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An Estimation of Future Sea Level Rise Due to Greenland Ice Sheet Melting

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We estimate future sea level rise due to the melting of the Greenland ice sheet. To this end, we forced GRISLI ice sheet model (LGGE, France) with output from climate simulations run with CNRM-CM5.1 in the framework of CMIP5 (Coupled Model Intercomparison Project phase 5).
GRISLI is a 3D thermo-mechanically coupled ice sheet model which mixes shallow ice approximation and shallow shelf approximation. The horizontal resolution is 15km. To operate GRISLI, surface mass balance (SMB) should be defined as a top boundary condition and serves as an input. In this study the SMB is calculated following three different technique:
(1)by the positive degree day method - SMB is assumed as a function of precipitation and temperature alone (provided by CNRM-CM5)
(2)by the direct use of the SMB computed by CNRM-CM5
(3)by the direct use of the SMB computed by the hybrid snow model CROCUS (driven by surface atmospheric forcing provided by CNRM-CM5.1 simulations). CROCUS is a physically-based point snow model, including most of the processes controlling the evolution of snow-pack characteristics.
In order to generate an initial state for the ice sheet being in near-equilibrium with the preindustrial climate, GRISLI was forced for the past 125ky period (i.e. since the last interglacial) with the output of a preindustrial simulation run by CNRM-CM5. Proxy data (CISM) of temperature and sea level rise changes for this period were also used as input. Then, GRISLI was forced with CNRM-CM5.1 data from a 1850-2005 historical experiment. This simulation of the recent past was extended to year 2300 under the two scenarios RCP4.5 and RCP8.5.
The accumulation rate and surface mass balance simulated by CNRM-CM5.1/CROCUS for the historical experiment were both validated by a comparison with Automatic Weather Stations located in different sites in Greenland, showing a bias of about 30%.
For the present climate, the sea level rise rate simulated by GRISLI is in a good agreement with known contemporary values. For example, for year 2010 our simulations yield +0.35 mm sea level rise per year. We also estimate the additional eustatic sea level rise due to Greenland ice sheet melting to be respectively +5 cm and +7 cm over the whole 21st century for the two scenarios RCP4.5 and RCP8.5. It should be noted that for the RCP8.5 scenario, in contrast to RCP4.5, the melting rate of Greenland accelerates very rapidly after the 21st century. This acceleration phenomenon is probably amplified both by the significant temperature increase over the Greenland ice sheet and also by topographic changes induced by the shrinking of the ice sheet.