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**THE POSSIBILITY OF CREATING A SYSTEM FOR ANALYSIS
AND MONITORING OF THE FIELDS OF THERMOHALINE
CHARACTERISTICS IN THE MARINE ENVIRONMENT BASED
ON THE REMOTE MEASUREMENTS IN UKRAINE**

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One of the most priority directions in the earth sciences in recent decades is the study of climate change on our planet. Most of this research belongs to the ocean. For a state with access to the Black Sea, it is important to have scientifically grounded ideas about the regional features of oceanological processes and predict potential natural changes affecting the marine ecosystem.

The Black Sea is a fairly well-studied basin. Therefore, there are classical ideas about its hydrophysical regime. Today there is a large amount of material from various observations on thermohaline characteristics and water circulation. Thus, the Black Sea can be used to test remote control methods and methods for calculating hydrophysical characteristics based on them [1, p. 5].

The modern stage of the study of the Black Sea basin, from the mid-1990s to the present, is determined by a very rapid decrease in the number of systematic expeditionary studies of the deep-water part sea. This is mainly due to the economic problems of the Black Sea states, the breakdown and loss of almost the entire science's research fleet. The main efforts of scientists from various departments are aimed at analysis and comprehending the entire set of information obtained at the previous stages in order to identify long-term changes in the ecosystem of the seas or their regions. In addition, the available information in the form of modern databases and information systems is used to study the features of various processes in marine ecosystems [2, p. 10–11].

The problems of remotely obtaining information about the phenomena and processes occurring in the entire water column of the marine environment are increasingly attracting the attention of researchers and specialists in various fields. The solution to this problem makes it possible to

control the characteristics of huge water areas, obtain their integral estimates and reduce research costs. Traditional methods of ocean exploration using research vessels and autonomous buoys cannot cover the entire ocean area and even its individual parts with constant measurements. Therefore, they do not give a complete understanding of their spatio-temporal variability. To study the corresponding response of the sea to climatic changes and anthropogenic impact, it is necessary to constantly monitor changes in the sea surface, the variability of the upper mixed layer, the vertical structure and dynamics of waters in the active layer of waters, processes in the shelf zone, etc. The simultaneous use of various remote sensing methods – satellite remote sensing of the Earth (ERS) and acoustic sounding provides continuous operational data on the state on the surface and in the water column. The strategy for the integrated use of remote sensing should ensure long-term and continuous collection and system integration of data obtained by various methods using modern technical means. This will allow them to be used in simulation modeling [1, p. 116].

Thus, the creation of a «System for analysis and monitoring of the fields of thermohaline characteristics in the marine environment based on the remote measurements» is an urgent task. It can be used to assess the dynamics of processes in the marine environment, the features of the spatio-temporal variability of thermohaline characteristics and effects of their change on hydrobiological, hydrochemical, hydrophysical processes and the ecosystem of the sea in general can be evaluated.

State Institute «Hydroacoustic Branch of Institute of Geophysics by S.I. Subbotin name of the National Academy of Sciences of Ukraine» has been engaged in research of the World Ocean on the basis of remote measurements (satellite and acoustic) for many years. Today, one of the priority scientific directions of the Hydroacoustic Branch is the study of the spatial distribution of hydrophysical characteristics in the marine environment by remote measurements methods. Original methods for calculating the vertical distribution of water temperature, sound speed and salinity of water by satellite and hydroacoustic data were developed [3; 4; 5]. For the efficiency of calculations an Automated Program Complex (APC) for calculating the vertical distribution of temperature and salinity fields in the marine environment by satellite and hydroacoustic data has been developed and tested on the example of the Black Sea. The initial data for the calculations using the APC are only daily satellite data of the sea surface temperature.

To visualize the results of calculations using the APC, maps of the distribution of temperature and salinity of water on the zonal section (latitude 43.15° N) for 03.07.2020 were built. On the map (a) (see Figure 1) the initial satellite data were the daily data on satellite measurements of the

Black Sea water surface temperature with 4 km step on latitude and longitude, measured companion NASA (Terra MODIS) [6].

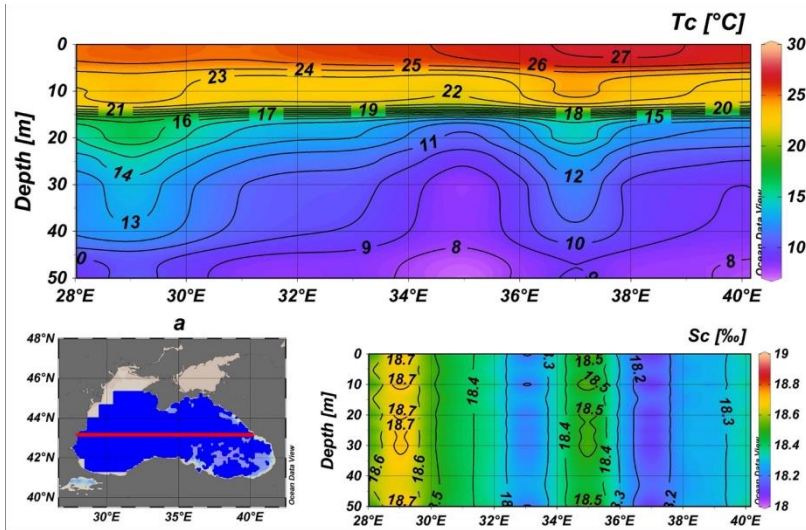


Figure 1. Distribution of calculated of water temperature (T_c) and salinity (S_c) on zonal section (latitude 43.15° N) in the Black Sea for 03.07.2020. The map (a) shows the location of section in the Black Sea

Figure 1 are built using computer program Ocean Data View (ODV) that is intended for the interactive exploration and graphical display of oceanographic and other geo-referenced profile, trajectory or time – series data [7].

The main advantages of the developed methods and the APC for calculating the vertical distribution of thermohaline characteristics in the active layer of the Black Sea deep-water area based on satellite and hydroacoustic data:

- Instant efficiency of calculations;
- Ease and automation of calculations;
- A minimum of initial data and their free and fast access, which is economically beneficial and convenient;
- Sufficiently high accuracy of calculations for research and applied purposes in various fields of activity;
- The calculation area covers a large sea area with a spatial resolution of 4×4 km;

– The ability to calculate the vertical distribution of thermohaline characteristics using both the APC as a whole and the distribution of individual hydrophysical characteristics by program modules in the active layer of the Black Sea deep-water area.

– If necessary, easy and quick modernization of the APC and program modules.

The principles of building of the APC for calculate of the vertical distribution of temperature and salinity fields in the active layer of the Black Sea by satellite and hydroacoustic data can be implemented to create a «System for analysis and monitoring of the fields of thermohaline characteristics in the Black Sea based on the remote measurements».

The developed methods and principles of building an the APC for calculation of vertical distribution of temperature and salinity fields of water according to satellite and hydroacoustic data can be applied also to others water area of the World Ocean, taking into account their hydrological conditions.

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