PREFACE
This document is the interim report describing activities and deliverables of the first halve of the OCEAN-UKRAINE project “Strengthening the oceanographic data management and operational forecast services at IBSS and MHI, Ukraine”.

NOVEMBER 2008

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**SUMMARY**

The Ocean-Ukraine project passed its midpoint and is progressing successfully. Expected deliverables have been presented and the work is moving according to the schedule. All remaining phases are already started and there is a full confidence of success of the entire project.

The essential steps ahead in the progress of the project were done during the project meetings that were organized both in Oostende, Flanders (May 2007, October 2007, and July 2008), and in Sevastopol, Ukraine (September 2007).

The project results have already been disseminated in Ukraine and in other Black Sea countries.

It is worth to mention the big step ahead done within the project in the IBSS capacity building. A set of the installed equipment gives a possibility not only to fulfill totally all other tasks of the OceanUkraine project but also to provide the IT support to the work within all international and national projects that are now being executed by the IBSS.
## TIMELINE

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**Project:** OCEAN-UKRAINE
**Date:** Thu 29/07/08

**Task**
- Split
- Summary
- External Tasks

**External Task**
- External Milestone
- Split

**Project Summary**
Phase 1.1: Review and analysis of the structure and state of Ukrainian National Oceanographic Data Centre and data centres of IBSS and MHI.

- **Description:**
  Review and analysis of the structure and state of Ukrainian National Oceanographic Data Centre and data centres of IBSS and MHI.

- **Expected deliverables:**
  Report on the state and capacity of the Ukrainian NODC and data centres of IBSS and MHI. Strategic action plan for further development of these data centres and creation of the distributed Ukrainian NODC according to the IOC/IODE recommendations.

- **Status:**
  Phase 1.1 was fully executed for the IBSS and was not finalised for MHI yet due to the following.

Till now the Ukrainian NODC was based on the Marine Hydrophysical Institute (MHI) of the National Academy of Sciences of Ukraine. It was dealing with the physical, chemical, and satellite data. At the moment it is not dealing with the marine biological data due to the lack of corresponding experience and staff. In the meantime the importance of marine biological data and their international exchange is growing permanently.

Due to these reasons, it was decided to shift to the distributed model of the Ukrainian NODC. From now on in Ukraine in addition to the NODC (DNA) based on the MHI Department of Marine Environmental and Information Technologies there will be one more NODC (DNA) based on the Laboratory of the Marine Information Systems (LaMIS) of the Institute of Biology of the Southern Seas (IBSS). Both institutions are the members of the Oceanological Centre of the National Academy of Sciences of Ukraine.

LaMIS fully responds to the minimum requirements to the NODC mentioned in the IOC Guide for Establishing a National Oceanographic Data Centre [UNESCO 2008]:

- LaMIS serves as the IBSS data centre and has experienced qualified staff of data managers, system administrators, and software developers.
- Thanks to the support from OceanUkraine project, LaMIS is fully equipped with the necessary computer and communication hardware and software including 2 servers, 1 TByte hard disk array, tape autoloader library back-up system, UPS, and other necessary additional equipment. It has two independent power cable lines and two independent Internet line connections that gives a possibility for a 24/7 work.
- LaMIS is already the official OBIS on-line data provider and participates in 5 international EC projects related to the data collection, storage, analysis, and distribution of the marine biological data.
- LaMIS has the close relations with IOC/IODE and informally has been already involved in the ODIN Black Sea activity.
So, the Ukrainian NODC/DNA is now in a transition from the centralized model based on the MHI to the Distributed model based on both MHI and IBSS. That is why, the survey for the MHI and repeated survey for the IBSS will be done later on in March – April 2009.

It is worth to mention that the results of the IBSS data centre survey were used as the main basis to make a decision to move to the distributed NODC model.

- Report:

Anon. (2007). State and capacity of the Ukrainian NODC and data centres of Institute of Biology of the Southern Seas (IBSS) and Marine Hydrophysical Institute (MHI).
Phase 1.2: Capacity building. Procurement and installation of the necessary computer hardware and software.

- **Description:**
  Capacity building. Procurement and installation of the necessary computer hardware and software.

- **Expected deliverables:**
  New computer equipment and software delivered and installed.

- **Status:**
  Phase 1.2. is near completed. All planned hardware was bought. Only some software is still to be bought.

The following equipment is bought and installed:

- Intel® Server Platform SR2500ALLXR with two Quad-Core Intel® Xeon® Processor E5450, 8Gb RAM and External SAS connectors
- HP StorageWorks 1510i Modular Smart Array iSCSI
- HP StorageWorks MSA20 SATA
- HP NC373T PCI Express Multifunction Gigabit Server Adapter with Internet Small Computer System Interface (iSCSI), and RDMA (Remote Direct Memory Access)
- HP StorageWorks 1/8 G2 Tape Autoloader
- 8-Port IP-Based Cascadable USB / PS/2 KVM Switch
- two APC Smart-UPS RT 3000VA

A figure below shows the hardware installation.

The optical fiber cable for the broadband connection with the Internet is laid from the nearest provider location to the IBSS (Fig.1.2.2).

A set of the installed equipment gives a possibility not only to fulfill totally all other tasks of the Ocean-Ukraine project but also to provide the IT support to the work within all international and national projects that are being executed by the IBSS.
Installation of the hardware

A scheme of the fiber optics line

- Report:
Phase 1.3: Analysis and inventorying of the biodiversity data at IBSS to be put in order and digitised.

- **Description:**
  Analysis and inventorying of the biodiversity data at IBSS to be put in order and digitized.

- **Expected deliverables:**
  Inventory of the IBSS biodiversity data to be put in order and digitised.

- **Status:**
  Phase 1.3 is ongoing now.

- **Report:**
  Due to the specific of data collection in IBSS the vast majority of historical biodiversity datasets were collected during scientific research cruises on several IBSS ships and ships of other organizations. According the preliminary inventory the amount of cruises is approximately 150 large cruises performed on IBSS ships and 100 cruises performed on ships of other research organizations. This amount doesn’t include small coastal monitoring expeditions. IBSS started the process of digitizing metadata on cruises. IBSS developed the metadatabase (http://data.ibss.org.ua/Data/Cruises.aspx) of marine expeditions performed by the IBSS scientists on board of the IBSS research vessels and the vessels of other institutions. The structure of this database was created to fit the international standard CSR (Cruise Summary Reports) developed within EU project SEA-SEARCH (2002 - 2005)(www.sea-search.net). Within EU project SeaDataNet (http://www.seadatanet.org) the CSR standard was upgraded to V1 version with the aim to improve interrelationships and to use of common vocabularies, wherever possible. The structure of IBSS metadatabase for marine expeditions is being improved now to fit the new standard.

For the moment database includes 81 cruises and 6374 stations (see below).
Also IBSS reviewed existing sources of biodiversity and other oceanographic datasets which were digitized previously within several international projects and available on CD-ROMs as standalone applications or as online sources. These sources are:

- Databases on CDs:
  - The Database on the Bioluminescence Field of the World Ocean (CD released in 2003)
  - Data on the Indian Ocean Ecosystem (CD released in 2000)
  - Plankton biodiversity and biovariability in the Indian and Atlantic Oceans (CD released in 2001)
  - Data on plankton and environmental characteristics (CD released in 2003)
  - Pelagic Ecosystems of the Tropical Atlantic Ocean (CD released in 2003)
- A Global Plankton Database: An Inventory and Data From the Former Soviet Union Expeditions (CD released in 2007)

- Databases online:
  - A Global Plankton Database: An Inventory and Data From the Former Soviet Union Expeditions (online version, released in 2005)
  - NMFS-COPEPOD: the global plankton database
  - IBSS data in MedOBIS
  - IBSS data in World Ocean Database

Full information on these data products is available at the IBSS web site: http://www.ibss.org.ua/Default.aspx?tabid=325
Phase 1.4: Creation of the IT infrastructure and software necessary to run the Virtual Lab at VLIZ and IOC/IODE Project Office.

- **Description:**
Creation of the IT infrastructure and software necessary to run the Virtual Lab at VLIZ and IOC/IODE Project Office.

- **Expected deliverables:**
IT infrastructure and software necessary to run the Virtual Lab is in place.

- **Status:**
Phase 1.4 has been finalised and resulted in a report with some recommendations on further development of organization input and output data flow.

- **Report:**

  I. **The Black Sea circulation models system.**
  The system of simulation of water circulation in the Black Sea was developed. The system consists of two models (basin-scale model and regional high-resolution model) and software of preparation the necessary input data. Both the Black Sea circulation basin-scale model and the regional high-resolution model and additional software have been installed on the server of the VLIZ virtual lab.

  1.1. **Models.**
  The basin-scale model of the Black Sea circulation as well as regional model are based on the model which was developed in the Atmospheric and Oceanic Sciences Program of Princeton University, the Geophysical Fluid Dynamics Laboratory of NOAA and Dynalysis of Princeton (http://www.aos.princeton.edu/WWWPUBLIC/htdocs.pom/index.html) (Princeton Ocean Model – POM) and adapted to the basin of the Black Sea.
  The principal attributes of the model are as follows:
  - Complete thermodynamics have been implemented.
  - It contains an embedded second moment turbulence closure sub-model to provide vertical mixing coefficients.
  - It is a sigma coordinate model in that the vertical coordinate is scaled on the water column depth.
  - The model has a free surface and a split time step.
  - The horizontal finite difference scheme is staggered and, in the literature, has been called an Arakawa C-grid.
  - The horizontal time differencing is explicit whereas the vertical differencing is implicit.
  The latter eliminates time constraints for the vertical coordinate and permits the use of fine vertical resolution in the surface and bottom boundary layers.
  The numerical scheme has been designed to readily accommodate the highly time-dependent and often nonlinear processes of coastal upwelling and eddy dynamics. The numerical model incorporates realistic coastline and bottom topography. The actual computer code is configured to take advantage of the array processing design of modern computers so that long-term integrations are possible at tolerable cost.
1.2. Basin-scale model.

The simulation domain for the basin-scale model area is covered with the grid that has space resolution of 4.8 km (236x130 meshes). The maximum depth is equal to 2150 m. The model has 36 calculation \( \sigma \)-levels. Time step for the internal mode is equal to 10 min, and for external – 6 s, so 1 day consists of 144 time steps of internal mode.

1.3. Data assimilation.

The basin-scale model assimilates sea level anomalies (SLA) and sea surface temperature (SST). SLA data provide an opportunity to describe surface geostrophic currents. But they are most efficient being used together with hydrodynamical circulation models. Assimilation of satellite altimetry in three-dimensional models permits to extrapolate the sea level surface measurements to the depth. For these purposes the procedure of satellite altimetry assimilation was developed. The satellite altimetry data obtained by ERS, TOPEX/Poseidon, GFO, Jason and EnviSat satellites were prepared in the center of space researches (CLS, France, Tulu) within the framework of the AVISO project (http://www.aviso.oceanobs.com/). The ground tracks of ERS satellites have the best spatial resolution, but their repeating cycles are equal to 35 days. TOPEX/Poseidon has the worst spatial resolution, but the best repeating cycle - 10 days. Preprocessing of data sets includes correction of atmospheric refraction influence, ionosphere dynamics, surface waves, tides and atmospheric pressure. As a result these data contain anomalies of the sea surface height with respect to a mean sea surface; the mean sea surface includes geoid height and a dynamical mean sea surface. This information is stored on CLS site that is renewed twice a week. These data for the Black Sea region are available in the Internet in a near real time mode. Being received, these data are further processed, particularly, the measurements performed nearer than 25 km from the coast are rejected due to their low accuracy. Then the fact that the AVISO data represent anomalies of the sea level and the mean sea surface height is taken into account. The time-averaged sea surface includes both geoid height and mean dynamical sea surface. Unfortunately, the accuracy of the geoid height for the Black Sea is not sufficient. This problem is avoided through the additional data processing based on careful estimation of the seasonal climate of the Black Sea circulation using all the available hydrographic data.

The procedure of assimilation of the satellite altimetry in the Black Sea circulation model is based on the theory of Kalman filter. It permits to correct optimally the model fields. To economize computer resources, a number of assumptions were done. The fields of errors are assumed to be statistically stationary, horizontally uniform and isotropic. Mutual correlation between the errors of salinity (temperature) and sea level are presented as a product of two multipliers depending on horizontal and vertical co-ordinates, respectively. Statistics of errors are considered to be proportional to those of the fields. According to these assumptions, auto- and mutual correlation functions used in the assimilation procedure are estimated.

SST data are provided by modern satellite systems and sensors (AVHRR, MODIS) up to 6-8 times/day with a spatial resolution 1 km that permits to study the processes and phenomena with a spatial size ~10 km and characteristic time few hours.
Sea surface temperature (SST) data from satellite observing platforms are assimilated into the model once a day. These data are provided by the MHI Remote Sensing Department and available on the web site [http://dys.net.ua](http://dys.net.ua).

1.4. **Atmosphere forcing.**
The atmospheric forcing on the sea surface is specified by the high-resolution regional atmospheric model operated in the real-time by the National Meteorological Administration (NMA) of Romania based on Meteo-France ALADIN family. ([www.arso.gov.si/ewglam_2005/presentations/02_romania.pdf](http://www.arso.gov.si/ewglam_2005/presentations/02_romania.pdf)).

1.5. **Regional model.**
The high-resolution nested grid model can be adapted to any Black Sea region. The bounded coordinates of the region, number of grid points and frequency of input data from basin-scale model to regional model are set by user. The nesting method that has been used is a passive, off-line, one-way interaction, where the nesting provides for information to be passed along the open boundaries from the basin scale model coarse grid to the regional high-resolution grid models. An integral constraint is applied so that the net mass flux across the open boundaries is identical to the net flux in the basin scale model. The main improvement is in the forecasting over the narrow coastal region, which is not adequately resolved by the coarser grid model.

II. **The VLIZ has provided with the MHI the passwords and logins needed to reach the server. In addition, the necessary service programmes for preparing of initial data, atmosphere forcing boundary data and data for assimilation have been installed.**

- **Recommendations:**
  - To exclude the stage of compilation during models runs and to keep only the executable files of models.
Phase 2.1: Standardization of the taxonomy used at the IBSS according to the European Register of Marine Species (ERMS) where relevant.

- **Description:**
  Standardization of the taxonomy used at the IBSS according to the European Register of Marine Species (ERMS) where relevant.

- **Expected deliverables:**
  Standardized Taxonomy to be used at IBSS

- **Status:**
  Phase 2.1 is ongoing now

- **Report:**
  Discussions with IBSS staff revealed that no taxonomy standardization activities are undertaken on the permanent basis and no global or European marine species registries are used to check and standardized taxonomy. Usually IBSS scientists use specific registers that are focused on one group of organisms like “Copepod Database: Diversity and Geographic Distribution of Marine Planktonic Copepods”.
  
  It was decided that when species related datasets from any sources is going to be included in IBSS database the species names will be verified towards ERMS and corresponding APHIAID for the species or higher taxon will be put to database and, at the same time, the original species name (as it was found in dataset primary source) will be preserved. This task is being performed by dataset originators.
  
  Zooplankton species from several IBSS cruises (18) and datasets (2) where checked towards ERMS and appropriate APHIAID were filled in database.

  To enable user to view full species information from ERMS the direct link was established between IBSS database and ERMS:
Phase 2.2: Test run of the MHI Black Sea hydrodynamic model using Virtual Lab and GRID computer facilities.

- **Description:**
  Test run of the MHI Black Sea hydrodynamic model using Virtual Lab and GRID computer facilities.

- **Expected deliverables:**
  Information necessary to specify the required computer infrastructure and changes to be made in the Black Sea hydrodynamic model to run it using Virtual Lab and GRID computer facilities. Brief report.

- **Status:**
  Phase 2.2 is fully completed. However, at the time of writing the interim report, already some corrections in codes of models have been made according to recommendations.

- **Report:**
  Test runs of models in the different modes have been carried out remotely from the MHI offices. These tests included:
  
  - Transformation the initial fields of sea temperature, salinity, level and current velocity created earlier in z-coordinates to sigma-coordinates.
  
  - Setting all necessary management parameters.
  
  The most essential changeable parameters are contained in the file “param.txt”. They are:
  
  - “time” – sets the initial time moment (time=0.0 corresponds to 1Jan1992 00hr, you can find correspondence between this time scale and real date in the file “calendar2007”);
  
  - “nread” - restart parameter: if nread=0 then run begins with initial fields, if nread=1 then from intermediate fields, which are written in the file “restart”;
  
  - “idays” - number of days to run;
  
  - “irest” - interval (in time steps) of writing “restart” file;
  
  - “ioutint” - interval (in time steps) of writing “out.dat” file and displaying on the screen some integral parameters.
  
  - “ioutf” - the frequency or writing output fields in the folder “12”;
  
  - “nsst” - assimilation of SST flag, if nsst=1 then you run the model with assimilation of SST, if nsst=0 then without;
  
  - “nas” - assimilation of altimetry flag, if nas=1 then you run the model with assimilation, if nas=0 then without;
  
  - “nest” - flag for writing data for the nesting model, if nest=1 then file is written, if nest=0 then not.
  
  - “lnest” - the frequency or writing fields for the nested model.
• Runs of the basin-scale model without assimilation of satellite sea level and surface temperature.
This is an example of results of calculations of sea level during these runs:

![Image of basin-scale model without assimilation]  

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• Runs of the basin-scale model with assimilation of satellite sea level and surface temperature.
This is an example of results of calculation of water density along the cross-section at 43N of latitude during these runs:

![Image of basin-scale model with assimilation]
• Visualization of the results of calculations using the GrADS software.

The examples of visualization of the results of calculations using the GrADS software:

The forth day of simulation. Salinity on the depth of of 2.5 m
without altimetry data assimilation with altimetry data assimilation

North-western shelf, 1 – without altimetry data assimilation, 2 – with altimetry data assimilation

Cross-sections along 31 E. Results obtained by using assimilation procedure

2)
Run the basin-scale model in order to prepare initial and boundary conditions (at the open boundary) for the fine resolution regional model. If parameter \( \text{nest}=1 \), user must enter from the screen minimum and maximum values of longitude and latitude of the region he chosen. Fields for the nested model are being written in the folder “Nest”. It is the file “nested”. In addition, two informative files are being written in this folder: “coord” containing information for the regional model and “info” containing information about records in “Nest” file.

Run the regional nested model.
The region:
Longitude: 27.473-28.512 85 grid points
Latitude : 41.486-43.841 165 grid points
(Basin scale grid cell was divided by 5x5 parts – new space resolution was about 1km.)
Time step: 3min.
Model run- 3 days (output for 3 days)
The model domain:
• Visualization of the results of calculations using the GrADS and SURFER Software.

Examples:

a) Using SURFER

![Salinity map 1992](image1)

b) Using GrADS:

The second day of simulation. Velocity fields on the depth of 40 m.

![Velocity fields 1994](image2)
Results obtained by regional model on the depth of 20 m.

Temperature

Salinity

The installed system showed ability and efficiency to simulate the Black Sea circulation remotely. The main improvement is in the forecasting over the narrow coastal region, which is not adequately resolved by the coarser grid model.

- **Recommendations:**
  - The data input to the models must be provided from individual input files not from the computer screen;
  - The input files must be located in the one folder;
  - The output files must be located in the arbitrary place on computer;
  - To develop script files for visualization of simulation results.
Phase 3.1: Data extracted and where necessary transcribed from paper from the archives at IBSS, according to standards developed.

- **Description:**
  Data extracted and where necessary transcribed from paper from the archives at IBSS, according to standards developed.

- **Expected deliverables:**
  Data contributed to OBIS and GBIF, through EurOBIS.

- **Status:**
  First test IBSS dataset was contributed to OBIS

- **Report:**
  DiGIR provider was installed and configured on IBSS server.
MSSQL view was created to extract biogeographical records from IBSS database:

First test dataset was provided to OBIS (809 records)

As new biogeographical records are put to the IBSS database they will be automatically included to the OBIS database view and transferred to the OBIS.
Phase 3.2: Operational phase for the Hydrodynamic model.

- **Description:**
  Operational phase for the Hydrodynamic model.

- **Expected deliverables:**
  Web based multidisciplinary geographic information system

- **Status:**

  Phase 3.2 does not officially fall within the first halve of the project. Most of the subtasks that are part of this phase still have to be started.
Phase 4.1: Dissemination of the project results in Ukraine, other Black Sea countries, and to entire scientific community.

- **Description:**
  Preparation of the project final report and scientific papers on the project results.

- **Expected deliverables:**
  Project final report and scientific papers submitted for publication.

- **Status:**
  Phase 4.1 is the last phase and does not officially fall within the first half of the project. However, based on the results already got within another phases of the project, the process of the dissimilation of the project results has been actively started by both institutions.

**MHI:**
Some project results were presented at these scientific meetings:

1. NATO-Advanced Research Workshop, September, 2007, Balchik, Bulgaria: 
   **Gennady Korotaev:** Design of the Black Sea operational forecasting system.

2. EuroGOOS 2008 Conference “Coastal to Global Operational Oceanography: Achievements and Challenges”, May, Exeter, GB: 
   **Alexander Kubryakov:** The Black Sea Nearshore Regions Forecasting System: operational implementation.
   **Gennady Korotaev:** Operational forecast of the Black Sea dynamics.

3. Training courses for the end-users “**Possibilities of operational oceanography and prospects of their use in Ukraine**”, 16-17 July 2008, Sevastopol.
   **Alexander Kubryakov:** The use of Virtual Lab to run of the Black Sea circulation models.

**IBSS:**
Some project results will be presented at these scientific meetings:

1. Fourth International Training Course for Young Researches

2. 2nd Biannual Conference **CLIMATE CHANGE IN THE BLACK SEA - HYPOTHESIS, OBSERVATIONS, TRENDS, SCENARIOS AND MITIGATION STRATEGY FOR THE ECOSYSTEM**, held in Sofia, Bulgaria, in October 2008.
   **Slipetsky, D.; et. al.** (2008), Black Sea Mnemiopsis Leidyi database and plankton check list: online tools developed within the black sea scene project.
Vladymyrov, V. (2008), Availability of data for the Black Sea climate change research.
Sergeyeva, O. et. al. (2008), Integrated data and information management system to collect and analyze biological data for climate change research.

There are three software tools that were created by IBSS within the EC Black Sea SCENE project for the Black Sea scientists: Mnemiopsis Database, Phytoplankton Check-list, and Zooplankton Check-list. They were developed based on the IBSS IT infrastructure created within the Ocean Ukraine project and the web sites of these tools have the corresponding acknowledges. Their screenshots are given below.
Phase 4.2: Preparation of the project final report and scientific papers on the project results.

- Description:
Preparation of the project final report and scientific papers on the project results.

- Expected deliverables:
Project final report and scientific papers submitted for publication.

- Status:
Phase 4.2 is the last phase of the project and it does not officially fall within the first halve of the project. However, some scientific papers the results of which are partly based on the project results and created IT infrastructure are already published. They are:

Slipetskyy, D.; Sergeyeva, O.; Gorbunov, V.; Vladymyrov, V.; Tezcan, D.; Myroshnychenko, V.; Gucu, A. (2008), Black Sea Mnemiopsis Leidyi database and plankton check list: online tools developed within the black sea scene project, Published in: Moncheva, S. (Ed.) BS-HOT 2008 Collected Reprints, Published on CD, 2008.


ANNEXES