IMPACT OF WINTER COOLING ON THE VARIABILITY OF THERMOHALINE CHRACTERISTICS OF ACTIVE LAYER IN THE BLACK SEA

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Abstract
The influence of the winter atmospheric forcing on the inter-annual variability of the Black Sea active layer's thermohaline structure during 1982-2008 is investigated. A high correlation between the variability of the winter-mean sea surface temperature/air temperature and thermohaline characteristics of the active layer during the following warm season was found. It is shown that winter atmospheric forcing significantly affects the variability of both temperature and salinity and density up to 150-200 m depth.
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The response of the marine environment to the long-term variability of the atmospheric forcing is a problem associated with the influence of the climate change on the ecosystem. It is especially important for the Black Sea since its ecosystem is very sensitive to the variability of the thermohaline structure [1, 2]. This variability on scales from synoptic to seasonal is reasonably well established [3, 4]. However, information on the longer-term variability and its connection with the large-scale atmospheric forcing is limited and refers mainly to the sea surface temperature (SST). The first attempts to associate the long-term variability of SST in the Black Sea with the large-scale atmospheric forcing are presented in [5, 6]. The goal of the present study is to investigate the influence of the winter atmospheric forcing on the inter-annual variability of the Black Sea thermohaline structure during 1982-2008. The results are based on a combined analysis of ship hydrological measurements, satellite measurements of the SST and NCEP/NCAR reanalysis data for the surface air temperature (SAT). The preliminary results of our findings may be briefly summarized as follows:

(1) the integral indicators of winter atmospheric forcing are SST (averaged for January to March) or SAT (averaged for December to February). SST and SAT are highly inter-correlated (R=0.92) which means that significantly longer time series of SAT may be used for analysis;

(2) the thermal climatic signal in the active layer is positively correlated with SST and SAT, reaches its maximum at 40-60 m and monotonously falls down with depth. The salinity and density variability is more complicated. They are negatively correlated with SST/SAT up to 80-100 m and change the sign of correlation to opposite at the level of the permanent thermocline. Inter-annual variability of the thermohaline characteristics becomes negligible at the depth of 150-200 m;

(3) an integral indicator of the long-term variability in the active layer of the Black Sea is the mean temperature of the cold intermediate layer (CIL). The CIL mean temperature decreased during 1982-96 and increased for about 0.9 deg.C in 1997-2002, which is consistent with the major climatic events described in [5, 6];

(4) we find out that the heat content deficit in the CIL is spatially inhomogeneous: it is about twice as thicker in the area of the continental slope compared to the deep area due to the specific water circulation;

(5) a statistically significant correlation between the CIL temperature and winter SST/SAT existed for two years. It means that the influence of winter cooling on a given specific year may be traced in the CIL characteristics during at least the two following years.

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