MODELING STUDIES OF THE GENERAL CIRCULATION AND BIOGEOCHEMISTRY IN THE BLACK SEA PERFORMED WITHIN THE FRAMEWORK OF RECENT INTERNATIONAL RESEARCH PROGRAMS

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A series of basinwide hydrographic surveys carried out during 90's as well as satellite imagery reveal a complex pattern of predominantly cyclonic, eddy-dominated basinwide circulation (Oguz et al., 1994). The Rim Current system flowing over the abruptly varying continental slope and margin topography all around the basin is a highly variable and dynamic entity with intense meanders, offshore jets, dipole eddy structures and ring formation events. The interior circulation exhibits a pattern of interconnected cyclonic eddies and/or gyres, varying in size and shape across the basin and with depth. Buoyancy-induced circulation due to the Danube River inflow dominates the wide shelf area on the northwestern part of the sea. Using the Princeton Ocean Model, relative importance of the wind stress, air-sea fluxes and lateral buoyancy fluxes in driving the general circulation non annual and monthly/seasonal time scales were explored by a series of numerical experiments (Oguz et al., 1995; Oguz and Malanotte-Rizzoli, 1996). These studies indicate that, under all forcing mechanisms, the overall basin circulation is characterized by a very strong seasonal cycle controlled primarily by the seasonal evolution of the surface thermohaline fluxes. The model circulation can be classified as a two layer system with vertical homogeneity in each layer. In the upper layer of about 150 m, the circulation pattern resembles that obtained by observations and dominated by mesoscale features. The circulation in the lower layer, below 300 m, consists of an elongated mildly meandering cyclonic cell over the flat interior of the basin. The shoreward side of this cell is covered by an anticyclonic recirculation zone which is wider and encircles the entire basin, as compared with the one in the upper layer.

A one dimensional, vertically-resolved, coupled physical-biochemical model was adopted to the central Black Sea conditions in order to simulate main features of the upper layer biogeochemical structure above the deep anoxic pool (Oguz et al. 1996, 1997). The model incorporates plankton productivity, organic matter generation, sinking and decomposition, nitrogen cycling (i.e. ammonification, nitrification and denitrification) as well as oxygen production and consumption. It consists of two groups of phytoplankton (diatoms and flagellates), micro, meso and macro zooplankton groups, detritus, ammonium, nitrite, nitrate and oxygen. Annual cycle of production with the fall and spring phytoplankton blooms in the mixed layer and subsurface production (between the seasonal thermocline and the base of the euphotic zone) during summer months are reproduced well by the model. Simulations indicate that strong stratification permits ventilation of water column to the depths of only 50-60 m even under very intense atmospheric cooling episodes. This part of the water column therefore exhibits efficient remineralization and nitrification processes. The recycled production in this zone is nearly about half of the total nitrate-based production. At poorly ventilated deeper levels, oxygen consumption leads to pronounced reduction in oxygen concentrations, reaching trace level values around 75 m depth within the central Black Sea. In the oxygen deficient part of the water column, organic matter degradation occurs via the denitrification, causing rapid depletion of nitrate stocks within the next 25 m layer. The total inorganic nitrogen then goes to a strong minimum near the oxic/anoxic interface zone.

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