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Modelling the impact of the Laurentide Icesheet on the timing of the Holocene thermal maximum

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Proxy records suggest that the timing of the Holocene thermal maximum varied considerably from place to place. In some regions this timing coincided with the orbitally forced summer insolation maximum in the earliest Holocene, but in other areas (Northern Canada, Southern Greenland, Central Europe) the thermal maximum occurred several thousand years later. To study the influence of the deglaciation of the Laurentide Icesheet – which was completed at 7 kyr BP – on this spatial variation in timing of the Holocene thermal maximum, we have performed several transient experiments covering the last 9000 years using the coupled atmosphere-ocean-vegetation model LOVECLIM. Considering the Laurentide Icesheet deglaciation, we quantified separately the impacts of the background meltwater fluxes and the changes in topography and surface albedo. These impacts are compared to the influence of the main long-term climate forcings, being variations in orbital parameters and changes in atmospheric greenhouse gas concentrations.

Relative to a reference run with only orbital and greenhouse gas forcing, the Laurentide Icesheet caused a 1 to 2˚C cooling of the North Atlantic Ocean surface during the period 9 to 7 kyr BP. This was partly caused by a shutdown of deep convection in the Labrador Sea due to the background meltwater fluxes, leading to a surface cooling in winter over the North Atlantic Ocean and Europe, and expansion of the Arctic sea-ice cover. On the other hand, the topography and high surface albedo of the Laurentide

Icesheet also contributed to the relatively cool conditions over the western part of the North Atlantic. Consequently, the Laurentide Icesheet was responsible for a delayed thermal maximum in large parts of the Northern Hemisphere. In an experiment that included all forcings, the Holocene thermal maximum was between 9-8 kyr BP over the central Arctic, Northern Eurasia and Alaska, while it was at 7-6 kyr BP over Eastern North America, the North Atlantic Ocean, Southern Greenland, and mid-latitude Europe. These results are in general agreement with proxy records.