InitMIP-Greenland experiments with the ice sheet model SICOPOLIS

*Ralf Greve[1], Reinhard Calov[2]

1. Institute of Low Temperature Science, Hokkaido University, 2. Potsdam Institute for Climate Impact Research (PIK Potsdam)

The Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6) brings together a consortium of international ice sheet and climate models to explore the contribution from the Greenland and Antarctic ice sheets to future sea level rise. For such projections, initialisations are required that provide initial states of the respective ice sheet. Therefore, as one of the first initiatives within ISMIP6, InitMIP-Greenland was launched in order to explore this issue for the Greenland ice sheet across a variety of models and initialisation techniques. Two different initialisation techniques are common, namely spin-up methods (paleoclimatic simulations until the present) and assimilation methods (assimilation of observations of the present-day ice sheet). We contribute to InitMIP-Greenland with the ice sheet model SICOPOLIS and two different spin-up techniques, (1) a SeaRISE-legacy spin-up over 125 ka with essentially fixed topography, and (2) a new spin-up over 135 ka with freely evolving topography. New methods applied for spin-up (2) are monthly-mean (rather than mean annual) input data for the present-day precipitation, a sub-grid-scale ice discharge parameterisation and an iterative correction of the present-day precipitation based on the misfit between the simulated and observed present-day ice thickness. The agreement between simulated and observed ice topography is naturally better for the fixed-topography case (1) than for the freely evolving case (2). Both spin-ups produce a realistic distribution of the surface velocity, including the major ice streams and outlet glaciers (at 5 km horizontal resolution). InitMIP-Greenland also comprises two future climate scenarios, ctrl (present-day climate over 100 a) and asmb (prescribed schematic surface mass balance anomaly over 100 a due to global warming), both to be run with freely evolving ice topography. The response of the ice sheet (mass loss) to the asmb forcing is, in absolute terms, ~50% larger for spin-up (2) than for spin-up (1), and relative to the respective control run ctrl even ~85% larger. This demonstrates impressively that, even with the same ice sheet model, different initialisation methods can lead to a major spread of results of future climate experiments.

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