



## **Coupled Northern Hemisphere permafrost-ice sheet evolution over the last glacial cycle**

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Permafrost influences a number of processes which are relevant for local and global climate. For example, it is well known that permafrost plays an important role in global carbon and methane cycles. Less is known about the interaction between permafrost and ice sheets. In this study a permafrost module is included in the Earth system model CLIMBER-2 and the coupled Northern Hemisphere (NH) permafrost-ice sheet evolution over the last glacial cycle is explored.

The model performs generally well at reproducing present day permafrost extent and thickness. Modeled permafrost thickness is sensitive to the values of ground porosity, thermal conductivity and geothermal heat flux. Permafrost extent at the last glacial maximum (LGM) agrees well with reconstructions and previous modelling estimates.

Present-day permafrost thickness is far from equilibrium over deep permafrost regions. Over Central Siberia and the Arctic Archipelago permafrost is presently up to 200-500 m thicker than it would be at equilibrium. In these areas, present day permafrost depth strongly depends on the past climate history and simulations indicate that deep permafrost has a memory of surface temperature variations going back to at least 800 kya (1000 years ago).

Over the last glacial cycle permafrost has a relatively modest impact on simulated NH ice sheet volume, except at LGM when including permafrost increases ice volume by about 15 m sea level equivalent. This is explained by a delayed melting of the ice base from below by the geothermal heat flux when the ice sheet sits on a porous sediment layer and permafrost has to be melted first. Permafrost affects ice sheet dynamics only when ice extends over areas covered by thick sediments, which is the case at LGM.