InitMIP-Greenland experiments with the ice sheet model SICOPOLIS

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The Ice Sheet Model Intercomparison Project for CMIP6 ("ISMIP6", endorsed by CMIP6 in mid-2015, www.climate-cryosphere.org/activities/targeted/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, initializations are required that provide initial states of the respective ice sheet. Two different initialization techniques are common, namely spin-up methods (paleoclimatic simulations until the present) and assimilation methods (assimilation of observations of the present-day ice sheet). Here, we focus on spin-ups for the Greenland ice sheet. Using the model IcIES, Saito et al. (2016) showed that, for the previous SeaRISE effort, a large part of the observed spread in results of the future climate experiments (Bindschadler et al. 2013) can be explained by differences in the spin-up and surface mass balance methods. Therefore, as one of the first initiatives within ISMIP6, InitMIP-Greenland was launched in order to explore this issue across a variety of models and initialization techniques (www.climate-cryosphere.org/wiki/index.php?title=InitMIP). We contribute to InitMIP-Greenland with the ice sheet model SICOPOLIS (www.sicopolis.net) and two different spin-up techniques, (1) a SeaRISE-legacy spin-up over 125 ka with essentially fixed topography (Bindschadler et al. 2013), and (2) a new spin-up over 135 ka with freely evolving topography. For both cases, we used the recently developed melting-CTS enthalpy method ("ENTM", Greve and Blatter 2016) as the solver for ice sheet thermodynamics. New methods applied for spin-up (2) are monthly-mean (rather than mean annual) input data for the present-day precipitation (Robinson et al. 2010), a sub-grid-scale ice discharge parameterization (Calov et al. 2015) 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. Results for these two runs are shown in Fig. 1. For spin-up (1), ctrl shows a notable drift towards a smaller ice volume (positive contribution to sea level), which is due to the sudden release of the fixed-topography constraint. By contrast, for spin-up (2), such a transition shock does not occur, so that the drift is very small. The response of the ice sheet to the asmb forcing is more than 50% larger for spin-up (2) than for spin-up (1), mainly because of the somewhat too large present-day ice sheet obtained by spin-up (2).

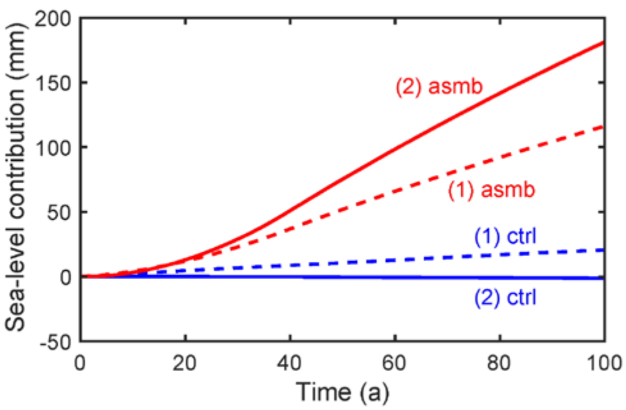

Figure 1. Sea-level contribution of the Greenland ice sheet for the runs ctrl and asmb. (1) Initialization by the fixed-topography spin-up, (2) initialization by the spin-up with freely evolving topography.

References

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