Marine Hydrophysical Institute RAS

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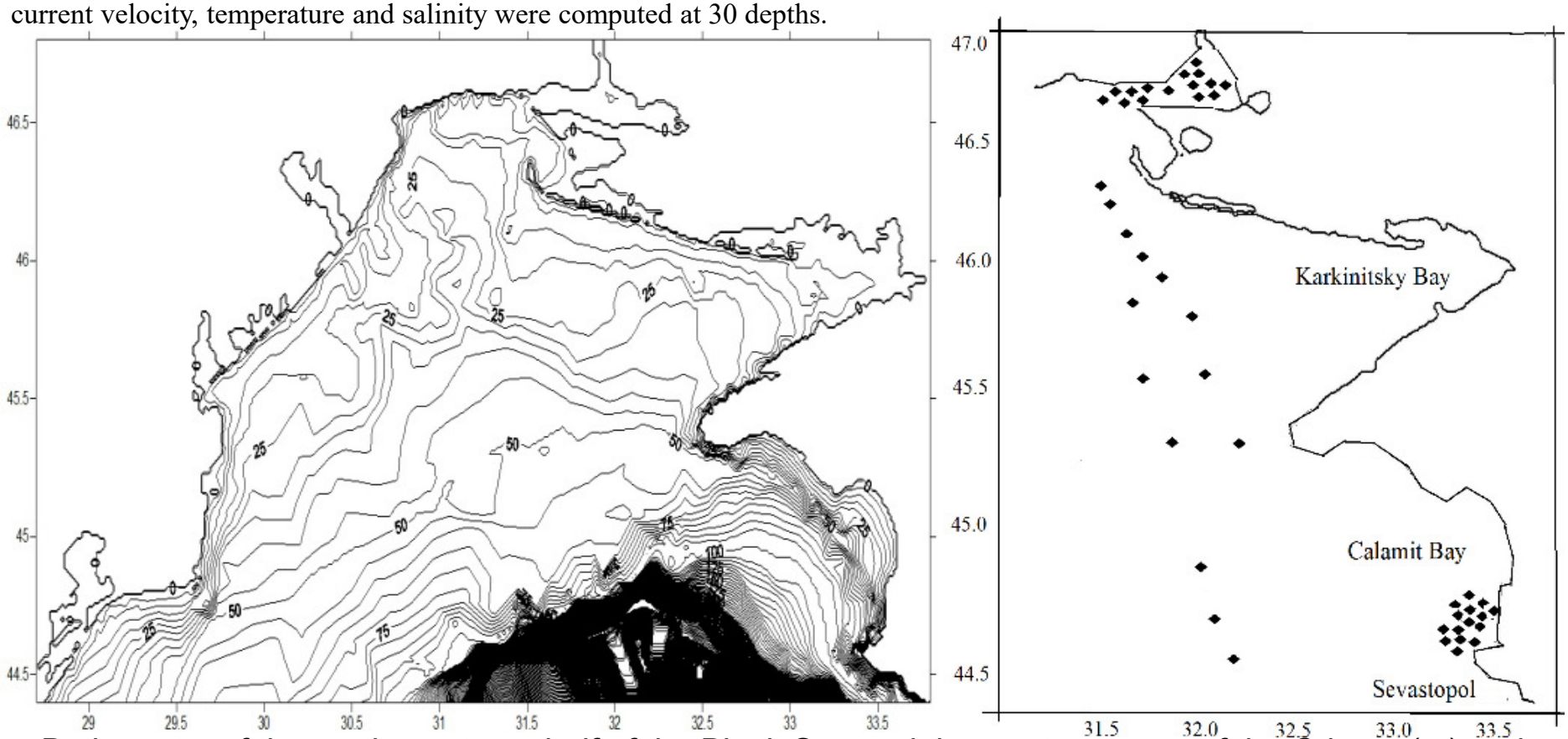
ANALYSIS OF CIRCULATION NEAR THE COAST OF THE WESTERN CRIMEA AND IN THE REGION OF SEVASTOPOL WITH THE ASSIMILATION OF TEMPERATURE AND SALINITY OBSERVATIONS

The main aim of the study is to reconstruct three-dimensional fields of currents, temperature and salinity, continuous in time and space, on the basis of assimilation of the observational data in the hydrodynamic model with a high resolution ~1.6 km and to carry out an analysis of mesoscale features of coastal circulation of the Black sea.

The system of model equations using the Boussinesq approximation, hydrostatic approximation and incompressibility of seawater in the Gromeko–Lamb form, the boundary conditions on the surface, at the bottom, on the solid lateral walls were written as in "Demyshev, S.G., Korotaev, G.K.: Numerical energy-balanced model of baroclinic currents of the ocean on the C-grid. Numerical models and results of calibration calculations of currents in the Atlantic Ocean, 163–231 (1992)."

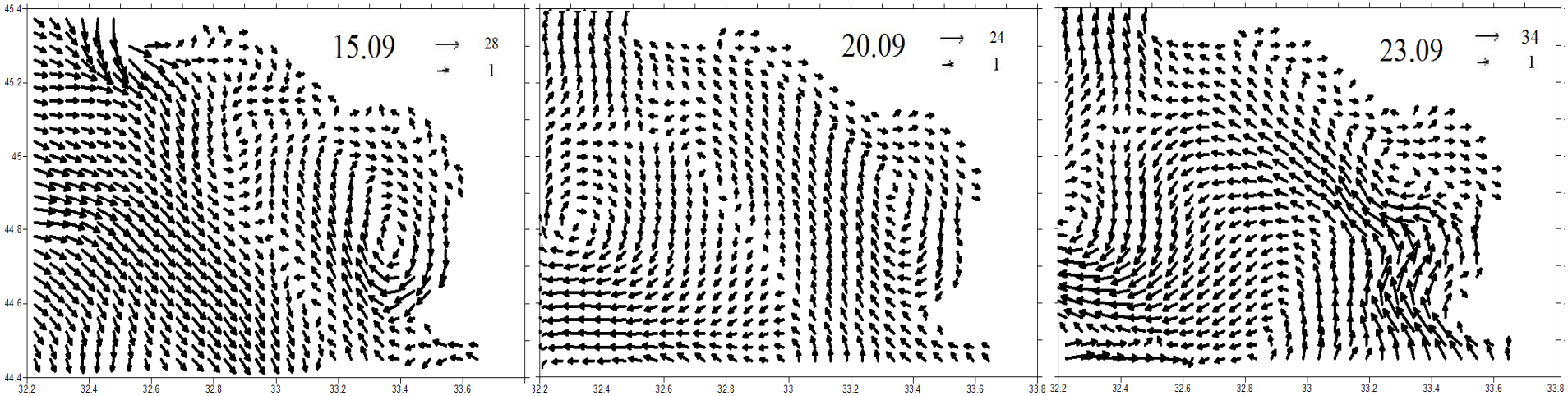
A simplified procedure of four-dimensional analysis, based on the method of sequential optimal interpolation, when the covariance functions of the temperature and salinity fields were calculated under the assumption of homogeneity and isotropy, was used to realize the procedure of assimilation of observational data.

We considered a region of the Black Sea (a north-western shelf and a western coast of the Crimea), limited by latitude 44.4ºN, located between meridians 28.5º and 33.5º E (we used a detailed presentation of bottom topography with a resolution ~1.6 km). The numerical experiments were carried out with a resolution ~1.6 km. The time step was equal to 30 s. The total period of integration of model equations 10 days (from 14 to 24 of September 2007). Along the vertical, horizontal components of the current velocity, temperature and salinity were computed at 30 depths.



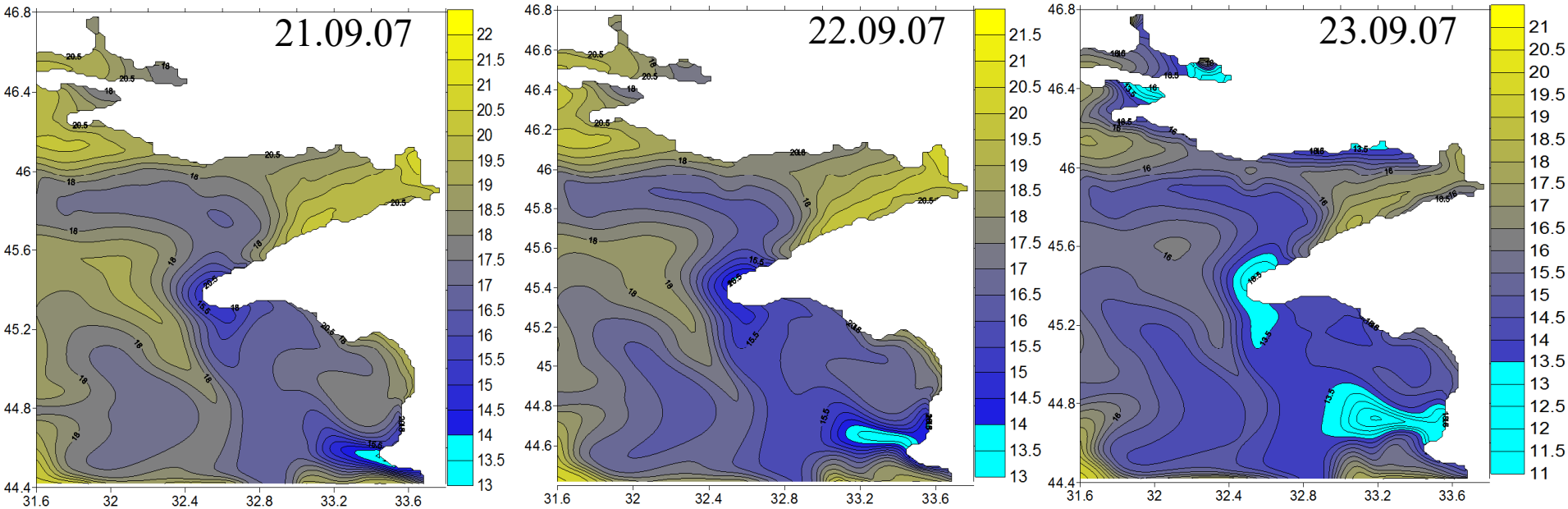
Bathymetry of the north-western shelf of the Black Sea and the western coast of the Crimea (m) and a scheme of stations, performed on the research vessel "Experiment" on 16–22 September, 2007.

Fields of currents on the horizon 1 m



The calculated current fields were characterized by mesoscale eddies and jets.

Fields of temperature on the horizon 1 m



According to measurement data and satellite images, cold water rise was observed on 22nd and 23rd of September in the southern part of Kalamitsky bay, due to the action of the north and north-east winds with rise to the surface of water with a temperature below 14ºC, which was proved by the results of numerical calculation. The distribution of cold waters was observed in the model temperature fields from 21st of September.

Conclusions

Fields of currents, temperatures, salinity were reconstructed on the basis of the hydrodynamic model with the assimilation of observational data of the hydrological survey from 14 to 24 of September 2007, taking into account the real atmospheric forcing and a high resolution (~1.6 km horizontally and 30 vertical layers) in the coastal area.

Calculated fields of currents were characterized by mesoscale eddies and jets. A cyclonic eddy in the central part of the region, an anticyclonic eddy in the Kalamitsky Bay and near the open boundary, intense jets, directed to the north, along the western coast and in the central part of the region were obtained in the upper layer of water. In comparison with previous calculations, those features were absent or were much smoother.

There was some cooling and desalination of the surface waters, which was noted in the estuaries, in the bays and near the cape Tarkhankut. As a result of the rise of the underlying cold waters, coastal upwelling in Kalamitsky Bay was reconstructed in September 2007, according to observational data.

Thus, a sequential analysis of observational data on the basis of the assimilation in the numerical model of dynamics enabled to reconstruct the mesoscale features of coastal circulation more accurately in the region of the western coast of the Crimea and the north-western shelf of the Black sea.