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Response of the Atlantic Meridional Overturning Circulation to Global Warming and Greenland Melting

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The reduction of the Atlantic Meridional Overturning Circulation (MOC) in a global warming scenario is related to increased stability of the water column in the North Atlantic (NA). This may be accomplished by warming in high latitudes, freshening in the NA region due to increased precipitation and river runoff, and fresh water input from a melting Greenland ice sheet. Most IPCC AR4 scenario simulations for the 21st century and beyond use coupled atmosphere ocean models without an interactive ice sheet model. Neglecting the fresh water input from Greenland, close to the deep water formation regions, may therefore lead to an underestimation of the MOC response to global warming: Would a rapid melting of the Greenland ice sheet lead to a shut-down of the MOC? In the IPCC A1B scenario, the Max- Planck- Institute for Meteorology climate model ECHAM5/MPI-OM (also run without interactive ice sheet model) predicts a weakening of the MOC by about 25% in the early 22nd century and a slow recovery thereafter. Here we discuss additional sensitivity experiments where anomalous fresh water flux is distributed around Greenland. Flux rates are estimated from diagnosed melting rates from the coupled model (up to 0.03 Sv for the A1B scenario) and upscaled in one experiment to 0.09 Sv. The simulations show the expected additional weakening of the MOC, but the difference to the original global warming experiment is relatively small, i.e. there is no shut-down of the THC, even for the high fresh water input simulation. The reasons for the relatively minor effects are: Fresh water supplied from the Greenland coast mainly affects the deep water formation in the Labrador Sea, where the warming has already shut off most of the convection; deep water formation in the Greenland Sea and the overflow transports miantain the core of the overturning. In general, the MOC strength is more sensitive to warming in the North Atlantic than to freshening. The latter could, however, point to the fact that the results may be model depending.