

Interactive comment on “Ensemble Variational Assimilation as a Probabilistic Estimator. Part II: The fully non-linear case” by Mohamed Jardak and Olivier Talagrand

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We thank M. Bocquet for his comments and suggestions. We give below a first response to some of these.

Like for the first and companion paper, I believe that a minor revision of the manuscript is necessary to address a few flaws and a list of very minor points. In particular, a few references are missing.

Specific remarks, in connection, or not, to the previous remarks are:

5. lines 24-25: “The performance of EnsVAR is compared with that of Ensemble

C1

Kalman Filter and Particle Filter in Section 3.”: again, out of a specific context, this does not make much sense in the absence of cycling, proper tuning of the methods, and so on.

We have mentioned (ll. 305-310) that the comparison with EnKF and PF cannot certainly be considered as definitely conclusive. But it is certainly instructive, for instance in that it suggests that there are no major differences between the results produced by the three methods that have been compared. And we do not understand why the referee considers that ‘this does not make much sense in the absence of cycling’ (see our response to his specific remark 34 about paper 1). And ‘proper tuning of the methods’ could be an endless task.

6. line 28: “successful in nonlinear as in linear conditions.”: it always depends on how long the data assimilation window is. As any other method, EnsVAR is bound to fail for very large windows.

We will qualify our statement by saying that it is valid for the time windows we have considered, but not necessarily for longer ones. But is not clear to us why any method is bound to fail for very large windows. Failure is certainly to be expected for strong constraint assimilation implemented with an erroneous model. But why should it be in the case of weak constraint ?

10. Section 2: Nice results. Similar and consistent results have been obtained, which should be briefly mentioned. Bocquet and Sakov (2013) have obtained very similar results with the iterative ensemble Kalman smoother (IEnKS) with the same window of 10 days, a time-interval of 1 day (as opposed to twice a day), an ensemble of 20 members and $\sigma = 1$: see Figure 4 of Bocquet and Sakov (2013). In particular the MDA IEnKS ($S = 1$), which is quasi-static, outperforms the SDA IEnKS which (in this reference) is not quasi-static. Other directly relevant references worth citing about quasi-static EnVar methods are Goodliff et al. (2015) and Carrassi et al. (2017).

Thanks for mentioning. We will look at those references.

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11. lines 82-83: "This improvement must be due to the fact that more observations have been used.": above all this is due to the fact that the middle point is farther apart from the end of the window, so that fresher observations have a strong information content leveraged by the unstable modes of the dynamics. This has been shown in Bocquet and Sakov (2014).

Thanks also for mentioning.

14. lines 102-113: Part of this analysis coincides with that of H. Abarbanel and his collaborators. I believe you should at least refer to one of their paper, for instance Ye et al. (2015).

Thanks again.

25. lines 294-296: In general, no claim can be made as to the accuracy of these methods (with the goal to estimate the truth) in the absence of cycling ;

26. lines 305-310: I already know for a fact (Bocquet and Sakov, 2013, 2014) that proper cycling would very significantly reduce the number of iterations. This should be mentioned.

Is that last comment the basis for your insistence on cycling (in the comment just before and in comment 5 ?

27. lines 328-330: "is cycling necessary at all, or can one simply proceed by implementing EnsVAR over successive, possibly overlapping, windows ?": This question has already a detailed answer in (Bocquet and Sakov, 2013, 2014) and subsequent references. To anticipate a question: yes, many of the conclusions obtained with the IEnKS would apply to EnsVAR. In essence: no, it is not absolutely necessary, but it would numerically help a lot to cycle the background (fewer iterations) and would yield a better accuracy.

Thanks once more.

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30. lines 348-349: "This defines a theoretical improvement on EnsVAR, based on an appropriate use of the Jacobian of the data operator." Liu et al. (2017) have already shown on a higher dimensional example that RTO might become inefficient (it is likely to be ultimately subject to the curse of dimensionality) as reported in their experiments and conclusions. This could be mentioned.

All right. Thanks.

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