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Data – model integration with water isotopes for the Heinrich event 1: evidence for an active north Atlantic deep water formation

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Representing Heinrich event 1 (a large iceberg armada released in the North Atlantic ocean at the start of the last deglaciation) in climate models is often achieved by means of freshwater hosing under Last Glacial Maximum (LGM) climatic conditions, assumed to be in equilibrium. Since icebergs are not only freshwater and the Last Glacial Maximum climate is not in equilibrium, it is legitimate to question this simplistic representation of the Heinrich Event.
Using a coupled climate model including water isotopes, we propose to investigate whether hosing simulations under LGM condictions can be considered as a meaningful representation of the actual Heinrich event 1 from the point of view of records of d18O in foraminiferal calcite.
Accounting for the depleted signature of ice-sheet sourced water, we simulated d18Ocalcite at the surface and within the ocean column and compared the results to a compilation of North Atlantic d18Ocalcite proxy data. Using a set of experiments with hosing in different regions, we systematically computed the distance between simulated and measured d18Ocalcite.
Our results indicate that first order simulated d18Ocalcite anomalies are broadly consistent with the measured anomalies and that a complete shutdown of the thermohaline circulation is not consistent with the observed foraminiferal calcite patterns. A more detailed statistical analysis of the planktic and benthic d18Ocalcite anomalies shows that the best experiment is obtained for a severely disturbed thermohaline circulation but not a complete shutdown. With our model sensitivity, this corresponds to a freshwater flux equal or above 0.18 Sv but less than 0.3 Sv. Our results also indicate a better agreement when the freshwater flux is applied in the Labrador Sea than when directly applied to the Ruddiman belt, in accordance with freshwater fluxes computed through iceberg modeling assuming a Labrador Sea source.