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A 3Dvar Assimilation Scheme Of Satellite Chlorophyll In A Complex Biogeochemical Model Of The Mediterranean Sea

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In the present work a 3Dvar assimilation approach is used for the assimilation of satellite surface chlorophyll concentration in a complex biogeochemical model of the Mediterranean Sea.
The OPATM-BFM biogeochemical model is composed by an advection and diffusion part (OPATM) and by a biogeochemical model (BFM), which accounts for more than fifty variables. The OPATM-BFM model has been already applied for hindcast and operational simulations of Mediterranean Sea at a resolution of 1/8°.
The 3Dvar assimilation scheme uses the methods for the error covariance matrix decomposition described in Dobricic and Pinardi (2008). In particular, the approach provides that the error covariance matrix is decomposed in a series of different operators (Vi), and that the assimilation solution is found in a reduced dimension space (control space). Then the solution for the state vector (biogeochemical variables) is obtained by the sequential application of the Vi operators. At the present stage the 3Dvar is used to correct the 3D field of the phytoplankton functional groups. The approach allows to implement new Vi operators, in order to increase the complexity and reliability of the assimilation scheme and to correct other state variables, and also to use new observed variables. This modular structure of the 3Dvar is a relevant benefit for the implementation of the DA in the framework of the application of OPATM-BFM biogeochemical model in the operational forecasting system of the Mediterranean Sea.
The available data for the biogeochemical assimilation consist of 5 days mean satellite sea surface chlorophyll concentrations, which are one of the MyOcean catalogue products (GOS – ISAC – CNR, http://gos.ifa.rm.cnr.it/).
In the 3Dvar application here described the propagation of the information from the sea surface to the three-dimensional field is a key aspect of the assimilation and it is realized by means of one of the Vi operators, named Vv. The definition of the Vv operator requires the evaluation of synthetic vertical profiles of chlorophyll concentration, wgich are given by Empirical Orthogonal Function decomposition. Sets of EOF synthetic profiles were calculated for each month of the year and also for different spatial subdivision of the Mediterranean Sea.
Preliminary tests of different configurations of the 3DVar elements and operators were used in order to optimize the assimilation scheme, then a run of sequence of 10 days forecasts and re-initialization via 3Dvar gave encouraging results. DA provides corrections both on basin scale model misfit with respect to satellite data and on local bloom events. Moreover, the application of the 3Dvar scheme provided correction on the basin scale overestimation of surface chlorophyll concentration, particularly in the Eastern Mediterranean Sea. At a local scale, the DA results show corrections on spatial localization and temporal evolution of typical bloom events in the Gulf of Lion (North West Mediterranean region). In this case the corrections are mainly related to the Diatoms dynamics, which is one of the four phytoplankton types of the biogeochemical model.
The results also highlight the need of an accurate analysis of the error estimation of satellite surface chlorophyll data, since high satellite values in areas with low concentration model forecast provide low effective corrections.

Dobricic, S., and Pinardi, N., Ocean Modelling, 22, 89–105, (2008).