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Maximum Likelihood Estimation of Inflation Factors of Error Covariance Matrices for Ensemble Kalman Filter Assimilation

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In the Ensemble Kalman Filter assimilation, a forecast error covariance matrix is estimated as the sampling covariance matrix of a forecast ensemble. However, it is well known that such estimations may be far from the true forecast error covariance matrix. On the other hand, the magnitude of observation error covariance matrices may also be incorrectly assigned. This may lead to a significant reduction in the accuracy of the assimilation. In this talk, we report an inflation approach on improving estimation of error covariance matrices based on the maximum-likelihood estimation developed by Dee and Da Silva (1999). The proposed approach is compared with the commonly used time-constant inflation and the time-dependent inflation proposed by Wang and Bishop (2003).

Our method was first tested on a 40-variable Lorenz model using spatially correlated observation errors. For time-constant inflation in the presence of large model errors, our approach can get similarly accurate results relative to the commonly used time-constant method. For time-dependent inflation, our method performs as well as Wang and Bishop (2003) method when model error is small. When model error becomes large, our approach behaves better than that method. Specifically, when the observation error variance is incorrectly specified, introducing a factor which is also estimated by maximum likelihood theory can obtain a "corrected" observation error variance close to the true one.

We then assessed our approach on a more realistic two-dimensional Shallow Water Equation model with spatially correlated observations. The results confirmed that the maximum-likelihood estimation theory is effective in retrieving the true states, whether the magnitude of observation error variance is correctly specified or not at every assimilation time steps.

References

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