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Localisation in particle filters: methods comparison and improvements

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Particle filtering (PF) is a generic weighted ensemble data assimilation (DA) method based on sequential importance sampling, suited for nonlinear and non-Gaussian filtering problems. However, PF practitioners often experience weight degeneracy leading to poor estimates of the model state. In fact, the number of ensemble members required for a successful application typically scales exponentially with the problem size. This phenomenon is known as the curse of dimensionality and prevents one to use PF methods for high-dimensional DA.

The use of local analyses to counteract the curse of dimensionality was suggested early on. It has similarities with the implementation of localisation which makes the ensemble Kalman filter (EnKF) viable with high-dimensional systems. However, in contrast with the EnKF, implementing localisation in the PF is a challenge because there is no trivial way of gluing locally updated particles together across domains.

In this presentation we review and compare recent implementations of the local PFs in geoscience. We suggest practical solutions to the difficulties of local particle filtering, that lead to improvements in the design of local PF algorithms. The performance of our algorithms is then illustrated using twin experiments with the Lorenz 40-variable model and a barotropic vorticity model.