EGU24-16340, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-16340
EGU General Assembly 2024

Deglacial AMOC sensitivity in freshwater hosing experiments using CESM

Dragan Latinovic, Ute Merkel, and Matthias Prange
MARUM, University of Bremen, Germany (dlatinovic@marum.de)

The last deglaciation is characterized by a sequence of abrupt climate events, with melting ice sheets as its most distinctive feature. By meltwater release, ice sheets affect the oceanic circulation and modulate the Atlantic Meridional Overturning Circulation (AMOC). Understanding the stability of the AMOC under deglacial boundary conditions is therefore of vital importance for a better understanding of the climate trajectory from the Last Glacial Maximum (LGM) to the Holocene. To this end, we explore the impact of different glacial/deglacial boundary conditions (greenhouse gas concentrations (GHG), orbital parameters, ice-sheet topography) on the stability of the AMOC in freshwater hosing experiments using the Earth system model CESM1.2. This study is part of coordinated activities within the German climate modeling initiative (PalMod). For this purpose, three different configurations with various combinations of boundary conditions are used: (i) Full 15.2 ka boundary conditions, (ii) 15.2 ka boundary conditions except for LGM GHG, and (iii) LGM boundary conditions with 15.2 ka ice-sheet topography. After initial spin-up model integrations (3000-4000 years), freshwater hosing (0.1 Sv and 0.2 Sv; 400-700 years) is performed to each experiment, in which the AMOC is perturbed in the ice-rafted debris belt in the Northern Atlantic Ocean (40°N–55°N, 45°W–20°W). We find that the AMOC is most stable with respect to hosing under full 15.2 ka boundary conditions. Under reduced (LGM) GHG forcing, the AMOC becomes more unstable and collapses with only 0.1 Sv of freshwater hosing. Under certain conditions (15.2 ka boundary conditions with 0.1 Sv hosing) the AMOC exhibits bistability. Abrupt recovery along with an overshoot of the AMOC after removal of the hosing resembles Bølling/Allerød (B/A) warming by its intensity and duration. Finally, spontaneous (unhosed) millennial-scale AMOC oscillations are found under LGM boundary conditions with 15.2 ka ice-sheet topography. In sum, our set of experiments indicates that the deglacial AMOC evolution was the result of a non-linear complex interplay between different forcing factors rather than a simple (linear) response to meltwater forcing.