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The seasonal and inter-annual variability of sea-ice, ocean circulation and marine ecosystems in the Barents Sea: model results against satellite data

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This study is aimed at modelling the seasonal and inter-annual variability of sea-ice, ocean circulation and marine ecosystems in the Barents Sea in the modern period. Adequate description of marine ecosystems in the ice-covered seas crucially depends on the accuracy in determining of thicknesses of ice and snow on the sea surface which control penetrating photosynthetically active radiation under the ice. One of the few models of ice able to adequately reproduce the dynamics of sea ice is the sea ice model HELMI [1], containing 7 different categories of ice. This model has been imbedded into the Princeton Ocean Model.

With this coupled model 2 runs for the period 1998-2007 were performed under different atmospheric forcing prescribed from NCEP/NCAR and ERA-40 archives. For prescribing conditions at the open boundary, all the necessary information about the horizontal velocity, level, temperature and salinity of the water, ice thickness and compactness was taken from the results of the global ocean general circulation model of the Max Planck Institute for Meteorology (Hamburg, Germany) MPIOM [2]. The resulting solution with NCEP forcing with a high accuracy simulates the seasonal and inter-annual variability of sea surface temperature (SST) estimated from MODIS data. The maximum difference between the calculated and satellite-derived SSTs (averaged over 4 selected areas of the Barents Sea) during the period 2000-2007 does not exceed 1.5 °C. Seasonal and inter-annual variations in the area of ice cover are also in good agreement with satellite-derived estimates.

Pelagic ecosystem model developed in [3] has been coupled into the above hydrodynamic model and used to calculate the changes in the characteristics of marine ecosystems under NCEP forcing. Preliminarily the ecosystem model has been improved by introducing a parameterization of detritus deposition on the bottom and through the selection of optimal parameters for photosynthesis and zooplankton grazing, providing a solution having acceptable agreement with SeaWiFS estimates of surface chlorophyll "a" concentration. The solution for the period 1998-2007 correctly reproduces the start and end of vegetation period, and, with satisfactory accuracy, the level of the spring phytoplankton bloom, but systematically overestimates the SeaWiFS chlorophyll concentrations in the northern part of the sea and in the summer everywhere except for the southern part. According to the results, the region of phytoplankton blooming during the spring outbreak is bounded by the western boundary of the sea and the edge of solid ice.

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