Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC3
https://doi.org/10.5194/gmd-2022-40-RC3, 2022

Comment on gmd-2022-40

Anonymous Referee #3

Referee comment on "An ensemble Kalman filter system with the Stony Brook Parallel Ocean Model v1.0" by Shun Ohishi et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2022-40-RC3, 2022

Title: An ensemble Kalman filter system with the Stony Brook Parallel Ocean Model v1.0

Authors: Ohishi et al.

Recommendation: Major revision

Summary

This manuscript describes the local ensemble transform Kalman filter (LETKF) implemented in the Stony Brook Parallel Ocean Model (sbPOM), with daily assimilation of satellite and in-situ observations. Sensitivity experiments with IAU and various multiplicative inflation methods are performed. Results show that the application of IAU improves the analysis balance, but degrades the analysis accuracy and also reduces ensemble spread. The constant multiplicative inflation with or without IAU had much larger imbalances and errors than the other configurations. RTPP and RTPS with IAU had improved balances and smaller errors when the inflation parameter is tuned. The presentation of the manuscript is fine, and the lessons of inflation and IAU with influences on imbalance and accuracy are useful for the ocean DA community. But the results need further clarifications and explanations. Please see my comments below.

- It is confusing about the impact of IAU on the assimilation results. Compared to NOINFL, IAU in NOINFL+IAU degrades the accuracy. Why IAU degrade the accuracy for ocean assimilation that has longer time scale than atmosphere?
- The authors state that IAU reduces the spread and accuracy of DA. But MULT, RTPP and RTPS have totally different impacts on the spread and accuracy when IAU is applied. Why MULT that also inflate the ensemble spread has the opposite impacts on spread and accuracy than RTPP and RTPS? Since the results with different inflation methods are inconsistent, it would be helpful to understand the roles of different inflation methods, especially the interactions with IAU.
- Previous studies of IAU (e.g., Lei and Whitaker 2016, He et al. 2020) showed that IAU has more advantages for variables that are more influenced by imbalances that variables that are less influenced by imbalances. However, results here are inconsistent with the previous findings. IAU improves the accuracy of wind field more than the accuracy of height field (Figures 3 and 4). Please provide explanations or insights for these counter-intuitive results.
- Details of how the verification are done are needed. Which time is the imbalance deltaNBE computed at? Is it the prior or posterior at middle of DA window? The RMSD is computed for the prior or posterior? How the RMSD is computed for experiments with IAU?
- Since assimilation is conducted at a daily frequency, both the daily prior and free forecast at longer forecast lead times worth to check.

Minor comments:

- L90, for the IAU configuration here, is the analysis computed at the middle of an DA window or not? The 1.5 times computational cost is compared to the standard method with or without IAU? It is not clear why analysis is performed at the beginning of an DA window.

References

He, L. Lei, J. S. Whitaker, and Z.-M. Tan, 2020: Impacts of Assimilation Frequency on Ensemble Kalman Filter Data Assimilation and Imbalances. J. Adv. Model. Earth Syst., 12, e2020MS002187.

Lei, L., and J. S. Whitaker, 2016: A four-dimensional incremental analysis update for the ensemble Kalman filter. Mon. Wea. Rev., 144, 2605-2621. doi: http://dx.doi.org/10.1175/MWR-D-15-0246.1.