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The global nature of the Holocene thermal maximum in transient coupled climate model simulations

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Proxy records indicate that both the timing and magnitude of the Holocene thermal maximum (HTM) varied considerably from place to place. In some regions the timing coincided with the orbitally forced summer insolation maximum in the earliest Holocene, but in other areas (e.g., Northern Canada, Southern Greenland, northern Eurasia) the thermal maximum occurred several thousand years later. The spatial variation in HTM timing and magnitude suggests the involvement of additional forcings and feedbacks. It is likely that the remnant Laurentide Icesheet (LIS) played an important role. Two important effects of the LIS on the early Holocene climate can be distinguished. First, the actual presence of the ice, with its relatively high surface albedo and an additional elevation, potentially acting as a topographic barrier. Second, melt water of the LIS drained into the oceans, causing the surface ocean to be relatively fresh in some areas, with potential effects on the ocean circulation. Indeed, paleoceanographic evidence suggests that deep convection in the Labrador Sea only started after most of the LIS was gone at about 8 ka. We have studied the global nature of the HTM in several transient experiments covering the last 9000 years, performed with the coupled atmosphere-ocean-vegetation model LOVECLIM. In these experiments, we consider the influence of the variations in orbital parameters and atmospheric greenhouse gases and the early-Holocene LIS deglaciation. Considering the LIS deglaciation, we quantified separately the impacts of the background melt-water fluxes and the changes in topography and surface albedo. We analyse the timing and magnitude of the HTM in several key regions, such as Europe, Greenland, North Atlantic region, Antarctica, North America, and East Asia.