Ocean Science
Discussions

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Interactive comment on "Impacts of mean dynamic topography on a regional ocean assimilation system" *by* C. Yan et al.

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The manuscript describes and explains the impact of different MDT used for assimilating altimetry data in a data assimilation system covering the Pacific and Indian Oceans, concluding that using a long-term mean SSH calculated from an assimilative experiment with the assimilation of hydrographic profiles provides better results.

I found the article well written, clear and concise, and I believe the topic is of interest for the data assimilation community, especially because data assimilation procedures require an MDT consistent with the analysis system itself, which is usually neglected when gravimetry derived MDTs are built. However, I found in my opinion a major weakness in the experimental design, therefore I recommend the manuscript for publication only after having fixed the issue (see below).

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General points

I believe the way the authors use the Rio et al. (2009) MDT, so called MDTOBS, is not correct or at least unfair. In facts, the MDT is defined as the elevation of the mean sea surface with respect to the Geoid. The Geoid is the gravitational equi-potential surface: it is defined for less than a reference height, i.e. a reference height for the Geoid (e.g. its spatial average) cannot be unambiguously determined. The authors use the Rio et al. 2009 MDT as it is, and it shows an offset of 0.80 m with respect to MDTMOD, MDTTS. This offset is completely artificial and should be removed before using MDTOBS, for instance imposing that the weighted spatial mean of MDTOBS is the same of MDTTS, i.e. subtracting 0.78 m in every point from MDTOBS and then using it. It is important to note that the Rio et al. (2009) MDT is defined without any constraint on the global mean, its global mean being in facts a meaningless number. Neglecting this, the authors use an MDT with an unrealistic offset. Being the offset positive, as the authors explain well, the data assimilation system quickly adjusts to the MDT, the sea level rises and there is subsequent temperature increase. I believe that this is an artifact. Temperature RMSE of up to 10 degrees Celsius are not realistic. I recommend the authors to adjust the MDTOBS in order to cancel the artificial offset and rerun the experiment. I expect results qualitatively similar but quantitatively very different. The way E_MDTOBS experiment is designed at the moment does not allow any strong conclusion on the performance of MDTOBS wrt MDTTS. By construction E_MDTOBS has too negative skills, and conclusions cannot robustly be drown.

A: Thanks for your comment. The MDTOBS is recalculated by removing an offset such that it has the same spatial mean as the MDTTS. Moreover, the related experiments are rerun. The results are shown in the manuscript.

Specific points

P1085L15: Not only to avoid the need for an uncertain Geoid: by construction the satellite measures the distance from sea surface to satellite, which in turns, by know-

ing the ellipsoid, gives distance between sea surface and ellipsoid, regardless of any underlying Geoid.

A: Thanks for your comment. This related sentence is modified.

P1086L19: Interesting to specify the coupling method (bulk formula?)

A: Thanks for your comment. In P1086L19, the related sentence is "The HYCOM is forced by the 6-hourly fields from the ERA-interim, including temperature, dew point temperature, mean sea level pressure, and wind." Only an ocean model HYCOM, instead of an coupled model, is used. I am sorry not to understand the coupling method you mentioned. Could you please explain this comment?

P1087L5: Interesting to specify how Equation (1) is solved (iteratively? Analytical local solutions?)

A: Thanks for your comment. The equation (1) is solved by an local analysis algorithm. The detailed analysis implementation is given by Evensen (2003). Evensen, G.: The Ensemble Kalman Filter: Theoretical Formulation and Practical Implementation, Ocean Dynamics, 53, 343-367, 2003

P1088L7 and later: Please specify which version of ENSEMBLES is used (EN3v1, v2 ??) and which version of AVISO is used. For the latter, please note that the last version defines SLA as anomaly w.r.t to 1993-2012, while previous versions w.r.t. 1993-1999. So it is important that authors specify the version and the period with respect to which anomalies are computed, because it is relevant for the MDT estimation.

A: Thanks for your comments. The EN3 (version 2a) is used. For SLA data, the previous version is used in which the anomaly is computed relative to the time average over 1993-1999. Moreover, it is specified in this manuscript.

P1088L14: Since in data assimilation usually along-track SLAs are assimilated, rather than mapped SLAs, the authors should justify this choice.

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A: Thanks for your comment. Compared with along-track SLAs, the mappled SLAs have a wide and homogeneous coverage. It avoids the effects of the sparse or non-homogeneous distribution of SLAs on the assimilation, and highlights the effects of MDTs.

P1090L27: where the "Argo observations" used for verification (Figures 3 and 5) come from? Is it a special dataset? Objective analyses?

A: Thanks for your comment. The Argo observations also come from the EN3 version 2a.

P1092L22: please explain what do you mean for "independent observations that were not assimilated": which observations are you talking about? How many?

A: Thanks for your comment. Not all observations are used for assimilation. We select a good profile from the observations falling in each 3×3 model grid bin for the assimilation. The selection order is as follows: first an ARGO profile, then CTD, then TAO, and finally XBT/MBT. In the model domain, there are about 11000 profiles which are not used for assimilation.

Technical points

P1084L1: "An ocean DATA assimilation"

A: Thanks for your comment. It is modified.

P1087L14: I believe A should be defined as the "ensemble anomaly" or "difference between ensemble members and the ensemble mean", NOT as just an ensemble.

A: Thanks for your comment. You are right. A is represented by the difference between ensemble members and the ensemble mean. The sentence is modified as "A is an ensemble anomaly"

P1089L6: "distribution" ? Maybe simply "maps" sounds better

A: Thanks for your comment. It is modified.

P1092L12 "whether the"

A: Thanks for your comment. It is modified.

P1093L22: change "regardless" to "for both"

A: Thanks for your comment. It is modified.

P1094L13: "assimilation-run-derived" => "assimilation-derived"

A: Thanks for your comment. It is modified.

P1094L23: "assimilation run"

A: Thanks for your comment. It is modified.

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