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Dynamics and climate sensitivity of Hans Tausen Iskappe (Greenland)

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Hans Tausen Iskappe (Greenland), situated at 82.5°N, 27.5°W, is the world's northernmost ice cap. During several field campaigns in the 70s and 90s, its ice thickness was measured, mass balance and meteorological measurements were made, and a 345 m deep ice core was drilled. From this ice core it is known that the ice cap (largely) disappeared during the Holocene Thermal Maximum. The present-day ice cap started building up some 3500-4500 years ago in a wetter and slightly warmer climate than at present.

Here we present first 3-D thermo-mechanical higher-order ice flow modelling results of the ice cap's fundamental climate sensitivity. The surface mass balance model considers snowfall and meltwater runoff. Net precipitation is based on RACMO$_2$.3 11-km output that is bi-linearly interpolated to 1 km. Runoff is calculated from a positive degree-day model that includes water retention in the snowpack with parameters derived from field measurements. The simulations are validated and calibrated with field observations complemented with satellite derived surface velocities. The ice cap geometry evolves to a state close to the presently observed for average 1961-1990 climate conditions, but the ice cap is found to already lose a large part of its volume and area under 1981-2010 conditions. Sensitivity analyses point out that the ice cap's northern part, situated on a plateau, is fairly stable under changing climatic conditions, whereas the southern part is much more sensitive. In our analysis we also investigate the effect of higher-order dynamics (compared to the Shallow Ice Approximation) and pay particular attention to what thresholds in the system could lead to a (partial) decay of the ice cap in the future.