Features of the Black Sea general circulation emerging from recent surveys and climatological data

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Analyses of data from three different sets of basin-wide surveys (September 1990, June 1991 and September 1991) and other limited surveys along the Turkish coast (1987-1989) are combined with analyses of the climatological data to describe the Black Sea general circulation. It is shown that above 400 dbar, the main features of the Black Sea circulation generally agree with the traditional schemes of circulation, and appear to be persistent on a seasonal and interannual basis though modified in size, position and intensity.

The most conspicuous feature of the upper layer general circulation is the cylonic meandering current confined essentially to the shelf-slope topography encircling the basin. It has a width of 50-100 km, with current speeds of 100 cm/sec and an average speed of about 25 cm/sec on its main axis. The interior of the Rim Current contains a series of cyclonic mesoscale eddies which occasionally merge into one elongated cell covering the entire basin interior, or become separate from each other by anticyclonic eddies pinched off from the Rim Current. The anticyclonic eddy occupying the southeastern corner of the basin constitutes the most persistent, quasi-permanent feature of the general circulation. Shoreward of the Rim Current is occupied by anticyclonic eddies with typical size of 100 km, generated by topographical irregularities and/or barotropic and baroclinic instability mechanisms. Two of the anticyclonic eddies are located to the northwest of the Bosphorus exit and in the vicinity of the Sakarya Canyon region. Two other anticyclonic eddies observed along the southern coast of the Black Sea are situated on the western and eastern sides of the Cape of Sinop. These coastal eddies are observed consistently in all the hydrographic surveys and in the satellite imagery and reproduced partially by the various numerical modeling studies. Along the northern coast of the Black Sea, the most pronounced quasi-permanent feature is the one observed in the relatively smooth continental slope topography of the Danube Fan, to the west of the Crimean peninsula. Three other anticyclones are found along the Caucasian, Crimean and Bulgarian coasts.

Contrary to the findings of the earlier studies, the recent surveys possess important vertical structure in the Black Sea general circulation. The intermediate-depth circulation between 500 dbar and 1000 dbar pressure levels does not show the Rim Current. The circulation consists of several sub-basin scale gyres.

The anticyclonic coastal eddies, aligned along the coast of the basin, appear to play fundamental role on the ultimate distribution of the Cold Intermediate Water. They are advected and entrapped by these eddies, and are continuously modified throughout the year. They often interact with the interior of the basin through the filaments and transverse jets.

The Mediterranean water intrusion and double diffusive convective mixing processes in the Black Sea

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A description of internal processes of convective - diffusive mixing in the Black Sea is given, based on a number of recent data sets.

The Mediterranean waters entering into the Black Sea are rapidly mixed with cold waters on the continental shelf (LATIF *et al.*, 1991) and sink to intermediate depths (≤ 500m), forming a series of cold intrusions spreading horizontally into the interior (OZSOY *et al.*, 1992a, b). The temperature, salinity, suspended load and some other properties of the intrusions can often be traced back to the source region near the southwestern margin. The intrusions result in a unique mechanism of convection partially supported by the unstable double diffusive regime of the interior. The time-dependent convective motions can lead to significant exchange across the permanent halocline, and may explain some peculiarities of the Black Sea interior stratification.

Continental shelf dynamics and coherent structures of the Black Sea circulation locally modify the transport by the intrusions. The interaction of cyclonic boundary currents with the abrupt topography of Sakarya Canyon, and instabilities of the boundary currents motivate cross-shelf transport of the shelf sediments via intrusions and filaments.

Geothermal heat fluxes acting on an otherwise tranquil deep water mass drive a bottom convective layer (OZSOY *et al.*, 1992a, MURRAY *et al.*, 1991). Laboratory experiments and available theory are far from explaining its evolution, but the time of origin of the convective layer is inferred to be of the same age as the formation of bottom waters. The absolute homogeneity of the properties of this layer everywhere in the Black Sea suggests efficient mixing by turbulent eddies. The characteristic time scale of overturning implies a homogenisation period of at least several hundreds of years, required for the entire basin. This may explain the observed continuity of bottom sediment layers within the basin.

The transports between the bottom and the upper layer waters appear to be determined by a diffusive interface at the top of the convective layer, and double diffusion in the water column. A peculiar thermostad separates the pycnocline region from the deep waters. Anomalous temperature fine structure can be observed at all depths in the water column, and appears to be larger near the basin lateral boundaries.

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