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Navigating the challenges of explicitly including ocean-ice shelf interactions in a global ocean model using an adapted ISOMIP+ configuration as a fit-for-purpose tool

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Currently, none of the global 1° ocean-climate coupled models used for the Coupled Model Intercomparison Project (CMIP) explicitly simulate sub-ice shelf cavity circulation. This circulation plays a critical role in global ocean overturning as it transforms salty water formed at the surface in Antarctica into the parent waters of Antarctic Bottom Water (AABW). A challenge that the ocean-climate modelling community faces is the inclusion of these ocean-ice shelf interactions in global ocean 1° resolution models, so as to explicitly simulate dense water production and export. Choices regarding various numerical schemes and parameterizations need to be made, but in testing sensitivity to these choices and feedback effects of biases, large super-computing costs associated with running a global configuration are incurred. To address this we present an adapted configuration of the Ice Shelf-Ocean Model Intercomparison Project (ISOMIP), named ISOMIP+K, as the default idealised ISOMIP+ setup is not appropriate for modelling the deep, cold Antarctic cavities responsible for forming the dense parent waters of AABW. ISOMIP+K is currently adapted for the NEMO ocean model, motivated by the fact that this model is used for 6 of the climate groups participating in CMIP. We present results from ISOMIP+K configurations for Filchner-Ronne, Larsen-C and Ross ice shelves, which are important for dense water formation and large enough to be resolved, albeit coarsely, in a global 1° Earth System Model. This adapted ISOMIP+K test case, which is now far from idealized, is used to test the effect of initial conditions, the choice of values for lateral diffusion of momentum, mixing, drag coefficients and bathymetry on key indicators describing melt, sub-ice shelf circulation and dense water export. As opposed to regional high resolution Southern Ocean configurations, the ISOMIP+K configurations are designed so that the lessons learnt are directly transferable to a global ocean configuration where each choice made is backed-up by extensive, yet affordable, testing.