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Simulations of ice shelves in the Parallel Ocean Program (POP), the ocean model of the Community Earth System Model (CESM)

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We present a series of simulations using POP2X, a modified version of the LANL Parallel Ocean Program version 2 (POP2) that includes circulations in ice-shelf cavities. The geometry of the ice-shelf/ocean interface is represented using the partial-top cells, following the approach developed by Losch (2008) for the Massachusetts Institute of Technology General Circulation Model (MITgcm). The model domain is an idealized domain reminiscent of the Ronne-Filchner Ice Shelf cavity. Our simulations show relatively warm circumpolar deep water (CDW) flowing into the Filchner trough, causing a large increase in melting under the ice shelf. Using more realistic geometry and climate forcing, Helmer et al. (2012) saw a drastic increase in melting in the late twenty-first century as a result of similar processes. We show that vertical model resolution can have a strong impact on the melt rate and circulation in the vicinity of the ice shelf. The results suggest that a resolution-conscious parameterization of the buoyancy-driven plume under ice shelves is needed.

This work is an early step toward coupling POP2X to the Community Ice Sheet Model (CISM) in order to perform more advanced modeling of ice-sheet/ocean interactions. Remarkable advances in ice-sheet model physics and numerical methods in recent years mean that a number of these models (e.g. the CISM; the Ice Sheet System Model; the Elmer Ice Sheet Model) have both sufficient physical accuracy and numerical scalability to be ready for inclusion in Earth System Models (ESMs). A significant stumbling block preventing full ice-sheet/ocean coupling is the inability of ocean models to handle ice-shelf cavity geometries that change in time. This is a major focus of our ongoing research.