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Modelling the influence of Lake Agassiz on Glacial Isostatic Adjustment and deglaciation of the Laurentide ice sheet

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ANICE is a 3-D ice-sheet-shelf model, which simulates ice dynamics on the continental scale. It uses a combination of the SIA and SSA approximations and here it is forced with benthic δ18O records using an inverse routine. It is coupled to SELEN, a model, which solves the gravitationally self-consistent sea-level equation and the solid earth deformation of a spherically symmetrical rotating Maxwell visco-elastic earth, accounting for all major GIA effects. The coupled ANICE-SELEN model thus captures ice-sea-level feedbacks and can be used to accurately simulate variations in local relative sea-level over geological time scales.
In this study it is used to investigate the mass loss of the Laurentide ice-sheet during the last deglaciation, accounting in particular for the presence of the proglacial Lake Agassiz by way of its GIA effects and its effect on the ice sheet itself. We show that the mass of the water can have a significant effect on local relative sea-level through the same mechanisms as the ice-sheet – by perturbing the geoid and by deforming the solid earth. In addition we show that calving of the ice-shelf onto the lake could have had a strong influence on the behaviour of the deglaciation. In particular, when allowing lake calving, the ice-sheet retreats rapidly over the deepening bed of Hudson Bay during the deglaciation, resulting in a narrow ice dam over Hudson Strait. This dam collapses around 8.2 Kyr causing a global sea level rise of approximately 1 meter – an observation that agrees well with field data (for example, LaJeunesse and St. Onge, 2008). Without lake calving the model predicts a drainage towards the Arctic ocean in the North.