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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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This is a very nice paper. Taking inspiration from the deterministic IEnKS, it significantly clarifies the derivation of the EnRML which I personally always found a bit convoluted. In spite of all the technical details, it is a relief to see the simple and sleek algorithm in page 12 of the manuscript. It allows for an immediate comparison with the deterministic IEnKS and it makes sense even without going into the details of the derivation. Part (and only part) of the simplification is reminiscent of the simplification operated in Bocquet and Sakov (2012) onto the IEnKF algorithm of Sakov et al. (2012) (line 21 of the main algorithm in Appendix A) without fundamentally changing the method. This could be briefly mentioned. I have not checked the appendices which are very technical and would require too much time to confidently check.

You will find below a list of minor suggestions, which could help improve the manuscript:

1. The line numbering is inconsistent (unpractical at best)!
2. line 1: The parentheses around stochastic are unnecessary.
3. line 12: "reservoir" → "oil reservoir": I believe reservoir is not natural for the usual NPG reader.
4. line 16: Readers unfamiliar with the EnRML may jump to the beginning of the derivation: section 2: But then, there would be no introduction at all for theses readers. They do deserve a few sentences! (the abstract does not count.)
5. lines 27-28: Parentheses are missing around the equations' number.
6. line 44: Bocquet and Sakov (2012) could be mentioned here, as it showed that the requirement for inverses in Sakov et al. (2012) was unnecessary.
7. lines 50-52: I guess you are missing the key point which is that chaotic model require sequential assimilation, whereas oil reservoir models, although nonlinear (and non trivial), are not chaotic.
8. line 59: "some of the results" → "some of the mathematical results" (otherwise, the statement would seem odd).
9. line 64: This has also been discussed in Liu et al. (2017) and to some extent Morzfeld et al. (2018).
10. page 3, line 12: Please define $\|$.
11. page 4, line 19: The section title is too generic and not consistent with the one chosen for section 2.3. "RML" would be more consistent.

12. page 4, line 30: "first-order" is ambiguous. Strictly speaking, this is second-order as a Taylor expansion but without second-order derivatives.

13. page 4, line 41: Please define $\mathbf{I}_M$.

14. Page 5, line 49: $\mathbf{C}_y$ is often called the innovation covariance matrix, or innovation statistics.

15. Page 5, line 50: "than the inversion to compute $\mathbf{C}$" → "than the inversion needed to compute $\mathbf{C}_\bullet$ in (7b)."

16. page 5, line 62: "yield" → "yields".

17. page 5, line 68: "without the costly use of Metropolis-Hastings": More fundamentally this is due to the curse of dimensionality (see e.g., Liu et al. (2017)).

18. page 7, line 6: "Maciejewski and Klein, 1985" → "as proven by ..." or use parentheses.

19. page 7, Theorem 1: At the NPG level, this result can be seen and written down on the back of an envelope, and that is why nobody cares to do so. It is nice though that you show it rigorously but since the heuristic for this proof is adamant, this would not really be required in NPG. By that I mean that previous authors are not really guilty. Also, I believe that the heuristic derivation is not restricted to Gaussian distributions, is it?

20. page 8, lines 41-48: This can be better understood thinking in terms of conditioning of the associated cost function.

21. page 8, line 58: "the control vector" → "a control vector" right? there may be several.

22. page 9, line 90: "Inversely" → "Conversely".

23. page 12, line 63: "pre-multiplying" is ambiguous. Say for instance on the right or on the left.

24. page 13, line 85: There is also a quasi-static variant of the deterministic IEnKS that would be worth considering (Fillion et al., 2018). However the data assimilation window length your chose might not be long enough to do so.

25. page 13, line 10: 10'000, do you mean 10,000?

26. page 14, line 18: I would add the smoothing RMSE to the numerical study to muscle it up. Moreover, I noticed that it is often uneasy for colleagues to grasp that such filter yields better filtering RMSE. I would show both the filtering and smoothing RMSEs to tell that these methods do both with high accuracy.

27. page 14, line 31: You could mention that this is qualitatively if not quantitatively similar to the deterministic versus stochastic EnKF.

28. Page 14, line 42: "has been subject of" → "has been the subject of".

29. page 14, line 42: "tuning of the step length": what does it mean? I really have no clue.

30. page 15, line 48: This is really reminiscent of the improvement brought about by Bocquet and Sakov (2012) onto Sakov et al. (2012) in the context of the deterministic IEnKF/IEnKS.

31. page 16, line 57: "do not go the length of" → "do not go to the length of".

32. page 16, line 63: "prove" → "proves".

33. page 16, line 68: "was is" → "was".

References

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