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An iterative ensemble Kalman filter in presence of additive model error

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The iterative ensemble Kalman filter (IEnKF) in a deterministic framework was introduced by Sakov et al., 2012 to extend the ensemble Kalman filter (EnKF) and improve its performance in strongly nonlinear cases. However, the IEnKF assumes that the model is perfect. This assumption simplifies the update of the system at a time different from the observation time, which makes it natural to apply the IEnKF for smoothing. In this study, we generalise the IEnKF to the case of an imperfect model with additive model error.

The new method called IEnKF-Q conducts a Gauss-Newton minimisation in ensemble space. It combines the propagated analysed ensemble anomalies from the previous cycle and model noise ensemble anomalies into a single ensemble of anomalies, and by doing so takes an algebraic form similar to that of the IEnKF. The performance of the IEnKF-Q is tested in a number of experiments with the Lorenz-96 model, which show that the method consistently outperforms both the EnKF and the IEnKF naively modified to accommodate additive model noise.

The extension of this formalism to an asynchronous EnKF in presence of additive model noise is also analysed and an algorithm is proposed.

P. Sakov, D. S. Oliver, and L. Bertino, 2012. An iterative EnKF for strongly nonlinear systems, *Mon. Wea. Rev.*, 140, 1988-2004.