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Development of perspective methods for modeling 3D currents for coastal systems in connection with environmental problems in South of France as well as South of Russia

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Shallow water reservoirs are complex multi-parameter hydrodynamic systems. The current and the coupled processes occurring in them are spatially three-dimensional and unsteady, and have essentially nonlinear character. Therefore, the use of field experiments to analyse such a systems is extremely labor intensive and costly. Without underestimating the role of field experiments, it should be nevertheless noted that the most optimal in terms of cost and reliability of the results is an approach based on a combination of relatively inexpensive and safe field experiments and mathematical modeling of the processes under study.

The present approach has several advantages with respect to the existing models. Three components of velocity vector from the full system of Navier-Stokes equations (and not on the basis of the hydrostatic approximation) and the equation of the surface elevation are calculated. In most hydrodynamic models of shallow water, the third component of the velocity vector is determined from the equations of continuity and the elevation surface level, which introduces significant error in the determination of the component. Calculation of the three components of velocity vector based on the equations of motion is a time-consuming process, so the hydrostatic approximation is used as an initial approximation for calculating the pressure. This approach greatly reduces the computing time and the costs.

Also one of the advantages of the present model is an improved parameterization of the vertical turbulent exchange coefficient, on the basis of ADCP measurement data (Acoustic Doppler Current Profiler). In modern numerical models of vertical turbulent exchange, this coefficient often appears as a fitting parameter. Among the numerous approximations of the coefficient of vertical turbulent exchange, the algebraic subgrid model of Belotcerkovskii, which is based on the determination of turbulent flows as multiplications of averaged over time (correlation) fluctuations of the horizontal and vertical velocity's components, showed itself in the best way in comparison with expedition data.

Mathematical and numerical modeling was carried out on the Azov Sea (Russia) and the lagoon Etang de Berre (France), taking into account three main forcing mechanisms: wind effect, fresh and marine water input (micro-tidal effect).

Expeditions were conducted in Azov Sea (in 2005 and 2006) and in the lagoon Etang de Berre (in 2006 and 2008), for obtaining data on the status and changes in hydro-physical and hydro chemical parameters. During these expeditions data on the velocity fluctuations in certain locations on the basis of ADCP measurements (WHS600 Sentinel) were obtained.

We studied the situation which can occur typically on the second half of the summer where the water, at the exit area of the waters of Taganrog Gulf in Azov Sea, can be saturated by organic compounds coming from rivers. For some wind intensity and direction, the presence of a closed vortex motion can be exhibited; then, these organic compounds can deposit on the seabed and their decomposition can lead to huge phenomena of hypoxia (as in 2001).

In the north-western part of the lagoon Etang de Berre, stable vortex structures can be exhibited for different forcing mechanisms, including the discharge of water from an hydroelectric dam. A large number of organic matter falls into this area. These substances are captured by the vortex structure, and, sinking to the bottom, form

the organic sediment. For temperatures typical for the summer period, begins intensive oxidation of the resulting sediment with a simultaneous decrease in the concentration of dissolved oxygen. In case of stable stratification phenomenon, occurs quite rapidly anoxia (complete lack of oxygen) and further expansion is on anaerobic cycle with the formation of hydrogen sulfide. This phenomenon was observed during the September expedition of 2006.