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Hindcast and Forecast of the Black Sea Ecosystem on the Basis of 3D Interdisciplinary Model

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3D interdisciplinary model was used to simulate evolution of the Black Sea ecosystem during the last three decades of the 20th century. The Black Sea marine ecosystem manifested significant changes during this period of time. Healthy ecosystem which was observed in 60-ies, early 70-ies was altered drastically by the impacts of many factors. Such an evident changes in marine biology of the Black Sea were accompanied by modification of the vertical geochemical structure. The most pronounced signature of the geochemical changes was an increase of nitrate concentration in the oxic/suboxic interface zone from 2 to 3 mmol/m3 in the late 1960s to 6–9 mmol/m3 during the 1980s and 90s.

The model of the Black Sea ecosystem is one way coupled with physical model and extends from the sea surface to 200m depth with 26 z-levels. The model includes 15 state variables. Phytoplankton is represented by two groups, typifying diatoms and flagellates. Zooplankton is also separated into two dimension parts: microzooplankton and mesozooplankton. The other compartments are carnivorous jelly-fish Aurelia Aurita and the ctenophore Mnemiopsis; omnivorous dinoflagellate Noctiluca; nonphotosynthetic free living bacteriaplankton; detritus and dissolved organic nitrogen. Nitrogen cycling is resolved into three inorganic forms: nitrate, nitrite and ammonium. Nitrogen is considered as the only limiting nutrients for phytoplankton growth. The geochemical part of the model is added also with oxygen and hydrogen sulfide.

Fulfilled numerical experiments on modeling of the Black Sea ecosystem dynamics managed to display the main features of the pelagic ecosystem evolution during three decades 1971 – 2001, which are known from numerous measurements. For example, the phytoplankton biomass grew during the time period from early 70s until early 90s, characterized the eutrophication phase of the Black Sea ecosystem. Surface concentration of the phytoplankton in the deep part of the basin increased during this time by about 3 times.

The ecosystem model was then used as a part of the Black Sea nowcasting and forecasting system, set up and developed in MHI in the framework of FP6 and FP7 projects. The further development or the Black Sea ecosystem model was its adaptation to the forecast problems, from which the most important one was initialization of the biogeochemical fields. A set of numerical experiments with assimilation of satellite chlorophyll-a data was carried out to elaborate the scheme of the Black Sea ecosystem forecast.