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Simulating Heinrich events in a coupled atmosphere-ocean-ice sheet model

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Heinrich events are among the most prominent events of long-term climate variability recorded in proxies across the northern hemisphere. They are the archetype of ice sheet – climate interactions on millennial time scales. Nevertheless, the exact mechanisms that cause Heinrich events are still under discussion, and their climatic consequences are far from being fully understood. We contribute to answering the open questions by studying Heinrich events in a coupled ice sheet model (ISM) atmosphere-ocean-vegetation general circulation model (AOVGCM) framework, where this variability occurs as part of the model generated internal variability without the need to prescribe external perturbations, as was the standard approach in almost all model studies so far.

The setup consists of a northern hemisphere setup of the modified Parallel Ice Sheet Model (mPISM) coupled to the global coarse resolution AOVGCM ECHAM5/MPIOM/LPJ. The simulations used for this analysis were an ensemble covering substantial parts of the late Glacial forced with transient insolation and prescribed atmospheric greenhouse gas concentrations.

The modeled Heinrich events show a marked influence of the ice discharge on the Atlantic circulation and heat transport, but none of the Heinrich events during the Glacial did show a complete collapse of the North Atlantic meridional overturning circulation. The simulated main consequences of the Heinrich events are a freshening and cooling over the North Atlantic and a drying over northern Europe.