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An adaptive approach to mitigate background covariance limitations in the Ensemble Kalman Filter

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A new approach is proposed to address the background covariance limitations arising from under-sampled ensembles and unaccounted model errors in the ensemble Kalman filter (EnKF). The method enhances the representativeness of the EnKF ensemble by augmenting it with new members chosen adaptively to add missing information that prevents the EnKF from fully fitting the data to the ensemble. The vectors to be added are obtained by back-projecting the residuals of the observation misfits from the EnKF analysis step onto the state space. The back-projection is done using an optimal interpolation (OI) scheme based on an estimated covariance of the subspace missing from the ensemble. In the experiments reported here, the OI uses a pre-selected stationary background covariance matrix, as in the hybrid EnKF/3DVAR approach, but the resulting correction is included as a new ensemble member instead of being added to all existing ensemble members.

The adaptive approach is tested with the Lorenz-96 model. The hybrid EnKF/3DVAR is used as a benchmark to evaluate the performance of the adaptive approach. Assimilation experiments suggest that the new adaptive scheme significantly improves the EnKF behavior when it suffers from small size ensembles and neglected model errors. It was further found to be competitive with the hybrid EnKF/3DVAR approach, depending on ensemble size and data coverage.