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Changes in the Arctic basin wave characteristics from CMIP5 simulations for the 21st century

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Significant reduction of the Arctic sea ice extent has been observed over recent decades. It has a great importance for the development of Arctic marine transportation. On the other hand, ice retreating should increase risks due to the increase in sea waves. This study focuses on the analysis of possible changes in the Arctic basin wave activity by the end of the 21st century. Characteristics of the Arctic basin waves were calculated using the WaveWatch III model. As the input data, we used simulated fields of sea ice concentration and surface wind derived from CMIP5 global climate models incorporating anthropogenic scenarios RCP4.5 and RCP8.5. Three models were selected for the further analysis as they show the most relevant correspondence to observed mean climatological parameters (ice concentration and wave heights) as well as to their changes in the beginning of the 21st century.

One of the aims of this study is to analyze an individual contribution of wind waves (wind component of the wave spectrum, or wind-seas) and swell waves to the total sea waves in the Arctic basin. Swell waves are generated remotely and are known to travel for a quite long distances, therefore, they can contibute effectively to the total sea waves in the Arctic basin.

Our results show that most of the models show a slight decrease of significant wave height (Hs) in the Atlantic sector of the Arctic in September-November which contrasts with an increase of Hs in the rest at the end of the 21st century. At the same time, the average wave energy mainly decreases to the west of Iceland.

The statistics of extremely high waves, dangerous for shipping, was investigated. Additionally, we studied the interplay between the Arctic wind-seas and swells when their heights were close but their directions differed. Generally, simulations show that occurrence of such events will increase in the Barents and Greenland Seas and will decrease in the Norwegian Sea. This tendency is more pronounced under the RCP8.5 forcing scenario.