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The Atlantic Meridional Overturning Circulation Stability Influenced by the Melting of the Greenland Ice Sheet under Various Warming Scenarios

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In this study, we aim to model melting processes of the Greenland ice sheet over the next 1000 years using the Earth system model COSMOS with a dynamic ice sheet module. Of primary interest is the resulting impact on the Atlantic meridional overturning circulation (GMOC/AMOC), which is expected to slow in response to a large freshwater (eg melt water) input. Six warming scenarios will be considered, one set corresponding to the IPCC's RPC Scenario 6, and another set corresponding to RPC Scenario 4.5, each time with 0.5, 1, and 2% increase of greenhouse gas concentration per year. It is expected that the freshwater input will slow down the AMOC overturning; each scenario producing a unique braking signal corresponding to how rapidly the Greenland ice sheet is forced to melt. It will be interesting to see if there is a CO_2 threshold level at which the slowdown of the AMOC begins and the melting phenomena becomes unstable and positively reinforces itself or instead, as previous studies have demonstrated with a prescribed amount of melting, if the freshwater input always allows for an eventual recovery of the AMOC to a stable state regardless of the rapidity with which the salinity anomalies develop. The primary difference between this set of experiments and those in previous studies shall be the dynamic nature of the ice sheet model, as we will allow the Greenland ice sheet to melt solely based upon atmospheric conditions rather than prescribing a salinity change directly into the ocean model. It is expected that higher levels of greenhouse gases will result in more rapid melting, which in turn will have a stronger braking affect on the AMOC, possibly with longer recovery times to the starting equilibrium point. It will additionally be of interest to see if it is possible to create a shift in this equilibrium, suggesting that the rapidity with which density anomalies are introduced may create a new stable deep water formation rate.