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Present and future changes of ice sheets in a coupled ice sheet-climate model

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The future evolution of the ice sheets covering Greenland and Antarctica is of importance, as ice sheets hold more than 99% of the Earths' freshwater. If released into the oceans, this freshwater could significantly impact the global climate, most prominently the oceanic overturning circulation and the sea-level. To model past and future climate change it is therefore important to integrate ice sheet models (ISMs) into state-of-the-art Earth System Models (ESMs), in order to account for the full range of feedback processes between ice sheets and other climate components.

However, the coupling of ISMs into ESMs remains challenging, especially due to the required downscaling of the surface mass balance (SMB) from the low resolution atmospheric grid of the ESM onto the high resolution ice sheet topography. Here we present results from model simulations with the Max Planck Institute ESM (MPI-ESM) coupled to the Parallel ISM (PISM; http://www.pism-docs.org). To bridge the gap between the different model resolutions of the atmospheric component of MPI-ESM and PISM a sophisticated energy balance model (EBM) is used to calculate and downscale the SMB. The modeled SMB for present-day climate conditions shows good agreement with SMB reconstructions from regional climate modeling (e.g. RACMO, MAR). To estimate the effect of different downscaling methods, simulations performed with the EBM are compared to simulations that use a commonly applied positive degree day approach. These comparisons are shown for simulations with present day as well as increasing greenhouse gas concentrations.