

Rescue of Black Sea Hydrological Data for Regional Classification and Studies of Seasonal and Interannual Variability

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Abstract- In the framework of the Project "Rescue of Black Sea Hydrological Data" collected from more than 100,000 Black Sea oceanographic stations from all sources and created a CD-ROM digital atlas "Physical Oceanography of the Black Sea" based on all available, historical hydrological data. For the providing data access and visualization the database management system was developed and included in CD-ROM.

I. INTRODUCTION

Information management and the creation and use of oceanographic data bases are recognized as important components in modern investigations of the world's oceans. In Ukraine great attention is paid to the rescue and archiving of oceanographic data and the creation of data bases. The Marine Hydrophysical Institute (MHI) of the National Academy of Science of Ukraine has accumulated considerable experience in this field as a result of participation in a number of national and international programs.

The participation of MHI, jointly with NOAA's Atlantic Oceanographic and Meteorological Laboratory, in the Project "Rescue of Black Sea Hydrological Data" Project is a logical continuation of its activities in rescuing, archiving, and analyzing oceanographic data.

The Project, funded by NOAA's Environmental Services Data and Information Management (ESDIM) Program, has two primary objectives. The first is to rescue observed-level data (with

associated metadata) collected from approximately 40,000 hydrographic casts made in the Black Sea. The second objective is to create a CD-ROM digital atlas "Physical Oceanography of the Black Sea" based on all available, historical, hydrological data. These data represent not only the 40,000 casts to be rescued but an additional 60,000 casts as well. The Project is concerned with data continuity and access as well as data rescue. The digital atlas will fill gaps in existing data sets and extend them to the beginning of the century. With a continuous data set extending over approximately one century, it will be possible for the first time to assess long-term changes in both coastal and deep-water regions of the Black Sea.

II. DATA BASE

An estimation and cataloguing of the available hydrological information on the Black Sea collected previously in framework of other international projects have been also conducted. Data were selected from the following sources:

- WOD – 98;
- MEDAR/MEDATLAS II;
- NATO TU BLACK SEA.

The additional data cover more than 40.000 stations. In total, collected 104 258 hydrological stations (T, S) received during more then 1200 research vessels cruises. The measurements were conducted from 1890 till 2001 during all seasons.

A special reference database includes all information about Research Vessel cruises (time,

types of measurements, used instruments, coordinates of stations).

Distribution of the hydrological stations on years and months for the Black Sea are shown in figures 1 and 2.

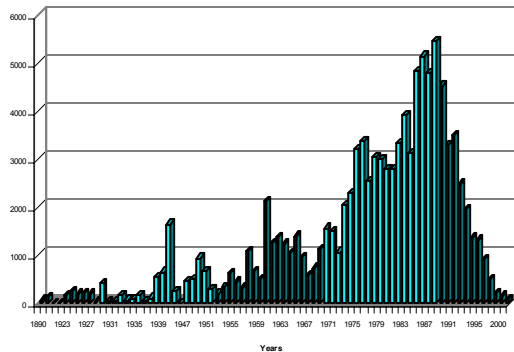


Fig.1 Distribution hydrological stations on years.

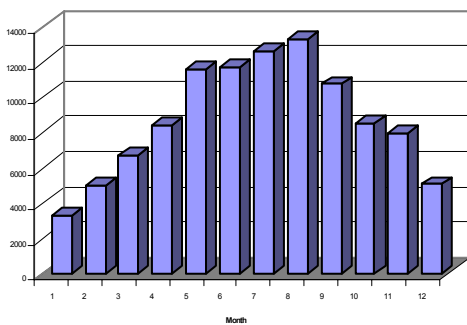


Fig.2 Distribution hydrological stations on months.

Range checking as first step was performed to eliminate data that are grossly in error. The range-check criteria as well as the check for perturbations in the vertical distribution of density, discussed below, were the same as in UNESCO (1993).

Further refinement of the data was done on the basis of a statistical check both in depth-parameter and density-parameter space. Oceanographic casts were subdivided into 40'x60' boxes where any value differing by more than three standard deviations from the mean was rejected. Statistical checking was done for each month in the layer 0-100 m and for all observations deeper than 100 m through a two-step process:

1. Checking of density at standard depths (three passes).
2. Checking of temperature and salinity on

isopycnal surfaces: from 5 to 11 by interval 1, from 12 to 17 by interval 0.1, from 17 to 17.3 by interval 0.01 σ (two passes).

III. DIGITAL ATLAS AND DATABASE MANAGEMENT SYSTEM

The digital atlas will be made available for international distribution on a CD ROM. We hope it will stimulate further investigation into both the hydrological structure of the Black Sea and the hydrological setting for chemical, biological, and meteorological processes, as well as the response of an enclosed sea to climatic changes in the Europe-North Atlantic climate system. Studies of the climatic condition of the Black Sea are interesting and important in the own right but they may also provide insights into the climatic conditions and variability of other ocean basins through comparative studies.

Data management software was developed. It provides two types of installation:

- compact - with database and atlas on CD;
- full - with all information and data on hard drive.

ESDIM Project data management software consists of two parts – atlas viewer and visual data selection unit.

Atlas viewer provides selection and viewing maps for temperature, salinity, density, dynamic height and heat storage parameters. Values of parameter, month and depth are selected by user.

It also provides export of current map (or all maps of atlas) to metafile (*.wmf file format). User may edit view properties of map and select one of two base maps of the Black Sea according to required size of result map file (Fig 3, 4).

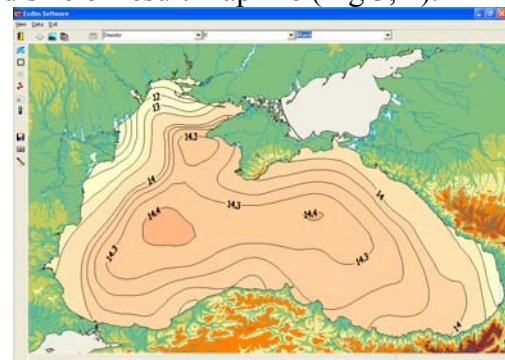


Fig3. Map of surface density field (March)

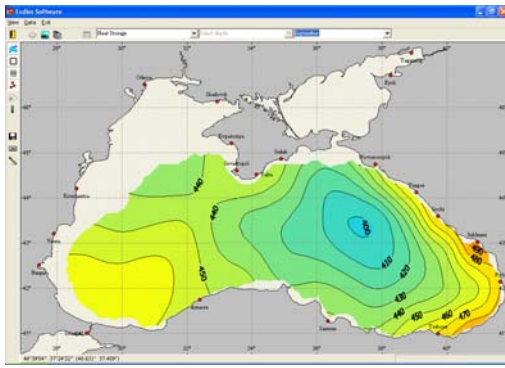


Fig 4. Map of heat storage field (September)

Data selection unit supplies data selection, viewing and export. It provides several ways of data selection:

- by organization and cruise (Fig 5 a, b);
- free selection including spatial and temporal data selection.

Spatial selection includes:

- selection by rectangle region (textual and map selection) (Fig 6. a, b);
- selection by free region (map only);
- selection for sea depth limits (textual only);
- and temporal selection:
- for date limits,
- for defined months and years.

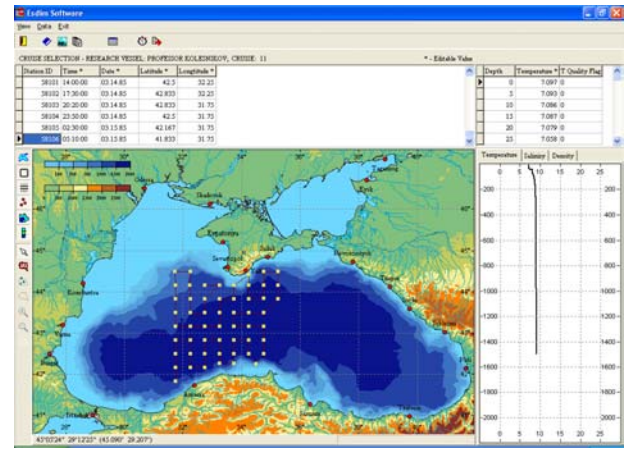


Fig 5 b. Result of selection

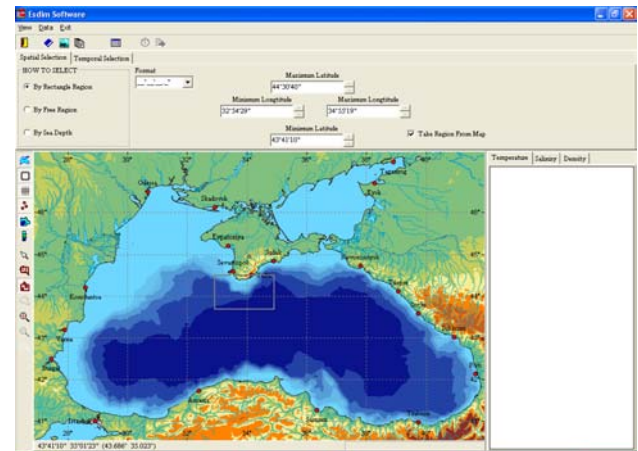


Fig 6 a. Spatial selection example

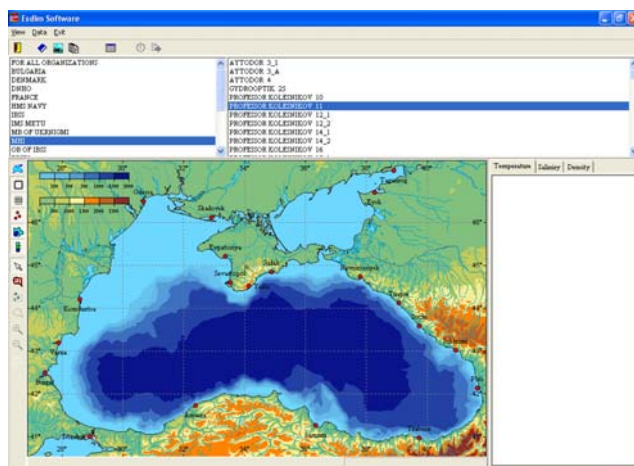


Fig5 a. Example of selection by organization and cruise

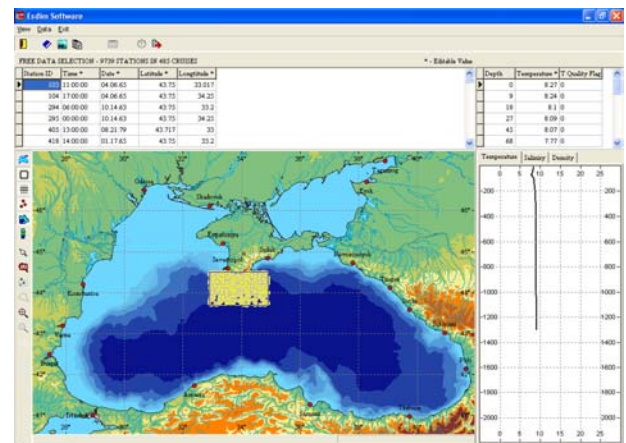


Fig 6 b. Result of selection

Spatial and temporal selection may be used simultaneously. Information on selected dataset includes:

- table, containing information of station location date and time;
- map of stations distribution for result dataset;
- information on stations and cruises count (for free selection only);
- data tables for temperature, salinity and density (calculated parameter);
- plots for vertical profiles of above mentioned parameters.

In order to provide quality check of station location and temporal parameters, velocities between stations for cruise data selection are calculated. User may edit station location, date and time to correct possible wrong values. Flag values for temperature, salinity and density contains data quality check results information. Flag for temperature and salinity is equal to zero if current corresponding parameter deviation value is in limits of $\pm 2\sigma$. Otherwise flag value is equal to 1. Flag value for density is equal to 1 if density inversion for corresponding value takes place. Otherwise flag value is equal to zero. Values of temperature and salinity may be edited to correct possible wrong values.

Database is stored in national format for providing SQL queries and making data selection more convenient but selected data may be converted from national format to OCL, BOD and CRUISE formats.

IV. CONCLUSIONS

Our progress to date includes collecting data from more than 100,000 Black Sea oceanographic stations from all sources. A database management system was developed that provides data access and visualization, primary quality check, export in several ASCII formats, and climatic maps of temperature, salinity and density. Data visualization includes cruise plots and station locations together with profiles of hydrographic parameters. The Project demonstrates the value of an international effort in the rescuing and archiving of observed oceanographic data and the experience gained sets the stage for future projects.

V. ACKNOWLEDGEMENTS

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