Improving the stability of the Local Particle Filter and Its Gaussian Mixture Extension: Experiments with an Intermediate AGCM

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Abstract

Penny and Miyoshi (2015) developed the local particle filter (LPF) in a form as the ensemble transform matrix of the Local Ensemble Transform Kalman Filter (LETKF). Potthast et al. (2018) applied the LPF in the German weather service's operational LETKF system and reported a stable performance. Walter and Potthast (2021) improved their LPF as a Gaussian mixture filter (LPFGM), what they call the LMCPF (Local Mixture Coefficients Particle Filter). Kotsuki et al. (2021) implemented the LPF and LPFGM with an intermediate global circulation model known as the Simplified Parameterizations, Primitive Equation Dynamics (SPEEDY), and reported that the LPFGM outperformed the LETKF in sparsely observed regions. However, performances of the LPF and LPFGM were sensitive to tunable parameters such as inflation and resampling frequency. This study aims to explore methods for improving the stability of the LPF and LPFGM. First, we revised the way to compute the posterior weights for the LPFGM. Walter and Potthast (2018) approximated the posterior weights of the LPFGM by those of the LPF. We introduced the exact posterior weights without approximation for the LPFGM, and showed that the exact weights improved the stability of the LPFGM in terms of the inflation parameter. Second, we implemented the optimal transport (OT) for constructing the resampling matrix from the posterior weights. Farchi and Bocquet (2018) reported that the OT was optimal for constructing the resampling matrix in the LPF through a series of experiments with the 40-variable Lorenz-96 model. However, our experiments revealed that the use of the OT in SPEEDY generally results in underdispersive posterior particles.

Keywords: local particle filter, non, Gaussian, LETKF, data assimilation

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