A new multiscale data assimilation method: Multiscale Local Gain Form Ensemble Transform Kalman Filter (MLGETKF)

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Abstract

A new multiscale, ensemble-based data assimilation (DA) method, MLGETKF (Multiscale Local Gain Form Ensemble Transform Kalman Filter), is introduced. MLGETKF allows simultaneous update of multiple scales for both the mean and ensemble perturbations through assimilating all observations at once. MLGETKF performs DA in independent local volumes, which lends the algorithm a high degree of computational scalability. The multiscale analysis is enabled through the rapid creation of many pseudo ensemble perturbations via a multiscale ensemble modulation procedure. The Kalman gain therefore intrinsically includes multi-scale model space localization. Experiments with a statistical model show that the full background covariance estimated by MLGETKF more accurately resembles the shape of the true covariance than a scale-unaware localization. The mean analysis from the best-performing MLGETKF is statistically significantly more accurate than the best performing scale unaware LGETKF. MLGETKF is further examined in a cycling DA context with a Surface Quasi-Geostrophic model. The root-mean-square potential temperature analysis error of the best performing MLGETKF is 17.2% lower than that of the best-performing LGETKF. MLGETKFreduces analysis errors measured in kinetic energy spectra space by 30-80% relative to LGETKF with the largest improvement at large scales. MLGETKF forecasts are more accurate than LGETKF, gaining 12-hour _˜ 1-day of predictability.

Keywords: multiscale, ensemble data assimilation, ensemble Kalman filter

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