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Applying a Local Ensemble Transform Kalman Filter Assimilation System to the NICAM-SPRINTARS model

T. Dai (1,2), N.A.J. Schutgens (1,3), X. Dong (4), G.Y. Shi (2), and T. Nakajima (1)

(1) The University of Tokyo, Atmosphere and Ocean Research Institute, Division of Climate System Research, Japan (tie_dai@aori.u-tokyo.ac.jp), (2) Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China, (3) Atmosphere, Ocean and Planetary Physics, University of Oxford, UK, (4) Department of Atmospheric Sciences, University of North Dakota,USA

A four-dimensional recent developed local ensemble transform Kalman filter (4D-LETKF) aerosol assimilation system has been applied to a new type of ultra-high resolution global cloud resolving model Nonhydrostatic Icosahedral Atmospheric Model (NICAM) coupled with the Spectral Radiation-Transport Model for Aerosol Species (SPRINTARS) to perform an experimental aerosol reanalysis. Unlike other aerosol assimilation schemes, the ensemble allows realistic, spatially and temporally variable model covariances. The analyzed variables are mixing ratios (the prognostic variables of the forward aerosol transport model), there is no need for the extra assumptions required by previous assimilation schemes analyzing aerosol optical thickness (AOT).
The implementation of this assimilation system and in particular the construction of the ensemble will be instructed. This ensemble should represent our estimate of current model uncertainties. Consequently, we construct the ensemble around randomly modified emission scenarios.
The performance of the assimilation system has been tested with the global surface network AERONET observed AOT and Angström exponent (AE) in February 2009. We present the sensitivity tests for the assimilation system, such as the major three numerical parameters for the ensemble Kalman filter: ensemble size nens, local patch size npatch and inflation factor . It appears that the value of the local patch size has by far the biggest impact on the assimilation. The assimilated aerosol results, such as AOT and AE, have been validated against the independent AERONET, SKYNET, MISR and MODIS observations. The preliminary results have shown that comparing the different observations, the assimilated aerosol results have made a significant improvement than its standard simulations. Moreover remaining errors are mostly random while they are mostly systematic for an experiment without assimilation. In addition, these results do not depend much on our parameters or design choices for the ensemble kalman filter assimilation system. The 4D-LETKF will be a tool adopted in future researches in aerosol data assimilation to improve our understanding of the global or regional aerosol spatial and temporal distributions and its climate effect.