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Ice-sheet feedbacks to freshwater perturbations on the climate system

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Fresh water inputs in North Atlantic due to huge surge of icebergs coming from ice sheets might be responsible for drastic regional and global abrupt climatic transitions. To quantify the sensitivity of climate system to these fresh water inputs, we use a model of intermediate complexity coupled to ice-sheet models for both Northern and Southern Hemispheres. We mimic the Dansgaard-Oeschger and Heinrich events by forcing the model with appropriate fresh water perturbations. Moreover, we perform perturbations at high latitudes for both Northern (North Atlantic) and Southern (Circum Polar Ocean) hemispheres. The originality of this study is to investigate with such a global model, the response of the coupled system to freshwater discharges in three different climate contexts, the Last Maximum Glacial (LGM), the Last Glacial Inception (LGI) and the present-day (PD) climates.

We show that: 1/ In all climate contexts, the stability of the North Atlantic circulation diagnosed through "hysteresis diagram is more sensitive to freshwater flux when ice sheets are considered as an interactive component of the climate system. 2/ The seesaw mechanism (swings between the Northern and Southern hemispheres) occurs mostly for the North Atlantic freshwater perturbation whereas it remains very weak for the Southern Ocean freshwater release. Moreover, in most cases, the seesaw is enhanced when ice sheets are interactive. 3/ An interesting result is that the fresh water perturbation amplifies the inception of an ice sheet at LGI. The sea-level drop is significantly increased and is in a better agreement with data.