Ensemble Kalman filtering with a graphical model

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It is known that the ensemble Kalman filter (EnKF) can estimate state variables properly using a relatively small ensemble size. Using an ensemble of much smaller size, however, the EnKF requires regularization of an ensemble covariance matrix that reduces spurious correlations between variables defined on distant grid points. One of the methods is localization of the ensemble covariance matrix using a correlation function that has a compact support.

The present study proposes an alternative method for regularizing the ensemble covariance matrix. The method assumes conditional independence between variables which is realized by imposing zero elements in the inverse matrix of the original covariance matrix. The EnKF is reformulated on the basis of the inverse covariance matrix. Since a graphical model is used in modeling the conditional independence, I call the present filtering method a graph-based EnKF (GEnKF). A numerical experiment using the Lorentz 96 model demonstrates that the GEnKF surely reduces spurious correlations and provides reasonable state estimates.