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Treatment of model error in sequential data assimilation

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We present two approaches to deal with the model error due to uncertain parameters and to the presence of unresolved scales.
An alternative formulation of the extended Kalman filter, referred to as Short-Time Augmented Extended Kalman Filter (ST-AEKF), for state and parameter estimation is presented first. In this algorithm, the evolution of the model error generated by the uncertain parameters is described using a truncated short-time Taylor expansion within the assimilation interval. This allows for a simplification of the forward propagation of the augmented error covariance matrix with respect to the classical state augmented approach. The algorithm is illustrated in the context of the Lorenz 36-variable model (Lorenz, 1996).
The results demonstrate the ability of the ST-AEKF to provide accurate estimate of both the system's state and parameters with a skill comparable to that of the full state augmented approach and in some cases close to the EKF in a perfect model scenario.
The model error due to unresolved scales is treated as a deterministic fully correlated process. An equation for the model error covariance required in the Kalman filter update is derived along with an approximation suitable for application with large scale dynamical systems typical in environmental modeling.
The approach is tested in the context of the two scales Lorenz model (Lorenz, 1996). The results show that the filter skill is significantly improved by implementing the proposed scheme for the treatment of the unresolved scales.