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A New Local Particle Filter Using Gamma Test Theory for High-Dimensional Models

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Particle Filters are non-Gaussian filters, which means that the assumption that the error distribution of the ensemble should be Gaussian is unnecessary. Like the Ensemble Kalman Filter, particle filters are based on the Monte Carlo approximation to represent the distribution of model states, which requires a substantial number of particles to approximate the probability density function of states in high-dimensional models. Localization is a useful method which is applied in Ensemble-type data assimilation system commonly for high-dimensional model. This study combines the localization in LETKF (Local Ensemble Transformation Kalman Filter) with particle filters and proposes a new local particle filter with ensemble space correction using Gamma Test theory for high-dimensional models. A series of tests with various parameters settings including different ensemble size, observation intervals, localization scale, inflation factors and observation operators were used to evaluate the performance of this new method using the Lorenz model with 40 variables. The results show that this approach can deal with the issue of dimensionality which otherwise leads to the collapse of the particle filters in high-dimensional systems. The Local Particle filter is stable and has considerable potential for complex higher dimensional models.