LGM ice sheets simulated with a complex fully coupled ice sheet – climate model

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Introduction
The major challenge in predicting future climate change is the validation of the numerical models. A particular good time period for testing ice sheet – climate interactions is the last glacial maximum (LGM). It combines large ice sheets with good proxy data coverage. We study the LGM climate with a coarse resolution complex climate model coupled with an ice sheet model. We validate our setup for comparing glacial as well as present-day climatologies with pre-industrial experiments with reconstructions and the present state. By performing experiments with both setups, we test our model under large perturbations that go beyond the linear range.

Model setup
Our model comprises of the atmosphere-ocean-vegetation general circulation model ECHAM5/MPIOM/LPJ ice sheet model ham. mPIOM is a modified version of the Parallel Ice Sheet Model from the University of Alaska, Fairbanks. We run ECHAM5 in T31 resolution (3.75 °), and mPIOM on 20 km grid covering most of the northern hemisphere. We do not use flux correction or anomaly maps in our models.

Results
The pre-industrial setup, we model the ice cover of Greenland and the Arctic islands fairly correctly. The ice sheet in Aksayak is caused by a temperature class of ECHAM5, that also occurs in stand-alone simulations and is lower in simulations with higher resolution. In general, the temperature differences to the marine Domains are within the expectations for a T31 (3.75 °) atmosphere model (SAT 1).

The coupled GISM experiment (ICE 1) features the major ice sheets Greenland, Launetide, Fennoscandia as well as an extra ice sheet over Labrador that connects the Northeast ice sheet with the Labrador sea current. While this continuous iceberg flow is repeatedly flushed into the Labrador Sea by the Hudson Bay ice stream (based between the Hudson Bay and Labrador Sea). The USM setup shows a global cooling (SAT 2), that is stronger over the land than over the oceans and masks over the ice covered areas than in the ice-free areas. Over the sea ice, the increased latitude and altitude causes a stronger cooling.

Conclusion
Our model has performed time couple ice sheet – climate model studies under pre-industrial as well as LGM boundary conditions fairly correctly. The shape of the ice sheets has a significant influence on the system processes and thereby on the global climate. Our model shows ice sheet collapse in a large part of Russia regardless of the boundary conditions. These pulses create strong upwelling in the ocean.

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