Marchuk Institute of Numerical Mathematics
of the Russian Academy of Sciences

Informational Computational System "INM RAS – Baltic Sea" for the marine environment state monitoring

Zakharova N.B., Agoshkov V.I., Lezina N.R. ,
Parmuzin E.I., Sheloput T.O., Shutyaev V.P.

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Introduction

- The main objective of the Informational Computational System (ICS) is reliable monitoring and forecasting of hydrophysical fields of the Baltic Sea and risk management

- The ICS includes numerical model of the Baltic Sea hydrothermodynamics, the oil spill model *(Agoshkov, Aseev et al., 2014)* describing the propagation of a slick at the sea surface and the optimal ship route calculating block *(Agoshkov, Zayachkovskiy et al., 2014).*

Introduction

- It is possible to calculate main hydrodynamic parameters:
  - temperature,
  - salinity,
  - velocities,
  - sea level.

using user-friendly interface.

Main possibilities of the ICS are presented in the work.

ICS STRUCTURE

- ICS is based on the INMOM numerical model of the Baltic Sea hydrothermodynamics developed in the INM RAS. *(Zalesny et al., 2013)*

The ICS includes:

- the block of variational data assimilation *(Agoshkov et al., 2015)*
- The tidal forces block *(Agoshkov, Assovskii, 2015)*
- The data processing module *(Zakharova, 2016)*
- The interface *(Sheloput et al., 2017)*

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Currently, the ICS allows to assimilate the sea surface temperature (SST)

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Data downloading, interpolation of data on the numerical model grid and the data verification

- The interface *(Sheloput et al., 2017)*

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The desktop version and web-interface

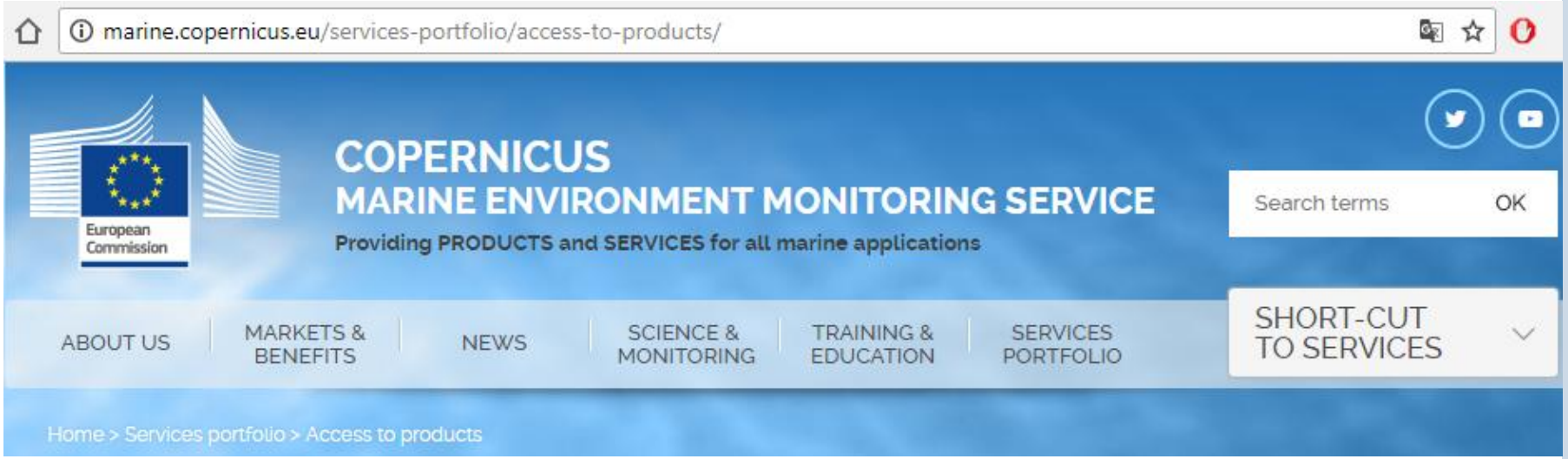
DATA

The ICS includes a block of SST variational data assimilation.

It is possible to use various observational data in numerical calculations:

2007-2017 years operational data (2018)

The data source used in the work is a Marine environment monitoring service (http://marine.copernicus.eu) by the European project Copernicus.



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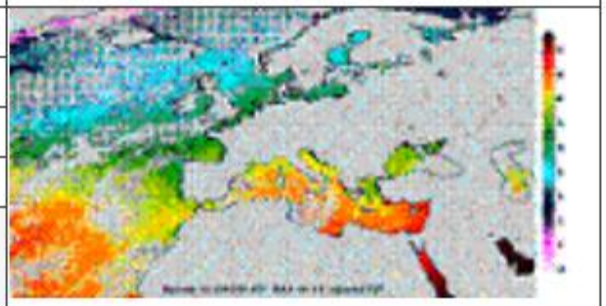
For the assimilation procedures of the operational data we use European ocean-sea surface temperature multi-sensor L3 observations in ICS. It is a daily-mean SST satellite observations.

SST_EUR_SST_L3S_NRT_OBSERVATIONS_010_009_A		
EUROPEAN OCEAN- SEA SURFACE TEMPERATURE MULTI-SENSOR L3 OBSERVATIONS		
OBSERVATION	L3	BAL NWS IBI
SST ⓘ		
0.02 degree x 0.02 degree (Surface only)		
From 2012-12-18 to Present		
daily-mean		
MORE INFO ADD TO CART WMS Sub-setting		

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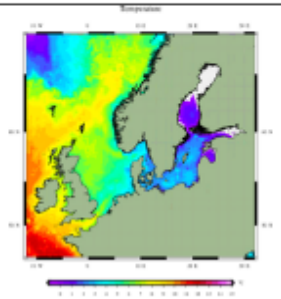
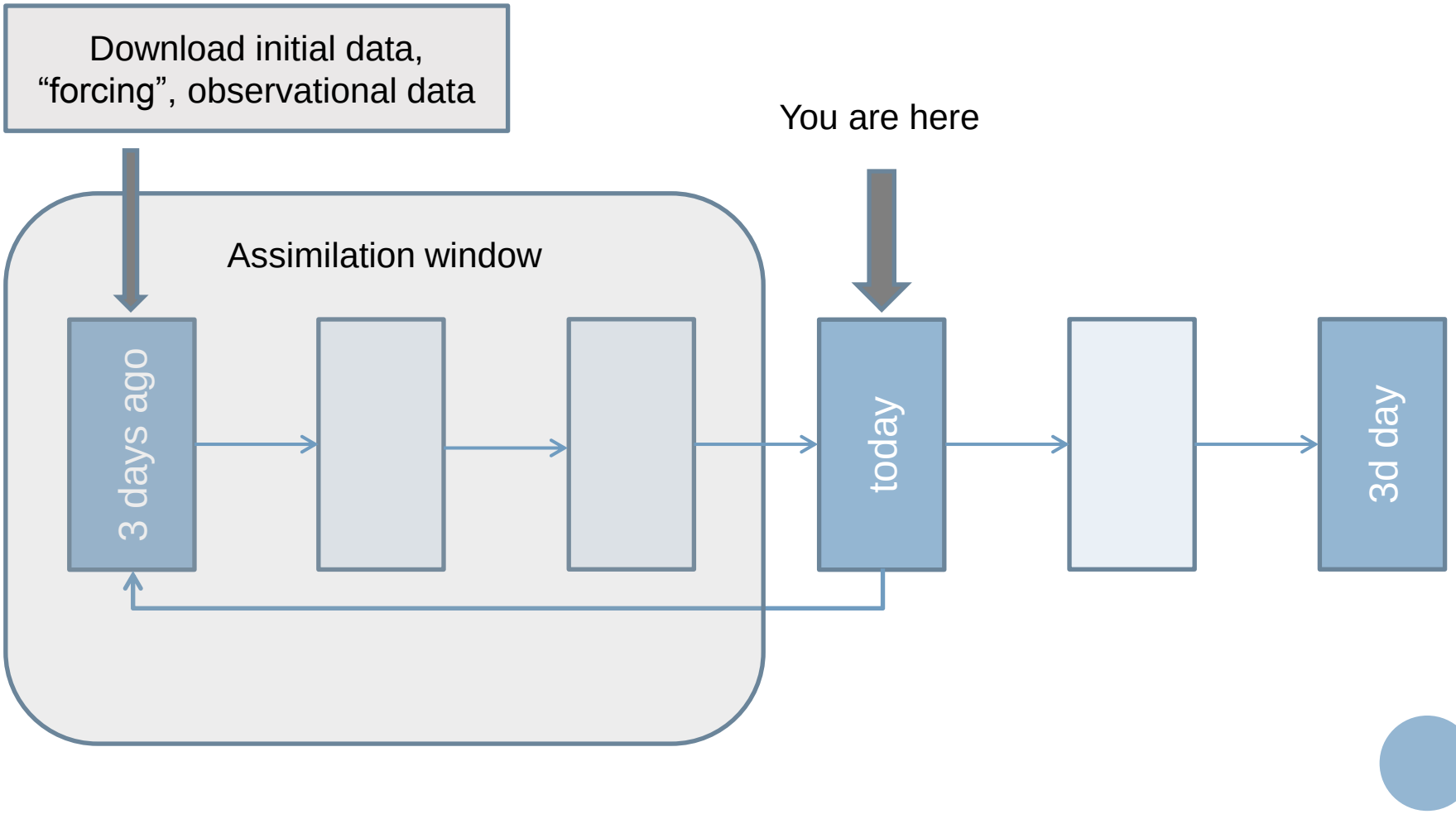
SST_BAL_SST_L4_REP_OBSERVATIONS_010_016		
BALTIC SEA- SEA SURFACE TEMPERATURE REPROCESSED		
OBSERVATION	L4	BAL
SST SIC ⓘ		
0.03 degree x 0.03 degree (Surface only)		
From 1982-01-01 to 2011-12-31		
daily-mean		
MORE INFO ADD TO CART WMS Sub-setting		

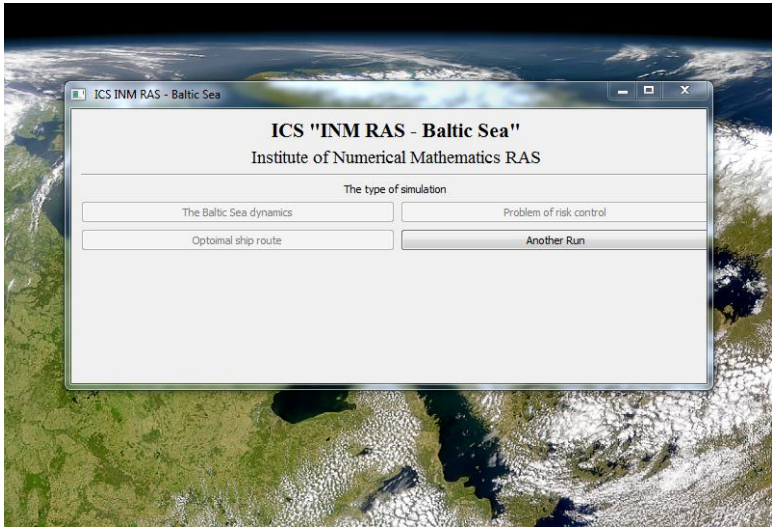
For calculations at older times, the observed data corresponded to mean daily Baltic SST according to the data of the Danish Meteorological Institute (Karagali et.al., 2012) are used, recalculated to the grids of the numerical model.

Operational forecasting

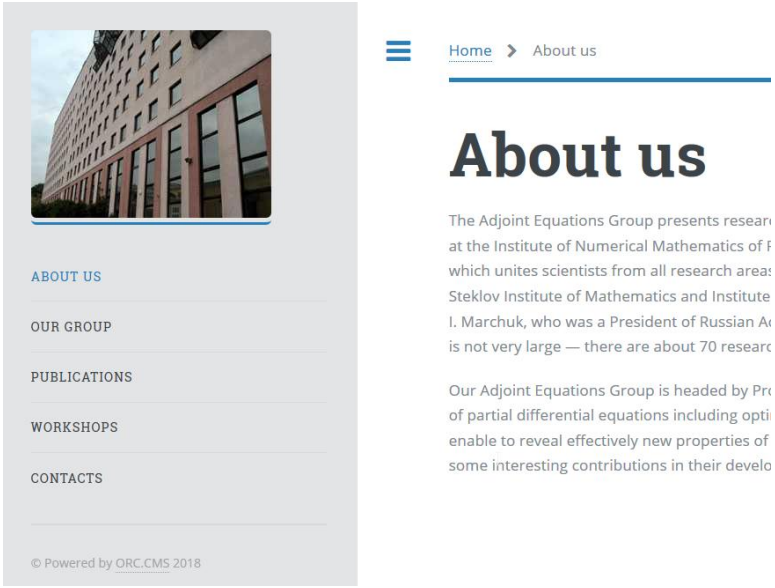


ICS INTERFACE

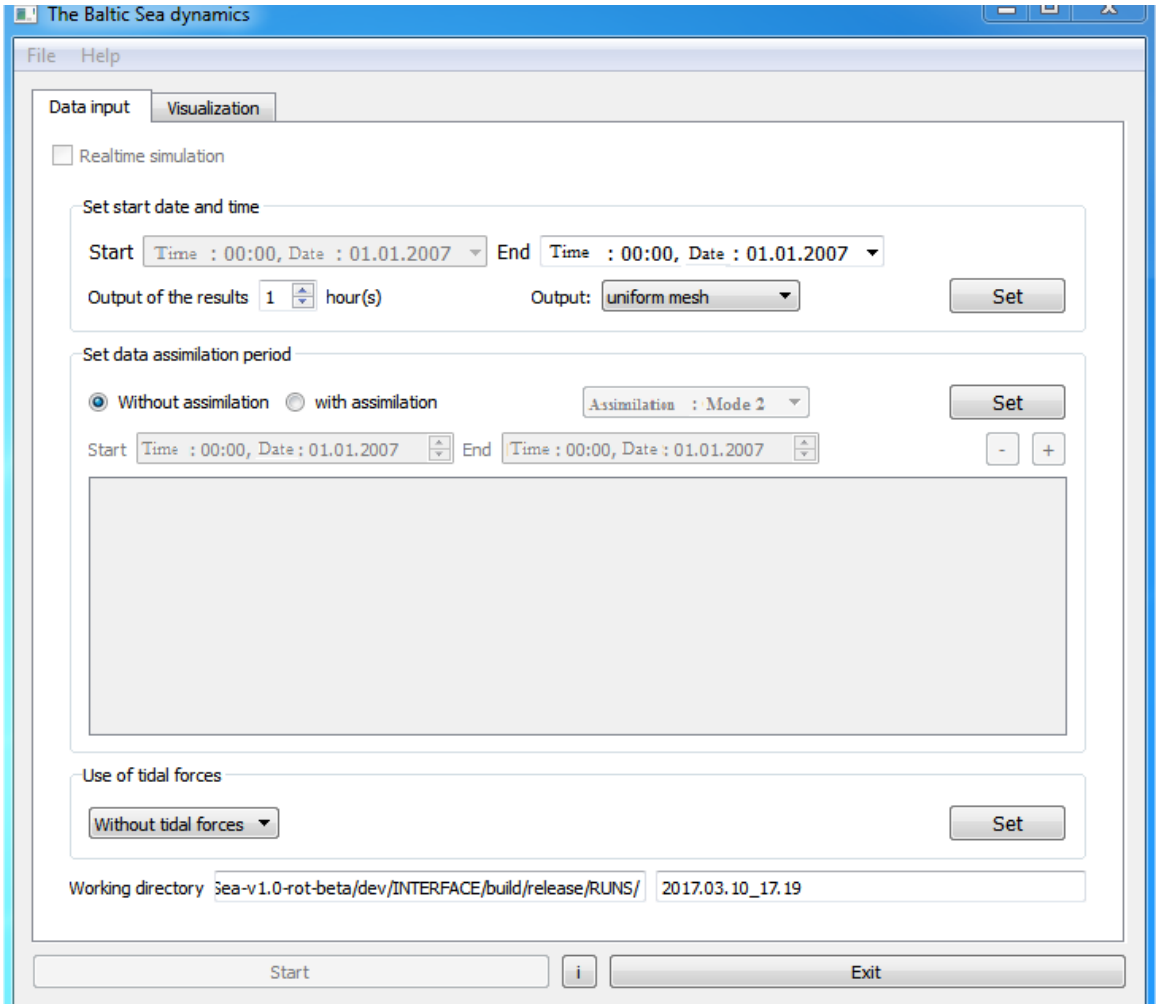
Desktop version (completed)



Web interface (in progress)



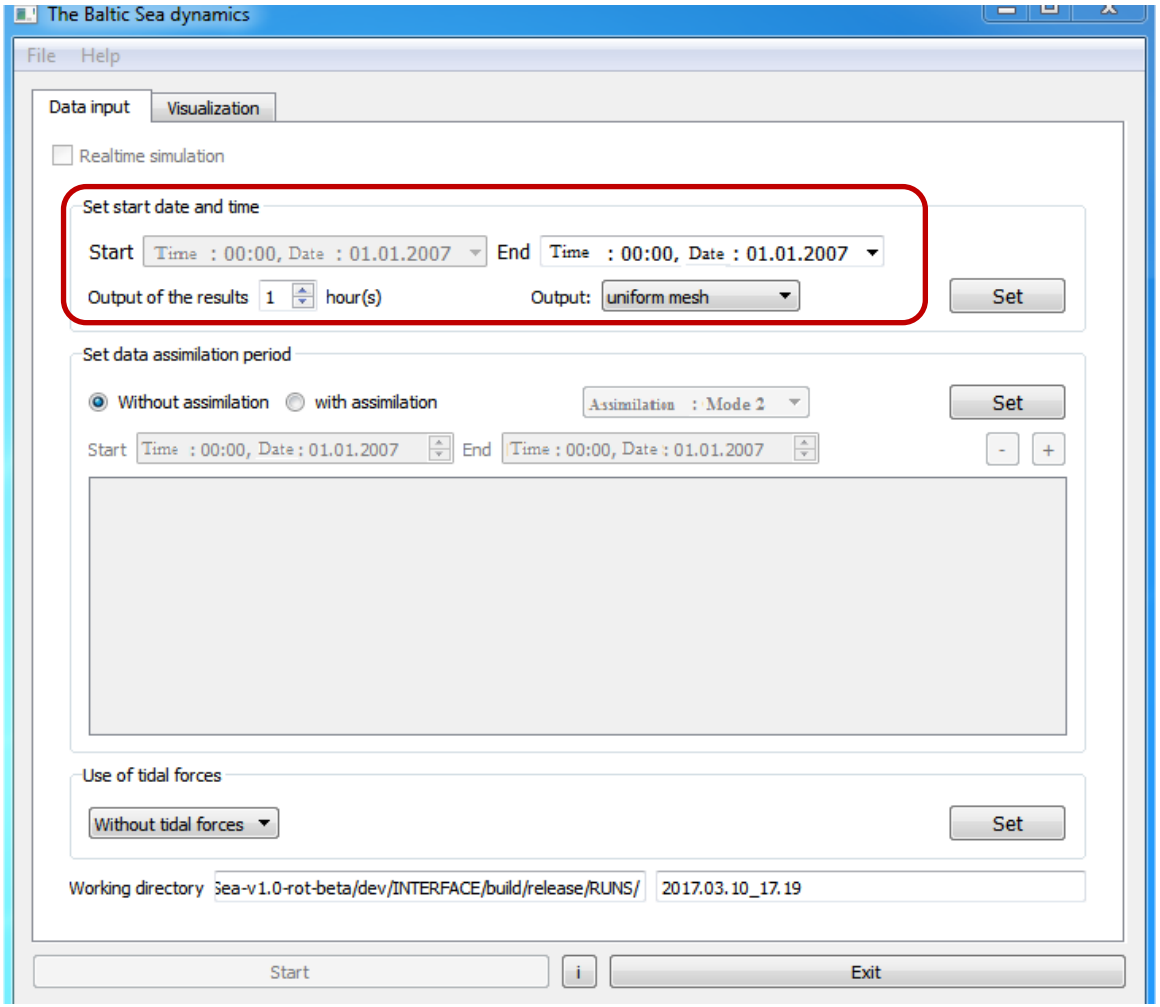
DESKTOP VERSION



The Baltic Sea dynamics block allows one to process the following information for the Baltic Sea area:

- sea currents,
- thermohaline structure and the density of water,
- distribution of basic hydrological and special settings.

Desktop version



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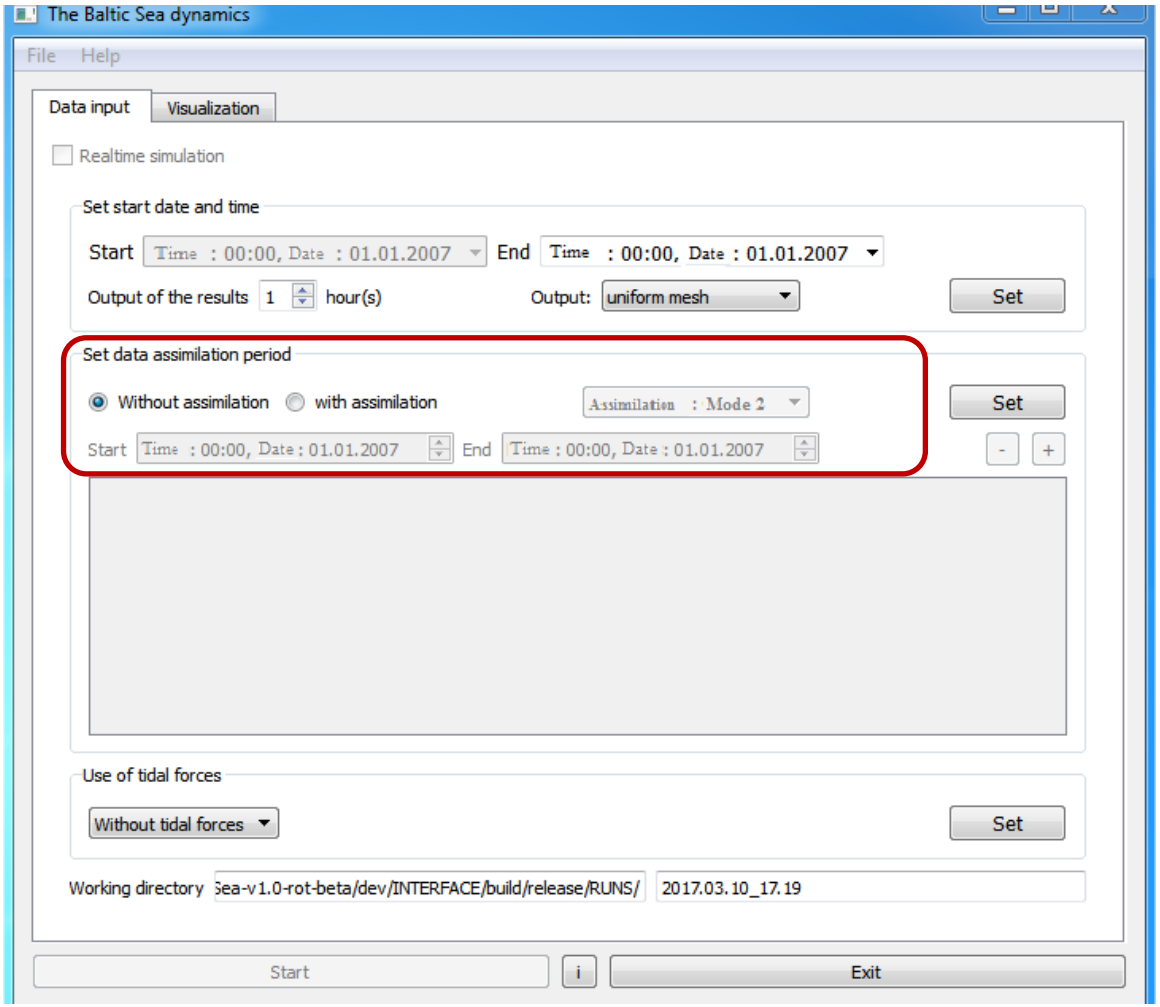

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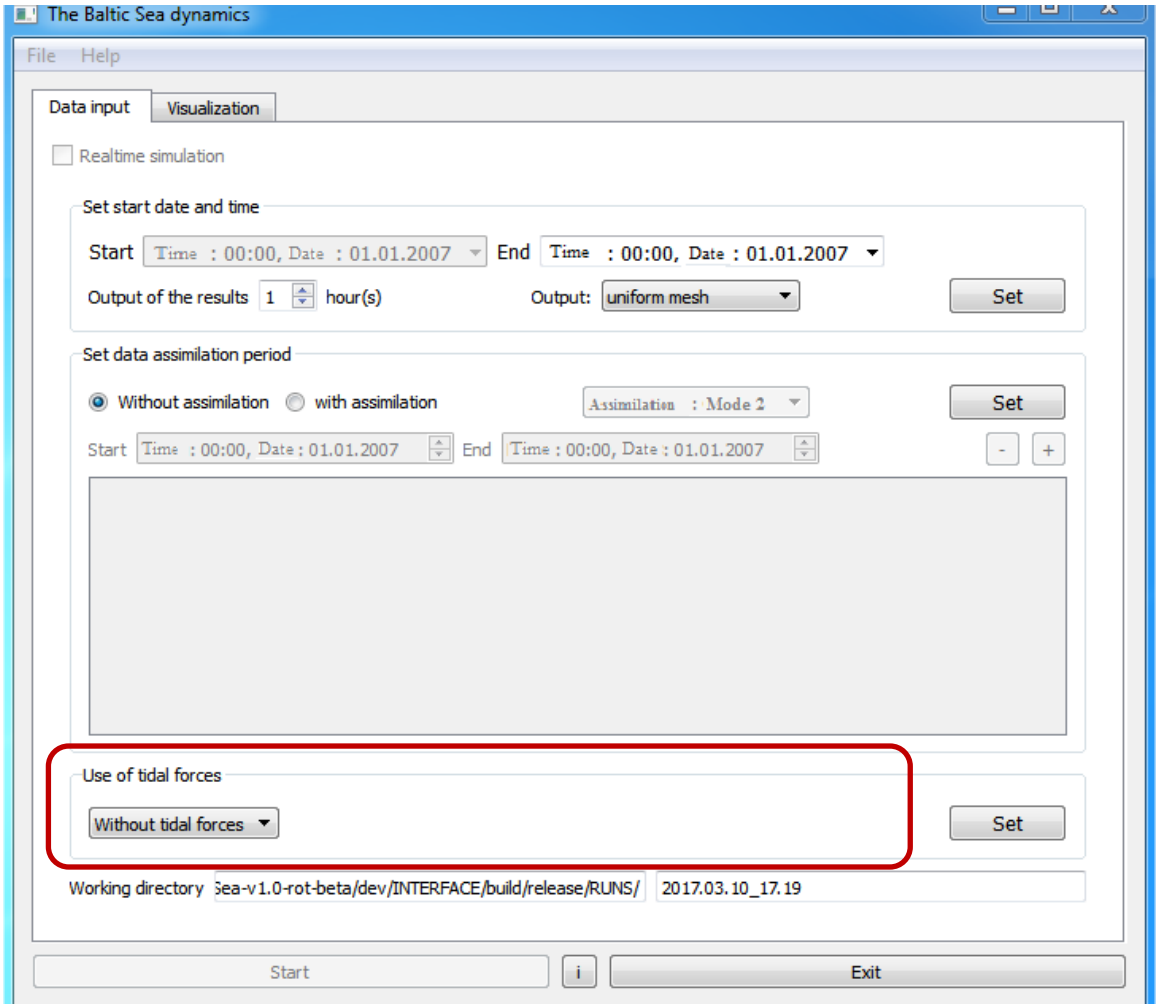

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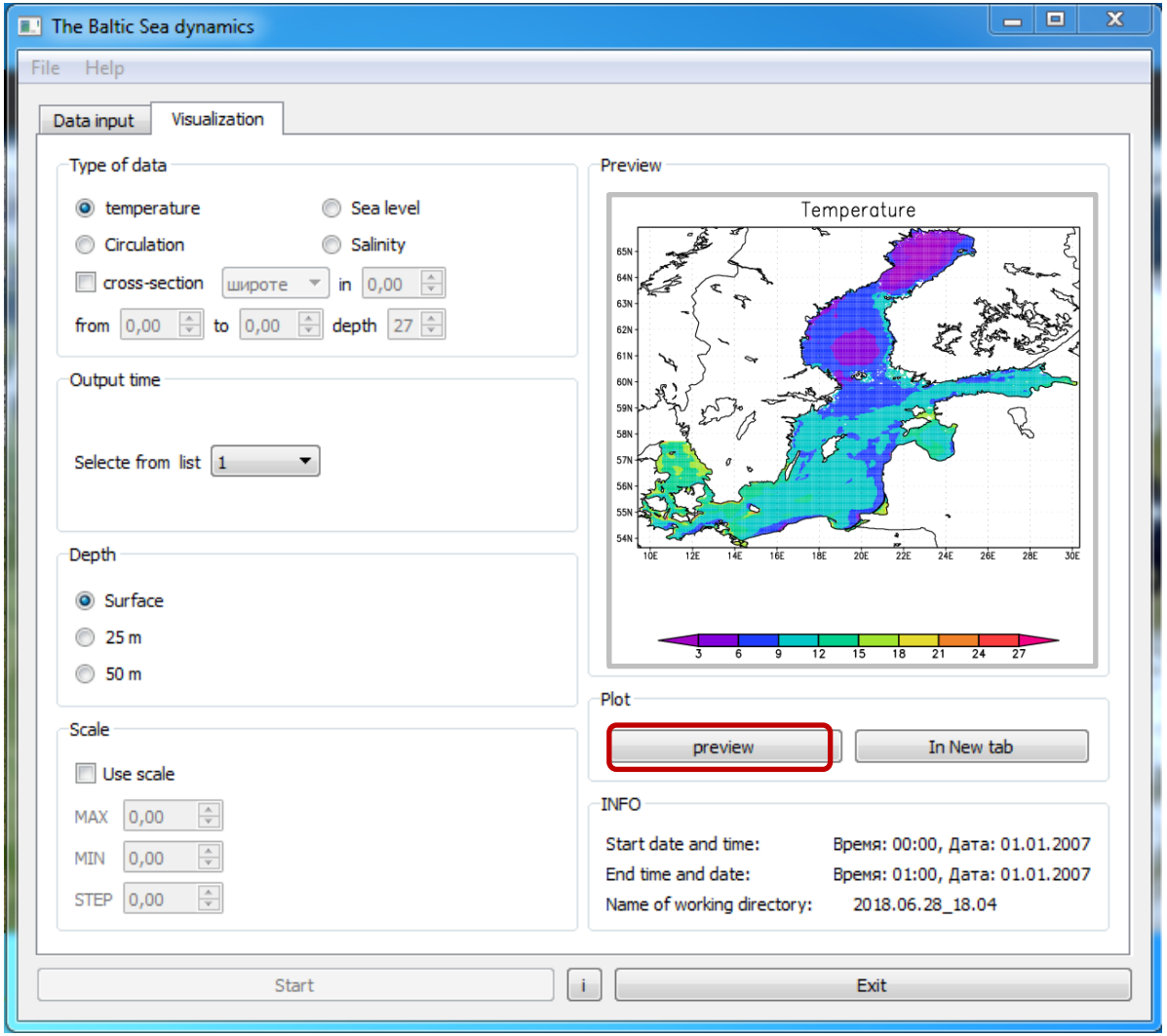

ICS allows one to carry out calculations of the following hydrodynamic parameters:

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The ICS allows to store, load and view the results of the experiments.

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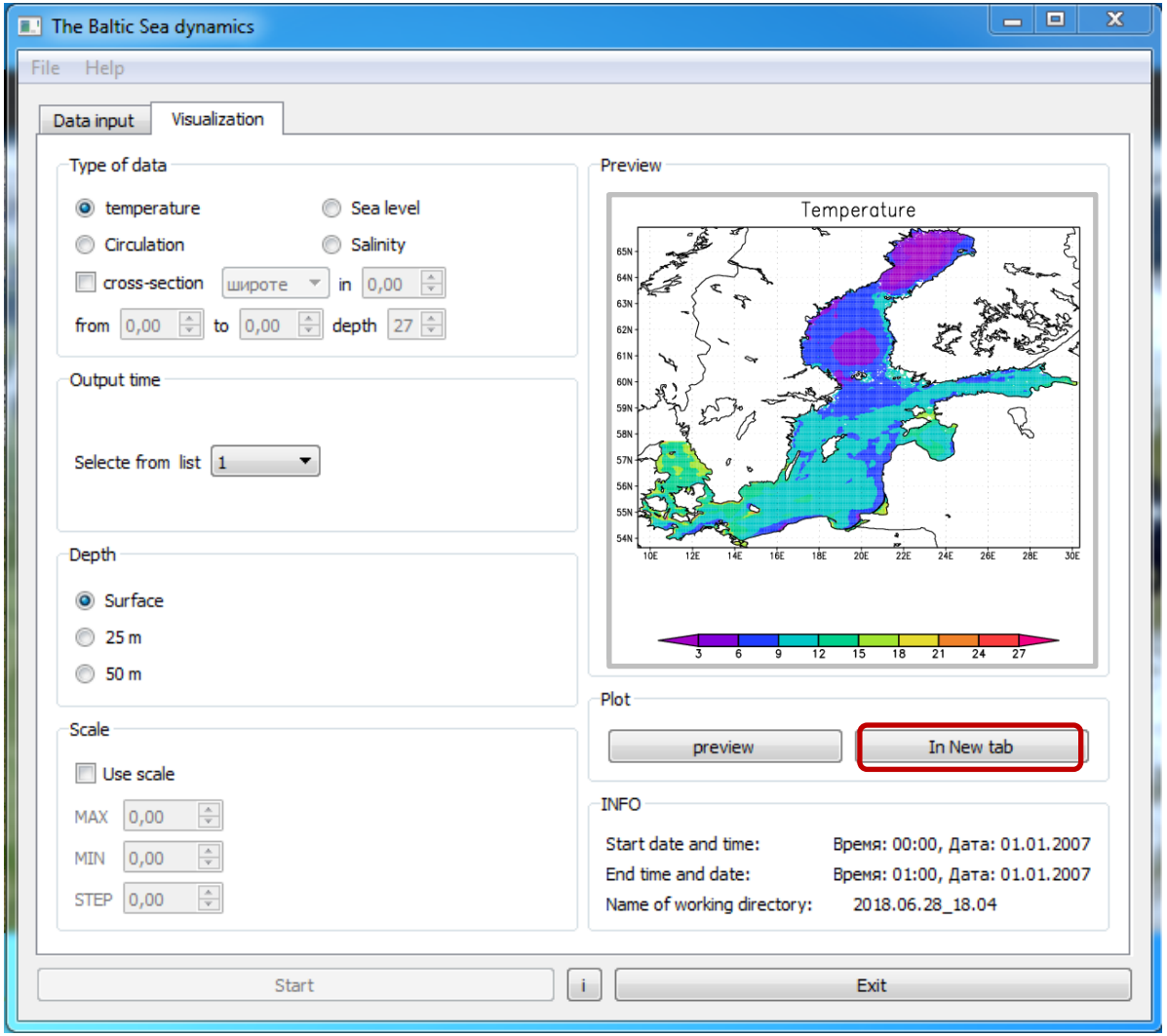

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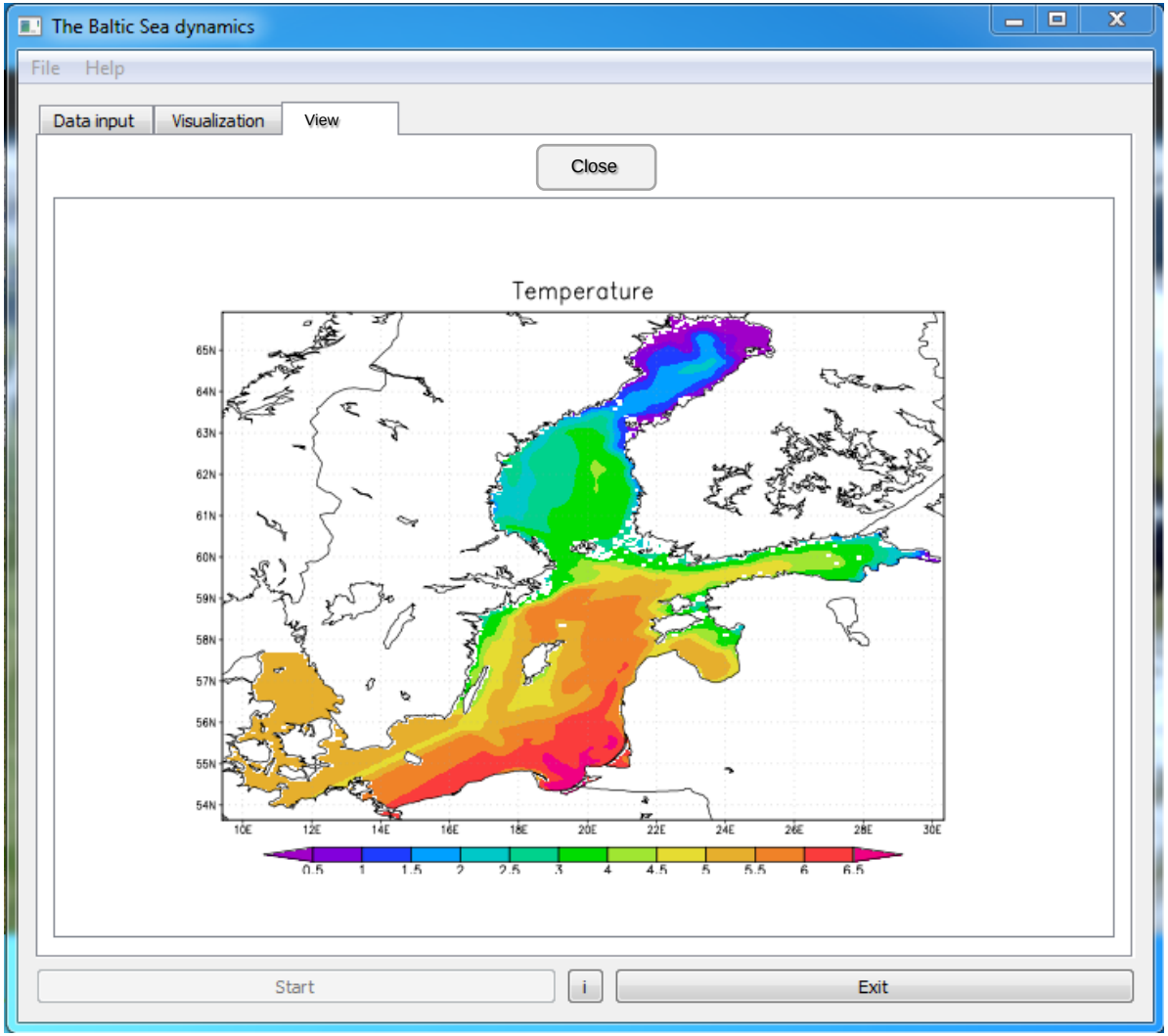

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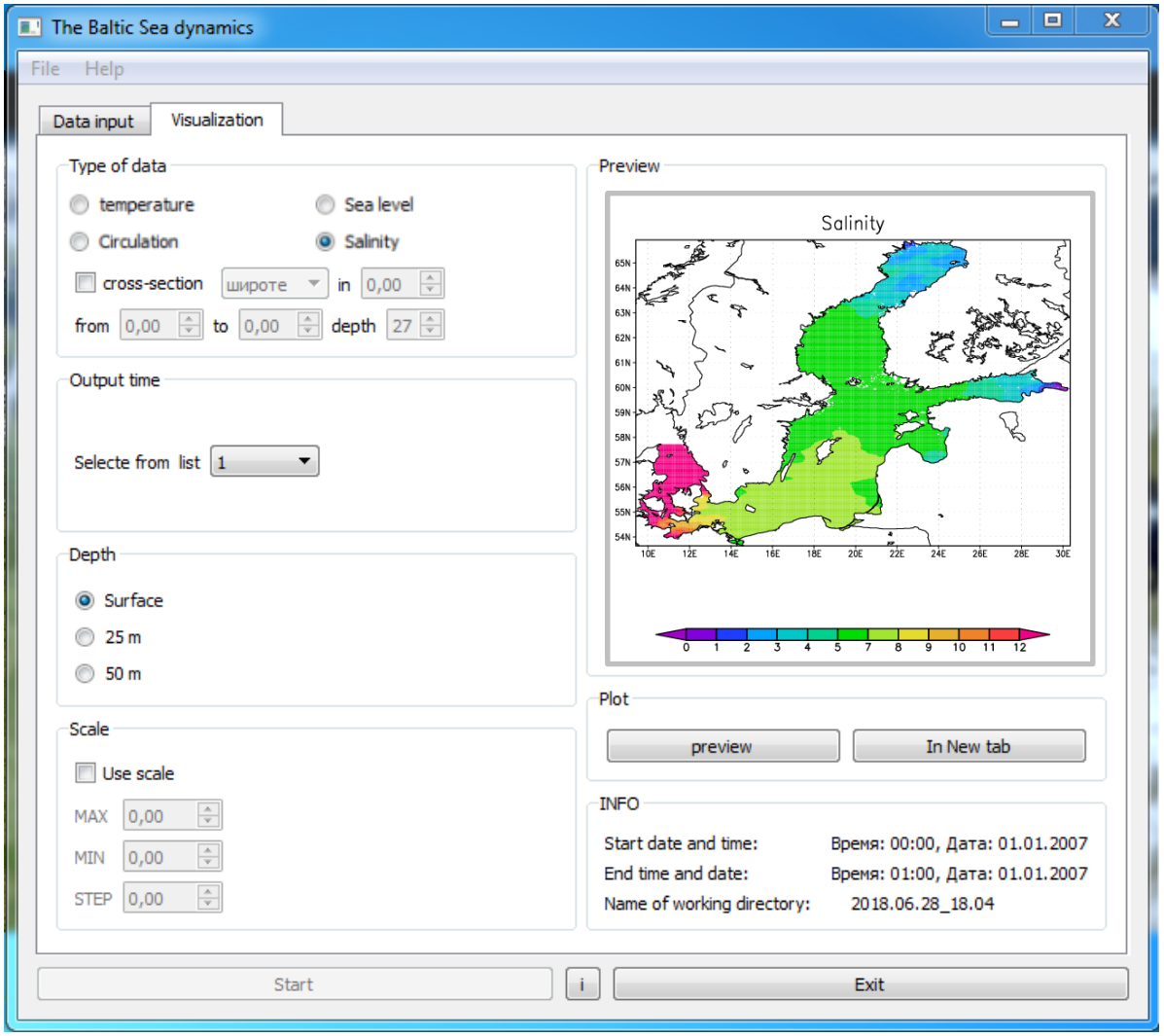

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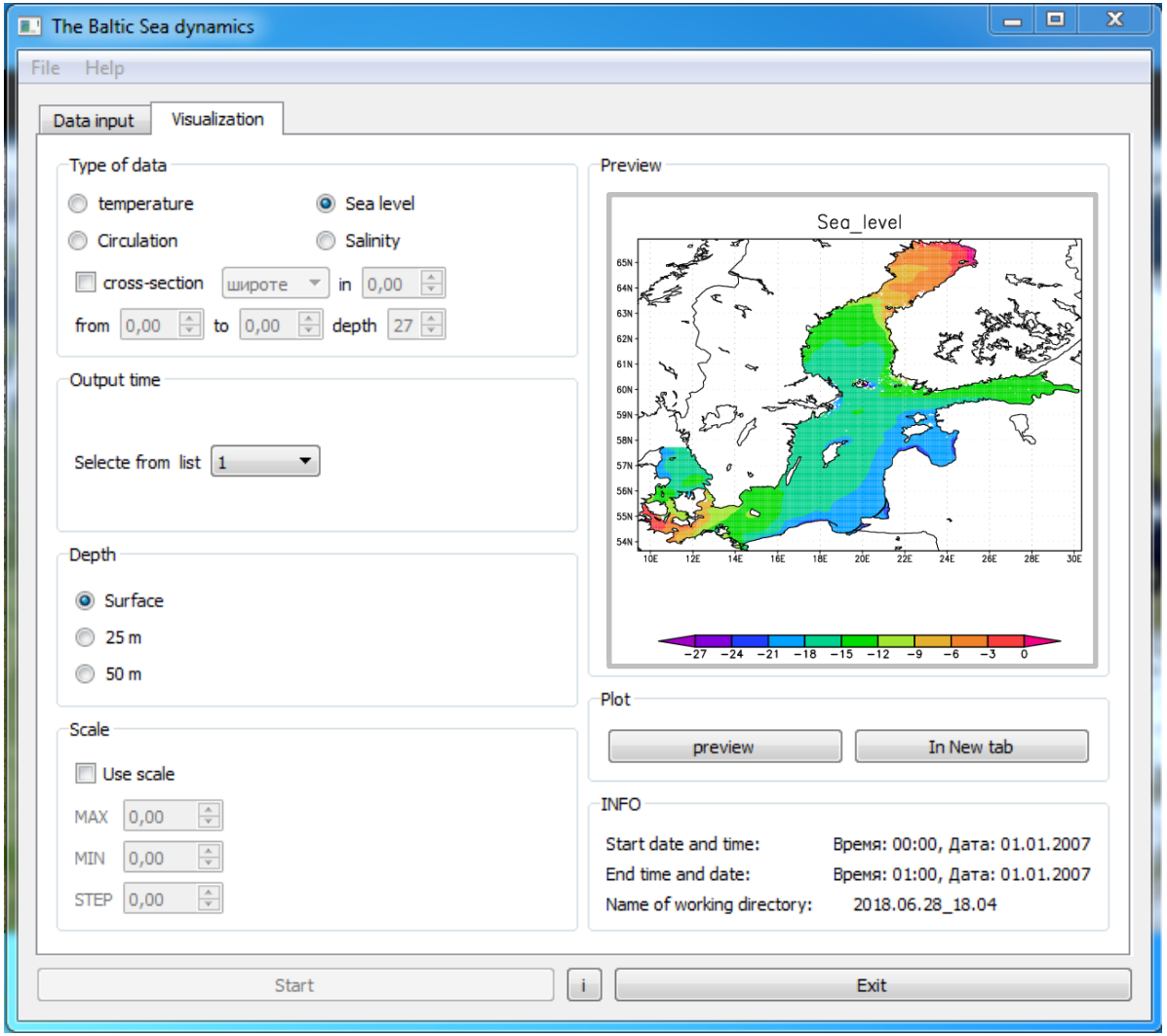

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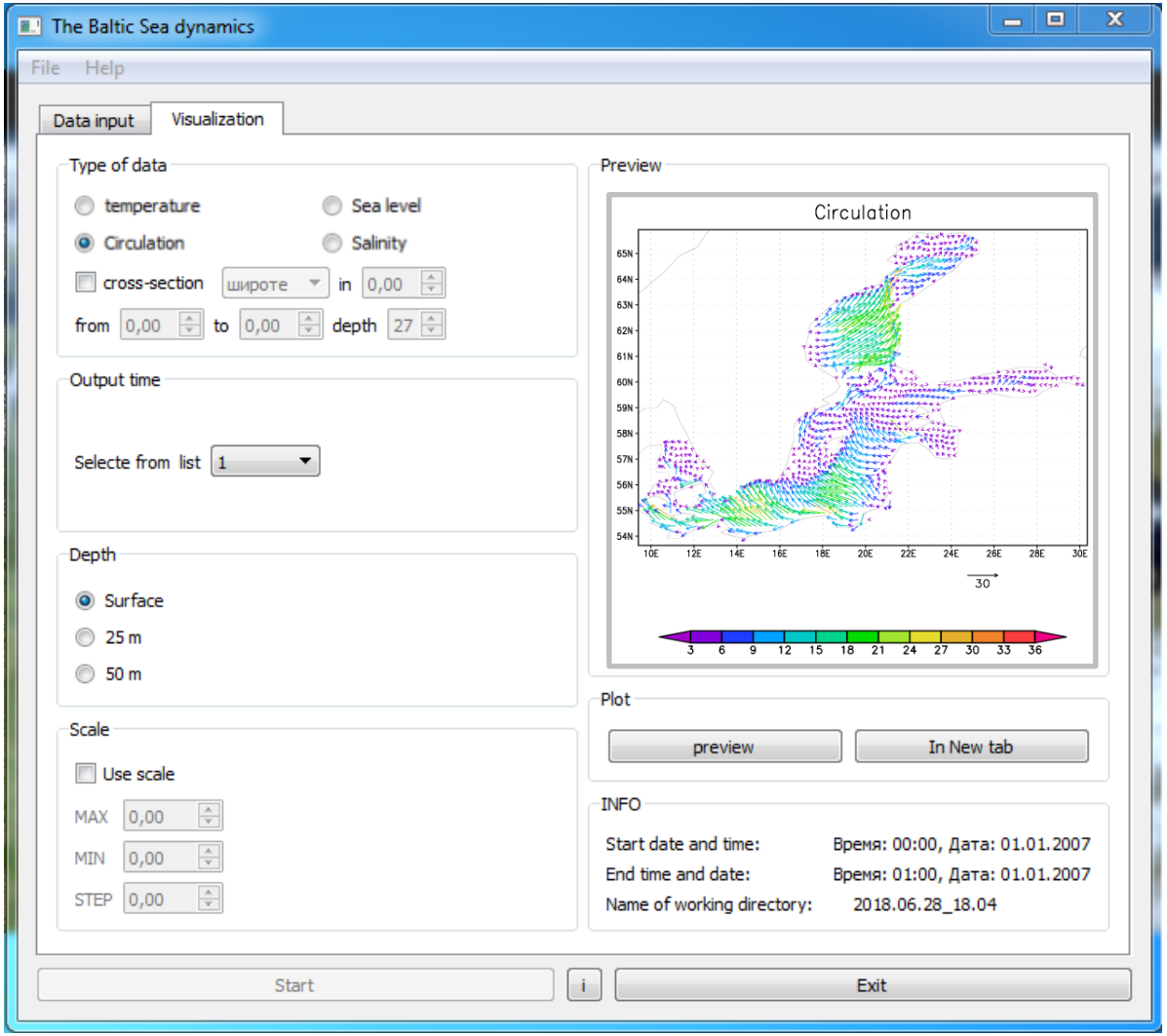

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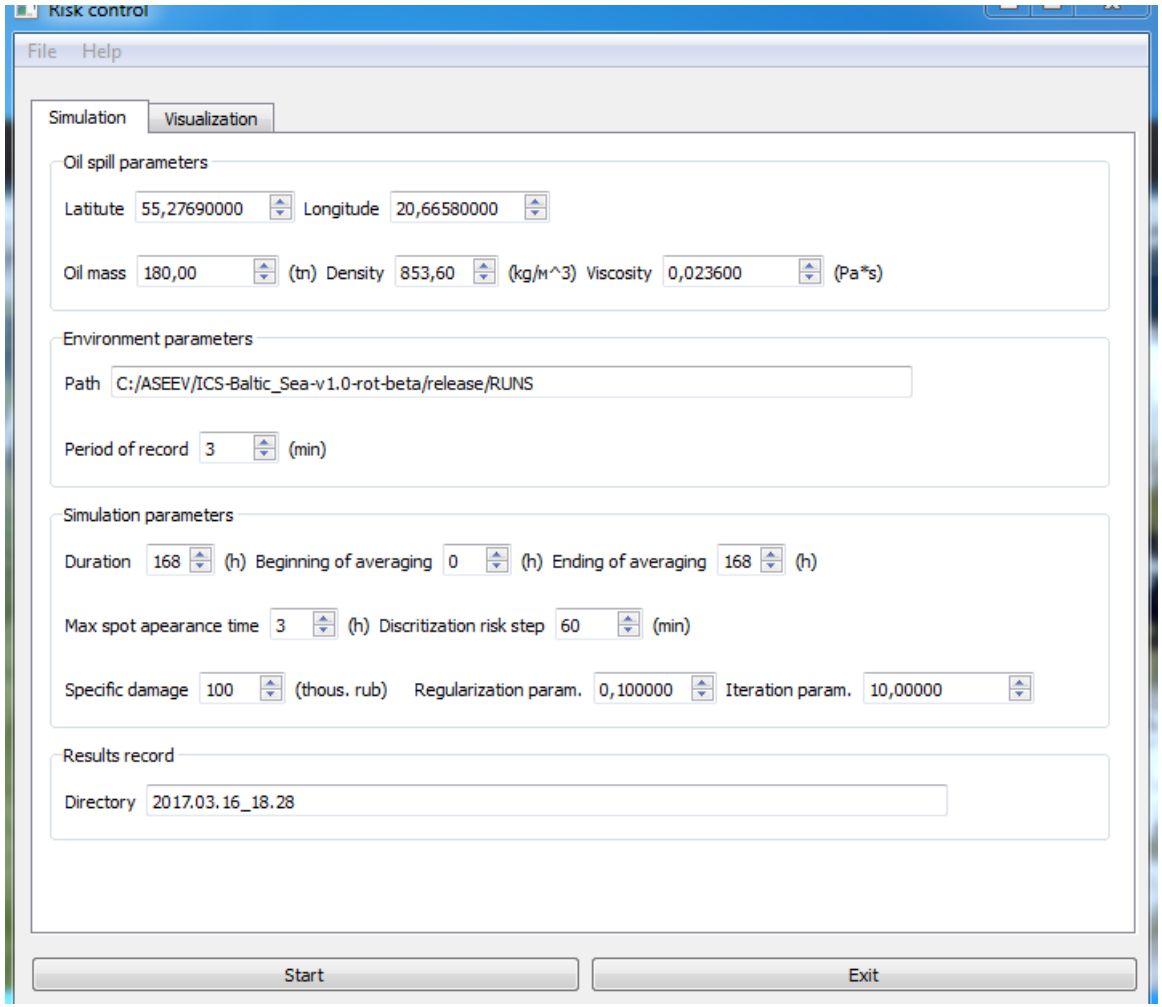
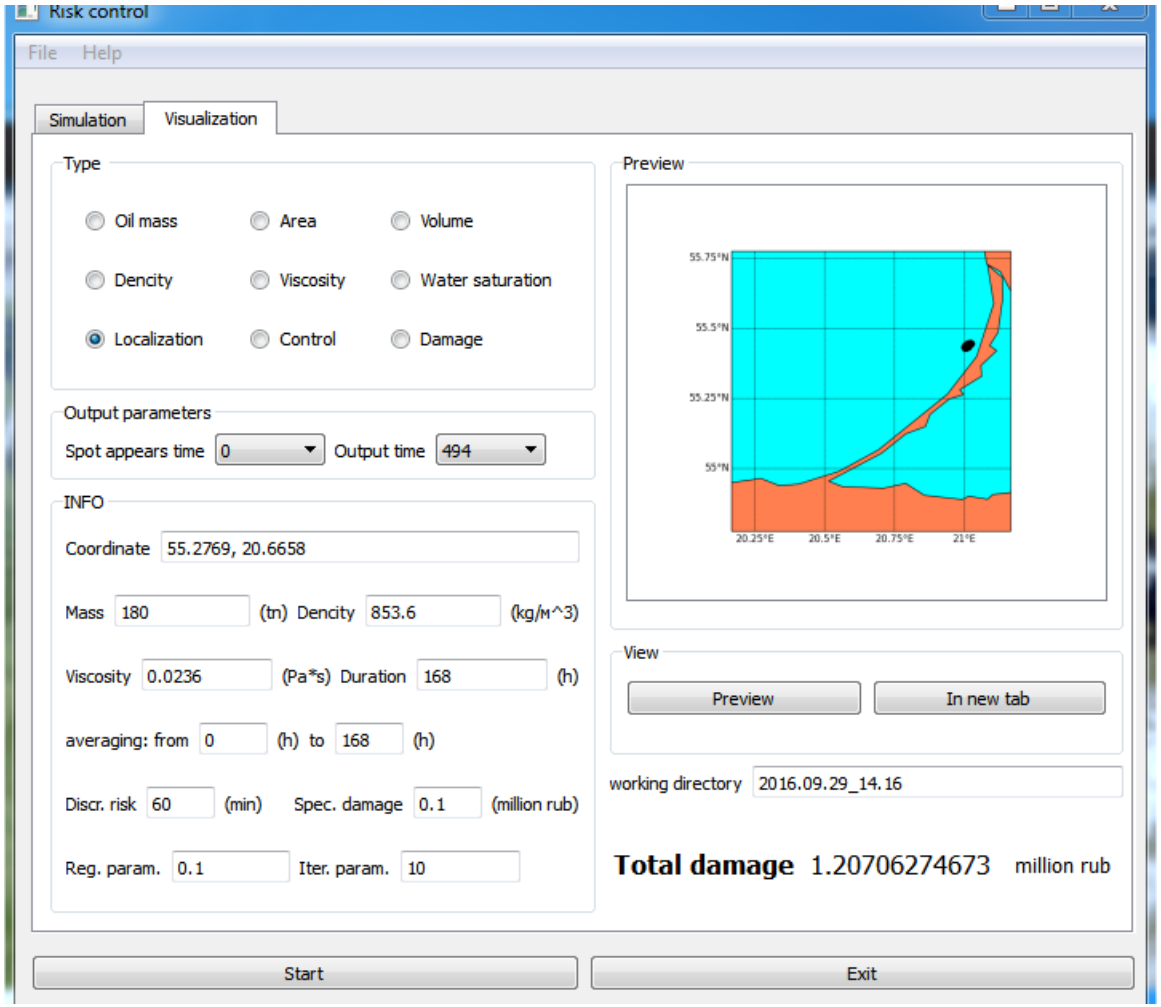
The risk control block



ICS allows to carry out calculations to solve a class of problems on risk management of oil pollution in the Baltic Sea:

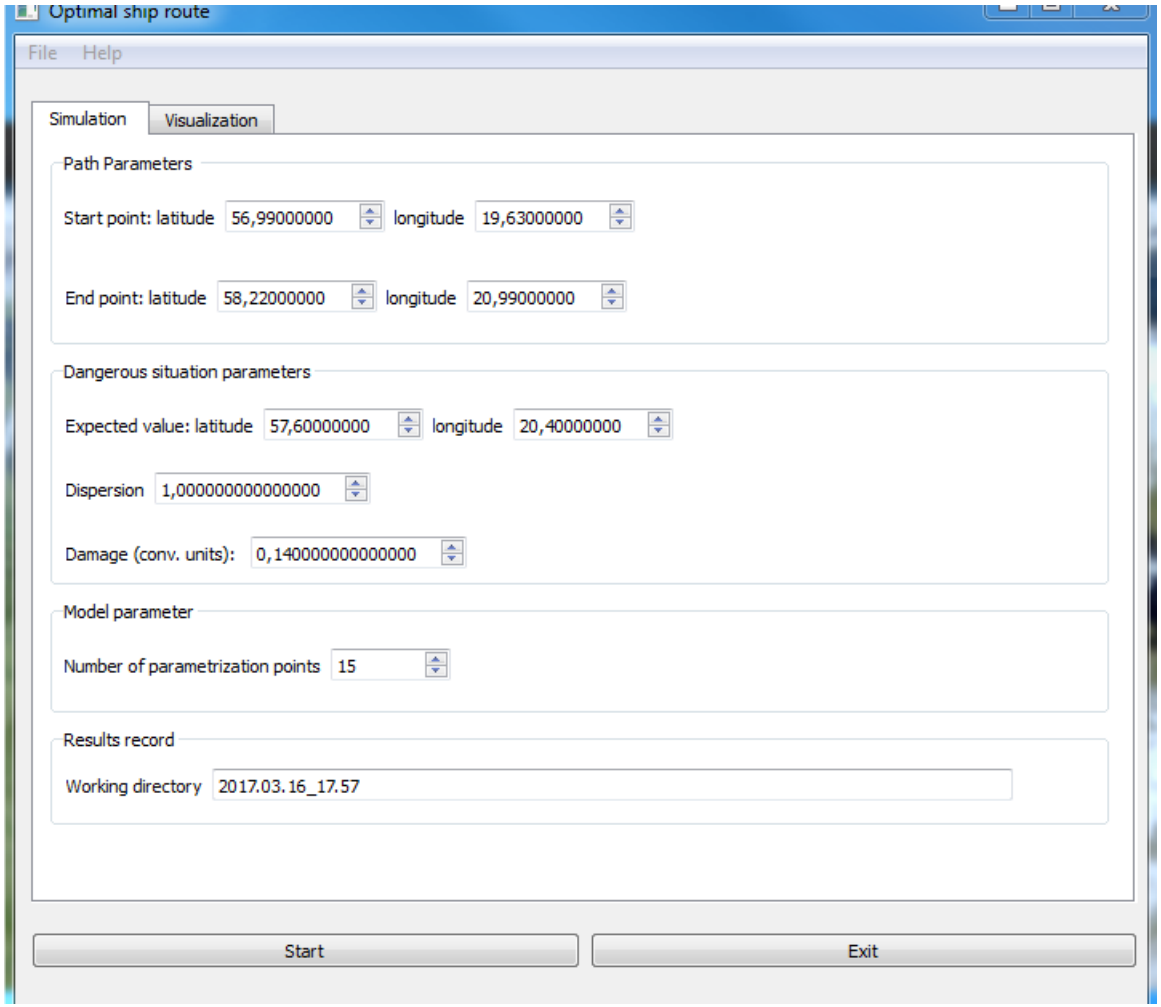
- to simulate the evolution of the various spot parameters (mass, volume, area, oil, density, viscosity, water content of the emulsion type "water-in-oil") under the influence of different types of methods for removing oil;

The risk control block



- to calculate the dependence of loss on the time of appearance of spots;
- to calculate the final risk value;
- to save and view the results in a graphic form, to download the earlier calculations for the visualization of the results.

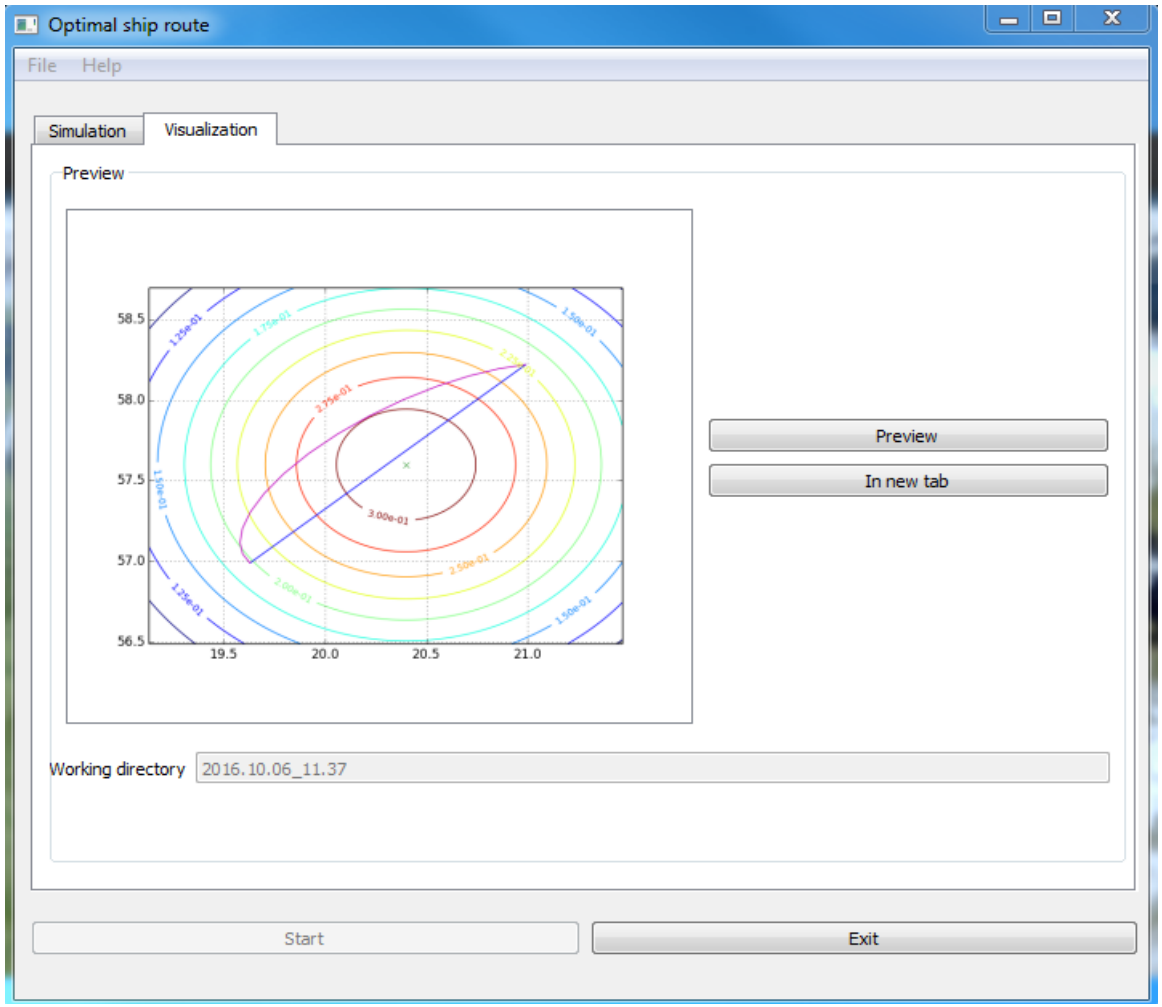
THE OPTIMAL SHIP ROUTE BLOCK



ICS allows to carry out calculations of the optimal ship route in stationary threats. In the system one can control the following parameters:

- the starting and ending points of the initial trajectory;

The optimal ship route block



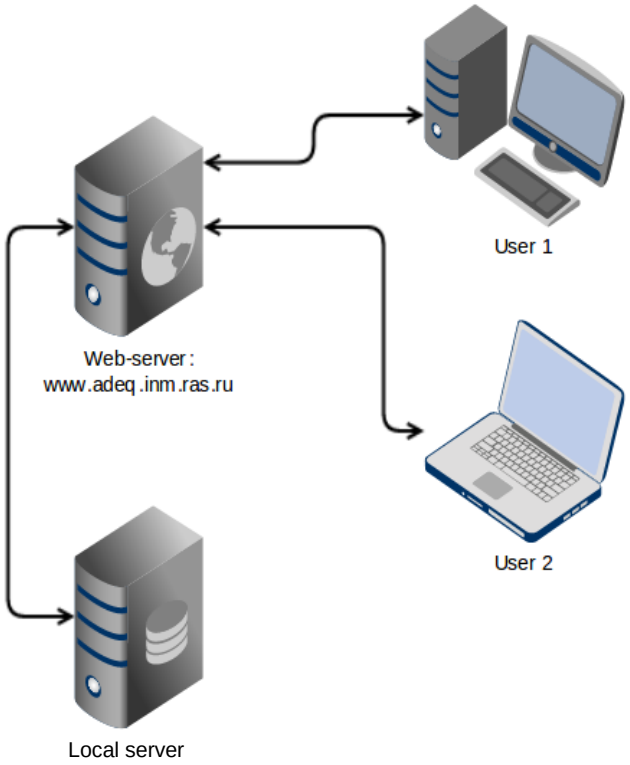
- mathematical expectation and variance of the probability distribution of a stationary threat;
- the damage that can be caused by the threat;
- the number of nodes to discretize the initial trajectory.

ICS WEB-INTERFACE

The **multi-user version of the ICS (MU ICS)** is designed to perform calculations on remote server without installing special software on the local computer. The goal of developing a MU ICS is to allow one to make calculations remotely, using a convenient web interface for specifying calculation parameters.

This approach has several **advantages**:

1. Possibility of free access to ICS from any PC that has access to the Internet.
2. Support for the joint work of a group of users.
3. Perspectives for the development of MU ICS are determined by the variety of technical solutions, the possibility of increasing computing power (i.e. the use of clusters, etc.)



Summary

- Variational data assimilation system “INM RAS – Baltic Sea” is designed for monitoring and forecasting the state of the Baltic Sea, modeling the processes of transporting pollutants in the sea area, solving a class of problems of minimizing risks and analyzing marine accidents.
- Using the ICS will make it possible to avoid or substantially mitigate the effects of natural and man-made disasters, to provide information support in decision-making on the protection of the environment, exploitation of marine resources and providing the optimal courses of ships.
- One of the features of this system is that it is designed for high-performance computing systems, provides users with the ability to access a web-version of the ICS, assimilates the input data of observations and transmits the output in a graphical and text form.

Future plans

- To complete web-version of ICS.

The study was supported by the Russian Science Foundation (project №14-11-00609)

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