Geophysical Research Abstracts
Vol. 21, EGU2019-4960, 2019
EGU General Assembly 2019

Model study showing the impact of floe size distribution on seasonal fragmentation and melt of Arctic sea ice

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Accurate modelling of the Arctic sea ice is important to be able to predict future shipping routes, model different strategies for preserving polar bear and other Arctic populations, and to allow Arctic communities to plan for the future. Furthermore, the Arctic is a key moderator of high latitude heat and momentum exchange between the atmosphere and ocean and has an important role to play in the global climate. However, sea ice models currently have a limited representation of the processes that drive the seasonal loss of sea ice. In particular, they assume that all sea ice floes adopt the same size and hence models are unable to represent accurately any processes that can perturb floe size and hence influence the volume of lateral melt. This includes waves that propagate into the sea ice and subsequently fragment the sea ice cover. Observations suggest that floes adopt a distribution of sizes, generally fitted to a power law. In this study a floe size distribution modelled as a truncated power law is imposed within the CICE sea ice model coupled to a prognostic mixed layer. The floe size distribution is characterised by three parameters: the minimum floe size, maximum floe size and exponent. The minimum floe size and exponent are fixed across the ice cover; however, the maximum floe size varies at a grid cell scale, reducing in size in response to lateral melt and floe break-up events. In freezing conditions, it is steadily restored to a fixed maximum value. Results are presented to show that the use of the floe size distribution increases the rate of sea ice loss from the marginal ice zone (regions with between 15 and 80 % ice cover) compared to the pack ice. Results are also presented to show the impacts of the floe size distribution on the sea ice vary significantly in scale depending on the choice of parameters, even within observed ranges. Finally, these results are compared to a prognostic approach to modelling the floe size distribution to identify the strengths and weaknesses of each method.