

Dear Editor,

We thank the Editor for his detailed handling of our manuscript and for giving us the opportunity to submit a revised version. We have taken the criticisms raised by the Editor and improved its positioning and its scope. The manuscript has been extensively revised, as detailed below.

1. Redefine the scope of the paper

The paper is focused on exploring DA in parametric space from a structure-oriented perspective rather than on demonstrating its advantages. To reflect this, we changed the title to "Data Assimilation of Coherent Structures in Parametric and Gridded Spaces: An Idealized Ocean Eddy Study". We also foregrounded the main empirically supported advantage of the method, that the shape of the geophysical structure (GS) is preserved through assimilation, and move the other, less firmly established claims to the conclusion, framed as potential benefits rather than demonstrated ones.

2. Remove remaining truisms from the paper

For the "linear-Gaussian updates" sentence, we kept the underlying point but named the specific algorithms (linear-Gaussian Kalman filter) and stated the distortion mechanism explicitly, before introducing the history of GS-focused DA in Introduction.

3. Strengthen the literature review by adding references

We strengthened the literature review by adding references on mesh-based assimilation that preserves structural properties, and on state decomposition into Gaussian and non-Gaussian components. We thank the Editor for the Rao-Blackwellization pointer — we now use it to motivate our approach explicitly, and additional diagnostics confirm our transformation only partially achieves Gaussian tractability: the radius parameter remains significantly non-Gaussian after fitting, as shown in Sect. 4.2.

4. Uncertainty propagation between the two spaces

We understood "interpolation" as relating uncertainty via a local linearization (e.g. Taylor expansion), and "marginalization" as propagating the full distribution without that approximation (e.g. our ensemble/Monte Carlo approach). The Taylor expansion (which was our first idea) produced unphysical results (negative analyzed heights over part of the domain), while our ensemble approach avoids this. This has been added in Appendix A. We now discuss diffusion maps and transport maps as candidate tools for the more general, non-idealized case where the projection isn't closed-form in Conclusion.

5. Provide a concrete theoretical estimate of computational cost

We provided a concrete theoretical (analytical scaling) estimate of computational cost as a function of physical dimension and tolerance, for a fixed Eulerian grid, an ALE (Arbitrary Lagrangian-Eulerian) adaptive mesh, and our parametric representation, treating ALE as an intermediate case between the two rather than as equivalent to either. This is an analytical argument, not a numerical benchmark; we did not implement an ALE solver. It has been detailed in the dedicated Sect. 4.4.

We believe the revised manuscript fully addresses all concerns raised by the Editor. The substantial revisions were the removal of all unsupported general claims, the full integration of the computational complexity, the addition of the Taylor expansion diagnostics and the careful positioning within the existing literature about uncertainties. We hope that makes the manuscript suitable for publication in its revised form.

Yours sincerely,

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