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Very high resolution modelling of the Surface Mass Balance of the Greenland Ice Sheet: Present day conditions and future prospects.

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Recent experiments with the Regional Climate Model (RCM) HIRHAM5 have produced new surface mass balance (SMB) estimates at the unprecedented high horizontal resolution of 0.05 degrees (∼5.5km). These simulations indicate a present day SMB of 347 ± 98 Gt/year over the whole ice sheet averaged over the period 1989 – 2012 driven by the ERA-Interim reanalysis dataset.

We validate accumulation rates over the ice sheet using estimates from shallow firn cores to confirm the importance of resolution to accurate estimates of accumulation. Comparison with PROMICE and GC-Net automatic weather station observations shows the model represents present day climate and climate variability well when driven by the ERA-Interim reanalysis dataset. Comparison with a simulation at 0.25 degrees (∼27km) resolution from the same model shows a significantly different calculated SMB over the whole ice sheet, largely due to changes in precipitation distribution over Greenland.

The very high resolution requires a more sophisticated treatment of sub-grid scale processes in the snow pack including meltwater retention and refreezing and an enhanced albedo scheme. Our results indicate retention processes account for a significant proportion of the total surface budget based on a new parameterization scheme in the model.

SMB projections, driven by the EC-Earth Global Climate Model (GCM) at the boundaries for the RCP 4.5 scenario indicate a declining surface mass balance over the 21st century with some compensation for warmer summer temperatures and enhanced melt in the form of increased precipitation. A cold bias in the driving GCM for present day conditions suggests that this simulation likely underestimates the change in SMB. However, the downscaled precipitation fields compare well with those in the reanalysis driven simulations. A soon-to-be complete simulation uses driving fields from the GCM running the RCP8.5 scenario.