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Effects of evolving topography and bathymetry during the last termination in a coupled climate model

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Running coupled climate models through a whole deglaciation is essential to understand the strong climate fluctuations occurring during that period of time. Here, we present results of the first set of Earth System Model (ESM) simulations of the last deglaciation with continuously evolving topography, coastlines and bathymetry. Because ESMs are generally not constructed to deal with time varying topography, land-sea masks etc., this presents a strong technical and scientific challenge. At the same time, it is a crucial step towards fully coupled simulations with interactive ice sheets and solid earth.

Changes in topography strongly influenced the climate during deglaciation. Directly, the opening of passages, as well as changes in throughflow depth and width influence the exchange between different ocean basins. The retreating ice sheets led to the flooding of vast shelf areas and freed the path for wind systems. Indirectly, small-scale changes in the surface topography could lead to drastically different river pathways, and could thus change the locations of freshwater inputs from the decaying ice sheets, with strong consequences on ocean circulation and deep-water formation.

Here we present first results from a set of transient simulations with the coarse resolution version of the Max Planck Institute Earth System Model (MPI-ESM) forced with the ICE-6G reconstructions of ice sheets and topography. Our runs cover the period of time between 26 kyr BP and present day. Orography and glacier mask for the atmosphere component, river pathways, land-sea mask, and ocean bathymetry are automatically updated every 10 years. The simulations are designed to highlight each individual effect (e.g. ocean bathymetry, land-sea mask, river routing). For the discussion of these effects, we also take advantage of a set of age and water mass tracers allowing to assess ventilation changes in the deep ocean as well as enabling comparison with deep sea proxy records.