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A data-driven method for improving the correlation estimation in serial ensemble Kalman filters

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Ensemble Kalman filters (EnKF) with small ensemble sizes tend to induce spurious long-range correlations in the ensemble approximation of the model covariance. The typical approach to this long standing issue consists of using space localization techniques that effectively reduce the spurious correlations. Many such techniques have been proposed, for instance with the tapering functions of Furrer and Bengtsson (2007) or the Gaspari and Cohn localization functions (1999). While these techniques have been very useful, they require exhaustive tuning and present challenges when applied to nonlinear observations. Recently, Anderson and Lei (2013) have introduced an approach based on empirical localization functions (ELF) that requires almost no tuning. However, ELF are constructed in stages and have limitations when applied to large atmospheric models. Motivated by this approach, a data-driven technique that requires no tuning, the localization mapping (LM), was recently introduced to improve the sample correlation estimation in the EnKF when small ensemble sizes are used. A LM is a linear map that takes the poorly estimated sample correlation in each EnKF cycle and transforms it into a sample of improved correlation. In an idealized OSSE with the Lorenz-96 model and for a range of cases of linear and nonlinear observation models, the proposed scheme improves the filter estimates, especially when the ensemble size is small relative to the dimension of the state space.