Contributions of the parametric Kalman filter in practical and theoretical data assimilation

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Abstract

The parametric Kalman filter (PKF) is a novel implementation of the Kalman filter (KF) which approximates the covariance dynamics by the parametric evolution of a covariance model all along the analysis and the forecast steps. In this talk we review the ideas behind this new approach and show some applications when the covariances are parameterized from the error variance and local anisotropy tensor. We first describe the update of the covariance parameters during the assimilation step in a 2D domain. Then, for the forecast step, we explain the design of the evolution equations by using an automatic symbolic computation tool, SymPKF, which calculates the second-order Gaussian filter equations. The PKF provides a low cost computation of the covariance dynamics but often needs a closure. An example of analytical closure is introduced, then generalized by the use of IA combining the physical equations and an automatic generation of a neural network architecture (PDE-NetGen). A multivariate prediction is shown for a simplified non-linear chemical model in 1D domain. While the PKF provides a practical implementation of the KF, it also offers some

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new theoretical tools to tackle difficult issues, such as the characterization of the model-error covariance due to the discretization. In particular, we characterized the loss of variance due to the model error which occurs in the discretization of the advection as encountered when using an ensemble Kalman filter in air quality.

Keywords: data assimilation, parametric kalman filter, AI approaches, model error covariance, error covariance dynamics