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Impact of wave mixing on the sea ice cover

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As information on surface waves in ice-covered regions becomes available in ice-ocean models, there is an opportunity to model wave-related processes more accurate. Breaking waves cause mixing of the upper water column and present mixing schemes in ocean models take this into account through surface roughness. A commonly used approach is to calculate surface roughness from significant wave height, parameterised from wind speed. We present results from simulations using modelled significant wave height instead, which accounts for the presence of sea ice and the effect of swell. The simulations use the NEMO ocean model coupled to the CICE sea ice model, with wave information from the ECWAM model of the European Centre for Medium-Range Weather Forecasts (ECMWF). The new waves-in-ice module allows waves to propagate in sea ice and attenuates waves according to multiple scattering and non-elastic losses. It is found that in the simulations with wave mixing the mixed layer depth (MLD) under ice cover is reduced, since the parameterisation from wind speed overestimates wave height in the ice-covered regions. The MLD change, in turn, affects sea ice concentration and ice thickness. In the Arctic, reduced MLD in winter translates into increased ice thicknesses overall, with higher increases in the Western Arctic and decreases along the Siberian coast. In summer, shallowing of the mixed layer results in more heat accumulating in the surface ocean, increasing ice melting. In the Southern Ocean the meridional gradient in ice thickness and concentration is increased. We argue that coupling waves with sea ice – ocean models can reduce negative biases in sea ice cover, affecting the distribution of nutrients and, thus, biological productivity and ecosystems. This coupling will become more important in the future, when wave heights in a large part of the Arctic are expected to increase due to sea ice retreat and a larger wave fetch. Therefore, wave mixing constitutes a possible positive feedback mechanism.