

Nonlin. Processes Geophys. Discuss., referee comment RC2
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Comment on npg-2021-28

Anonymous Referee #2

Referee comment on "Ensemble Riemannian Data Assimilation: Towards Large-Scale Dynamical Systems" by Sagar Kumar Tamang et al., Nonlin. Processes Geophys. Discuss., <https://doi.org/10.5194/npg-2021-28-RC2>, 2021

The authors extend their recent work on Ensemble Riemannian Data Assimilation (EnRDA) to high-dimensional systems. Specifically, "high" here refers to a dimension size where optimal mass transport (OMT) would become computationally intractable using standard approaches with OMT to approximate the resulting probability distributions. The numerical experiments considered have DA test problems with dimensions of 40 and 4290, and each uses 50 ensemble members for the EnRDA implementation. The EnRDA results in the numerical experiments demonstrate an improvement over a stochastic EnKF when both are applied to DA test problems that are constructed to have strong systematic bias.

This paper is clear and well written. In particular I commend the authors for their nice introduction to OMT which will be accessible to readers familiar with DA, but not with OMT.

I think the word "towards" in the title demands a more extensive "Summary and Concluding Remarks" section. Clearly the issue of OMT's need to observe all dimensions is a serious challenge for EnRDA to be applied to assimilate real data into high-dimensional models. Although you do discuss this, the discussion is rather brief. Further, for systems of dimensions 10^6 - 10^8 , it seems that for EnRDA to be applied, some kind of dimension reduction would have to be introduced. How might EnRDA and dimension reduction work together? What are the challenges? A paragraph or two thinking about what might be tried on this front would be useful.

Minor comments:

- Would M and N typically be different in practice? For presentation, it totally makes sense to keep them distinct. Yet if $M=N$ in practice for EnRDA, you might want to mention this explicitly to the reader.

- There seems to be a word missing on line 255, "..enables to obtain"