The Error-Subspace Transform Kalman Filter

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Ensemble square-root Kalman filters are currently the computationally most efficient ensemble-based Kalman filter methods. In particular, the Ensemble Transform Kalman Filter (ETKF, [1]) is known to provide a minimum ensemble transformation in a very efficient way. A similar filter algorithm is the Singular Evolutive Interpolated Kalman (SEIK, [2]) filter. In contrast to the ETKF, the SEIK filter solves the estimation problem of the Kalman filter directly in the in the error-subspace that is represented by the ensemble. Further, the matrix square roots computed in the analysis step of the filters are distinct. Comparing both filters shows small differences between their ensemble transformations, while their state estimates are identical if the same forecast ensemble is used for the analysis. To obtain the minimum transformation also with a filter using directly the error subspace, a new projection onto the error subspace is introduced. It leads to the Error-Subspace Transform Kalman Filter (ESTKF, [3]). The ESTKF shows a slightly lower computational cost compared to the ETKF. Using numerical experiments with the parallel data assimilation system PDAF [4,5, http://pdaf.awi.de], we show that also the SEIK filter can profit from the use of a symmetric matrix square root. In addition, the effect of the new projection in the ESTKF is shown.

References

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