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Comparison of different hybrid Kalman filter algorithms for a large scale chemistry transport model

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A number of algorithms were introduced to solve data assimilation problems for large-scale applications. In this research study, a Kalman filter coupled to the EUROS atmospheric chemistry transport model has been used to estimate the ozone concentrations in the boundary layer above Europe. Two Kalman filter algorithms, the reduced rank square root (RRSQRT) and the ensemble Kalman filter (ENKF) were implemented in a prior study [Hanea et al. 2004]. To take the best of both into account, two combinations were applied by making use of the reduced-rank approximation of the covariance matrix as a variance reductor for the ensemble Kalman filter. The hybrid algorithms, Partial orthogonal ensemble Kalman Filter (POENKF)and Complementary orthogonal subspace filter for efficient ensembles (COFFEE), were coupled with the EUROS model. The performance of these algorithms is compared, taking root mean square errors into account and aiming for a large improvement in terms of computational time when using a hybrid algorithm. The COFFEE algorithm reduces the computational burden significantly, providing at the same time estimations as good as the simple algorithms. The performance of the low rank algorithms is bound by the nonlinear properties of one model. In order to explain the connection, some measures of nonlinearity were calculated and linked with the performance of these algorithms.