3D MODELLING OF THE BLACK SEA NORTH WESTERN SHELF ECOSYSTEM

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Abstract

In the framework of the SESAME European project, a coupled physical-biogeochemical model has been developed to simulate the ecosystem of the Black Sea during the last decades. The biogeochemical model describes the foodweb from bacteria to gelatinous carnivores and explicitly represents processes in the anoxic layer down to the bottom. After validations of the model, equilibrium states from climatologic runs are presented, corresponding to identified key time slices. From them interannual run are studied to compare the interannual variability scales with those between different climatological equilibrium, for the different component of the ecosystem.

Keywords: Black Sea, Models

In the framework of the SESAME European project, a coupled physical-biogeochemical model has been developed to simulate the ecosystem of the Black Sea during the last decades when eutrophication and invasion by gelatinous organisms seriously affected the stability and dynamics of the system [1]. The biogeochemical model describes the foodweb from bacteria to gelatinous carnivores and explicitly represents processes in the anoxic layer down to the bottom.

For calibration and analyses purposes, the coupled model has first been run in 1D in the central Black Sea [2]. The biogeochemical model involves some hundred parameters which are first calibrated by hand using published values. Then, an identifiability analysis has been performed in order to determine a subset of 15 identifiable parameters. An automatic calibration subroutine has been used to fine tune these parameters. In 1D, the model solution exhibits a complex dynamics with several years of transient adjustment. This complexity is imparted by the explicit modelling of top predators. The model has been calibrated and validated using a large set of data available in the Black Sea TU Ocean Base.

The calibrated biogeochemical model is implemented in a 3D hydrodynamical model of the Black Sea (GHER). A first experiment is driven under climatologic atmospheric, riverine forcings and initials conditions constructed to correspond to three different time-slices: 60-70 (pre-eutrophication phase), 83-90 (severe eutrophication phase), 93-2000 (recovering). This experiment is conducted in order to differentiate the equilibrium states reached by the model for those different forcing sets. Resulting spatial and temporal variations in the annual cycle of the different species, as well as chemicals dynamics will be presented using representations and criticized.

A particular way of representation has been studied to reduce the dimensionality of the data at hands, making use of the Self-Organized Maps technology. We will present the basic principles of this method which automatically recognize self coherent regions in a temporal-multivariate way of speaking, allowing to gather in a single glance the gross annual dynamic of the entire model [3].

Then, inter-annual computations have been initialized from those equilibrium states. Physical dynamics can be accurately criticized in regards with circulation structures and thermo haline annual cycle, using processed sea surface satellite images, circulation features identified in literature and in-situ measurements. This allows us to assess a certain level of confidence attributable to the biological patterns observed in the results. This comes as a complement to what the scarcity of biological data allow us to directly criticize concerning their spatio-temporal correctness [4]. Inter-annual variability is then explored under the light of precedent analysis concerning the different equilibrium states.

During this study, a particular interpolation technique using the software DIVA has been used to reconstruct the 2D and 3D fields for biological data needed for initialisation of the model, and those that are used for visual comparison with the results. This kind of reconstruction, made tricky by the scarcity of data but nonetheless essentials to model study, will be given some minutes for presentation and the obtained results will be presented.

References

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