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Discussions

Interactive comment on "Impact of SLA assimilation in the Sicily Channel Regional Model: model skills and mesoscale features" *by* A. Olita et al.

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Dear Editor,

first of all we would like to thank the two referees for pointing out some important issue.

Here follows the Reply (R:) to each question (Q:) raised by the two reviewers.

The revised manuscript will incorporate the following corrections.

Reply to Referee #1:

General Comments:

Q: The ms topic is important for improving the sub-regional ocean forecasts by using the SLA assimilation and the validation with limited in-situ data.

However, there is not clear indication what is the effect of the double assimilation of the SLA, taking into account that the parent MyOcean MFS regional model providing the initial and lateral boundaries already assimilated the same data.

R: This is the most important issue pointed out by ref.#1. Actually we miss to discuss this specific question, that we found very interesting and still object of discussion by the scientific community, as not many papers deal with this argument. We will add some lines of discussion in the Methods section about the problem of assimilating "twice" the same data, pointing out this specific issue and citing appropriate references.

Actually the data are not assimilated twice over the entire model domain, with the exception of the first day: the regional model is initialized only once at the start of the two-years integration.

At the boundaries, the coarse model fields actually already assimilated the same data, but, as shown by Vandenbulcke et al. (2006), this is absolutely not sufficient to allow one-way nested regional model to mantain this signal nor to describe small structures that can be only resolved by the high resolution model.

In other words, the signal contained in the boundaries, if the domain is big enough, cannot be transferred throughout the domain, more and more as it concerns meso-scale and sub-meso-scale features that are not properly resolved by the coarse model. The conclusion of Vandenbulcke et al. (2006) supports this fact, as well as our results showing improved performances of the analyses vs freerun.

So, replying to the answer of the referee, the effect of the "double" (that is not really double with the exception of the boundaries region) assimilation is that the reg-model is improved.

Further, the boundary conditions for regional analyses or re-analyses are always

provided by models that ASSIMILATE data. So, once shown that without assimilation (even if the assimilation is performed by the parent model) the regional solution is worse, the choice is in any case to assimilate those data (for one-way nesting schemes).

Another solution, applied by Vandenbulcke (2006) was to run togheter the coarse and regional model performing a two-way nesting, assimilating only data in the regional model.

This last solution, at present, cannot be applied in our specific implementation, as the coupling is offline and one-way. However it could be matter for future studies and tests.

Specific comments:

Q: line 17, replace references...

R: Reference has been replaced with two references of Astraldi et al (Gasparini co-author).

Q: Page 424 Line 20: clarify if indeed the SIM simulations refer to the operational system of SCRM. Also clarify the difference between ANO and AN1, respectively those between V0 and V1 MyOcean products, because is not clear at this paragraph.

R: The SIM simulation is an "ad hoc" experiment with a setup similar to the operational one. Concerning the difference between experiments we tendencially would accept another suggestion of the referee (see below) about using the SIM and AN1 experiments, removing AN0 from the paper (as AN0 is incomplete and not comparable with in situ data).

Q: Page 425 Line 21: please clarify if indeed the SCRM use the 6 hourly ECMWF and not the 24 h averaged.

R: THe SCRM actually uses 6-h fields, as already specified in the text.

Q: Page 427 2.3 Data and analysis The MFS data used for initialization and for lateral

conditions in the present work already assimilated the same SLA. .....snip.....

R: This issue has been already pointed out in the "general comments".

Q: Page 427 Propose to use SIM and AN1 experiments, due to the fact that in ANO the time series data is not complete and there are missing data.

R: We agree with the referee: the paper should not loose its core by removing the AN0 experiment. The effect of assimilating coastal observations (the reason why V0 dataset, containig no coastal obs, has been used) would deserve more space and a separate manuscript. The removal of AN0 will also improve the readability of the paper.

Q: Page 429 From line 16: If the reasons for the V0 worse performance caused by the fact that the Vo SLA is of less precision and of less spatial coverage? Then why the need to compare and use these data of less quality??

R: The V0 data are just a previous release (a different reprocessing version) of the same SLA dataset than V1. So the "quality" of V1 is just supposed to be better , above all because presence of coastal observations, but this has to be demonstrated. Further, for assimilation purposes, a given dataset X1 could give better results than X2 even if the "quality" of X1 (in terms of rmse with in situ) is worse, for example because X1 retains more physical information in respect to X2 due to different filtering and corrections. This for assimilation purposes. In any case, as in the reply above, we will remove the V0 experiment from the revised version of the paper. We will mantain the core of the present manuscript that is showing the impact of SLA assimilation at regional scale, as in the title.

Q: Page 430 From line 10: please clarify how the assimilation of SLA provide a better definition of the AW path??

R: This is an evidence of the results: AN1 shows the AW signatures in salinity better fitting the AW signatures observed by satellite than SIM. This is because, at regional scale and in this specific domains, the corrections in SLA are mainly related to pres-

ence/positions of (anti-)cyclonic structures that interact (or are related) with AW in different ways: Anticyclenes are continously generated by baroclinic instabilities of the AC, that transposrts the AW eastward. Further, as shown for example by Sorgente et al. 2011, even small sub-mesoscale features can be responsible or can co-operate for the several branching that the AW encounters along its eastward path. Finally, the AW transported eastward by AC, ATC and AIS, as it flows along continental shelves, has its own altimetric signature that can be subject to corrections performed by the assimilation system.

Q: in several pages in the entire ms: use capital for Mediterranean

R: Changed in the revised version.

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Reply to Referee #2:

General Comment:

Q: The subject of assimilating altimetry in regional models, and the impact it will bring, is a difficult one. The results presented in this paper are modest, but they deserve publication. The presentation quality is not always good (spelling, color bar not always

labelled in figures). In addition the text is a bit verbose and technical, especially with respect to its contents: either it should be more concise, or it should contain more science.

The introduction presents the important role of the SC in the Mediterranean, especially regarding the exchanges of water masses between E and W basins, and the role of

eddies in transporting mass. I would have expected to see the success of data assimilation in the light of this. is the resulting transport more consistent to what is known?

I know that this is ambitious, but in my view this should probably be the ultimate test of using DA here.

R: Replying to the question here above contained, we agree with the referee that more science could be contained in the paper, in particular ad analysis of the transport through the channel and its relation with mesoscale processes. The main problem in accomplishing such an analysis is to validate or at least evaluate the results. In any case we think, as the referee suggests, that this analysis deserves to be made even if ambitious. As suggested in the last comment, we will analyse eddy and mean flows and the mass transport to understand how assimilation of SLA can influence the dynamics in quantitative terms.

Specific Comments:

Q: page 424 lines 1-2: SLA is certainly not the most effective data for assimilation *at the regional scale*. See what is done in IOOS regions for instance.

R: The sentence has been changed as follows: "Satellite SLA are one of the most important data (togheter with satellite SST and in situ profiles) today available for assimilation in ocean numerical models".

Q: page 425 para 2.1: I am wondering if something is done to match the steric cycle in the model and the one contained in V0 and V1, over the modelling domain? Also page 429 I would have liked to see average misfits to estimate the amount of bias remaining in the RMSE

R: The steric signal is present in the AT satellite SLA, while the model does not modellize it. In the analysis cycle, when we calculate misfits we remove the misfits average from the satellite SLA tracks to remove the steric effect. We agree with the referee concerning the need of plotting the bias: we added the BIAS time series to the revised figure.

Q: page 429: Is the obc scheme hindering the effect of assimilation in the domain interior? Does it allow modifications in the net mass transport through the channel?

R: The obc scheme partially hinders the effect of the assimilation near the boundaries,

as it constraints the NET transport: this could partially influence transports also in the domain interior. In any case the assimilated eddies show their impact in transports in areas far from the boundaries, for example at the Tunisia-Sicily Strait, even in NET transport over short time scales. Further, only the NET is constrained at boundaries, so Eastward and Westard component can change significantly once the NET is conserved by the obc constrain above cited.

Q: page 429 line 1: Is this an overall RMSE in time? Or an overall bias? Unclear.

R: This is an overall RMSE in time.

Q: page 431: It would have been nice and to the point to see estimates of the changes

brought by "assimilated" eddies onto the mass transport and/or to the eddy/mean flow interactions (Reynolds stresses).

R: as previously pointed out, we will provide, in the revised paper, an estimation of transport and/or eddy-mean flow interactions for both SIM and AN1 experiments.

Q: page 432 para 1: How about adding a theta-S constraint in 3DVar?

R: A T-S constraint is actually present, as it is represented by the vertical EOFs describing vertical covariances among state vector variables.

Interactive comment on Ocean Sci. Discuss., 9, 421, 2012.