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Incorporating Correlated Observation Errors in Ensemble Data Assimilation

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Observations used in combination with model predictions for data assimilation can contain information at smaller scales than the model can resolve. Errors of representativity are errors that arise when the observations can resolve scales that the model cannot. Representativity errors when combined with the errors in the observation operator are known as forward model error. Representativity errors have been shown to be correlated and time dependent, but currently they are not correctly accounted for in assimilation schemes. A better understanding of these errors, and how they could be calculated, would allow them to be incorporated into the observation error statistics to provide more accurate analyses and enable better use of available observations.

In this work we develop a new method for diagnosing and incorporating correlated and time-dependent forward model error in an ensemble data assimilation system. The method combines an ensemble transform Kalman filter with a method that uses statistical averages of background and analysis innovations to provide an estimate of the observation error covariance matrix. From this estimate of the observation error covariance matrix the forward model error covariance can be obtained by removing the uncorrelated instrument error.

To evaluate the performance of the method we run identical twin experiments in a simplified model. Using this approach we are able to recover the true observation error covariance in cases where the initial estimate of the error covariance is incorrect. We are also able follow time-varying observation error covariances where the length-scale of the true covariance is changing slowly in time. We find that including the estimated forward model error in the assimilation improves the analysis.