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Comment

Interactive comment on “Sequential assimilation of multi-mission dynamical topography into a global finite-element ocean model” by S. Skachko et al.

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Review of the manuscript "Sequential assimilation of multi-mission dynamical topography into a global finite-element ocean model" by S. Skachko, S. Danilov, T. Janjic, J. Schroter, and D. Sidorenko.

In this Ocean Science Discussion paper the authors describe the assimilation of SLA observations into a finite-element global model. I think that this paper is interesting for the publication in Ocean Science. However, there are several comments that should be addressed by the authors before its acceptance. I also think that it is necessary to make another numerical experiment (Comment 16).

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Comments:

1. Page 259, line 10. If I understand correctly, the method consists in nudging the velocity field towards the velocity which is in balance with climatology of temperature and salinity. Although this method may reduce the model drift from the climatology, it could introduce other types of systematic errors present in the objective analysis of climatological temperature and salinity. In addition, this method constrains the surface elevation gradients towards the objective analyses of the climatology.
2. Page 260, line 24. I think that version V2 is already a suboptimal data assimilation system. It assimilates information from objective analyses of temperature and salinity using an improvised algorithm.
3. Page 261, Line 20. It is not explained how the MDT substituted the geoid.
4. Pages 260-261. Is the model incompressible? How is the steric effect present in the data set treated?
5. Page 262, lines 10. I do not agree that only or even mostly the errors in bottom topography cause the model bias.
6. Page 262, line 13. I also do not agree that a long term mean difference prohibits the application of the sequential data assimilation. If observations are available frequently short model simulations will not have large biases.
7. Page 262, line 25 – Page 263, line 10. Again, I think that this is a kind of data assimilation which obviously reduces the model drift.
8. Page 263, line 15. I think that the main reason for the reduction of the variability is the nudging of the velocity field towards the climatology.
9. Page 263, line 27. What are the benefits of the V1 model?
10. Page 264, line 6 and line 20. Is there an ensemble of model forecasts or these are general statements about the possible application of the filter? If there is an ensemble

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it should be described with more details.

11. Page 264, line 18. Considering that observations are interpolated onto a grid before the assimilation, what justifies the diagonal form of the matrix R ? How is the value 5cm chosen? Is it the square root of diagonal values?

12. Page 264, line 25. On a grid with the horizontal resolution of 1.5 degrees such a small horizontal radius of influence practically decorrelates the correction on each model point from all surrounding points!

13. Page 265, last paragraph. Again I do not understand whether the background error covariance matrix is constant in time or it is evolved by an ensemble of model forecasts starting from the perturbed analyses.

14. Page 267 and Fig. 3. It is very strange that initially the discrepancy between analyses and observations grows (red dots). What is the reason for this?

15. Page 267 and Fig. 3. Corrections (red dotted lines) grow during the assimilation. How is it possible when at the same time background states (blue dots) become more accurate?

16. Section 5. I think that an experiment with the assimilation of SLA data and without the nudging to the climatology is necessary to fully understand the impact of SLA observations ($V1 + SLA$ observations).

17. Fig. 5. I guess that "with respect to observations" should be removed.

18. Page 269, Line 20. I am sure that small errors in the calculation of the first baroclinic mode cannot explain the problems in the analyses. There are many better ways (both statistical and variational) to estimate the vertical correlation of background errors than the use of the first baroclinic mode. Some of them are even mentioned in the introduction.

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