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Assessing the links between Greenland Ice Sheet Surface Mass Balance and Arctic climate using Climate Models and Observations

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Changes in different parts of the Arctic cryosphere may have knock-on effects on other parts of the system. The fully coupled climate model EC-Earth, which includes the ice sheet model PISM, is a useful tool to examine interactions between sea ice, ice sheet, ocean and atmosphere. Here we present results from EC-Earth experimental simulations that show including an interactive ice sheet model changes ocean circulation, sea ice extent and regional climate with, for example, a dampening of the expected increase in Arctic temperatures under the RCP scenarios when compared with uncoupled experiments. However, the relatively coarse resolution of the climate model likely influences the calculated surface mass balance forcing applied to the ice sheet model and it is important therefore to evaluate the model performance over the ice sheet.

Here, we assess the quality of the climate forcing from the GCM to the ice sheet model by comparing the energy balance and surface mass balance (SMB) output from EC-Earth with that from a regional climate model (RCM) run at very high resolution (0.05 degrees) over Greenland. The RCM, HIRHAM5, has been evaluated over a wide range of climate parameters for Greenland which allows us to be confident it gives a representative climate forcing for the Greenland ice sheet. To evaluate the internal variability in the climate forcing, we compare simulations from HIRHAM5 forced with both the EC-Earth historical emissions and the ERA-Interim reanalysis on the boundaries. The EC-Earth-PISM RCP8.5 scenario is also compared with an EC-Earth run without an ice sheet to assess the impact of an interactive ice sheet on likely future changes. To account for the resolution difference between the models we downscale both EC-Earth and HIRHAM5 simulations with a simple offline energy balance model (EBM).