Simulation of Glacial Climate Change

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The cryosphere as a part of the Earth system is represented by the polythermal ice sheet model SICOPOLIS. The fine resolved ice sheet model is coupled to the coarse resolution model CLIMBER-2 via the surface interface SEMI. Up to now mainly paleoclimate runs have been carried out with the coupled model. We plan future scenarios for the response of the Greenland ice Sheet to greenhouse warming. Here, we present simulations of glacial inception and Heinrich events.

Glacial Inception

Our simulations explain the rapid glaciation on the Earth's surface (Fig. 1) by an interplay of a number different mechanism. While there is still considerable inland ice build-up with present-day (pre-industrial) CO_2, there is no glacial inception with present-day insolation (Fig. 2a). The push of glaciation came from the insolation changes. Furthermore, we show that the dynamics of the vegetation together with the ocean (Fig. 2b) is

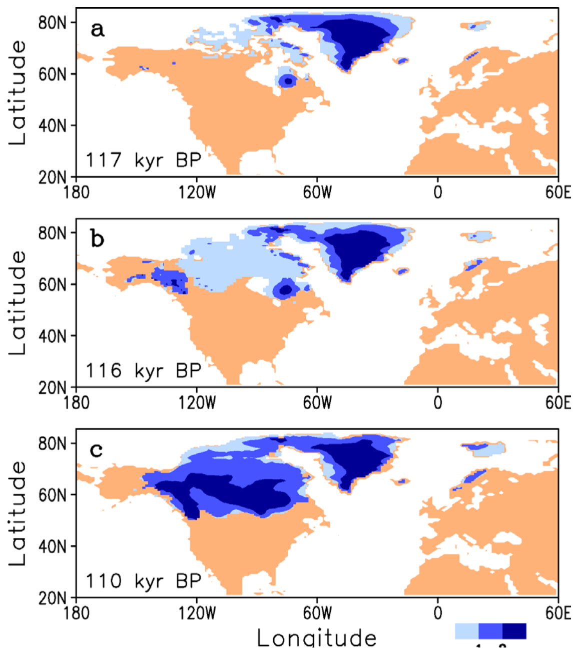

Figure 1: Simulation of certain phases of inland ice initiation at the beginning of the last glacial cycle. The main part of ice volume was build-up in North America. ***a****: at the beginning only small restricted areas had been nucleated.* ***b****: Through ice albedo feedback the ice advanced rapidly in area.* ***c****: Finally, a slow increase of ice volume follows.*

crucial to model the sea-level changes as observed in the proxies.

Heinrich Events

Our simulations explain Heinrich events as internal mechanism of the inland ice. When the Laurentide ice sheet (Fig.3) reached a critical thickness, the basal ice is surging with velocities up to 7 km/yr causing a dis-

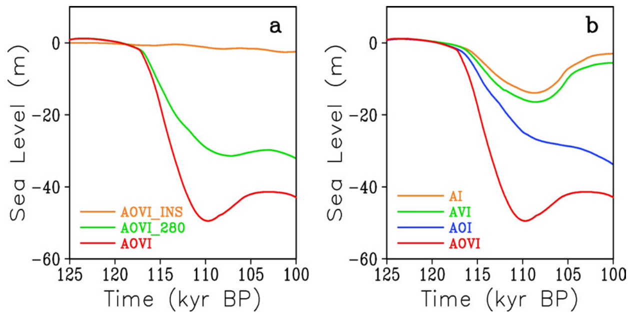

Figure 2: See level change resulting from the ice volume. Different scenarios in comparison with the standard simulation AOVI are shown. ***a****: AOVI_INS is with constant present-day insolation and AOVI_280 is with constant pre-industrial CO_2.* ***b****: Feedback analysis. The climate components O (=Ocean) and V (=Vegetation) are switched on/off, respectively; e.g., AOI is with active atmosphere, ocean and inland ice component, but constant (passive) vegetation.*

charge of about 0.1 Sv into the Labrador sea. Such a freshwater flux is sufficient to shut down the thermohaline Atlantic circulation. Our modelled sea-level change due the ice surges agrees with the proxydata.

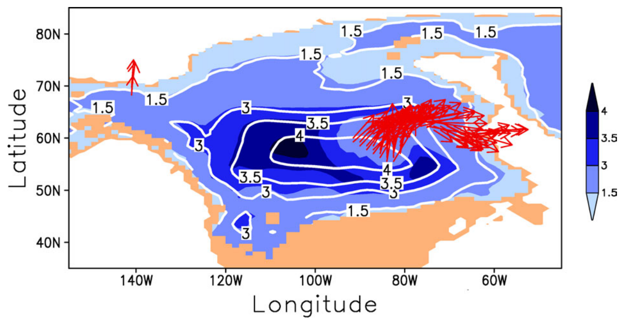

Figure 3: The Laurentide ice sheet before (the elevation is represented by isolines) and after (the elevation is depicted by blue shading) a Heinrich event. The red arrows show the ice flux during that Heinrich event. It is clearly seen that the ice sheet is developing from an one-dome to a two-dome structure, because immense ice masses are discharging into the Labrador sea.