NASA MERRA-2.



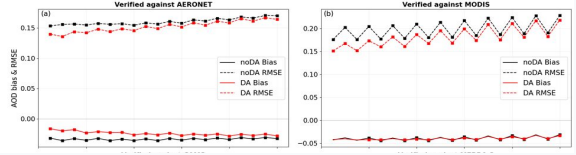
Key Takeaway: DA effectively moderates overestimated peak AOD forecast in Saharan dust area.
DA improves the intensity of organic carbon plumes, yet overestimates magnitudes in some areas during peak wildfire seasons.

3.2 Evaluation against AERONET obs



Result: Globally, DA reduces mean error of total AOD background by over 10% compared to noDA baseline.

4 Evaluation of 5-d forecast of total AOD



Result: DA experiment demonstrates a consistent and statistically significant reduction in RMSE throughout the 5-d period.

5. Future Plan

- Explore the assimilation of AOD retrievals from geostationary satellites.
- Refine the bias correction approach and background covariance tuning to address the wildfire overestimation issue.