A particle filter with merging procedure for sequential data assimilation

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A new filtering technique for sequential data assimilation, the merging particle filter (MPF), is proposed, and its performance is evaluated experimentally. In the MPF, the filtering procedure is performed based on sampling of a forecast ensemble as also done in the PF. However, unlike the PF, each member of a filtered ensemble is generated by merging multiple samples from the forecast ensemble, such that the mean and co-variance of the filtered distribution are preserved. This merging of multiple samples allows to avoid the particle degeneration problem, which is inevitable in the particle filter (PF). Another advantage of the MPF is that it can be applied to cases with a nonlinear relationship between a state and observed data where the application of the ensemble Kalman filter (EnKF) is not necessarily effectual. We introduce the newly proposed MPF technique, and evaluated its performance through a number of experiments using the Lorenz 63 model (Lorenz 1963) and the Lorenz 96 model (Lorenz and Emanuel 1998).