Geophysical Research Abstracts
Vol. 13, EGU2011-2383, 2011
EGU General Assembly 2011

Ensemble Kalman filtering without the intrinsic need for inflation

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In the high-dimensional context of geophysics, efficient implementation of the ensemble Kalman filter (EnKF) requires the use of *ad hoc* techniques such as inflation and localisation. They are meant to compensate for the misspecification of background errors (resulting from a previous ensemble forecast) that often leads to underestimated analysed errors. The main *intrinsic* source of error in EnKF is sampling error. External sources of error, such as model error, or model-induced non-Gaussian deviations of the probability density function of errors, are not considered in this study. In this new approach, the data assimilation system is informed of the ensemble nature of the forecast, and not only of the empirical mean and of the empirical error covariance matrix as is usually done. We obtain under general assumptions a prior that takes into account potential sampling flaws. This generates a new class of ensemble Kalman filters. One variant is the finite-size ensemble transform Kalman filter (ETKF-N). It is tested on the Lorenz 95 model. Accounting for sampling issues, ETKF-N is optimal without inflation. However localisation is still mandatory, and a local version of the new class of filters is tested (LETKF-N). Whatever the size of the ensemble, the filter is best without inflation or with a small deflation. Its overall performance without tuning compares well with optimally tuned LETKFs.