Local Ensemble Transform Kalman Filter with Cross-Validation

Mark Buehner*†[1]

[1]Environment and Climate Change Canada – Dorval, Canada

Abstract

Many ensemble data assimilation (DA) approaches suffer from the so-called "inbreeding" problem. As a consequence, there is excessive reduction in ensemble spread by the DA procedure, causing the analysis ensemble spread to systematically underestimate the uncertainty of the ensemble mean analysis. The stochastic EnKF algorithm used for operational NWP in Canada largely avoids this problem by applying cross validation, that is, using an independent subset of ensemble members for updating each member. The goal of the present study is to evaluate new variations of the local ensemble transform Kalman filter (LETKF) that also incorporate cross validation. The new LETKF approaches are evaluated using both idealized experiments and in the context of real NWP systems. In idealized numerical experiments, the new LETKF approaches are shown to produce reliable analysis ensembles such that the ensemble spread closely matches the uncertainty of the ensemble mean, without requiring any ensemble inflation. In the context of a regional numerical weather prediction system, experiments are performed with the new LETKF-based approaches with cross validation, the standard LETKF, and the stochastic EnKF. All approaches with cross validation produce similar ensemble spread, though the amplitude of the changes to the individual members is much larger with stochastic approaches. Results from pre-operational testing of the LETKF with cross validation in the global ensemble prediction system show a statistically significant improvement over the operational system when no recentering on a 4D-EnVar analysis is performed. The new LETKF approach will replace the operational stochastic EnKF during the next system upgrade.

Keywords: LETKF, EnKF, ensembles

*Speaker

†Corresponding author: mark.buehner@canada.ca