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Nonlinear Processes in Geophysics
Discussions

Interactive comment on "Revising the stochastic iterative ensemble smoother" *by* Patrick N. Raanes et al.

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Review of manuscript NPG-2019-10 "Revising the stochastic iterative ensemble smoother" by Patrick N. Raanes, Andreas S. Stordal, and Geir Evensen

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This is a useful study that nicely sums up the existing literature on the stochastic EnKS (mainly known as EnRML), offers a simplified and more efficient algorithm, and compares performance of the method with that of a few other popular iterative schemes in two Lorenz-96 based experiments.

Apart from a few suggestions and questions below, the manuscript overall seems to be in a good shape to recommend it to **publish with a minor revision**.

1. P.1, L.15: **IES**

   The Ensemble Smoother (ES) van Leeuwen and Evensen (1996) is a non-sequential method. It involves no ensemble update during the whole run of the system. While ES produces an optimal analysis for linear systems only, it also seems to be a popular approach for nonlinear systems with stable dynamics, e.g. in reservoir modelling.

In contrast, the EnRML is a sequential method specifically designed for nonlinear dynamics. I am therefore a bit lost when the authors say that EnRML is "also known as the iterative ensemble smoother (IES)", particularly considering that the paper in general is fairly thorough in reviewing the literature, and that Geir Evensen is one of the authors.

If the above is correct, then using the term "ES-MDA" in regard to a sequential method also seems somewhat controversial.

2. P1., L.18 and further: **Gu et al.**

   Should be "Gu and Oliver".

3. P.5, L.49: $\mathbf{C}_y$ **may be identified as the prior covariance of observation**

   Should be "as the prior covariance of innovation".

4. P.5, L.61: **Sakov et al. (2017)**

   Should be "Sakov et al. (2018)".

5. P.7, L.26: **Using the $\mathbf{C}_x$ in its stead is flawed and damaging because it is zero in the directions orthogonal to the ensemble subspace, so that its use would imply that the prior is assumed infinitely uncertain (i.e. flat) as opposed to infinitely certain (like a delta function) in those directions.**

   I used to believe that using $\mathbf{C}_x^+$ is not a problem because the cost function is estimated in the ensemble subspace only.

6. P.8, L.57: **Bocquet et al.,2013**

   Should be "Bocquet and Sakov, 2013".

7. P.14, L.12: **where the data assimilation window has been fixed at L = 0.4, which is near optimal (cf. Bocquet et al., 2013, Figures 3 and 4)**

   I am missing the point why $L = 0.4$ is near optimal.

8. Section 4.2

   It would also be interesting to see results for a more nonlinear case $\Delta t_{obs} = 0.8$.

References

van Leeuwen, P. J. and G. Evensen, 1996: Data assimilation and inverse methods in terms of a probabilistic formulation. *Mon. Wea. Rev.*, **124**, 2898–2913.