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Waves, Ice and Ocean in future projections of the Arctic and Southern Ocean

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A new development to couple a Sea Ice-Ocean General Circulation Model (OGCM) with ocean waves and analyse the impact of the waves on sea ice and upper ocean is presented. The motivation for the study stems from the recent changes in the Arctic sea ice: not only sea ice extent has been significantly lower in the recent decade than the climatology in summer and winter, but also it is much more broken and mobile, allowing the ocean surface waves propagate in the central Arctic. This mobile sea ice modifies momentum transfer from the atmosphere to the ocean and affects the heat storage in the mixed layer and halocline. The fragmented ice dynamics is currently not routinely accounted for in the climate and operational models.

We present simulations performed with a high-resolution sea ice-ocean general circulation global model NEMO (stands for Nucleus for European Modelling of the Ocean) coupled with the ocean wave model output from model of the European Centre for Medium-Range Weather Forecasts (ECMWF). The wave-ice coupling includes ice break–up by waves and a new granular rheology.

We examine the observed wave increase and changes sea ice fragmentation and the predicted future widening of the Marginal Ice Zone (MIZ) in the Arctic and the Bellingshausen–Amundsen Seas of the Southern Ocean. The study discusses implications of the project future changes in the sea ice and ocean for climate and forecasting and asserts their impacts on the ocean biogeochemistry and ecosystems.

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