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Dust aerosol analysis and prediction with 4D-EnKF data assimilation

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We have developed an advanced data assimilation system for a global aerosol model with a four dimensional ensemble Kalman filter (4D-EnKF) in which the Level 1B data from the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) were successfully assimilated. Dust aerosol analysis and prediction experiments were performed with or without the use of the 4D-EnKF data assimilation system in the spring of 2007. The analysis or prediction results were validated via three independent observations: 1) the ground-based lidar network data in East Asia, 2) Moderate Resolution Imaging Spectro-radiometer (MODIS) measurements over East Asia, and 3) weather reports on aeolian dust events in East Asia derived from WMO Surface Synoptic Observations (SYNOP). Detailed four-dimensional structures of dust outflows from source regions over oceans and continents were well reproduced by this data assimilation system. And furthermore, the intensity of dust emission at each grid point was also corrected as a consequence of the inversion analysis using the 4D-EnKF data assimilation system. This dust aerosol analysis was used as initial conditions for dust aerosol prediction in East Asia. The model forecast scores were improved by using the results of the data assimilation analysis. Our system makes it possible to supply the initial conditions for dust aerosol forecasting with high accuracy, even in remote areas and across clouds lacking observation. These results are valuable scientifically for the comprehensive study of aerosol behavior as well as operationally for aerosol forecasting.