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Local Particle Filter Implemented with Minor Modifications to the LETKF Code

Cloud and precipitation processes are generally highly nonlinear, resulting in strongly non-Gaussian PDF. Particle filters treat non-Gaussian PDF explicitly and would be potentially effective for data assimilation of cloud and precipitation variables. Penny and Miyoshi (2015) developed a Local Particle Filter (LPF) in a form as the ensemble transform matrix of the Local Ensemble Transform Kalman Filter (LETKF). The LETKF has been widely used for various geophysical systems including global and regional numerical weather prediction (NWP) models and Martian atmospheric models. Therefore, implementing consistently with an existing LETKF code is useful. The particle weights of LPF, or equivalently the ensemble transform matrix of LPF, consist of 0 and 1 entries, and the smooth spatial transition of local weights is essential. German Weather Service (DWD) implemented the LETKF for their operational global model ICON based on an icosahedral grid system, where the LETKF weights are computed at a coarser analysis grid and interpolated into a higher-resolution icosahedral model grid. The interpolation brings spatial smoothing similarly to weight interpolation (Yang et al. 2008). The spatial smoothing is beneficial for smooth spatial transition of local weights, particularly for LPF. Potthast et al. (2018) applied the LPF weights in the German LETKF system and reported a stable performance in the operational setup. They called their LPF system LAPF (Local Adaptive Particle Filter). Further, Walter and Potthast (2019) improved their LAPF as a Gaussian mixture filter, what they call the LMCPF (Local Mixture Coefficients Particle Filter). This study aims to sort out the various implementations of LPF consistently with an existing LETKF code. Here we use the LETKF code first developed by Miyoshi (2005) based on an intermediate AGCM known as the SPEEDY model. In this presentation, we would like to focus on the theory and code designs of the LPF and its Gaussian mixture extension, with only minor modifications to the existing LETKF code.

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