Ensemble Kalman Filtering Without the Intrinsic Need for Inflation

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Efficient implementation of the ensemble Kalman filter (EnKF) requires the use of ad hoc techniques such as inflation and localization. They are meant to compensate for the misspecification of the background errors (from a previous ensemble forecast) that often leads to underestimated analyzed errors. Aside from external sources of noise, such as model error, the main intrinsic source of error in the EnKF is sampling error. To account for those sampling errors, it is possible to derive a new prior in place of the usually assumed Gaussian prior of the traditional EnKF. This defines the so-called finite-size EnKF (EnKF-N). It has been tested on a wide range of 1D and 2D-toy models, where it does remove the need to tune and apply inflation to cope with sampling errors [1].

A dual formulation of the EnKF-N has also been derived [2]. It shows that EnKF-N is very similar to a traditional deterministic EnKF, with a multiplicative inflation specified by an algebraic equation. This shows in return that sampling errors are better dealt with by multiplicative inflation (or the EnKF-N). The dual EnKF-N can also be seen as an adaptive inflation scheme and it is compared to other adaptive inflation schemes.

In addition to the new light this approach sheds on the EnKF, it is also practically useful when developing and testing new methods on low-order data assimilation systems because it avoids the burden of tuning inflation on systematic numerical tests.

References

[1] Bocquet, M. "Ensemble Kalman filtering without the intrinsic need for inflation", *Nonlin. Processes Geophys.* 18, 735-750, 2011.

[2] Bocquet, M. and Sakov, P. "Combining inflation-free and iterative ensemble Kalman filters for strongly nonlinear systems", *Nonlin. Processes Geophys.*, 19, 383-399, 2012.