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Is a warming of the Antarctic continental shelf reversible?

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Simulations with the coupled sea ice-ice shelf-ocean models BRIOS and FESOM, forced with climate model output for IPCC-AR4 scenarios E1 and A1B, show a strong sensitivity of the southern Weddell Sea to the freshwater fluxes related to sea ice formation. As a consequence of continuous freshening during the 21st century, the slope current changes course into the Filchner Trough and underneath the Filchner-Ronne Ice Shelf affecting its basal mass flux and the ice shelf/ice sheet dynamics.

As a follow-up, we investigate the possibility for the system to return to present conditions with saline continental shelf waters at the surface freezing point and the slope current following the shelf break westwards. It turns out that starting from year 2199, a return to 20th-century atmospheric forcing reduces the Filchner-Ronne basal mass loss by 50% within 80 years, which is still 10 times the present value of 80 Gt/a. However, prescribing a mean 20th-century ice shelf basal melt water flux reverses the hydrography of the southern Weddell Sea to present conditions within less than a decade. The importance of basal melt water for the system is evident also by the fact that prescribing the mean 20th-century basal fluxes starting in 2050 does not allow the coastal current to penetrate into the Filchner Trough. Our study shows that once the system reaches the 'warm state' only a substantial cooling of the open ocean waters - less feasible in a warming climate - or a significant reduction of basal melting would stop warm waters from entering the continental shelf and the sub-ice cavity. The latter, however, can only occur after a significant reduction of the ice shelf area.