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Ocean Science
Discussions

Interactive comment on "Dense CTD survey versus glider fleet sampling: comparison of the performance for regional ocean prediction West of Sardinia" *by* Jaime Hernández-Lasheras and Baptiste Mourre

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Reviewer: General Comments: The manuscript investigates the impact of the assimilation of dif- ferent datasets on simulations and forecasts performed with a mesoscale resolving regional model (ROMS) implemented in the Western Mediterranean sea. I generally like the paper. Authors investigate the impact of new technologies and sampling strate- gies on the description of the ocean state. My main concern is about the behaviour of the model without assimilation. In particular, as the authors state (p.12 l.2-4) "min and max are shifted by 0.2 kg/m3 in the panels corresponding to the simu-

lations due to a persistent bias in the model density field": it seems that something is going wrong with temperatures. Temperatures at 50 m (Top-left panel of fig.8) seem up to 2 degree cel- sius warmer than data, that is quite a lot for this depth and period. I wonder if this could be an issue related to surface fluxes and/or to a bad vertical discretization (maybe the model fails to match stratification and thermocline position). Or, it could be a BIAS due to the lenght of the (drifting) simulation? I ask the Authors AT LEAST to discuss the sources of such bias and possible (future or present) ways to fix it. Further, to better understand the relevance of such bias on simulations (and thus the impact of assimila- tion) it would be good to see also layers shallower than 50 m: I suspect an even higher temperature and density bias on shallower layers. If the BIAS is larger than 1-2deg C it should be better to fix it BEFORE assimilation.

Response:

We first would like to thank the reviewer for her/his positive feedback and comments which we think have helped us to improve the manuscript.

We fully agree that model bias is a major concern for this kind of data assimilation study and so completed the paper with a better description of this particular aspect in our system.

In particular, the 0.2kg/m3 difference found between the simulations and the density field inferred from the observations for the period 20-23 June (Fig. 9) remained unexplained in the initial version of the manuscript. After a careful revision of innovations, model and observed temperature and salinity fields, we could not find the theoretically corresponding differences in temperature and salinity. Looking into further details, we identified the source of this bias as an error in the computation of the potential density, related to a different reference level considered for the model and observations. This error, which was mainly affecting the range of colorbars in Fig. 9 (now Fig. 11 in the revised version), has been fixed in the revised manuscript. Once this correction applied, there is no remaining density bias between the model results after data assimilation

and Scanfish and CTD observations. Density values on CTD stations collected on 20 June north of the Scanfish tracks were also added to the DIVA reconstruction, allowing to extend the coastal fringe of relatively denser water. Notice that these stations were already considered in the initial version of manuscript for the computation of the RMSD.

As mentioned by the reviewer, the second important point concerned the apparent temperature bias in the model without data assimilation. To this respect, we have added in the manuscript pictures of the SST from model and observations over the whole domain at the beginning of the simulation, as well as a map of the differences, and histograms of SST, SLA, T and S innovations. Positive and negative SST differences are found all over the domain, illustrating that no significant bias affects the data assimilation system, which is applied over the whole domain. When focusing on the REP14 area, local positive differences are found (the model being warmer than the observations, also represented by negative innovations), but these are related to local processes and far from systematic over the whole domain. The pdf of innovations (figure 5) also show that no significant bias is affecting the analysis.

We have also changed the figure presenting the general circulation in the domain so as to illustrate the model general circulation (Figure 1). The free run model has been deeply evaluated in other studies which are in the process of peer-reviewed publication.

Reviewer: Specific Comments, grammar and typos: Title: I would suggest a change in the title as in its present form it misses to inform about Analyses/Data assmilation. Something like "Sampling strategy does matter: impact of assimilation of glider data compared to dense CTD survey in a regional ocean model West of Sardinia". Or maybe shorter but I suggest with the information of the performed ocean synhteses.

Response: We have changed the title.

Reviewer:

Abstract is ok. Intro and or Methods: The paper misses a description of the known circulation of the area. There are papers specifically devoted to the circulation of the Sardinian sea (Ribotti et al. 2004 about surface mesoscale circ; Testor et al. 2003, 2005 about LIW transport mediated by Sardinian eddies; Olita et al. 2013 about surface circula- tion and upwelling; papers already published in the same special issue as the present manuscript; some other references to the area can be found in Mediterranean-scale studies).

Response:

We have extended the description of the circulation in the area and added some of the suggested references.

Reviewer:

-p4 line 17: a description/reference of the EnOI method and algorithms is missing. Is the software developed by Authors? If yes, it should be referenced or de- scribed (even in an Appendix)-

Response:

The description of the data assimilation system has been enlarged and been separated in a new section “2.3 – Data Assimilation system” . References of former applications of the code which was adapted for the present study have also been added.

Reviewer:

-p6 line 30: "an horizontal" should be "a horizontal"

Response:

Done.

Reviewer:

-p8 line 5: it is not clear if the observations used for RMSD are independent (i.e. are them also assimilated during spinup?).

Response:

The “generic” observations (SLA, SST, Argo) were also assimilated during the spinup period. This point is highlighted in page 9 l.11-12 “A spinup period of 9 days was imposed for all these data-assimilative simulations, during which only the generic observations were assimilated” , and illustrated in figure 7, were the timeline of the spinup and data-assimilative simulations is represented.

Reviewer:

-P15 line 17: "The domain localization approach guarantees that the assimilation of dense profile observations from gliders and CTDs over a reduced area does not degrade the results over the whole modelling domain". Please repeat also here what the "domain localization" procedure/alghorithm do. PLease also show somewhere the impact of such procedure on the whole modelling domain (for instance by showing some sensitivity test to the chosen radius)

Response:

We have extended in Section 2.3 the explanation of the domain localization approach used in this study. We also add here some pictures from sensitivity tests that were performed to illustrate the effects of the localization. Figure 1, from this review, shows the temperature fields at 50m depth of two experiments assimilating CTDs with 200 and 40km of localization radius respectively. The proper description of these effects would require a dedicated study. We think that this aspect remains out of the main scope of the paper and decided not to include these figures in the manuscript.

Reviewer:

-p17 line 7-9 " In this study, the CTD initialization survey results in a similar forecast performance after data assimilation as an 8-glider continuous monitoring of the area flying along predefined paths with regular spacing": Please also specify that such "regular spacing" is the same as the meridional spacing of CTD sampling grid. This is important to be specified as it seems that the larger number of data (higher along trasect resolution) from glider data does not imply an improved ocean state description after assimilation, which on the contrary is "just" function of the maximum resolution of your grid (resolution is larger across transect than along transect). This would suggest of course that CTD sampling would benefit by an equally spaced grid, and that probably glider data assimilation would benefit a finer maximum resolution (that could be able to catch submesoscale you observed to be smoothed by your system).

Response:

This is a very interesting point. A sentence has been added in the discussion: “It should be highlighted that the meridional spacing in the case of the 8 gliders fleet is the same as for the CTD casts (10km). The improvement provided by the higher spatial resolution offered by gliders in the zonal direction might be limited by the spatial resolution of the model, which do not allow to ingest the very fine-scale features observed by the gliders. In that sense, it is likely that glider data assimilation would further benefit from an increase of the model resolution.”

Reviewer:

-p18: Adaptive sampling procedure (finalized to assimilation) would probably lead to better description of some specific features BUT with the limitations of what said here above, i.e. limited (in resolving features) by the maximum resolution of the sampling grid in a given area (combined with the resolution of the model itself).

Response:

These limitations have been added in the text.

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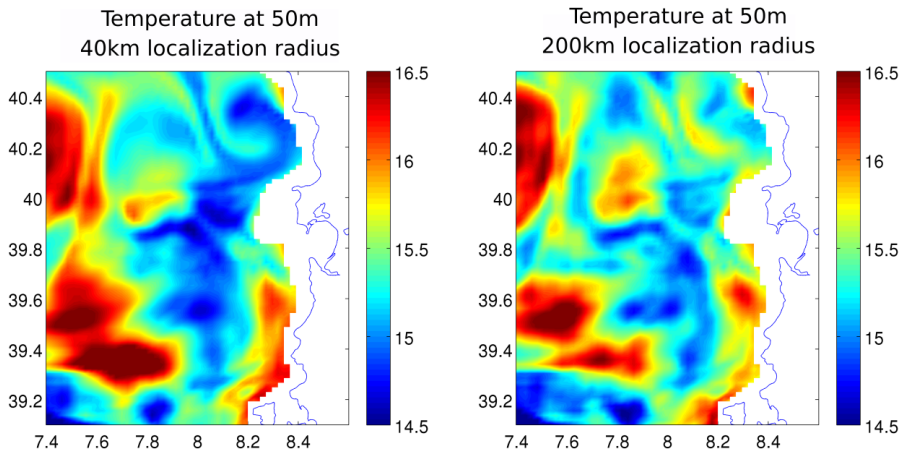

Fig. 1. Temperature fields at 50m depth for two different experiments assimilating CTDs with a localization radius of 40km (left pannel) and 200km (rigth pannel)