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Can boreholes help to constrain the dynamics of the Laurentide ice sheet on the millennial time-scale during last glacial period?

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The Last Glacial Period (LGP) was characterized by the presence of three large ice sheets in the Northern Hemisphere (Greenland, Eurasian Fennoscandian and Laurentide). The latter occupied most of North America and representing a quantity of ice similar than to present-day Antarctica. It is thought to be the main contributor to the six major episodes of ice discharge (Heinrich events, HE), coincident with the temperature minima observed in Greenland during this time period. In the past, internal oscillations of the Laurentide Ice Sheet (LIS) were supposed to be the main cause of these quasiperiodic large-scale ice discharges. However, recent studies proposed other triggering mechanisms involving the effects of oceanic circulation changes on the LIS dynamics.
Here, the 3D thermomechanical ice sheet/ice shelf model GRISLI is used to simulate such millennial-scale ice disharges under these two fundamentally different mechanisms: internally triggered ice sheet oscillations and induced ice purges as response of oceanic changes. The mechanisms associated with LIS multi-millennial oscillations are investigated, including classical as well as new interpretations of HEs. This was accomplished due to the hybrid character of the GRISLI model,i.e. the combination of a Shallow Ice Approximation (SIA) with a Shallow Shelf Approximation (SSA). This setup allows it to consider the floating part of the ice sheets as well as to treat fast flowing ice streams under different formulations.
Our analysis attempts to assess the likelihood of the two possible mechanisms triggering the periodic LIS discharges, comparing synthetic borehole temperature profiles driven by the basal ice sheet temperature, and the ground surface temperature, respecively. First sensitivity calculations indicate that the impact should be detectable, with temparature anomalies of up to 1K. In addition, our study could identify those regions where the imprint of the differing triggering mechanisms is most clear, suggesting areas for future borehole research.