

Interactive comment on “Assessing the impact of multiple altimeter missions and Argo in a global eddy permitting data assimilation system” by Simon Verrier et al.

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We are thankful for the time and the energy spent to address these comments. The following will answer one by one the comments and questions that have been raised up from the first version of the manuscript.

“In this paper, the analysis in horizontal distributions are estimated from the differences of each OSSE (Sat1,2,3 and Arg1) from NR (?) (e.g. Fig. 2,4,5,6,7,8,11,15). In order to understand more clearly on the impact of single and multi altimeter data on the assimilation system, it would need the differences among Sat1, 2, 3 as well as the difference from FR.”

C1

- Our results are based on the comparison between each experiment including the Free Run and the Nature Run (NR). This gives a complete characterization of the errors made by the AR. Figures show differences between the OSSEs and the Nature Run which represents the truth. We judge that comparing experiments between themselves will make the article too long.

“page 4, 2nd paragraph from the bottom. It is needed that more explanation on larger improvements of Sat2-Sta1 than one of Sat3-Sat2. This pattern occurs in all comparisons.”

- The reviewer highlights the fact that improvements are higher when passing from one to two altimeters rather than from two to three altimeters. These scores are relative to error reduction from one experiment to the previous one. In deed first altimeter brings the biggest error reduction compared to the Free Run but second and third altimeters keep reducing this error. We add “In fact, first altimeter brings the biggest error reduction compared to the Free Run but second and third altimeters keep reducing this error” p4 line 35. Those results can also be seen in the description of the error spectrum where the reduction of the error is visible at multiple scales. An explanation is that the first altimeter brings the most important contribution by constraining the large scale mean Sea Surface Height.

“page 5, 3rd paragraph from top (line 10-11). In the OSSE, this statement is only relevant in the 7 day forecast of this OSSE, and results of the comparison must be changed by the periods of forecast. Is there any more generalized result on this impact?”

- Here, the comment deals with the forecast period. As we specify it, we only focus on a 7-day forecast window but we will point it out again in the manuscript. We do not have more general results concerning the period of forecast except that error growth is close to a linear evolution in function of the time.

“page 5, line 14. “Model predictability” It is needed more detail discussion on “Model predictability”. What is the definition of the predictability in this analysis?”

C2

- This comment is about the definition beneath the “model predictability”. Here it highlights the forecasting capability of the forecasting system. We replaced the sentence in the manuscript by “The error increase between the analysis and forecast for each experiment highlights the model forecasting capabilities at 7 days in the different regions”

“page 5, 4th paragraph from top (line 14). It is unclear why the MSE increase globally 28% for Sat1, 35% in Sat2, 37% for Sat3. The previous results show that MSE decrease by adding multiple altimeter data. It seems that more discussions on the error are needed.”

- We need to rephrase our sentence. In deed it was not clear enough. When we write “MSE”, it is in fact “relative MSE in % between analysis and forecast and not errors between experiments” p5 l19. “page 5, line 28. What is “model surface error fields”? It would be guessable, but in order to understand more clearly, it is needed to clarify what the error field is.”

- Concerning this comment, we complete our sentence by specifying that error fields refer to the difference between AR and Nature Run. We corrected it as follow: “Wavenumber spectra were calculated from the sea level error fields (AR - NR)”.

“page 6, 1st paragraph from top. The spectrum of variance preserving form seems to show different results from the spectrums in Fig.10, especially on impacts in the length scales. The spectrum of variance preserving form would need to be shown, and it need to discuss on the differences of OSSEs in scale between the spectrums.”

- As suggested by the reviewer, we add the variance preserving spectrum to complete the previous spectrum. Conclusions are not changed but the figures show more clearly that “The error reduction due to altimeter data assimilation is visible for all of the three selected regions: the free model run error spectrum is higher at all wavelengths larger than 100 km.”

C3

“page 7, line 7-8. Model results show the assimilation of altimeter data improved MSEs of subsurface temperature and salinity, and Authors suggest two brief possible mechanisms. The mechanisms would be model and assimilation scheme dependent, so more detail discussion on this mechanism is needed.”

- This comment is about how well sub surface temperature is improved compared to salinity by assimilating altimetry observations. Except in the Gulf Stream, salinity is not significantly improved when assimilating altimetry data (cf supplementary figures joined to this answer). It is because in the system, sea level errors are well correlated to upper temperature errors and less to salinity’s through the model covariance error matrix. We modified the end of the paragraph like this: “As density variations are mainly correlated to temperature variations and less salinity variations in most of the ocean regions, this explains why assimilating altimeter data improves the representation of the temperature fields (e.g. Guinehut et al., 2012).”

“fig. 4, 5, 6, 7, 8, 9 It seems that more organized figures would be needed rather than separated figures, which is associated with the results in Fig 10.”

- Here it is more a suggestion is about re-organizing multiple maps together. We found that this way of representation allows a better visibility of the impact of the assimilation on the mesoscale in each region.

“page 2, line 23-24. It seems that this statement is irrelevant.”

- Finally we are not sure to understand what is irrelevant in our statement. We write about OSSEs and not OSEs, that have been done in fact extensively done in the past but not OSSEs.

- About the technical comment, we modified and corrected what has been pointed out.

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C4

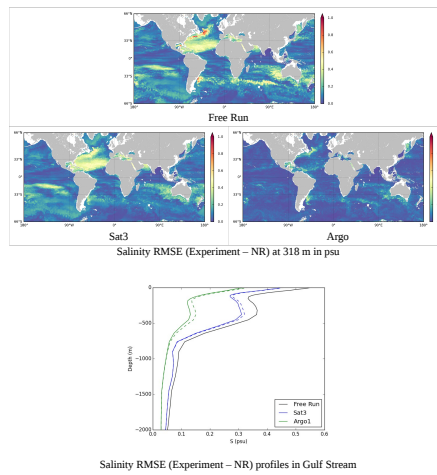


Fig. 1.