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Modelling Sea-ice Desalination

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Salt is a crucial component of sea ice since it determines many of the ice's physical properties. Salt that is rejected from sea ice into the underlying ocean has an impact on the stability of the oceanic mixed layer and consequently also on the global ocean circulation. Despite this importance, the temporal evolution of sea-ice salinity and salt release into the underlying ocean are still only poorly represented in climate models. To overcome this limitation we have developed a new one-dimensional thermodynamic model that allows us to simulate the salinity evolution of sea ice. The core of this new model is derived from the enthalpy-based model developed by Notz & Worster (2006). A major improvement of the new model is the inclusion of gravity drainage, which has been shown to be the main desalination process of sea ice. We parametrize gravity drainage by means of a Rayleigh number. Once this number exceeds a critical threshold, convection sets in. The strength of this convection is proportional to the amount that the Rayleigh number exceeds the critical value. We assume that brine leaving the ice flows downward through brine channels and is replaced by underlying ocean water that seeps upward through the interstitial pore space. This parametrization is based on Wells et al. (2010) and gives results that are in good agreement with laboratory experiments.