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Ocean Science Discussions

Interactive comment on "Implementation of position assimilation for ARGO floats in a realistic Mediterranean Sea OPA model and twin experiment testing" *by* V. Taillandier and A. Griffa

Anonymous Referee #1

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Comments on "Implementation of position assimilation for ARGO floats in a realistic Mediterranean Sea OPA model and twin experiment testing" by V. Taillandier and A. Griffa

"General comments" ———————— The subject of this manuscript, which concerns the assimilation of ARGO float positions, is quite interesting and brings new elements for data assimilation and the reconstruction of the ocean state. Through commonly used twin experiments, the aim of the manuscript is to quantify the potential of float position data to constrain the state of a realistic configuration of the Med Sea containing mesoscale features.

Some specific comments should be answered before publication.

The manuscript is usually easy to understand. Some comments are listed below that should improve the presentation/clarity of a few points.

"Specific comments" ————————-

Concerning the methodology:

*** section 2.1: The assimilation method produces a velocity correction "Delta u(z_rho)" at the parking depth at the initial time (state of the art) or at the final time (operational mode). This correction is then projected on the vertical axis to provide a correction over the whole water column. An operator is applied in order for this velocity correction to: - conserve the basin volume - be non-divergent Reading (page 261;lines 9-11), the depth integrated velocity correction "Delta U" is changed from equation 2 to equation 3: "..."Delta U" is further imposed to be non-divergent and re-computed from the diagnostic stream function...". For the sake of reproduction/traceability of results some technical details should appear concerning the way the basin volume is enforced and how the flow stays non-divergent.

*** section 3.2: This should be actually a minor comment (but since it is just a guess...): there is no information about what is the "wrong" initial condition. My guess is that all the model state variables (temperature, salinity, meridional and zonal velocities) are perturbed ("wrong"). If only velocities were perturbed, the study would lose most of its interest. So provide some details.

*** section 3.2: Is the "background" integrated from the initial conditions of 1 March 2000 AND forced by fluxes corresponding to the month of March 1999 ? ("...evolve according to forcing and dynamics" is not accurate enough).

*** section 3.2: I am not sure to clearly understand what is a "perfect" data compared to the "realistic" data; especially when looking at figure 2. As I understood from the text, a perfect data position is given by: - the float position at which a float starts drifting

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at its parking depth after its dive - the float position at which a float stops drifting at its parking depth before starting its upcast

In realistic condition, those positions are not known. An Argo float is positioned after it surfaces (say typically a couple of hours between it surfaces and the first satellite localisation). Then the float is advected by surface currents for 4-6 hours to transmit its data; it is still positioned. The last position is known a couple of hours before the dive starts. Hence "shear errors" is composed with: the accumulated drift from the parking depth to the surface + surface drift before the first position AND surface drift after the last position + accumulated drift during the descent to the parking depth.

Looking at Fig. 2, we get the impression that the "realistic" position is taken in the middle of the surface drift, which probably overestimates the "shear error", especially because surface currents are more intense than subsurface ones. Some clarifications on this "shear error" should be given on Figure 2 and the related text. Also a quantification of the "shear error" should appear somewhere in the text (depending on the kinetic energy of the region).

*** section 3.2, page 266 line 20: I do not understand the following: "In order to minimise the effects of initial conditions, in all cases the homogeneous release is maintained". What is the “homogeneous release” ?

*** section 4.1, Fig. 4: Why does the adjustment error do not start at 100% with the procedure "state of the art" ? Why is the correction done at days 2.5, 7.5, 12.5, ... ? I expected a first correction at day 5, and then at days 10, 15, 20, 25, 30 since a sequence is 5-day long (starting at 100% at day 0, that is day 1, 00h". Did I miss anything ? Clarify.

*** section 4.1. State in the text that what is shown is the estimate at the end of the last sequence (it is written in the legend only).

*** Despite temperature and salinity fields are corrected for thermal wind shear, I guess an adjustment phase still exists between the velocity field and the tracer field at the beginning of the integration starting from corrected fields. Could the authors comment on this since is if often a problem for operational data assimilation ?

*** section 4.2, page 269, line 17: I guess that "the passive relaxation" refers to the natural adjustment between velocity/tracer fields when integrating the model. The term relaxation is often used to relaxation terms added to the model prognostic equations, I was somewhat confused by the terminology.

*** section 4.2, page 271: it is stated here (and also in the next sections) that the estimated surface fields are similar to the truth. I was wondering whether the surface forcings (plus relaxation to temperature and salinity at the surface if it exists in this configuration), that are perfect, may by themselves also lead to improvements in the surface properties/circulation. Indeed, "wrong" conditions are those of March 1, 2000. If you apply the true forcing fields (wind, heat, E-P and may be some T&S surface relaxation) that correspond to March 2000 to those "wrong" initial conditions, then the first levels of the model will probably have the tendency to converge to the true state without any assimilation during the time integration.

*** section 5, p272: Again, a quantification of the "observational error" produced by the "shear drift" (in the model!) would help to convince the reader for the discussion that starts line 21: "This different behaviour..."

*** section 6: Discussion - points to add

- The exercise is repeated for a month. What happens when the procedure is cycled for a year ? Is there a convergence to the true state ? Some corrections of the model state are due to wave propagation. It may appear that, with time, small scale propagating corrections generated by some data assimilation lead to a sea state that regionally diverges from the true state. Can we expect such behaviour when the process is cycled for a longer time period ?

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- More fundamentally, in this manuscript, temperature and salinity corrections are produced from corrections of the velocity fields to obey the thermal wind shear equilibrium. I am somewhat surprised that the author do not use the vertical profile of temperature and salinity measured by ARGO floats (surface-2000m). Why are they not used ? Is there any inconsistency with the thermal wind shear they used ? Does the use of such measured T and S profile helps to improve the assimilation of float position ?

- As far as I know, the ARGO network should not exceed (unfortunately) a resolution of one float per 3 x 3 degree (lat x long). That means 3 to 4 floats in the Med Sea region considered here. Furthermore, positions of ARGO floats deployed in the world oceans are known once every 10 days (not once every 5 days). Reducing the number of floats significantly decreases the performance of the method as shown on Figs 9b and 10. We still have a few improvements however and maybe that cycling the assimilation on a longer time would help. But, what would be the impact of reducing the frequency of positions to one every 10 days with such a low float density ? I guess the answer if of interest...

Other points:

"Technical/minor corrections" - clearly state in section 2.1 that the velocity correction "Delta u(z_rho)" at the parking depth is done at each (x,y) horizontal grid point no matter a float position is available at (x, y).

- section 2.2: If I am right, remind the reader that the prior state is either the oceanic state at the initial time (state of the art) or at the final time (operational mode).

- section 3.1: while referring to the ARGO floats in relation to MFSTEP (page 264; line 11), a useful information would be to give the effective number of floats deployed in the region.

- section 3.2, Eq. 8: in this equation "t" is the final time-step of a given sequence, right ?

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