Simulation of Annual Plankton Productivity Cycle in the Black Sea by a coupled Physical-Biological Model

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The annual cycle of the plankton dynamics in the central Black Sea is studied by a one-dimensional vertically resolved physical-biological upper ocean model, coupled with the Mellor-Yamada level 2.5 turbulence closure scheme. The biological model involves interactions between the inorganic nitrogen (nitrate and ammonium), phytoplankton and herbivorous zooplankton biomasses, and detritus. Given a knowledge of physical forcing, the model simulates main observed seasonal and vertical characteristic features; in particular, formation of the cold intermediate water mass and yearly evolution of the upper layer stratification, the annual cycle of production with the fall and the spring blooms, as well as the subsurface phytoplankton maximum layer in summer. Initiation of the spring bloom is shown to be critically dependent on the water column stability. It commences as soon as the convective mixing process ceases and before the seasonal stratification of surface waters is developed. It is followed by a weaker phytoplankton production at the time of establishment of the seasonal thermocline towards the beginning of May. While summer nutrient concentrations in the mixed layer are low enough to limit production, the layer between the thermocline and the base of the euphotic zone provides sufficient light and nutrient to support the subsurface phytoplankton development. The autumn bloom takes place some time within November and December months; its period of development depends on the environmental conditions. In the case of weak grazing pressure to control the growth rate it is found that, once it commences, relatively high phytoplankton concentrations persist for the whole winter season. The system therefore may possess either a two distinct blooms (spring and fall) or one unified continuous bloom structure during November-to-March depending on variabilities in the oceanographic characteristics.

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ABSTRACTS