Abstract 1:

A18: Aerosol Observability and Predictability: From Research to Operations for Chemical Weather Forecasting

Lagrangian Displacement Ensembles for Aerosol Data Assimilation

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A challenge common to many constituent data assimilation applications is the fact that one observes a much smaller fraction of the phase space that one wishes to estimate. For example, remotely-sensed estimates of the column average concntrations are available, while one is faced with the problem of estimating 3D concentractions for initializing a prognostic model. This problem is exarcebated in the the case of aerosols because the observable Aerosol Optical Depth (AOD) is not only a column integrated quantity, but it also sums over a large number of species (dust, sea-salt, carbonaceous and sulfate aerosols).

An aerosol transport model when driven by high-resolution, state-of-the-art analysis of meterorological fields and realistc emissions can produce skillful forecasts even when no aerosol data is assimilated. The main task of aerosol data assimilation is to address the bias arising from innacurate emissions, and the Lagrangian misplacement of plumes induced by errors in the driving meterorological fields. As long as one decouples the meteorological and aerosol assimilation as we do here, the classic baroclinic growth of errors is no longer the main order of business.

We will describe and aerosol data assimilation scheme in which the anaysis update step is conducted in observation space, using an adaptive maximum-likelihood scheme for estimating background errors in AOD space. This scheme includes explicit sequential bias estimation as in Dee and da Silva (1998). Unlikely existing aerosol data assimiltion schemes we do not obtain analysis increments of the 3D concentrations by scalling the background profiles. Instead, we explore the Langrangian characteristics of the problem for generating local displacement ensembles. These high-resolution, state-dependent ensembles are then used to parameterize the background errors and generate 3D aerosol increments. The algorithm has computational complexity comparable to the forecasting step by the aerosol transport model, currently running at a resolution of 1/4 degree, globally. We will present the result of assimilating AOD retrievals from MODIS (on both AQUA and TERRA satellites) and MISR instruments, using independent insitu sun photometer measurements from AERONET for validation. The impact on the GEOS-5 Aerosol Forecasting will be fully documented.