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Simulation of coupled evolution of climate and Greenland ice sheet up to A.D. 2300

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The Greenland ice sheet (GrIS) is highly sensitive to climate forcing, as shown by current observations. Here, we use one of the few coupled ice sheet and ocean-atmosphere general circulation models to examine the coupling between the GrIS surface mass balance (SMB), elevation and dynamical flow. Surface melt is calculated with an energy balance scheme, avoiding the use of empirical melt-temperature relationships (e.g., positive degree days). Despite the course horizontal resolution of the atmospheric model (ECHAM5T31, $\sim$3.75 degrees), the model shows reasonable skill in the simulation of the GrIS surface climate and surface melt when compared with a regional model ($RACMO_2$).
Our results reveal a growing present-day GrIS in the absence of anthropogenic forcing, in response to reduced insolation forcing since the mid-Holocene. Biases in the simulation of the present-day GrIS are partially attributed to atmospheric sources. We assess the sensitivity of the GrIS to future anthropogenic greenhouse gas forcing through three Representative Concentration Pathways and their extensions until A.D. 2300, as well as to climate variability through a small ensemble of historical and RCP/ECP8.5 simulations. The elevation-SMB feedback enhances future GrIS decay with 8-11% (by 2100) and 24-31% (by 2300), depending on the scenario. The small ensemble shows a 2.5 times spread in present-day GrIS decay rates.