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Hydrological regime of the Black Sea waters: numerical modeling

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The aim of the present work was to study the hydrological regime of the Black Sea basing on climatic temperature and salinity data massives and using numerical modeling techniques.
The climatic temperature and salinity data massives used in this research are based on measurements performed between 1956 and 1995. Measurements from each month of the year were averaged during this period and the averaged values were interpolated to a grid of 12' x 16' cells. To optimize the calculations monthly data were replaced by three-month running average at depths more than 400 m and by yearly averaged data at depths more than 1000 m. In order to improve the quality of the data a search for water density inversion was performed at every grid node.
The model used in this research is a mode split sigma-coordinate numerical ocean model developed at the University of Bergen. It is also known as the Bergen Ocean Model (BOM).
Monthly 3-D fields of temperature, salinity and current velocity were received as a result of modeling. In order to visualize this data maps of temperature and salinity distribution at different depths and sections were created. Quite good accordance of modeling results with the present knowledge on the hydrological regime and termohaline structure of the Black Sea was found.
The surface temperature values are higher in the southeastern part of the sea in all seasons. It is particulary evident in February, when the waters in the shallow northwestern region become extremely cold – down to 0 °C – due to strong heat exchange with the atmosphere and considerable river discharge. At the same time the surface water close to the Georgian coast is relatively warm, its temperature may rise up to 10 °C. The vertical distribution of water temperature is unique in the Black Sea due to the presence of the well-known cold intermediate layer, which exists from summer to autumn, and a gradual temperature growth from the depth of approximately 200 m and till the bottom. The bottom temperature is nearly the same in all seasons – approximately 9,1 °C.
The values of salinity at the sea surface are usually less near the coasts (16 – 17 ‰ than in the central areas of the sea (approximately 18 ‰ due to fresh water discharge and its further transportation by surface currents. A very strong surface salinity gradient is observed in May near the Danube estuary. The salinity values are growing with the depth. They reach their maximal values at the bottom of the sea – approximately 22,3 ‰.
The most significant surface currents of the Black Sea are the cyclonic Main Rim Current (MRC) running along the continental slope, several quasi-cyclonic gyres inside the MRC and quasi-static anticyclonical eddies between the MRC and the shore. The MRC is most intense in spring, its velocities may reach 24 cm/s at that time.