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A modified ensemble Kalman particle filter for non-Gaussian systems with nonlinear measurement functions

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The ensemble Kalman particle filter (EnKPF) is a combination of two Bayesian-based algorithms, namely, the ensemble Kalman filter (EnKF) and the sequential importance resampling particle filter(SIR-PF). It was recently introduced to address non-Gaussian features in data assimilation for highly nonlinear systems, by providing a continuous interpolation between the EnKF and SIR-PF analysis schemes. In this paper, we first extend the EnKPF algorithm by modifying the formula for the computation of the covariancematrix, making it suitable for nonlinear measurement functions (we will call this extended algorithm nEnKPF). Further, a general form of the Kalman gain is introduced to the EnKPF to improve the performance of the nEnKPF when the measurement function is highly nonlinear (this improved algorithm is called mEnKPF). The Lorenz '63 model and Lorenz '96 model are used to test the two modified EnKPF algorithms. The experiments show that the mEnKPF and nEnKPF, given an affordable ensemble size, can perform better than the EnKF for the nonlinear systems with nonlinear observations. These results suggest a promising opportunity to develop a non-Gaussian scheme for realistic numerical models.