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Feedbacks emerging from variable floe size in the Arctic sea ice cover

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Sea ice is not homogenous and is instead made up of individual pieces of ice that are called floes. Observations show that these floes range in size from just metres to tens of kilometres. Sea ice and climate models have historically assumed a fixed floe size, if there is an explicit representation of floe size at all. There have been several recent efforts to include a treatment of variable floe size within sea ice models. These models have included several processes thought to be important in floe size evolution including break-up of sea ice by waves, lateral melt and growth, welding together of floes, and brittle fracture processes. Floe size can have a direct impact on sea ice evolution via several mechanisms including lateral melt rate, momentum exchange between the sea ice, ocean, and atmosphere, and the ice rheology. Floe size distribution (FSD) models have so far been used within sea ice models to primarily explore the direct impact of floe size on the sea ice cover, and there has been little exploration of the possible resulting feedback processes.

In this study we consider a prognostic approach to modelling the FSD within the CICE sea ice model where the shape of the FSD is an emergent characteristic. We consider results from both standalone sea ice simulations and fully coupled climate simulations. These results are used to explore whether an improved representation of sea ice-ocean and sea ice-atmosphere feedbacks modifies the impact of floe size on the sea ice concentration and thickness over both pan-Arctic and localised scales. We will focus on feedbacks that result from changes to the lateral melt rate, considering in particular whether there is a significant impact from the ice-ocean albedo feedback mechanism. Finally, we will discuss the necessary conditions for there to be significant feedbacks resulting from the inclusion of floe size distribution models in sea ice and climate models.