

Validation of a New Algorithm for Empirical Localization of Observations for Ensemble Kalman Filter Data Assimilation in Global Atmospheric Models

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Localization in the ensemble Kalman filter (EnKF) is a technique to reduce the sampling error in the statistical relations between observations and model state variables. Localization is required for good results in applications of the EnKF to large atmospheric and oceanic models. The empirical localization algorithm described here uses the output from an observing system simulation experiment (OSSE) and constructs localization functions that minimize the root mean square (RMS) difference between the truth and the posterior ensemble mean for state variables. This algorithm can automatically provide an estimate of the localization function and does not require tuning of the localization scale. Moreover, the algorithm can compute an appropriate localization function for any potential observation type and state variable kind.

The empirical localization algorithm is investigated in the dynamical core of the Geophysical Fluid Dynamics Laboratory (GFDL) B-grid model and the Community Atmospheric Model version 5 (CAM5). In the B-grid model, the empirical localization is computed for every observation type and state variable kind. The empirical localizations are Gaussian-like functions and have detailed structures for observations and state variables that are relatively close to each other. The empirical localization outperforms the best Gaspari and Cohn (GC) localization that is obtained by tuning the GC localization cutoff. In CAM5, the empirical localization function is computed for the horizontal and vertical separately, thus the vertical localization is explored. The horizontal empirical localizations are similar to the GC localization, but the vertical empirical localizations are much broader and have a nearly linear relationship with the natural logarithm of pressure for small separations between observations and state variables. The empirical localization in CAM also produces smaller RMS error than the GC localization that is routinely used for assimilation with CAM.