Ocean circulation and water mass transformation beneath Filchner-Ronne Ice Shelf: results from a three dimensional ocean model

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Ice shelves around Antarctica's coastline provide the largest interface between the Antarctic Ice Sheet and the Southern Ocean. Melting and freezing at the base of these floating extensions of the ice sheet affect ice shelf geometry and dynamics, and are therefore crucial to ice sheet evolution as well as to the generation of globally significant water masses. In the southern Weddell Sea, the annual growth and decay of sea ice over the broad continental shelf and the interaction between ice shelf and ocean, drive the ocean circulation beneath Filchner-Ronne Ice Shelf (FRIS). Ultimately, water masses entering this sub-ice shelf cavity are cooled and freshened, exiting as Ice Shelf Water that flows down the continental slope, making a significant contribution to the Weddell Sea deep and bottom waters.

Applying a modified version of the Miami Isopycnic Coordinate Ocean Model (MICOM) to the southern Weddell Sea and the cavity beneath FRIS, the model results compare well with the limited number of available observations. With the inclusion of tidal forcing and using a horizontal grid resolution of 0.35 degrees of longitude, the model indicates that the majority of the flow into the cavity occurs to the west, in Ronne Depression, while the outflow of around 0.6 Sv occurs in the east, along Filchner Ice Front. Further to the north at the continental shelf break, around 0.9 Sv spills over the Filchner Sill. Beneath FRIS, the average melting at the ice shelf base is 0.24 m/a, with melt rates close to some deep grounding lines exceeding 10 m/a, particularly around Foundation Ice Stream. With so few direct observations from this region, the model also provides useful suggestions for the ocean circulation pattern away from these locations and for the modification of dense water masses trapped within deep depressions... Such results are invaluable in guiding the efficient planning future field work.