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Response to a warming inflow in a coupled model of Filchner-Ronne Ice Shelf cavity

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To study the interaction between the Southern Ocean and the Antarctic ice sheet, a Regional Antarctic and Global Ocean (RAnGO) model has been developed. The coupled model is based on a global implementation of the Finite Element Sea ice—Ocean Model (FESOM) with a mesh refinement in the Southern Ocean, particularly in its marginal seas and in the sub-ice shelf cavities. The cryosphere is represented by a regional setup of the ice flow model RIMBAY, which comprises the Filchner-Ronne Ice Shelf and the grounded ice in its catchment area up to the ice divides. At the base of the RIMBAY ice shelf, melt rates from FESOM's ice shelf component are prescribed. RIMBAY returns ice thickness and the position of the grounding line.

Model runs with a 20th-century climate forcing yield realistic basal melt rates and a quasi-stable grounding line position close to the presently observed state. In a centennial-scale warm-water-inflow scenario, the model suggests a substantial thinning of the ice shelf and a gradual retreat of the grounding line. A more dramatic response is prevented by the steep topography upstream from most of current grounding lines in this area. The potentially negative feedback from ice shelf thinning through a rising in-situ freezing temperature is more than outweighed by the increase of deep-drafted ice shelf area. Compared to a control simulation with fixed ice shelf geometry, the coupled model thus yields a slightly stronger increase of ice shelf basal melt rates.