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Modelling the Greenland ice sheet surface mass balance

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The PalMod project aims to understand the climate system dynamics and variability with focus on the last glacial cycle. One of the challenges for the simulation of the climate variability of the last glacial cycle is the ice sheet modelling. Global climate simulations are not able to resolve the accumulation and ablation of ice sheets over steep topography gradients in sufficient detail. We aim to improve the representation of key processes of ice sheets, which accounts for the effects of unresolved scales in coarse resolution models. In order to achieve this, we use the regional climate model COSMO-CLM to perform high resolution simulations driven by global climate models. Such simulations allow to estimate mesoscale effects on the ice sheet surface mass balance, which are subgrid scale for the global models. Finally, the added value of such high resolution simulations help to develop parameterisations for global climate models modelling the last glacial cycle.

First, we need to provide a realistic modelling of the surface mass balance of the Greenland ice sheet with COSMO-CLM. We adapted and set up the regional climate model for simulations of the present day Greenland ice sheet. The sensitivity to different model setups concerning e.g. the modelling domain, the resolution (50 vs. 25km), or the importance of considering sea ice was investigated. Validation runs were performed with reanalysis data from the European Centre for Medium-Range Weather Forecast (ECMWF) Interim Reanalysis (ERA-Interim) with a horizontal resolution of $\sim 0.7^\circ$ on 60 vertical levels. Simulations were validated with multiple observations and gridded reanalysis datasets for the period 1995-2015. Results show that the means of precipitation, temperature and the surface mass balance generally agree well with observation data although biases are present, depending on the region and season. Overall best agreement with observations was achieved for the CORDEX-Arctic region as modelling domain on a 25 km resolution.
In a second step, this “optimal” model configuration is used for simulations driven with present-day ECHAM6 data provided by our project partners (MPI, AWI). The surface exchanges contributing to the Greenland surface mass balance will be analysed in detail.
In a next step, regional paleoclimate simulations will be performed and parameterisations of the accumulation and energy balance over the ice sheets will be developed based on statistical-dynamical downscaling.