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A role for land surface forcing of North Atlantic climate and isotope signals during the 8.2kyr event?

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An important example of abrupt climate change occurred 8200 years ago in the North Atlantic and is generally known as the 8.2kyr event. This abrupt ~160 year cooling appears to coincide with the final drainage of the ice-dammed Lakes Agassiz and Ojibway. The resultant influx of meltwater to the North Atlantic is assumed to have perturbed the Atlantic Meridional Overturning circulation, reducing northward heat transport and causing widespread cooling. Numerous lines of evidence support this theory, with reconstructions showing changes in deep water formation, reductions in salinity and evidence of sea-level rise. Coupled general circulation model (GCM) simulations driven with realistic estimates of the meltwater flux show a regional cooling but fail to replicate the duration or the magnitude of this event in comparison with proxy archives.

Meltwater injection was not the only rapid climate forcing in operation at this time. Drainage of the pro-glacial lakes would have had a profound effect on the boundary layer heat fluxes over North America, with potential teleconnections further afield. In this work we use an isotope-enabled version of the coupled GCM HadCM3 with boundary conditions appropriate for the time period of 9kyr (including ice sheets, greenhouse gases and orbital parameters). This model tracks oxygen isotopes throughout the hydrological cycle allowing more robust comparison with proxy archives. We analyse the impact of the removal of a lake area corresponding to Lakes Agassiz and Ojibway at this time and present sensitivity tests designed to analyse the contributions from lake removal, orographic change and the assumed isotopic content of the pro-glacial lakes.

The results show a distinct pattern of cooling across North America (in the annual mean) with an apparent teleconnection to the Barents Sea, where there is warming associated with sea-ice reduction. The isotopic implications depend on the initial isotopic content of the pro-glacial lake. Assuming a uniform value of -30 permille, the δ^{18}O of precipitation anomaly shows reasonably strong deviations across different parts of the North Atlantic region implying a possible contribution to signals detected in proxy archives. These results raise the possibility that land surface changes associated with abrupt climate change events might be more important than previously assumed.