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Investigating the evolution of major northern hemisphere ice sheets during the last glacial-interglacial cycle under the effect of both insolation and CO_2 forcings

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A 2.5-dimensional climate model of intermediate complexity coupled with a 3-dimensional thermo-mechanical ice sheet model (ISM) is used to simulate the evolution of Northern Hemisphere (NH) ice sheets during the last glacial-interglacial cycle. This coupled model accounts for the interactions between atmosphere, ocean, cryosphere and biosphere, as well as their evolution.

Our results show a quite satisfactory evolution of NH ice sheets from 126 ka BP until present time, although some differences with geological data reconstructions still exist. Moreover, we investigate the respective climate and ice sheets responses to both insolation and atmospheric CO_2 concentration through a series of sensitivity experiments.

We show that the North American and the Fennoscandian ice sheets do not respond with the same sensitivity to atmospheric CO_2concentration and insolation. The Laurentide ice sheet starts to build up and then develops as soon as the insolation signal decreases around 120 ka BP, which is in agreement with benthic foraminifer $\delta^{18}O$ signal. The summer insolation is the main factor responsible for the early build up of the North American ice sheet around 120 ka BP, whereas both low insolation and low atmospheric CO_2 concentration are necessary to trigger a glaciation over Eurasia at around 72 ka BP. At the last glacial maximum, the simulated sea-level decrease corresponding to the contribution of northern hemisphere ice sheets is about 95 m. Accounting for the contribution of the Antarctic ice sheet, estimated at around 17 m by previous modelling studies using the same model, the sea-level drop is around 112 m. This estimate is close, within the error bars, to some sea-level reconstructions.

Key words: climate models of intermediate complexity, modeling studies, northern hemisphere ice sheets, external forcings, insolation, atmospheric CO_2 concentration, glaciation, deglaciation.