Gain form of the Ensemble Transform Kalman Filter and its relevance to satellite data assimilation with model space ensemble covariance localization

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Abstract:

Recently developed ensemble data assimilation schemes make the size M of the ensemble of forecast error proxies used in ensemble data assimilation scheme larger than the size K of the ensemble propagated by the non-linear model. These techniques overcome problematic aspects of vertical ensemble covariance localization in satellite data assimilation and, in the case of the Ensemble Transform Kalman Filter (ETKF), enable the simultaneous update of entire vertical columns of model variables. However, the ETKF produces the same number of analysis perturbations as forecast perturbations. This presents the conundrum of how to create K analysis error proxies from the M forecast proxies that (a) best sample the true posterior error covariance, and (b) ensure that independent Local applications of the ETKF result in smooth spatio-temporal fields. This article describes a variation on the ETKF called the Gain ETKF (GETKF) that uses M forecast error proxies to transform K forecast perturbations into K analysis error perturbations without using perturbed observations. The approach yields a localization length scale dependent inflation factor. Experimentation described herein shows that the GETKF outperforms a range of alternative ETKF based solutions to the aforementioned problems. In cycling data assimilation experiments with a newly developed storm-track version of the Lorenz 96 model, the GETKF analysis Root Mean Square Error (RMSE) matches EnSRF RMSE at shorter than optimal localization length scales but is superior in that it yields smaller RMSE for longer localization length scales.