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Ocean Science Discussions

Interactive comment on "Study of the combined effects of data assimilation and grid nesting in ocean models – application to the Gulf of Lions" *by* L. Vandenbulcke et al.

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We wish to thank the Anonymous reviewer for the many constructive remarks and comments. Changes will be made in the submitted article accordingly. We would like to briefly answer each of his specific comments here as well.

page 298 line 25: the EOFs are multigrid and calculated over all the grids at the same time in a single operation. This will be specified in the text in a more detailed manner. The list of approximations made to build the model error covariance matrix P will be given in the text at the beginning of the paragraph, before developping each of them in detail. In Fig 5, the legend says all panels are related to the first 3D multigrid multivariate EOF.

page 299 paragraph 1: the two limitations will be stated clearly and explicitly at the begining of the subsection (see previous comment).

page 299 paragraph 3: Why not include the velocity (U and V fields) in the state vector for data assimilation? Our experience showed (in our own simulations) that it was often very difficult to obtain good covariances between T,S and elevation fields and the velocity field. Therefor, we did not trust the assimilation procedure to update the velocity based on T and elevation observations, and we choose to only correct velocities with currents in geostrophic balance with the T,S,elevation correction. It is true however that the error on current velocities may have a non-geostrophic part. We feel that by getting the P matrix by a more adequate method than from a historical run, we might have captured the correct covariance between all 5 variables (T,S,elevation,U,V) and hence it would have been interesting to include U and V in the state vector.

page 300 paragraph 3: about adding random errors to the observations consistent with R. Unfortunately, we did not add those random errors in our simulations. It is known that this leads to a too strong reduction in variance. Adding this noise to the observations would have added a supplementar stochastic variance to model SST and SLA, and thus to the resulting RMS curves. The RMS error measure is a filter, thus it already filters (part of) this stochastic signal. The study area (Gulf of Lions) being relatively small, there is a risk that the RMS still contains a part of the random signal, which could further be eliminated by an "ensemble" of twin experiments (prohibitive for us, due to numerical cost).
Furthermore, we represented the observations error matrix by a diagonal matrix. It is known that this matrix contains different contributions, at least some of them being not diagonal (i.e. the representativity error). Thus, adding noise consistent with a diagonal R matrix would still be an approximation – even less crude than not adding noise at all. In any case, not adding noise to the observations is an error which we think affects all of the study cases (1 to 5) in a similar way, and does not change the qualitative comparison between the different test cases.

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page 303 lines 8-10: corrections made in the coarse-resolution grid do not have a very significant impact on the boundary conditions of the fine-resolution grid, hence on the fields inside the latter grid. In any case, this impact is smaller than a direct correction inside the fine-resolution grid. Only if the coarse-resolution grid fields would be very different from the truth (with respect to the error covariances), then it would be important to correct the fields in the coarse-resolution grid. This is indeed a main result of our work. We will try to reformulate the corresponding sentences in order to emphasize this more.

The text and figure will also be adapted and improved according to all the minor comments and typos. We will add a short overview of previous atempts of two-way nesting. Specifically about some of the comments:
-page 295 line 3: the closure scheme is a k (turbulent kinetic energy) closure. It requires to specify some characteristic length l. All details about it can be found in the cited article (Nihoul 89).
-page 297 lines 3-4: we use ... climatology: in all the grids
-section 2.4: the first internal Rossby radii in the Gulf of Lions are indeed consistent with the estimates given in the section describing the study area.
-page 300 section 3, we will explain better, and from the start of the section, what we call "control run" and "free run" (wrong initial conditions, wrong atmospheric forcing). Indeed there is a natural tendency for the SST RMS error between the free run and the control to decrease in time. This is due, in our opinion, to the fact that SST tends to an equilibrium with the atmosphere. It seems that perturbing the air temperature and cloud coverage leads to similar equilibrium states as the control run. Only during the last part of the simulation does the free run SST again departs from control run SST. In the corresponding graphic for SLA, the RMS error between free run and control run is increasing most of the time. This is because the principal variability source for SLA comes the LPC current, which possesses variability due to processes such as baroclinic instabilities and formation and propagation of eddies; they have a more chaotic nature.

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-page 309 middle panel: 0° means eastwards, 90° being to the North (this will be added in the figure legend).

Interactive comment on Ocean Sci. Discuss., 3, 291, 2006.