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Modelling ice-ocean interaction in ice shelf crevasses

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Ocean freezing within ice shelf basal crevasses could potenially act as a stabilising influence on ice shelves, however ice-ocean interaction and ocean dynamics within these crevasses are as yet poorly understood. To this end, an idealised two-dimensional model of an ice shelf basal crevasse has been developed with a simple model of frazil ice formation and deposition. Model results show two different flow regimes, dependant on the amount of freezing in the crevasse: one driven by freezing at the top of the crevasse and the other by the ingress of meltwater from outside the crevasse. In the first, freezing at the top of the crevasse leads to the formation of an unstable overturning circulation due to the rejection of dense, salty water. In the second, a buoyant layer is formed along the sides and roof of the crevasse, stratifying the water column. Frazil ice precipitation is found to be the dominant freezing process at the top of the basal crevasse in the freeze-driven case, with direct freezing being dominant in the melt-driven case. In both cases, melting occurs lower down on the walls of the crevasse due to the strong overturning circulation. The freezing in ice shelf crevasses and rifts is found to be highly dependant upon ocean temperature, providing a stabilising influence on ice shelves underlain by cold waters that is not present elsewhere.