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Assessing Surface Mass Balance Schemes relevant for coupling of the PISM ice sheet model for Greenland to climate models

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Observations show that the Greenland Ice Sheet is sensitive to changes in the climate forcing which primarily manifests itself as the surface mass balance (SMB). Therefore, getting a realistic SMB is a key issue when an ice sheet model is coupled to a global or regional climate model. In this study, we assess the Greenland SMB computed using three schemes that are commonly applied in ice sheet modelling, i.e. 1) a positive degree-day scheme using temperature and precipitation from the climate model, 2) an offline SMB calculation using precipitation and radiative fluxes from the climate model, 3) an in-line SMB calculation within the climate model. In these three SMB calculations, the climate model outputs are from simulations using the global climate model EC-Earth at a horizontal resolution of about 125x125 km and forced by the ERA-Interim reanalysis as the boundary conditions for the period 1989-2009. The model output is then downscaled to the ice sheet model grid (20x20 km) using simple elevation corrections with standard lapse rates. To evaluate the impact of downscaling due to the coarse resolution of the global model, a fourth way of computing SMB is applied, using the regional climate model HIRHAM5 that dynamically downscales the same ERA-Interim reanalysis data for 1989-2009 to a resolution of 20x20 km. The SMBs calculated using the four different methods are evaluated using the ERA-Interim reanalysis and available observations of the Greenland SMB. Furthermore, the sensitivity of the response of the Greenland ice sheet to different SMBs is investigated by comparing the modelled equilibrium states obtained using the four sets of forcing fields. Finally, we discuss if the parameter selection and model assumptions are appropriate for modelling climates different from present-day.