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The effect of sudden ice sheet melt on ocean circulation and surface climate 14-16 ka

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Collapse of ice sheets can cause significant sea-level rise and widespread climate change. Around 14.6 thousand years ago, global sea level rose by ~15 m in less than 350 years[1] during an event known as Meltwater Pulse 1a. Modelling work[2,3] has suggested that approximately half of this ~50 mm yr^{-1} sea level rise came from a North American ice Saddle Collapse that drained into the Arctic and Atlantic Oceans. However, dating uncertainties make it difficult to determine the sequence of events and their drivers, leaving many fundamental questions. For example, did the abrupt ice melting and subsequent ocean freshening have any detectable climatic impact? Was melting from the Northern American ice sheets responsible for the Older-Dryas[4] or other cooling events? And how were all these signals linked to changes in Atlantic Ocean overturning circulation[e.g.5]?

To address these questions, we examined the effect of the North American ice Saddle Collapse using a newly developed high resolution network drainage model coupled to an atmosphere-ocean-vegetation General Circulation Model. Here, we present the first quantitative routing estimates of the consequent meltwater discharge and its impact on climate.

The results show that approximately 50% of the Saddle Collapse meltwater pulse was routed down the Mackenzie River into the Arctic Ocean, and around half was discharged directly into the Atlantic via the St. Lawrence River. This meltwater flux, equivalent to a total of 7 m of sea-level rise, caused a strong weakening of Atlantic Meridional Overturning Circulation (AMOC) and widespread Northern Hemisphere cooling. The greatest cooling is in the Arctic, but there is also significant warming over North America. We find that AMOC (and climate) is most sensitive to meltwater discharged to the Arctic Ocean.

[1] Deschamps et *al*. (2012) *Nature* **483**, 559–564. [2] Gregoire et *al*. (2012) *Nature* **487**, 219–222. [3] Gomez et *al*. (2015) *GRL* **42**(10), 3954-3962. [4] Menviel et *al*. (2010) *QSR* **30**, 9-10. [5] Roberts et *al*. (2010) *Science* **327**, 75–78.