

# Changes of sea waves characteristics in the Arctic basin from model simulations for the 21st century

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The decrease in the sea ice extent in the Arctic basin in recent decades is accompanied by changes in sea waves. Here we analyze characteristics of wind waves activity in the Arctic basin using the WAVEWATCH III model ([http://polar.ncep.noaa.gov/mmab/papers/tn276/MMAB\\_276.pdf](http://polar.ncep.noaa.gov/mmab/papers/tn276/MMAB_276.pdf)) simulations forced by wind and sea ice fields from simulations with the CMIP5 global climate models under different scenarios. Special attention is paid to the assessment of relative contribution of wind sea waves and swells to the total sea waves activity in the Arctic basin. Possible changes in the characteristics of sea waves characteristics are estimated by model simulations for the 21st century. Regional effects of interaction of wind sea waves and swells (chop-like events) are also estimated. Modeling was performed for the area north of 50°N with a spatial resolution of 1° in longitude and 0.5° in latitude. Both historical (1990-2005) and anthropogenic (RCP4.5 and RCP8.5 for the period 2006-2100) scenarios were used (see [1,2]).

The analysis of simulations with 11 models was carried out. Figures 1-3 present the results of simulations with the ACCESS1-3 and inmcm4 models with reasonable agreement with satellite data both regarding the location of sea ice boundaries in the Arctic basin and their changes over the recent decades.

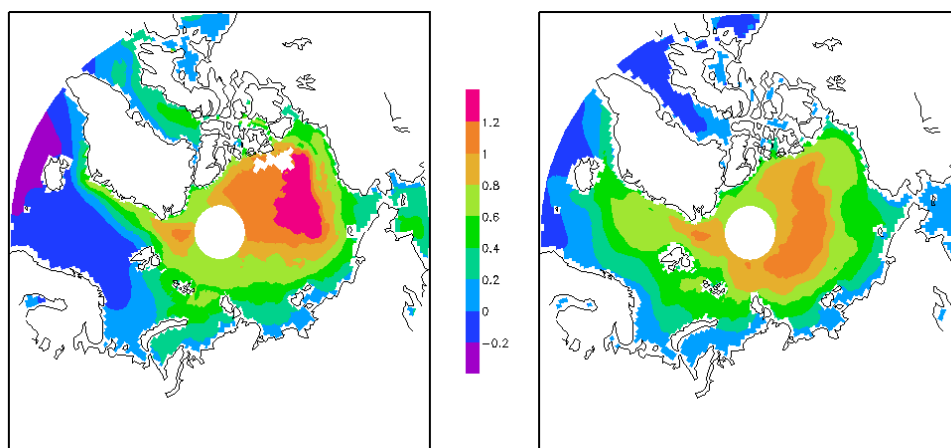


Figure 1. Changes in significant wave height (m) to the end of the 21<sup>st</sup> century (2091-2100) relative to the period 1990-2005 as simulated by WAVEWATCH III model with climate forcing from ACCESS1-3 (left) and inmcm4 (right) simulations under the RCP8.5 scenario.

According to the simulation results, a significant wave height and its extrema increase in different areas of the Arctic basin are related to a decrease in the sea ice extent (Fig. 1). The opposite tendency appears for the Atlantic sector of the Arctic basin with a reduction in wave height. These results based on simulations with global climate models under historical and RCP scenarios confirm previous results based on simulations with the regional model HIRHAM under SRES scenario [1].

Results of model simulations also demonstrate the complex response of swell sea waves in the Arctic Ocean to a combined effect of wind and sea ice forcings in a climate-change scenario during the 21<sup>st</sup> century (Fig. 2).

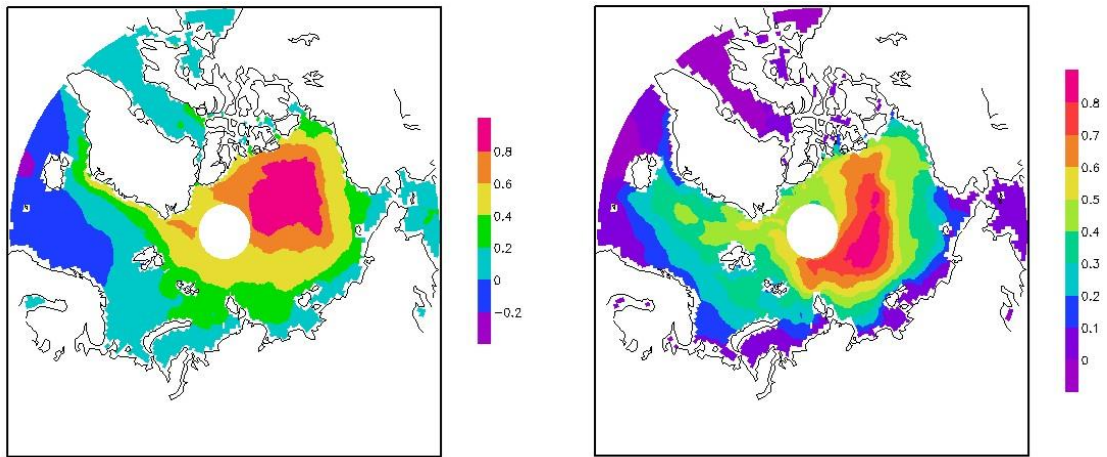


Figure 2. Changes in significant wave height of swell (m) to the end of the 21<sup>st</sup> century (2091-2100) relative to the period 1990-2005 as simulated by WAVEWATCH III model with climate forcing from ACCESS1-3 (left) and inmcm4 (right) simulations under the RCP8.5 scenario.

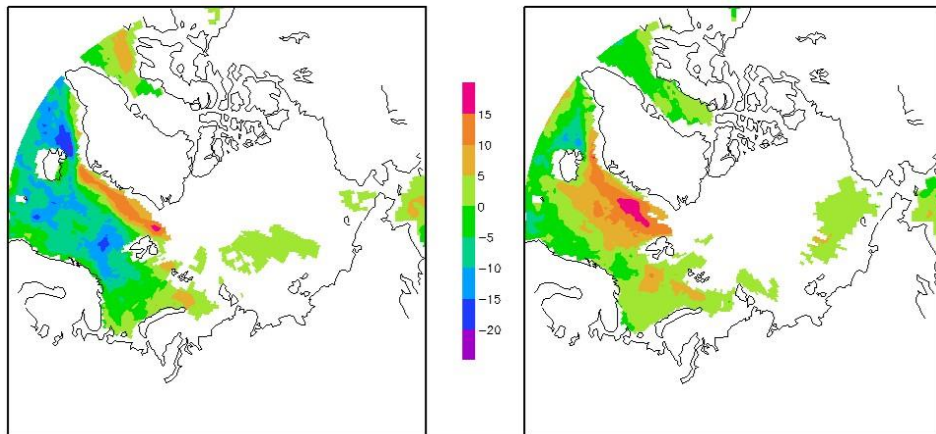


Figure 3. Changes in chop occurrence (number of cases per year) to the end of the 21<sup>st</sup> century (2091-2100) relative to the period 1990-2005 as simulated by WAVEWATCH III model with climate forcing from ACCESS1-3 (left) and inmcm4 (right) simulations under the RCP8.5 scenario.

According to the obtained results, the occurrence of chop-like events increases in the Greenland Sea and for different inner Arctic basin areas and decreases in the Norwegian Sea and the Barents Sea in the 21st century under RCP8.5 scenario (Fig. 3). Also, it is worth to note that model simulations show the general increase of the sea waves total energy in the Arctic basin in the 21st century for all months.

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## References

1. Khon V., Mokhov I.I., Pogarskiy F., Babanin A., Dethloff K., Rinke A., Matthes H. (2014) Wave heights in the 21 century Arctic Ocean simulated with a regional climate model. *Geophys. Res. Lett.*, **41** (8), 2956-2961.
2. Khon V.C., Mokhov I.I., Semenov V.A. (2017) Transit navigation through Northern Sea Route from satellite data and CMIP5 simulations. *Environ. Res. Lett.*, **12**, 024010.