Ice/Ocean coupled model based recommendations for sub-shelf melting parameterisations in standalone ice-sheet modelling

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Sub-shelf melting is thought to be the main driver of ice-shelf thinning in West Antarctica, potentially affecting the stability of the upstream ice sheet. Standalone ice-sheet models account for sub-shelf melting through parameterised relationships of various complexity. The simplest are depth dependent without accounting for any physics, some of intermediate complexity are based on linear or quadratic thermal forcing, and the most complex relationships also account for the advection of water masses along the ice shelf bottom surface (Lazeroms et al, 2017 and Reese et al, 2017). Those parameterisations are all based on some level of assumptions. However, their use is much more straightforward in terms of computation time when compared to an ice-ocean sheet system, especially for large spatial and/or temporal scale studies.

Here, we perform an ensemble of ice/ocean (ElmerIce/NEMO) coupled experiments, using multiple ocean physics and numerical discretisations within the cavity to account for ocean model uncertainty, in order to simulate the centennial response of an idealised marine ice-sheet (MISOMIP1) to various time-varying profiles of ocean temperature and salinity. We confront the coupled results to the aforementioned parameterisations in terms of sub-shelf melt rates and impact on the ice flow, and propose a series of recommendations on their use in standalone ice-sheet modelling. We discuss whether the parameterisations account for sufficient physics to be used in standalone ice-sheet modelling, and propose improvements to those parameterisations in order to make them more realistic.