Investigation of the Baltic Sea water dynamics in various ranges of spatio-temporal scales using the model INMOM.

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In this paper we present a formulation of the problem of the Baltic Sea dynamics. The basic procedure used in the solution of the problem is the method of multicomponent splitting. This splitting method has two main roles, i.e., first, it allows one to solve the problem efficiently in time, second, to construct a flexible, hierarchically developed information and computing system. The essence of the method consists in the representation of a complex model system as a set of separate, simpler subsystems (modules).

The spatial resolution of the model is 1/15°×1/30°×25 in the longitude, latitude, and vertical direction. The grid domain contains 311×359 nodes in the horizontal plane, σ-levels are nonuniformly distributed over the depth. The time step is equal to 5 minutes.

The bottom topography has been prepared using the data presented by the St. Petersburg division of N. N. Zubov State Oceanographic Institute (SOI). The resulting topography is presented in Fig. 1.

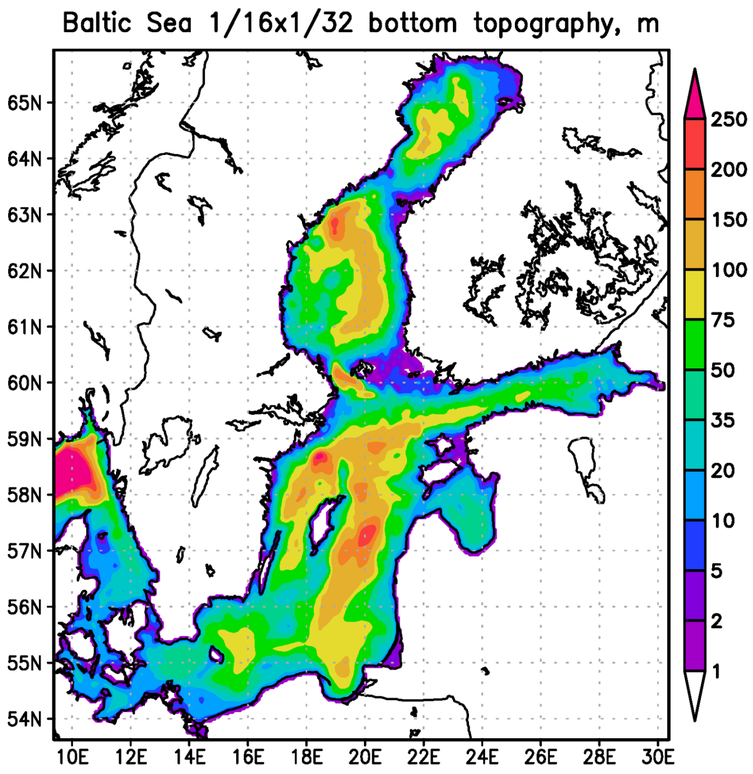
The initial conditions for the temperature and salinity are constructed from the data presented by service http://www.myocean.eu . These data include the mean monthly temperature and salinity of the Baltic Sea. These data are used for the calculation of the initial temperature and salinity fields and the average monthly climatic fields of temperature and salinity on the surface of the Baltic Sea.

The calculation of atmospheric forcing uses the characteristics from the CFSR (NOAA) dataset having the spatial resolution of 0.5◦ in longitude and latitude. The following atmospheric characteristics were used in this case: the air temperature and humidity at the height of 2 m, the pressure at the sea level, the wind velocity at the level of 10 m; the downward short-and long-wave radiation, precipitation, specified with the step of 12 hours. Sum of the water discharges was considered as a runoff, the climatic averaged monthly data of 29 rivers of the Baltic Sea was used.

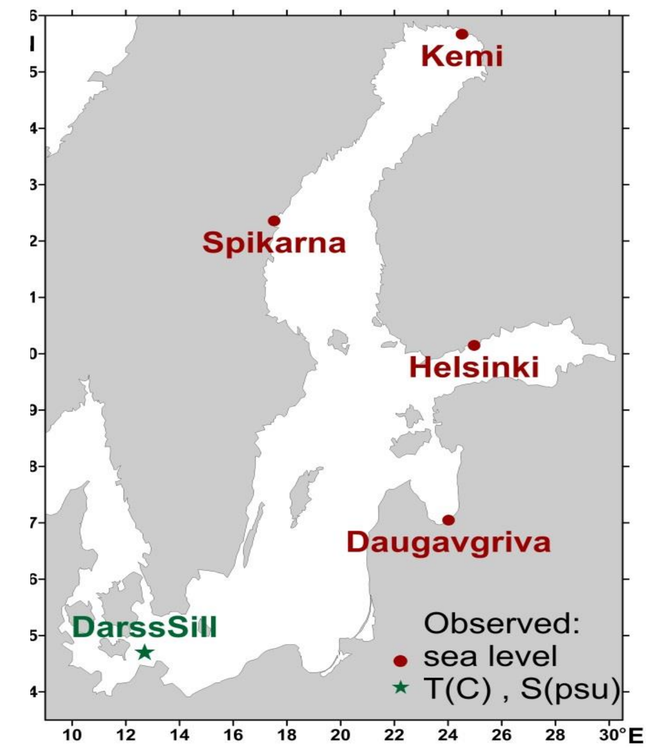
In the Danish channels hourly measurements of level at Aarhus stations (56 °09‘N, 10 °13’E) and SjaellandsOdde (55 °58’30 NL, 11 °22’20 EL) were served as boundary conditions for the sea level. Hourly data was interpolated along the whole line of the border of the area.

Comparison of the sea level calculated by the model and measured in coastal points (fig. 2) showed a good visual agreement (fig. 3). Correlation coefficients of the observed data and the calculated values of sea level are reaching 0.7-0.87.

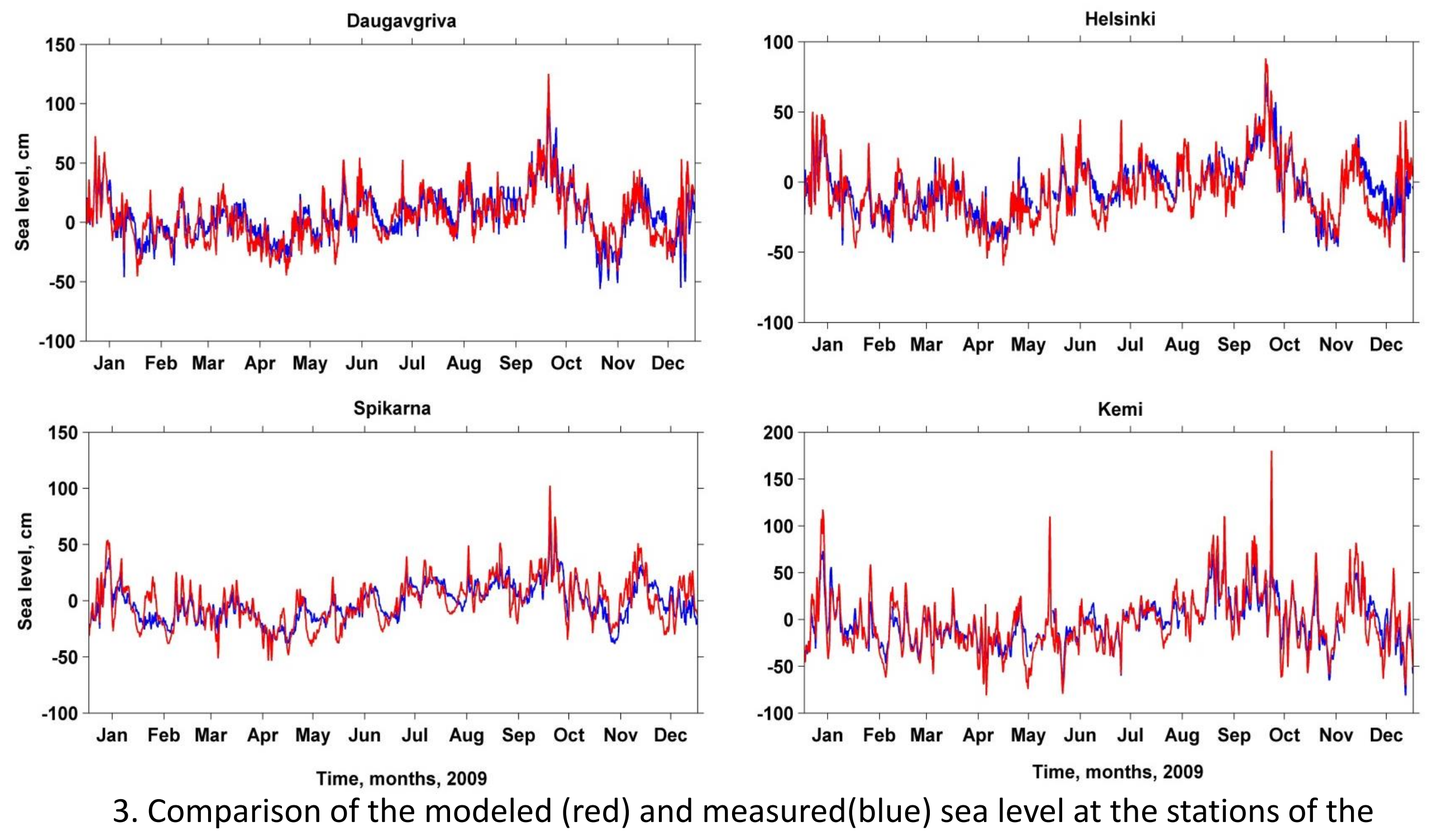
The average circulation of the Baltic Sea calculated by the model (fig. 4) is in a good agreement with the quasicontinuous sea circulation, - the cyclonic scheme of current motions is observed in the Gulf of Bothnia, both at the deep-water, and in the northern parts. A stream flow to the area of Neva and a counter-current flow on the northern coast is observed in the Gulf of Finland. In the central Baltic area cyclonic character of currents is noted also: along the east coast – to the north, and along the western coast– to the south.



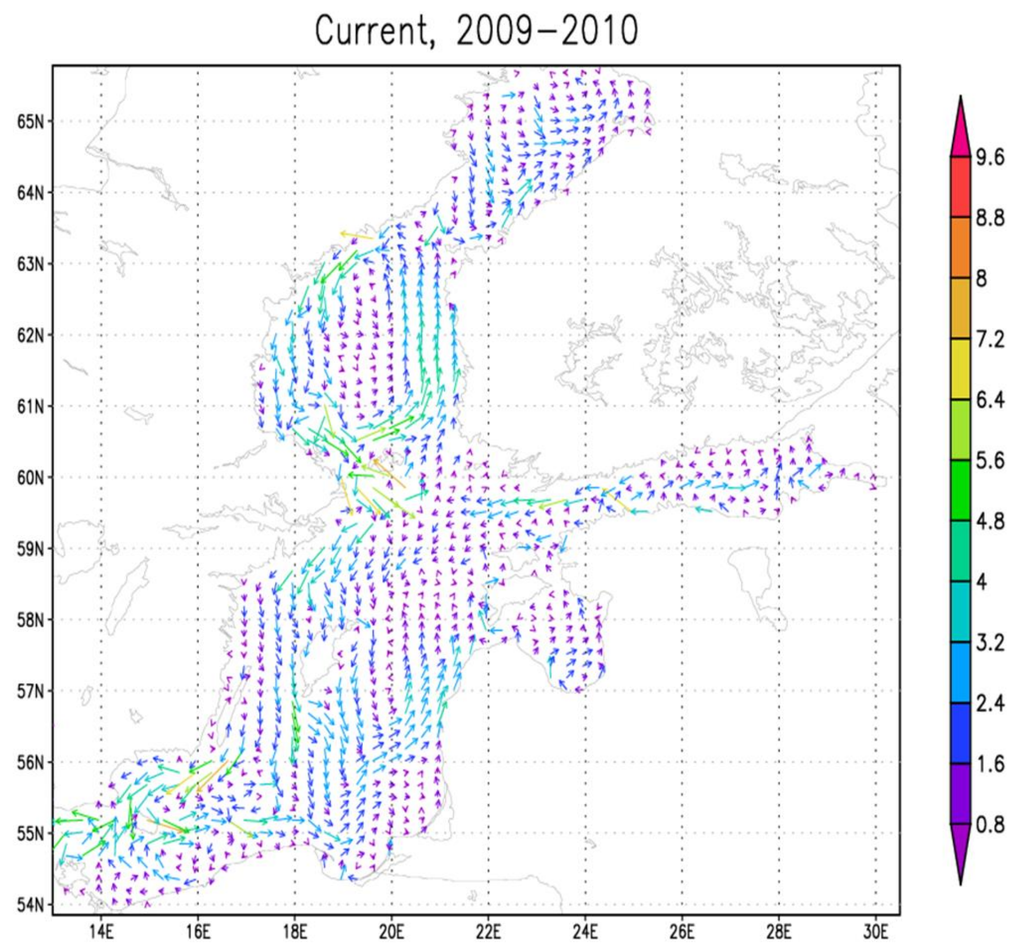
1. Baltic Sea topography [m].



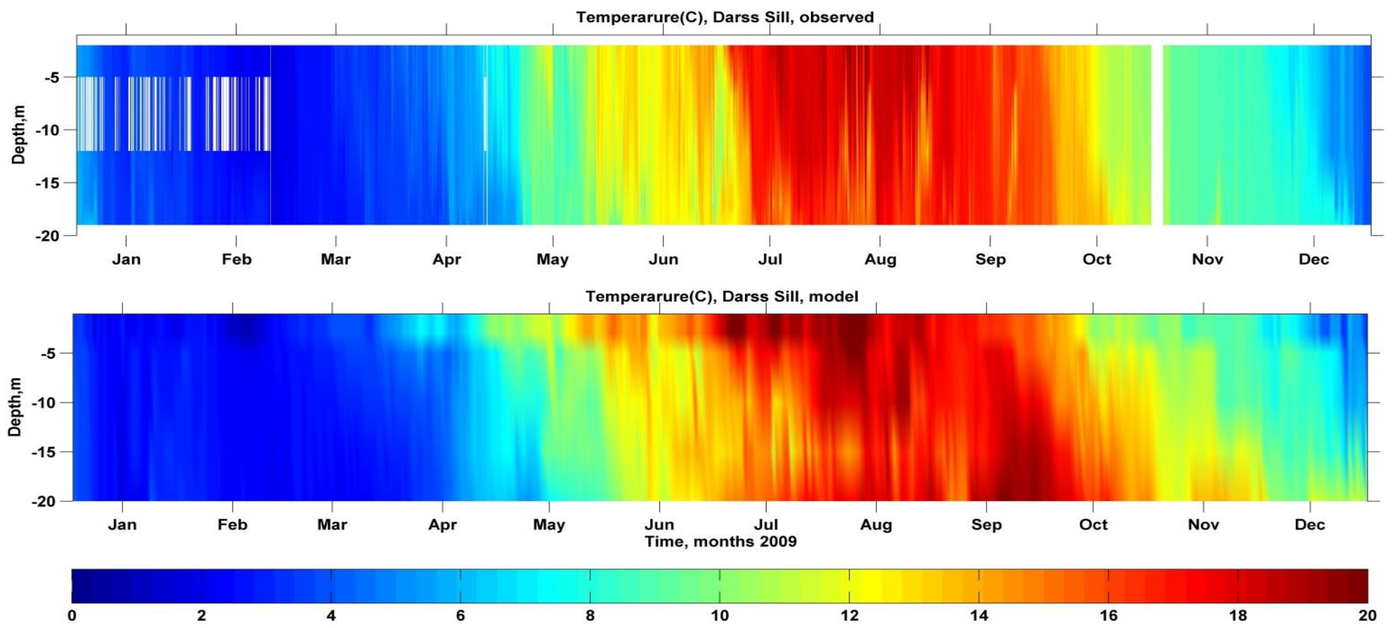
2. Stations which observed data on water temperature, salinity and the sea level.



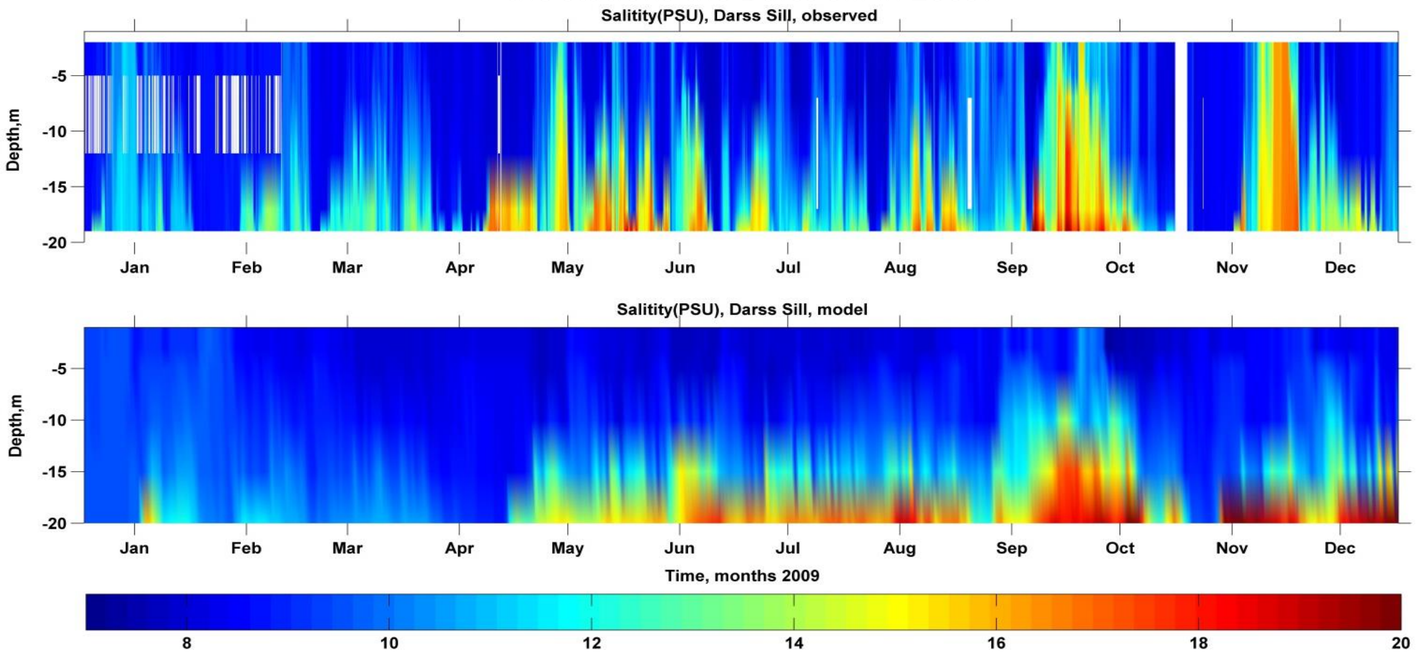
3. Comparison of the modeled (red) and measured(blue) sea level at the stations of the Baltic Sea in 2009.



4. The average circulation of the Baltic Sea, calculated by the INMOM model for 2009-2010.



5. Comparison of the modeled (bottom) and measured (top) water temperature at the stations the Darss Sill in 2009.



6. Comparison of the modeled (bottom) and measured (top) water salinity at the stations the Darss Sill in 2009.

The comparison of the calculated by the model values for water temperature (fig. 5) and the shown schedules from Darss Sill station (available on a site www.bsh.de of the German institute of hydrography) revealed that the reconstructed by the model water temperature is well agreed with the measured data during a year time period. The seasonal course in temperature can be traced – winter temperature is of about 4-6 degrees, summer warming up in the bottom layer is up to 14-18, in the upper layer 18-20 level is noted.

Calculation of salinity (fig. 6) and its comparison with Darss Sill station data (www.bsh.de) evidenced that the model can reproduce water flows from the North Sea. The model adequately reproduces a spring freshening event, and also depicts two intensive flows through entire water column which take place in October and December.