4D-Localized Particle Filter Method in KENDA for ICON-LAM

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Abstract

Nonlinear data assimilation methods like particle filters aim to improve the numerical weather prediction in a non-Gaussian setting. The localized adaptive particle filter (LAPF), introduced by R. Potthast, A. Walter and A. Rhodin in 2019, overcomes filter collapse in a high-dimensional framework. This particle filter was further developed by Walter et al. (2021) to the local mixture coefficients particle filter (LMCPF) which was tested within the global ICON model. In the LMCPF method the background distribution is approximated by Gaussian mixtures. After a classical resampling step, Bayes' formula is carried out explicitly under the assumption of a Gaussian distributed observation error. Furthermore, the particle uncertainty can be adjusted which affects the strength of the shift of the particles toward the observation. Lastly, Gaussian resampling is employed. As for the LETKF, all steps are carried out in ensemble space. We explore the potential of the LMCPF in the kilometre-scale ensemble data assimilation (KENDA) system with the limited area mode of the ICON model (ICON-LAM) and compare the particle filter method to the localized ensemble transform Kalman filter which is operationally used at the German Weather Service (DWD). Both methods describe four-dimensional data assimilation schemes if the observation operators are applied during the model forward integration at the exact observation times and not only at analysis time. This leads to four-dimensional background error covariance matrices at times and locations of the observations which are employed to derive the analysis ensemble. We present experimental results for the LMCPF in comparison with the LETKF method in KENDA used at DWD for the ICON-LAM model.

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