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Preservation of Gaussianity in the Ensemble Retrospective Optimal Interpolation

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The second and higher-order moments of the prior error need to be known in order to more correctly estimate the error covariance of an evolved state of a nonlinear dynamical system. Retrospective optimal interpolation (ROI) may require relatively less information on the higher-order moments of the prior errors than an ensemble Kalman filter (EnKF) because it uses the initial conditions as the background states instead of forecasts. Analogous to the extension of a Kalman filter into an EnKF, an ensemble retrospective optimal interpolation (EnROI) technique was derived using the Monte Carlo method from ROI. In contrast to the deterministic version of ROI, the background error covariance is represented by a background ensemble in EnROI. By sequentially applying EnROI to a moving limited analysis window and exploiting the forecast from the average of the background ensemble of EnROI as a guess field, the computation costs for EnROI can be reduced. In the numerical experiment with a perfect-model assumption, the cost-effectiveness of the suboptimal version of EnROI is demonstrated to be superior to that of EnKF using perturbed observations.