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Antarctic sub-shelf melt rates via SIMPEL

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Ocean-induced melting below ice-shelves is currently suspected to be the dominant cause of mass loss from the Antarctic Ice Sheet (e.g. Depoorter et al. 2013). Although thinning of ice shelves does not directly contribute to sea-level rise, it may have a significant indirect impact through the potential of ice shelves to buttress their adjacent ice sheet. Hence, an appropriate representation of sub-shelf melt rates is essential for modelling the evolution of ice sheets with marine terminating outlet glaciers. Due to computational limits of fully-coupled ice and ocean models, sub-shelf melt rates are often parametrized in large-scale or long-term simulations (e.g. Matin et al. 2011, Pollard & DeConto 2012). These parametrizations usually depend on the depth of the ice shelf base or its local slope but do not include the physical processes in ice shelf cavities. Here, we present the Sub Ice shelf Melt Potsdam modEL (SIMPEL) which mimics the first-order large-scale circulation in ice shelf cavities based on an ocean box model (Olbers & Hellmer, 2010), implemented in the Parallel Ice Sheet Model (Bueler & Brown 2009, Winkelmann et al. 2011, www.pism-docs.org). In SIMPEL, ocean water is transported at depth towards the grounding line where sub-shelf melt rates are highest, and then rises along the shelf base towards the calving front where refreezing can occur. Melt rates are computed by a description of ice-ocean interaction commonly used in high-resolution models (McPhee 1992, Holland & Jenkins 1999). This enables the model to capture a wide-range of melt rates, comparable to the observed range for Antarctic ice shelves (Rignot et al. 2013).