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Holocene lowering of the Laurentide ice sheet affects North Atlantic gyre circulation and climate

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The Laurentide ice sheet, which covered Canada during glacial periods, had a major influence on atmospheric circulation and surface climate, but its role in climate during the early Holocene (9-7 ka), when it was thinner and confined around Hudson Bay, is unclear. It has been suggested that the demise of the ice sheet played a role in the 8.2 ka event (an abrupt 1-3 °C Northern Hemisphere cooling lasting ∼160 years) through the influence of changing topography on atmospheric circulation. To test this hypothesis, and to investigate the broader implications of changing ice sheet topography for climate, we analyse a set of equilibrium climate simulations with ice sheet topographies taken at 500 year intervals from 9.5 ka to 8.0 ka. Between 9.5 and 8.0 ka, our simulations show a 2 °C cooling south of Iceland and a 1 °C warming between 40-50° N in the North Atlantic. These surface temperature changes are associated with a weakening of the subtropical and subpolar gyres caused by a decreasing wind stress curl over the mid-North Atlantic as the ice sheet lowers. The climate response is strongest during the period of peak ice volume change (9.5 ka – 8.5 ka), but becomes negligible after 8.5 ka. The climatic effects of the Laurentide ice sheet lowering during the Holocene are restricted to the North Atlantic sector. Thus, topographic forcing is unlikely to have played a major role in the 8.2 ka event and had only a small effect on Holocene climate change compared to the effects of changes in greenhouse gases, insolation and ice sheet meltwater.