Nonlinear Filtering and Smoothing for Very High-Dimensional Geophysical Systems

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Particle Flow Filters and Smoothers allow for sampling posterior probability density functions (pdf) in very high-dimensional spaces. They are based on iterative minimization of the KL-divergence (or other distance measures) between the pdf represented by the particles and the posterior pdf. The methodology can be seen as an ensemble of 3Dvars for a filter, and an ensemble of 4Dvars for a smoother, in which the particles interact during the minimization. We will discuss deterministic and stochastic versions of the Particle Flows, and their relative advantages. . We also present a surprisingly simple and robust solution to the problem that particle flows need the gradient of the log of the prior pdf, which is only know by its samples. The methodology uses straightforward kernel methods and localization procedures. finally, if time permits, we will discuss a continuous version of a particle flow smoother that avoids the need to consider the prior of the state, and only works with the prior of the errors in the model equations. All developments will be illustrated with low and high-dimensional geophysical examples.

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