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Feedbacks between ice and ocean dynamics at the West Antarctic Filchner-Ronne Ice Shelf in future global warming scenarios

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The ice flow at the margins of the West Antarctic Ice Sheet is moderated by large ice shelves. Their buttressing effect substantially controls the mass balance of the WAIS and thus its contribution to sea level rise. The stability of these ice shelves results from the balance of mass gain by accumulation and ice flow from the adjacent ice sheet and mass loss by calving and basal melting due to the ocean heat flux.

Recent results of ocean circulation models indicate that warm circumpolar water of the Southern Ocean may override the submarine slope front of the Antarctic Continent and boost basal ice shelf melting. In particular, ocean simulations for several of the IPCC's future climate scenarios demonstrate the redirection of a warm coastal current into the Filchner Trough and underneath the Filchner-Ronne Ice Shelf within the next decades.

In this study, we couple the finite elements ocean circulation model FESOM and the three-dimensional thermomechanical ice flow model RIMBAY to investigate the complex interactions between ocean and ice dynamics at the Filchner-Ronne Ice Shelf. We focus on the impact of a changing ice shelf cavity on ocean dynamics as well as the feedback of the resulting sub-shelf melting rates on the ice shelf geometry and implications for the dynamics of the adjacent marine-based Westantarctic Ice Sheet. Our simulations reveal the high sensitivity of grounding line migration to ice-ocean interactions within the Filchner-Ronne Ice Shelf and emphasize the importance of coupled model studies for realistic assessments of the Antarctic mass balance in future global warming scenarios.