

## ***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.***

### **Anonymous Referee #2**

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The paper described several OSSE experiments where simulated altimeter and Argo profiles are taken from a 1/12 global ocean model and assimilated into a  $\frac{1}{4}$  ocean model. 1, 2 and 3 altimeter track sets are assimilated and one experiment where all 3 altimeters along with Argo are assimilated based on data from 2009.

This feels a bit like an old study that has not been written up since the question of justifying Multiple altimeters was popular 6-7 years ago. As expected the results improve when assimilating multiple altimeters although this has importantly been shown before assimilating real data in OSE experiments using innovation reductions.

There is no discussion of scientific questions related to these results and I think the study needs such scientific discussion to merit publication so I would say Major revi-

sions. Here are some questions that occurred to me:

Define the scientific problem more rigorously! If you are just asking what's been observed then clearly more altimeters observe more detail. Is that all this paper shows with the sea level errors? To go beyond this you need to discuss how well the model can extrapolate sea level in space and time, either between tracks or from one analysis to the next (forecast). Perhaps there is enough data from 1 altimeter for a good model and good assimilation scheme to extrapolate very well, in which case further altimeters will not lead to improvement? The paper seeks to emphasise the models failure to do this rather than asking how well it has done and whether that's likely to be a limitation for future systems.

Do the 7 day forecasts beat persistence in sea level error for Sat 1, 2,3? The results show that errors grow quickly from the analysis and they grow faster with more altimeters. Sat3 presumably has more small scales which should evolve faster so and be less well captured by persistence? However Page 6 line 4 seems to suggest that the forecast error growth appears strongest at larger scales ~300km which would run counter to this argument.

The assimilation of absolute sea level page 3 line 38 is likely to have a big impact on the results. Each new altimeter assimilated brings a further "correction" of the MDT towards the 1/12 values. Deserves discussion.

The paper claims to examine complementarity between Argo and altimeters. But the results do not show result for assimilating Argo alone (I suspect Argo 1 results in Fig 14 would be very similar). Are Fig 14 analyses similar or better than forecasts? Also you do not show any impact of Argo on sea level errors? Perhaps forecast errors in sea level might reduce?

Say more about why salinity is not improved? Surely T-S error covariances should give some S improvement if T is improved because a lot of error is heave which preserves T-S relationships?

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Minor comments State 7 day forecast times in abstract.

Use of “relative reductions” and MSE reductions rather than using RMSE reductions always relative to the free run makes the % reductions for each satellite appear larger. I think at least the errors in RMSE should also be quoted as this then reflects reductions in sea level units i.e. cm rather than  $\text{cm}^2$ .

Page 3 line 35 Would altimeter errors not have some error correlation along tracks? Explain more whether the SAM2 assimilation method is still an ensemble method, and how many members are used. This is relevant to capturing T-S correlations for example. You might then explain what “Evolutive” means bottom P2 Also is an analysis and 7 day forecast done every day or are all the diagnostics showing averages of analyses and forecasts at 7 day intervals?

Fig 2 Units should be  $\text{cm}^2$ . State period in legend Jun-Dec 2009. Text around maps too small to read.

Fig 10 Are these errors MSE or RMSE spectra?

Fig 11 Legend remove “in cm”

Fig 13 coloured lines hard to distinguish. Also would be useful to see this regionally eg GS etc.

Fig 14 Should really include Argo only run

P5 L25 This paragraph should appear earlier in motivation section

P6 L31-35 35%, 13% and 4% all refer to different areas, seeking the largest values. This should be clear in text. Introduce “upto” before each %age for example 65,57,54% appear as 64,56,53% in table

P6 L34 Why are velocity improvements uniform in the vertical?

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