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Ocean Science
Discussions

Interactive comment on "Variational assimilation of Lagrangian trajectories in the Mediterranean ocean Forecasting System" *by* J. A. U. Nilsson et al.

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Reply to Anonymous Referee #1 OSD 8, C878-C881, 2012.

Specific comments

1-2) The reviewer ask whether the drifter and Argo data are assimilated at nominal depths or at integrated depth intervals. A description of the Lagrangian trajectory observational operator is requested.

Answer 1-2) The Lagrangian data assimilation of the observed trajectories is performed at their respective 'parking depths', that is, at 15m for the drifters and at 350 m for

the Argo floats. There is no comparisons to vertical average values of the velocity fields. The introduction of velocity-field corrections at 15m and 350m depth can, thereafter, influence the characteristics of the nearby waters through the linear operators in the 3DVAR background covariance matrix. A brief description of the construction of OceanVar and the trajectory model in the observational operator will be provided in an Appendix, as suggested by the referee.

3) The manuscript fails to clearly state the applied observational errors of the Lagrangian data sets, and in particular how the error related to the drifter positions was estimated.

Answer 3) The text on pages 2507-2508 dealing with the instrumental and representativeness (observational) errors will be rewritten in a more comprehensive manner.

Sensitivity tests had been carried out for 1000-m, 3000-m, and 5000-m drifter observational errors, but these were not described in the manuscript (this could be added). In the first test, where an error related only to the instrumental uncertainties (1000 m) was applied, OceanVar failed completely to converge towards the observations. Increasing the error to 3000 m OceanVar proved capable of minimizing the cost function, however, suffered still from convergence problems with increased cpu time as a result. The results obtained from this experiment were promising and similar to those presented in the manuscript (in terms of RMS misfits). Finally, the model experiment applying a 5000-m observational error yielded stable OceanVar solutions, with slightly improved ocean forecasts and reduced cpu time compared to the "3000m-experiment".

The apparent need for a larger observational error in the near-surface velocity field would be due to the inherent non-linear small- and meso-scale dynamics of the upper ocean circulation, compared to the relatively slower velocity fields at depth (showing less "smaller" scale features). The eastern Mediterranean surface circulation is dominated by a highly variable meso-scale eddy field and the meandering Libyo-Egyptian current system, which make accurate velocity-field predictions a most challenging task.

The dispersion in the Mediterranean Sea surface layers was studied by Pizzigalli et al., 2007, in the framework of comparing drifter observations to corresponding synthetic trajectories from a Lagrangian model (off-line integration of the MFSPP MOM model). They investigated the seasonal dispersion variations and calculated also "climatological" (2000-2004) dispersion estimates (cf. Table 1). Due to their results, the basin-average autumn (Oct-Dec) dispersion after 1 day can be approximated to 25+/-15 km. It is worth pointing out that the OGCM in our study is more advanced than the previous operational system based on MOM, thus the output presented here should decisively be more accurate, however, the estimated 1-day dispersion of $\sim$25 km could serve as an upper limit for the representativeness of the surface fields in the Mediterranean Sea during fall.

In this context, the application of a 4.9 km representativeness error yielding a total observational error of 5 km, would seem in its order and well below the "maximum dispersion limit".

The 2000-m observational error applied for the Argo float positions resulted from sensitivity tests that were performed and presented in Nilsson et al., 2011.

4) Drifter assimilation is capable of decreasing (and improving compared to observations) the IP gyre depth.

Answer 4) Thank you for this remark, in fact you're right, I will elaborate on this further on page 2513.

Technical and Typo Corrections

I agree on all comments, and will revise the manuscript accordingly.

References

Pizzigalli et al., 2007: Seasonal probability dispersion maps in the Mediterranean Sea obtained from the Mediterranean Forecasting System Eulerian velocity fields, Journal of Geophysical Research, Vol. 112, doi: 10.1029/2006JC003870.

Interactive comment on Ocean Sci. Discuss., 8, 2503, 2011.