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The simulations based on 20th centuryCMIP5 MPI-ESM data for the period 1920-2005 and RCP8.5 scenario forcing for the period 2000-2099 have been performed with regionally coupled ESM ROM (Sein et al., 2015, JAMES). The results of these simulations were used to prescribe boundary conditions and atmospheric forcing for regional eco-hydrodynamic sea models of the Baltic Sea (SPBEM) and the Barents Sea (EHBARSEM). The runs with these two models were carried out for the modern period 1960-2005.

In this version of EHBARSEM we used the MITgcm as a thermohydrodynamic block and an original 7-component ecosystem model. The results of the model run for above modern period for the Arctic shelf region (Kara, Barents and White Seas) are shown in Fig.1 and 2. The estimates of the spatial distribution of the chlorophyll-a concentration in the surface layer have clarified the effect of sea ice on primary production in the Arctic seas, including under conditions of a changing climate that leads to a significant reduction of ice cover in the Arctic Ocean. The clear relationship between the area of the marginal ice zone and primary production has been obtained: the moments of their spring-summer peaks coincide completely and they are highly correlated (0.87), proving the importance of this zone in the functioning of the marine ecosystem. As expected, the interannual variability of the integrated primary production and the total sea ice area (both averaged over the hydrological year — from October to September) have demonstrated an antiphase oscillation which means that the reduced sea ice cover area in the previous winter is one of the main reasons for the increase in primary production in the current year.

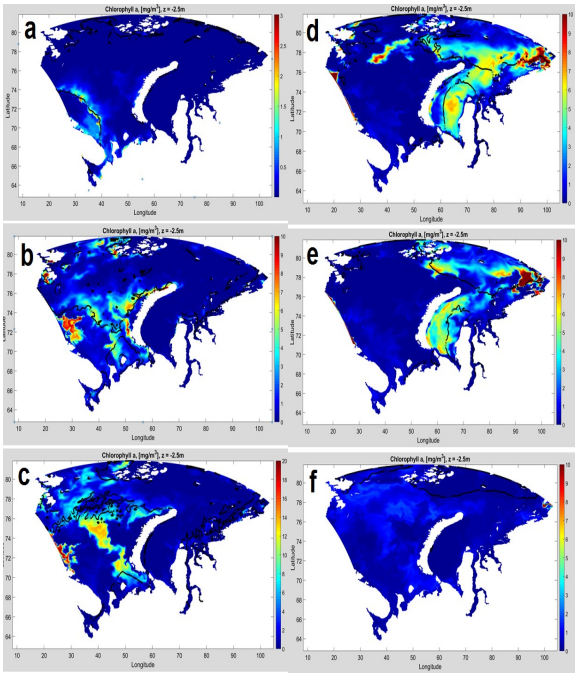

Fig. 1. Modeled chlorophyll-*a* surface concentration and the position of 0.8-isoline of the sea ice compactness (ice edge): *a* — 01.05.2003; *b* — 31.05.2003; *c* — 07.06.2003; *d* — 20.06.2003; *e* — 25.06.2003; *f* — 18.07.2003.

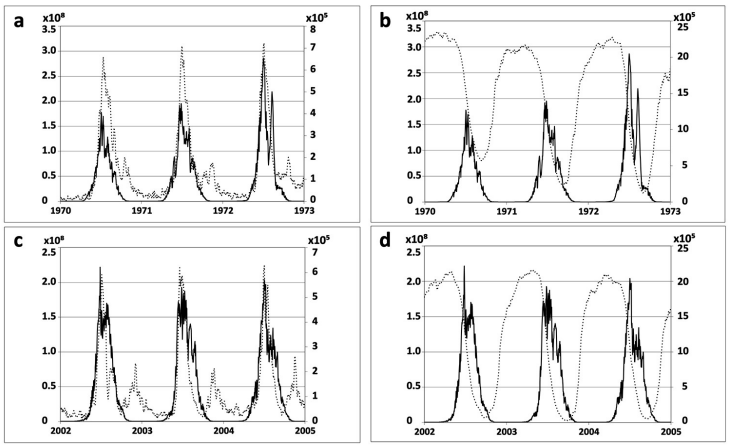

Fig. 2. Interannual time series of the integrated over the model domain ocean primary production (PP) (solid line, [mmol N/s], left scale), marginal ice zone (Smiz) and total ice area(Sice) (dotted line, [km^2], right scale) in the beginning and in the end of the period 1966-2005: a) PP и Smiz, 1970-1972 ; b) PP и Sice, 1970-1972; c) PP и Smiz, 2002-2004; d) PP и Sice, 2002-2004.

Combining the results of the above SPBEM run for modern period and an earlier SPBEM run for future period, statistical estimates were made for the occurrence of maximum values of temperature, dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP) during winter (January-February) and biomass of blue-green algae during the vegetative period (April-September) for different periods in the whole Baltic Sea and Gulf of Finland (Table 1). These estimates show that the probability of occurrence of maximum values of the water temperature in winter will increase both for the Baltic Sea and for the Gulf of Finland in the future. The probability of occurrence of maximum values of DIN and DIP will increase in the Baltic Sea and decrease in the Gulf of Finland, which in turn will increase the probability of maximum blooms of blue-green algae in the Baltic Sea, but will not effect the intensity of blooming in the Gulf of Finland.

Table 1- Probability (%) of the occurrence of maximum values of temperature, DIN and DIP during winter (January-February) and biomass of blue-green algae during the vegetative period (April-September) for different periods of time in the whole Baltic Sea and Gulf of Finland

	Baltic Sea		Gulf of Finland	
Period	1970-2005	2051-2090	1970-2005	2051-2090
Water temperature, °C	9	93	9	82
DIN, mgN/m^3	9	91	10	2
DIP, mg P/m^3	7	100	9	4
Biomass of blue-green algae, mgN/ m^3	9	100	9	13

Publications:

Isaev, A.,Voloshchuk, E.,Ryabchenko, V.,Eremina, T., Gordeeva, S. Assessment of hazards in the Baltic Sea ecosystem in the future climate. International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, 17(41), 2017, pp. 359-366.

Martyanov S. D., Dvornikov A. Yu., Ryabchenko V. A., Sein D. V., Gordeeva S. M. Investigation of the relationship between primary production and sea ice in the arctic seas: assessments based on a small-component model of marine ecosystem. Fundamentalnaya i Prikladnaya Gidrofizika. 2018, 11, 2, 108—117. doi: 10.7868/S2073667318020107