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Local assimilation of sea surface temperature and elevation in a two-way nested model of the Gulf of Lions, using a single multigrid state vector

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A three fold nested model is built, covering (a) the Mediterranean Sea (resolution 1/4 degree) (b) its North-Western part (resolution 1/20 degree), and (c) the Gulf of Lions (resolution 1/100 degree). The GHER hydrodynamic model (see e.g. [1]) is used for a simulation of the springs of 1997 and 1998. As the model allows mode splitting, the timestep in each grid is 3 seconds for the barotropic modes, and 3 minutes for the baroclinic modes. ECMWF atmospheric forcings and MODB4/MEDAR climatic data are used. This simulation is run with one-directionnal and bi-directionnal nesting (i.e. without and with statevector feedback), and results are compared.

The output of the 1997 and 1998 simulations (3D temperature and salinity fields, and sea surface elevation field) are then used to build 3D multivariate EOFs over the 3 grids alltogether. This guarantees perfect correlations between points from different grids, that are physically at the same location.

The following twin experiment is then set up. The simulation from 1998 serves as a control run. A delayed state of this run, serves as initial conditions for the perturbed run. The first 40 EOFs are used to build a reduced-rank model errorspace. Sea surface temperature and sea surface elevation from the reference run, physically located in the Gulf of Lions, are then assimilated in the perturbed run, using a reduced-rank optimal interpolation assimilation scheme. A previous experiment showed non-physical long-range corrections (far outside the Gulf of Lions); these corrections are removed by multiplying the corrections with a radial Gaussian function centered on the corresponding observations. The multivariate statevector ensures corrections are made to temperature, salinity and sea surface elevation fields. Using the corrected fields, the geostrophic equilibrium is used to calculate corrections to the velocity field.

In this above twin experiment, observations are assimilated all at once in the 3 grids since a single statevector is used. The results are compared to classic approaches where each grid has a corresponding statevector, and observations are assimilated in a single grid (or in different grids separately).

Finally, ongoing research about statistical predictors is presented. Indeed, primitive equation models are too costly to evolve the errorspace in time, even when reduced-rank assimilation schemes are used. Statistical methods aim to replace the hydrodynamic model by a much faster method, that would then be used to evolve in time each of the directions of the errorspace, or alternately, the members of an ensemble method. Statistical methods need to be trained on real results; they are thus first tested on the model itself rather than on the errorspace. Preliminary results are presented.

References:

1. Beckers, J.-M., 1991. Application of a 3D model to the Western Mediterranean. *Journal of Marine Systems, vol. 1, 315-332*