

Geosci. Model Dev. Discuss., referee comment RC1  
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## Comment on gmd-2022-98

Anonymous Referee #1

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Referee comment on "Observing system simulation experiments reveal that subsurface temperature observations improve estimates of circulation and heat content in a dynamic western boundary current" by David E. Gwyther et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2022-98-RC1>, 2022

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This manuscript presents results of an observing system simulation experiment to assess how surface and XBT measurements can improve the accuracy of a data assimilated model simulation in the region of the East Australian Current.

Major comments:

On the generation of the baseline: In this paper, the "baseline" state is created by running the model using perturbed initial conditions. However, deviations from reality do not arise only from uncertainty on initial conditions. Uncertainties on mixing parameterizations and meso-/submesoscale representation can also be important. Also, real observations always have more noise (internal waves, turbulence...). Random noise could be added to synthetic observations to increase their realism. By using a baseline generated by the same dynamical model, are you not placing your assimilation system in a very favourable situation?

Choice of synthetic observations: The authors have chosen to test XBT strategy but not any of the other observing systems, such as gliders, Argo, etc. Also, they chose to focus on temperature-only data, while salinity data are available on other platforms than XBT. Yet I imagine they should have an impact. Any reason for that? As it stands, this does not meet the criteria of an objective assessment of the value and complementarity of different observing strategies?

Conclusions are weakly supported by the results. The description of the beneficial impact of XBT observation seems exaggerated. In particular, it is very hard to assess the impact of different assimilated datasets as the baseline case is never presented anywhere. Another puzzling aspect is that the case assimilating all "data" is markedly less good than the one with only one XBT section.

Overall, I am not convinced this paper is best suited for publication in Geophysical Model Development. There is no model development presented here.

Minor comments:

- l. 1 and l. 16: WBCs are not necessarily poleward flowing. Maybe add here that you focus on Subtropical WBCs.
- l. 23: Not all DA methods combine model-obs in a "dynamically consistent way". State here that you are using 4DVar with 5 days windows.
- l. 86: why is the resolution varying so much in such a small domain? And how?
- l. 255: These results are very confusing. How is it possible that the worse experiment be the one assimilating the largest amount of data? Why do you not show the baseline case to see how bad the run is without assimilation? Looking at this figure only would actually lead me to conclude that XBT data have a very minor impact if not a detrimental one on the representation of the circulation.
- l. 389: I do not understand which feature in the deep MKE is better represented thanks to XBT assimilation. On the contrary, it seems to me that deep properties are somehow worsened by XBT assimilation when compared with the Ref.
- Discussion is mostly a repetition of the Result section. What is the purpose?