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SIMULATION OF LARGE-SCALE INSTABILITIES OF THE LAURENTIDE ICE SHEET WITH A 3-D POLYTHERMAL ICE-SHEET MODEL

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Large-scale instabilities of the Laurentide ice sheet (Heinrich events, HEs) are simulated with the 3-D polythermal ice-sheet model SICOPOLIS which is coupled bi-directional with the climate component of the Earth-system model CLIMBER-2. SICOPOLIS simulates the thickness, velocity, temperature and water-content for grounded ice sheets. In this version it resolves the northern Hemisphere with 1.5° longitude and 0.75° latitude, and its time step is half a year. Our modelled large scale surges discharge up to 15 percentage of the total ice volume of the Laurentide ice sheet. The recurrence time between the simulated HEs is between 5,000 to 10,000 yrs and its duration is about 300 to 1200 years, which corresponds closely with the proxy-records. One key-factor of our simulations is the basal sliding which applies if the basal ice is at melting point. High basal sliding – in our simulation up to 7 km/year – is restricted to sediment covered regions in North America. We will closely discuss the mechanism of the large-scale instabilities – in particular, the development and evolution of activation and deactivation waves, which are the cause of the quasi-instantaneous appearance and disappearance of the large scale surges. Furthermore, we show that our modelled HEs are robust – they occur within a broad range of values of the sliding parameter, with different sliding laws as well as with changed surface mass balance or surface temperature. Nevertheless, the periodicity and amplitude of the HEs depend on the former quantities and the sliding parameter has a threshold above which crossing HEs start to develop. Similar internal oscillations of the ice sheet can be modelled with a flat basal topography and simple parameterisations of the snowfall and surface temperature on the ice sheet also. Such a setup could be useful for comparison with other ice-sheet models.