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The importance of vegetation feedbacks on the past and future reglaciation of Greenland

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Vegetation feedbacks could potentially play an important role in the past and future evolution of the Greenland ice sheet but have largely been neglected from previous studies (e.g. Lunt *et al.*, 2004; Toniazzo *et al.*, 2004). Changes in vegetation type result in changes in surface albedo and surface roughness length, and hence affect the energy balance at the surface altering the climate over Greenland. This work focuses on modelling inception events from the pre-Quaternary and future reglaciation of Greenland.

We have used a climate model of intermediate complexity to assess the response of the climate when the Greenland ice sheet is replaced with a number of fixed vegetation types. The Grid ENabled Integrated Earth system model (GENIE) has been designed for speed to enable paleoclimate simulations, long-term future projections and large ensemble sensitivity studies. We perform an ensemble of one-hundred year simulations with the ice sheet present and subsequently replaced with bare soil, tundra and boreal forest respectively. The vegetation types are defined by their snow-covered albedo, snow-free albedo and surface roughness length. The largest temperature change over Greenland relative to an ice sheet present is observed for the boreal forest simulation with an average increase in temperature of 8˚C. Furthermore, large differences occur between the vegetation types. Subsequent sensitivity studies are performed to determine how much temperature change is due to surface albedo and how much due to surface roughness length. Results indicate that surface roughness length could be as important as surface albedo when considering the effects of vegetation on the climate over Greenland. We also present results where the ice sheet model GLIMMER is forced offline to investigate the effects of different fixed vegetation

types on the glaciation of Greenland. This work highlights the importance of using a fully coupled vegetation-climate-ice sheet model to investigate the reglaciation of the Greenland ice sheet.