In data assimilation, covariance matrices are introduced in order to prescribe the properties of the initial state, the system noise (model error, process noise), and the observation noise (observation error). Suitable specification of the covariance matrices is essential for obtaining sensible estimates, and misspecification of the matrices may lead to over- or under-fitting of the data and/or failure of the assimilation altogether. We present a technique for optimizing covariance matrices for observation noise.

Here we propose an efficient algorithm for the maximum likelihood estimation of the observation noise covariance. The algorithm is based on an analytical derivation of the derivative of the ensemble-approximated likelihood with respect to the observation noise covariance, and forms an iterative updating procedure for estimating the optimal covariance parameters. The algorithm works with the ensemble-based filters in which the likelihood can be approximated with the ensemble. Since the algorithm does not require evaluating likelihood for every combination of the covariance parameters as done in Ueno et al. (2010), it can estimate many elements in the observation noise covariance matrix.