DATA ASSIMILATION IN A TWO-WAY NESTED MODEL OF THE LIGURIAN SEA

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Abstract

A two-way nested model is applied to the Mediterranean Sea. The model grid is refined twice in order to achieve a 1/60° resolution grid of the Ligurian Sea. Sea surface temperature , sea surface height and CTD profiles are assimilated in this nesting system. The assimilation scheme is multivariate (temperature, salinity and surface elevation) and multi-grid, i.e. all nested models are assembled into one state vector.

Keywords: data assimilation, nested models, Ligurian Sea

The GHER 3D primitive equation model is implemented with three different resolutions: a low resolution model (1/4°) covering the whole Mediterranean Sea, an intermediate resolution model (1/20°) of the Liguro-Provençal basin and a high resolution model (1/60°) simulating the fine mesoscale structures in the Ligurian Sea. Boundary conditions and the averaged fields (feedback) are exchanged between two successive nesting levels. Further explications can be found in Barth *et al.* [1].

The nesting system is coupled with a reduced order, optimal interpolation data assimilation scheme. The state vector is composed by temperature, salinity and sea surface elevation.

Novel in the present approach is that these variables from the three nested model grids are assembled to one multi-grid state vector. This implementation allows to take into account the correlation of the variables across the nested model grids in order to avoid for example artificial gradients after an assimilation cycle.

The eigenvectors of the covariance matrix are constructed by an EOF analysis of the free model run. Cross-grid correlations especially in the overlapping domains are thus consistently represented. Horizontal correlations over long distances are suppressed by multiplying each error mode with a set of radial Gaussian functions. This procedure increases considerably the rank of the covariance matrix but ensures the local impact of each observation.

Corrections for the velocity are obtained from a linearised geostrophy relation, except near the coast where the velocity correction is gradually decreased to zero.

Sea surface temperature (SST, from the DLR EOWEB), sea surface height (SSH, from the CLS) and CTD profiles (SIRENA cruise from SACLANT Center and cruises from the MEDAR/MEDATLAS database [2]) are assimilated into the model. In overlapping model grids the measurements are related to the highest resolution grid. Since the SSH has a resolution of 1/8°, the surface elevation of the Ligurian Sea and the Liguro-Provençal model are filtered in order to be coherent with the space scales present of the observations. The assimilation scheme works only with spatially uncorrelated observations. This assumption is not true for representative error of the SST with a resolution of 1 km. The weight of this data is reduced in order to take into account the redundancy of the data. Another approach tested is the creation of data bins of mean temperature in a small rectangle.

Starting from the 1st January 1998 the low and intermediate resolution models are spun up for 18 months. The initial conditions for the Ligurian Sea are interpolated from the intermediate resolution model. The three models are then integrated until August 1999. During this period SST, SSH and the CTD profiles are assimilated. The results are compared with a free model run. In particular the model forecast just before the assimilation step are compared with the observations. The model forecast and the measurements are then independent and the difference is a measure of the model forecast skill and the impact of the previous assimilation cycles. The validation procedure is detailed in Alvera-Azcárate *et al.* [3].

References

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