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The response of the West Antarctic Ice Sheet to ocean warming beneath the Filchner Ronne Ice Shelf

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The ice flow at the margins of the West Antarctic Ice Sheet (WAIS) 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 (FRIS) 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 sensitivity of the ice dynamics within the entire FRIS catchment to simulated future basal shelf melt rates. Our simulations indicate a high sensitivity of the ice dynamics for the Möller and the Institute Ice Stream but only very little response of other ice streams like Rutford, Foundation and Recovery Ice Stream to enhanced basal shelf melting. The grounding line between the Möller and Institute Ice Streams is located on a submarine ridge in front of a deep trough further inland. In this area, basal shelf melting causes a local thinning of the FRIS. The consequent initial retreat of the grounding line continues once it reaches the adjacent reverse-sloped bedrock. We state, that a possible 'point of no return' for a vast grounding line retreat along this steep reverse bedrock slope might have been crossed already even for simulated present-day melt rates, indicating that the WAIS is currently not in equlibrium. Furthermore, our simulations show an accelerated grounding line retreat in this sector of the FRIS as an answer to modeled future cavity warming scenarios leading to an additional mass loss of the WAIS.