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# The last deglaciation simulated in a coupled atmosphere-ocean-ice sheet model

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One of the major challenges in climate modeling is the simulation of glacial-interglacial transitions. A few models of intermediate complexity have been successful in simulating the last termination. Complex atmosphere-ocean general circulation models (AOGCMs) have been shown to be able to yield realistic climate changes with prescribed ice sheets. Here we presents results from our first successful attempt to simulate a substantial part of the last glacial cycle with an AOGCM coupled interactively with a state-of-the-art ice sheet model.

The ECHAM5/MPIOM AOGCM is interactively coupled to a northern hemisphere set up of the dynamical ice sheet model PISM and the dynamical vegetation model LPJ. This model is integrated from the late Glacial into the Holocene using insolation and greenhouse gas concentrations as transient forcing. The land sea mask remains fixed at the LGM state. River routing and surface elevation for the atmospheric model component are calculated interactively. To make these long simulations feasible, the atmosphere is accelerated by a factor of 10 relative to the other model components using a periodical-synchronous coupling technique. A mini-ensemble with different initial conditions is run. Additionally, one simulation is run fully synchronously without acceleration in the atmosphere.

In all simulation the northern hemispheric deglaciation starts between 18 and 17 kyr BP, consistent with the onset of global warming. The model produces Heinrich event like variability. These rapid ice discharge events have a strong impact on the North Atlantic meridional overturning circulation (NAMOC). The simulated decrease of the northern hemisphere ice sheets starts at 20 kyr BP.

During the deglaciation the interactive river routing has a strong impact on the simulated NAMOC. The retreat of the Laurentide Ice Sheet together with the depressed topography due to the former ice load leads to a redirection of the surface runoff from the melting southwestern Laurentide from the Gulf of Mexico to the Arctic. The consequence is a rapid reduction/suppression of the formation of North Atlantic deep water (NADW). When the Laurentide Ice Sheet retreats from the Hudson Strait, this becomes the new drainage route. Hence, the fresh water is released into the Labrador Sea and is less effective in suppressing the deep water formation in the North Atlantic. As a consequence, the NADW formation recovers within a few decades. These results show the potential importance of interactive river routing for rapid changes in NAMOC strength during the deglaciation.