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Wissenschaftliche Zusammenfassung der kumulativen Dissertationsschrift

Numerical simulation of the Antarctic ice sheet and its dynamic response to external perturbations

This thesis covers the numerical simulation of the Antarctic sheet-shelf system with the Parallel Ice Sheet Model (PISM).
The model is modified in order to capture the specific interplay between ice-shelf geometry and discharge of inland ice. This grounded inland ice contributes to sea-level rise when flowing into the ocean through dynamically active regions, called ice streams. Floating ice shelves exert a buttressing back-stress on the ice streams that feed them. A physical stress boundary condition is implemented at the calving front. This ice margin is simulated at sub-grid scale and moves freely in all horizontal directions, according to a kinematic first-order calving law. The discretization scheme for mass transport is adapted to conserve mass in the modified shallow hybrid approximation of stress balance. The modified Potsdam Parallel Ice Sheet Model (PISM-PIK) is tested and tuned in a dynamic equilibrium simulation of the Antarctic sheet-shelf system, along with the implementation of Antarctica specific boundary conditions at the base and surface of the ice, and appropriate mass-flux reporting. The influence of three ice parameters for flow and sliding is assessed in a sensitivity study with a version of PISM that includes the above modifications. The analysis of some important processes governing ice discharge within the framework of climate-forcing experiments from the SeaRISE and ice2sea projects sheds light on their underlying physical mechanisms and relative importance. The model spread in dynamic ice discharge due to parameter uncertainty is assessed for different types of climate forcing. While sub-shelf melting, reduced basal friction and surface warming result in increased ice discharge, a negative feedback dampens the volume gain from enhanced snowfall through a dynamic increase in ice discharge.
This work contributes to the development of a broader basis for projections of future ice discharge from Antarctica in a warming climate.

Potsdam, im Januar 2012