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21st century changes in the surface mass balance of the Greenland ice sheet simulated with the global model CESM

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We present here the first projections of 21st century surface mass balance change of the Greenland ice sheet simulated with the Community Earth System Model (CESM). CESM is a fully-coupled, global climate model developed at many research centers and universities, primarily in the U.S. The model calculates the surface mass balance in the land component (the Community Land Model, CLM), at the same resolution as the atmosphere (1 degree), with an energy-balance scheme. The snow physics included in CLM for non-glaciated surfaces (SNiCAR model, Flanner and Zender, 2005) are used over the ice sheet. The surface mass balance is calculated for 10 elevation classes, and then downscaled to the grid of the ice sheet model (5 km in this case) via vertical linear interpolation between elevation classes combined with horizontal bilinear interpolation. The ice sheet topography is fixed at present-day values for the simulations presented here. The use of elevation classes reduces computational costs while giving results that reproduce well the mass balance gradients at the steep margins of the ice sheet.

The simulated present-day surface mass balance agrees well with results from regional models. We focus on the regional model RACMO (Ettema et al. 2009) to compare the results on 20th-century surface mass balance evolution and two-dimensional patterns. The surface mass balance of the ice sheet under RCP8.5. forcing becomes negative in the last decades of the 21st century. The equilibrium line becomes $\sim$500 m higher on average. Accumulation changes are positive in the accumulation zone. We examine changes in refreezing, accumulation, albedo, surface fluxes, and the timing of the melt season.