The vortical motions in the Black Sea obtained by the 3D thermo-hydrodynamical numerical model

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On the basis of the original baroclinic numerical model of the Black Sea dynamics full picture of the current field, isolines of the temperature and salinity fields with taken into account of alternation of two types of the atmospheric nonstationary circulation - (a) January cyclonic and (b) west wind cases - having a place above the sea basin were constructed.

The problem was solved by the two-cycle splitting method. Numerical realization of the problem shows that the circulation of the Black Sea is changed from layer to layer with depth. The currents have different character and the depth steepness structure, which undergoes some changes in time.

The calculations also show that these winds, which blow about 20 h, form hierarhy of the turbulent meso-scale vortexes streamlined by the main Black Sea current. Under the atmospheric cyclone in the surface layer of the sea the Ekman turbulent layer of 12 m thickness is created. Here it is described in detail a separate vortex - Taylor-Praudman potential vortex - in the east part of the current: (a) January cyclonic vortex after forcing of the atmospheric cyclone is generated during about ten hours and has steady vertical cylindric configuration with diameter d =˜ 200 km and height h =˜ 50 m. The vortex characteristics are given in figures: the distribution of the velocity, temperature, salinity and horizontal turbulent viscosity in the vortex against the distance from the center of the vortex along the parallel and meridian, respectively; vertical distribution of the temperature gradient, salinity stratification, Brunt-Väisälä frequency, and Richardson number taken near the vortex wall with maximal velocity. The main Black Sea current's volume transport in sverdrup around the vortex was calculated.

The obtained vortexes are classified from the new position by means of universal Reynolds number Re, where the turbulent viscosity is used instead of kinematic one. It is obtained that at universal $Re>1$ the vortex are stable, but at $Re<1$ the vortex disappears.