Sensitivity of the Greenland Ice Sheet in the climate model EC-Earth

Marianne Sloth Madsen, Shuting Yang, and Gudfinna Adalgeirsdottir

Danish Meteorological Institute, Danish Climate Center, 2100 Copenhagen Ø, Denmark (msm@dmi.dk)

The challenge when including an ice sheet model in an Earth System
Model (ESM) is to reproduce the present day ice sheet as closely as
possible while the ice sheet is in equilibrium with the modelled
climate under the present day conditions. We address this by coupling
the state-of-the-art ice sheet model PISM (Parallel Ice Sheet Model)
with the ESM EC-Earth. PISM can simulate spatially and temporally
varying ice streams (fast flowing ice) by use of the shallow shelf
approximation as a "sliding law" for the shallow ice
approximation. In the fully coupled system the ice sheet model PISM is
driven by the surface mass balance and the surface temperature from
the atmosphere-ocean modules, while the ice melt and surface albedo as
well as the PISM simulated changes in ice-extent and topography
feedback simultaneously to the atmosphere-ocean modules.

Different climate forcings are obtained from EC-Earth simulations
using pre-industrial and present day conditions and evaluated with the
reanalysis data (ERA40/ERA-Interim) as well as with
observations. Various sets of forcings, including that of the
reanalysis, are then downscaled to the grid size of PISM (20km x 20
km). The sensitivity of the Greenland ice sheet to different climate
forcings is quantified. The importance of snow parameterization in
the atmospheric model and the presence of fast processes in the ice
sheet model is also explored. Furthermore, the ice sheet in the fully
coupled system is examined.