Application of Ensemble Sensitivity to Data Assimilation

Shu-Chih Yang[1] and Eugenia Kalnay[2]

1: National Central University, Taiwan
2: University of Maryland, USA

Given an ensemble of forecasts, it is possible to determine the ensemble sensitivity (ES), i.e., a linear combination of the forecasts that, given the choice of the perturbation norm and forecast interval, will maximize the growth of the perturbations (Enomoto, 2007, Matsueda et al., 2010). Because the leading ES vector indicates the directions of the fastest growing forecast errors, we explore the potential of applying the ES in Ensemble Kalman Filter for correcting fast growing errors. We construct the ES within a quasi-geostrophic multi-level channel model and use the Local Ensemble Transform Kalman Filter (LETKF) for the data assimilation experiments. We confirm that even during the early spin-up the final ES with a 6-h forecast window is strongly related to the background errors. Thus the ES has the potential to improve data assimilation methods through the correction of fast growing errors. A positive impact is found when using the initial ES as the additive perturbations to inflate the analysis ensemble compared with optimal random perturbations.

When an Ensemble Kalman Filter (EnKF) is "cold-started" from random perturbations, it has a long spin-up period. The "running in place" (RIP) method has been introduced to accelerate the EnKF spin up by improving the accuracy of the mean state and the structure of the flow-dependent error covariance. Under the LETKF-RIP framework of the QG model, the ES is applied to rotate the ensemble perturbations to align along the fast growing errors. Results suggest that using the ES further improves the accuracy of the LETKF-RIP analysis without enlarging the ensemble size, by effectively projecting the ensemble perturbations onto the fast growing directions.