Geophysical Research Abstracts
Vol. 19, EGU2017-2864, 2017
EGU General Assembly 2017

Geographic dependent Parameter Optimization on Dust Emission in East Asia by Trajectory-based 4DVar

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In East Asia areas, the Severe Dust Storms (SDS) originated from the Gobi and Mongolia desert severely affect the atmospheric environment and climate system not only in the source regions, but also in the downwind areas including many mega-cities. Various dust forecast models have been developed to simulate the dust emission, transportation, and deposition. In contrast to the latter two processes, it is more difficult to accurately identify the emission source region and emission flux rate, which can lead to huge differences in forecast and observation of dust concentration.

In our study, a geographic dependent Fricion Velocity Threshold (FVT) is introduced in the dust emission equation. Because of the geographic dependence of dust model sensitivities, we allow the FVTs to vary geographically instead of using a spatially constant one. The trajectory-based 4DVar data assimilation is used to estimate the FVTs. To improve the efficiency, the model-based FVTs reduction scheme is implemented, with which the number of involved FVTs is reduced from several tens of thousands to several hundreds. Furthermore, an improved FVTs sampling scheme is used instead of the Monte Carlo sampling method.

This geographic dependent FVT optimization is explored within a twin-experiment framework, in which both the aerosol optical depths (AODs) and the ground station observations transformed from the expected model realization are assimilated. The optimized FVTs, as well as the estimated forecast of dust concentrations, are evaluated.