Non-Gaussian Ensemble Data Assimilation using a Deterministic Approach

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Various methods implementing non-Gaussian data assimilation are described in the literature. But all of them are either extensions of Gaussian-based methods (e.g. EnKF with anamorphosis) or Monte-Carlo based filters still inapplicable to high dimensional systems (e.g. particle filters) as mentioned in Snyder et al. [2008].

In this presentation, we introduce an ensemble filter, the Multivariate Rank Histogram Filter (MRHF), which extends the Rank Histogram Filter (RHF) of Anderson [Anderson, 2010] in order to apply Bayes theorem to solve the full non-Gaussian problem. While the RHF takes into account non-Gaussianity only in the observed variables and the observations, the MRHF also deals with the joint non-Gaussianity of all variables. The data assimilation problem is solved by splitting the problem of estimating a joint density into a series of smaller problems of estimating conditional, one-dimensional densities. The MRHF analysis scheme is completely deterministic and reproducible, meaning no randomness is involved in the sampling process. The MRHF also presents the advantage to perform an intrinsic localization, which considerably decreases the number of particles needed. However the curse of dimensionality still strikes when the observations are overly scattered.

We describe a series of experiments on several small case benchmarks, each of them corresponding to different levels of non linearity and non-Gaussianity, and show that, in each case, the MRHF provides an appropriate correction to the prior ensemble. In the medium term, the MRHF will be implemented to solve the strongly non-Gaussian problem of the assimilation of ocean color data in physical-biogeochemical models, in the framework of the European project SANGOMA.

References

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