A complex of hydrodynamic models as a basis for operational forecasting system for the Gulf of Finland

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For the Baltic Sea area the forecasting atmosphere model HIRLAM with the spatial resolution of 18 km and three-dimensional sea model HIROMB with the spatial resolution of 5.5 km are used as parts of an integrated operational forecasting system. The resolution used in the sea model is not enough for the adequate description of coastal shallow water areas and small water bodies (Neva Bay, Luga Bay, Vyborg Bay, skerry and port areas). To get over this restriction, in this study an attempt to create an integrated complex of coordinated hydrodynamic models as a basis for predicting both the hydrodynamic and environmental state of the Gulf of Finland waters was undertaken. In addition, the complex has to provide forecasting catastrophic events such as floods, oil spills, accidental wastewater discharges, eutrophication.

The general structure of the regional model complex is shown in Fig.1. This complex includes the following main models (in solid contour): (1) atmospheric model MM5, which is used in operational practice in Saint-Petersburg Centre for Hydrometeorology and Environmental Monitoring, (2) Gulf of Finland model (GOFM) (Neelov et al., 2003), (3) Neva Bay model (NEVAM) with super-high spatial resolution of about 50m (Ryabchenko et al., 2006), (4) wind model SWAN (Simulating WAves Nearshore), developed by the Technical University of Delft, Netherlands. Apart from these models, the complex includes databases of input data (initial and boundary conditions), as well as blocks of information exchange between the models.

The complex is working in the following way. Atmospheric model MM5 is producing the forecast of atmosphere state for several days ahead using the ECMWF (European Centre for Medium-range Weather Forecasting) and NCAR (National Centre for Atmospheric Research, USA) results of re-analysis as initial and boundary conditions. Calculated fields of atmospheric characteristics (surface pressure, wind, temperature and air humidity, precipitation, cloud cover) together with the data on sea level, water temperature and salinity at the open boundary of the Gulf of Finland from HIROMB and observations data on rivers' runoffs and temperatures are used by the GOFM for the forecast of hydrological characteristics in the Gulf. Forecast of hydrological characteristics in the Neva Bay is carried out by the NEVAM model using data on atmospheric characteristics from MM5, data on sea level, temperature and salinity at the open boundary of the model area located in the Eastern Gulf of Finland from GOFM, and observational data on Neva discharge and temperature. Wind wave parameters in the Gulf of Finland and Neva Bay are calculated by the SWAN model using information on surface wind from MM5 model and on surface currents from GOFM and NEVAM. Initial conditions for calculation of hydrological characteristics in the Gulf of Finland are produced by the St.Petersburg Baltic Model (SPBM) (Neelov et al., 2003).

To verify the reliability of the model complex work, test runs with the different parts of the complex were carried out. In particular, the NEVAM was used for forecasting the hydrological regime in the Neva Bay under atmospheric forcing prescribed from the forecast of atmospheric parameters by model MM5. Three situations for both usual (no strong storm surges) and extreme conditions (the case of flood in Saint-Petersburg) were simulated. In the case of the flood in St.Petersburg (26.10.2006), modeled changes of water level follow those prescribed at the western boundary lagging about 1 and 3 hours respectively for stations 'Kronshtadt' and 'Institute of Miners'. As an analysis of all above situations showed, if prescribed water level at the western boundary fits its observed changes, the agreement between model and observations at the above stations turns out to be satisfactory (as, for example, it was for flood situation 26.10.2006).

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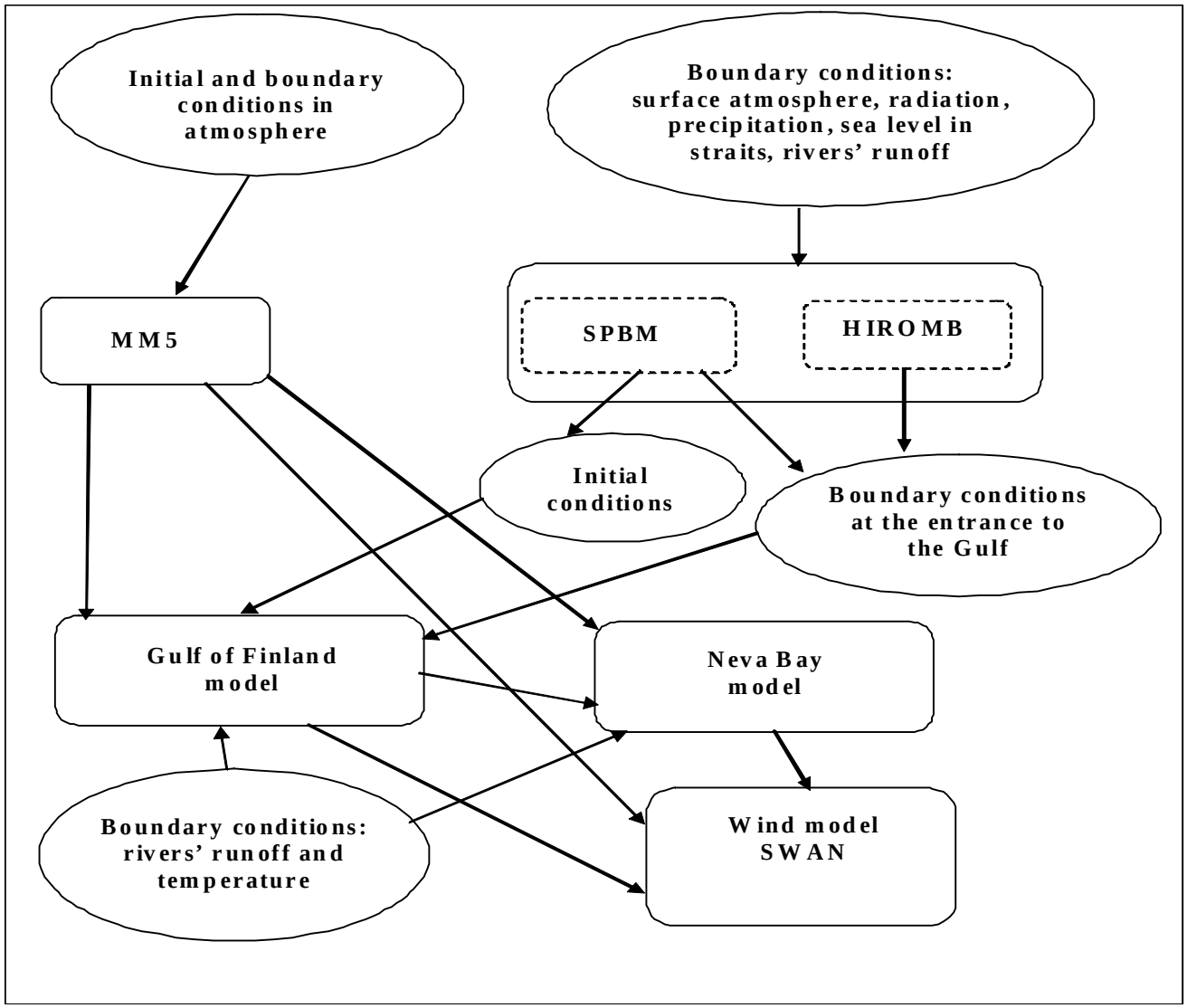

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