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AMOC recovery in a multi-centennial scenario using a coupled atmosphere-ocean-ice sheet model

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Future global warming will affect ocean conditions by different mechanisms. One mechanism is the melting of the Greenland Ice Sheet (GIS), which may lead to a freshening of regions of deep water formation and eventually contribute to a possible slowdown of the Atlantic Meridional Overturning Circulation (AMOC). We simulate the two Coupled Model Intercomparison Project (CMIP) scenarios RCP4.5 and RCP8.5, to assess the effects of melt-induced fresh water on the AMOC. We use a newly developed coupled multi-resolution atmosphere-ocean-ice sheet model with high resolution at the coasts resolving the complex ocean dynamics. Our results show an AMOC recovery for both scenarios in simulations run with and without an included ice sheet model. We find that the ice sheet is not only acting as a source of freshwater to the ocean but also as a sink. This leads to local storage and redistribution of freshwater and largely compensates for the meltwater release. This physical consistency is missing in climate models without dynamic ice sheets. Therefore, we argue that freshwater hosing experiments should be assessed critically, as they might overestimate the North Atlantic freshening, induced by ice sheet melting. Because of the compensating effect, we find little effect of the included ice sheet model on the AMOC. Our results show a main freshwater release in West Greenland. There, the freshwater might be trapped in the Labrador Current and transported away from regions of deep water formation. Our results show an AMOC recovery, starting within the first half of the 22nd century. We assume the increase in net evaporation over the Atlantic and the resulting increase in ocean salinity, to be the main driver of this recovery.