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Iceberg discharges and oceanic circulation changes during glacial abrupt climate changes

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Proxy data reveal the existence of episodes of increased deposition of ice-rafted debris in the North Atlantic Ocean during the last glacial period. These are interpreted as massive iceberg discharges mainly from the Laurentide Ice Sheet. Although these have long been attributed to self-sustained ice sheet oscillations, growing evidence points to an active role of the oceanic circulation. Here we will present simulations of the last glacial period carried out with a hybrid ice sheet–ice shelf model. Two mechanisms producing iceberg discharges are compared. First, we reproduce the classic binge-purge by which the iceberg surges are produced thanks to the existence of an internal thermo-mechanical feedback that allows the ice sheet to behave under an oscillatory regime. Second, our ice-sheet model is forced by an oceanic warming index derived from proxy data that accounts for the impact of past ocean circulation changes on ocean temperatures. In this case, the model generates a time series of iceberg calving that agrees with ice-rafted debris records over the past 80 ka. We compare the two theories and discuss their advantages and weaknesses in terms of both the robustness of the physics on which they are based and their comparison with proxies. This comparison highlights the importance of considering past oceanic circulation changes in order to understand the ice-sheet dynamics. However, the ultimate processes determining abrupt changes in the Atlantic Meridional Overturning Circulation (AMOC) remain elusive. Therefore we will also analyze several proposed mechanisms that aims to explain such AMOC reorganizations, focusing on those that do not require freshwater flux forcing.