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Assessing basal melt parameterisations for Antarctic ice shelves using a cavity-resolving ocean model

Clara Burgard[1], Nicolas C. Jourdain[1], Ronja Reese[2], Adrian Jenkins[2], and Pierre Mathiot[1]
[1]Univ. Grenoble Alpes/CNRS/IRD/Grenoble INP, IGE, Grenoble, France
[2]Department of Geography and Environmental Sciences, Northumbria University, Newcastle Upon Tyne, UK

Ice shelves at the outskirts of the Antarctic ice sheet are thinning due to warm ocean water intruding into their cavities. Thinning reduces the ice shelves' buttressing potential, which means that the restraining force that they exert on the ice flowing across the grounding line is lower and more ice is discharged into the ocean. Taking into account ocean-induced melt, or basal melt, is therefore crucial for accurate sea-level projections. Still, its current representation in ice-sheet models is the main source of uncertainty associated with the Antarctic contribution to global sea-level rise in climate projections.

An increasing amount of high-resolution ocean models are now able to resolve the circulation in the cavities below the ice shelves. However, running such models on multi-centennial scales or in a large ensemble is computationally expensive, especially when coupled with ice-sheet models. Instead, several parameterisations of varying complexity have been developed in past decades to describe the link between hydrographic properties in front of the ice shelf and basal melt rates. Previous studies have shown that the performance of these parameterisations depends on the ice shelf and that individual adjustments and corrections are needed for each ice shelf when applying them on the circum-Antarctic scale.

In this study, we assess the potential of a range of existing basal melt parameterisations to emulate basal melt rates simulated by a cavity-resolving ocean model on the circum-Antarctic scale, without regional adjustments. To do so, we re-tune the parameters of the different parameterisations using an ensemble of simulations from the ocean model NEMO as our reference. We find that the quadratic dependence of melt to thermal forcing and the plume parameterisation yield the best compromise, in terms of integrated shelf melt rates and spatial melt rate patterns. Parameterisations based on the box model, however, yield basal melt rates further from the reference. Additionally to the newly tuned parameters, we also provide uncertainty estimates for the tuned parameters, for applications in large ensembles.