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Representation of basal melting at the grounding line in ice flow models

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While a lot of attention has been given to the numerical implementation of grounding lines and basal friction in the grounding zone, little has been done about the impact of the numerical treatment of ocean-induced basal melting in this region. Several strategies are currently being employed in the ice sheet modeling community, and the resulting grounding line dynamics may differ strongly, which ultimately adds significant uncertainty to the projected contribution of marine ice sheets to sea level rise. We investigate here several implementations of basal melt parameterization on partially floating elements in a finite-element framework, based on the Marine Ice Sheet–Ocean Model Intercomparison Project (MISOMIP) setup: (1) melt applied only to entirely floating elements, (2) melt applied over all elements that are crossed by the grounding line, and (3) melt integrated partially over the floating portion of a finite element using two different sub-element integration methods. All methods converge towards the same state when the mesh resolution is fine enough. However, (2) and (3) will systematically overestimate the rate of grounding line retreat in coarser resolutions, while (1) converges faster to the solution in most cases. The differences between sub-element parameterizations are exacerbated for experiments with high melting rates in the vicinity of the grounding line and for a Weertman sliding law. We conclude on the impact of this parameterization on simulations of the Antarctic ice sheet.