UNDERSTANDING OF THE BLACK SEA CIRCULATION AND THERMODYNAMICS USING OPERATIONAL OCEANOGRAPHY TOOLS

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Abstract
New datasets became available last years due to realization EC FP5, 6 and 7 projects in the Black Sea. Analysis of those datasets shows that the circulation variability on scales from week to years is induced by wind. Seasonal cycle of the Rim current is driven by regional air-sea coupling. Overlapping of the Rim current intensification and surface cooling is the reason of the warm stream formation in winter along the eastern boundary of the Black Sea, which smoothes climate of the Caucasian and Southern Crimea coasts. Specific phases of onshore or offshore Ekman layer transport and river runoff contributes to formation of the sea surface salinity. Simulations of the Black Sea ecosystem using current reanalysis permit to assume that the deep-sea upwelling provides also significant contribution to the basin eutrophication in 1980s.

Keywords: Circulation, Black Sea, Upwelling

DDevelopment of the Black Sea nowcasting and forecasting system in the framework of FP5 ARENA, FP6 ECOOP, SESAME and ASCABOS, FP7 MyOcean and MyOcean2 projects made possible to integrate all observations by means of their assimilation in circulation and ecosystem models [1]. Two set of standard MyOcean and MyOcean2 products which are provided by the Black Sea Monitoring and Forecasting Center [2] present three-dimensional arrays of temperature, salinity and current velocity resulted from operational nowcast and reanalysis cover 1971 – 2015 years. Those datasets analysis allow improve significantly understanding of the Black Sea circulation and thermodynamics against previous knowledge summarized by Stanev [3].

Common consideration of space altimetry and profiling float data shows that variability of temperature and salinity fields is adiabatic in a broad scale range starting from weeks and up to few years [4] and is controlled by the wind stress vorticity. Particularly seasonal cycle of the Black Sea circulation is controlled by the annual variability of the wind stress curl. Available potential energy support by the annual mean wind stress curl is realized in instability of the Black Sea Rim current and generation of mesoscale eddies. Numerical simulations show that mesoscale eddies cause formation of well known western and eastern gyres of the Black Sea circulation [5].

Analysis of temperature and current velocity arrays shows that heating of local atmosphere by the sea in winter produces cyclonic winds above the basin which generate onshore Ekman transport and following intensification of the Black Sea Rim current. Proper shift of phases between onshore or offshore Ekman transport and river fresh water runoff together with cross-frontal transport by eddies and deep-sea upwelling form surface salinity of the Black Sea. Consideration of temperature field show that the Rim current in winter transports warm water along the eastern boundary of the basin which smoothes climate of the Caucasian and Southern Crimea coasts.

Prominent feature of the Black Sea circulation is deep upwelling in the central part of the basin. This upwelling supports permanent pycnocline and restricts deepening of the Black Sea mixed layer. Simulations of the long-term Black Sea ecosystem evolution based on three-dimensional current reanalysis permit to assume that the deep-sea upwelling provides also significant contribution to the basin eutrophication in 1980s.

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