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Future evolution of the Greenland Ice Sheet in a coupled climate and ice sheet model: CESM2.1-CISM2.1 contribution to ISMIP6

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There are large uncertainties in projections of 21^{st} century and future multi-century global sea level rise. Part of the uncertainty stems from the lack of ability to robustly resolve interactions and feedbacks between ice sheets and the rest of the climate system in global circulation models. Coupling an ice sheet model to a global climate model will help us in this regard.

The Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6) is a CMIP6-endorsed MIP that focusses on the Greenland and Antarctic Ice Sheets. One ISMIP6 goal is a set of simulations with climate models coupled to ice sheet models (ISM). This will enable to assess the climatic impact of the ice sheet dynamic response onto the climate.

The Community Earth System Model version 2.1 (CESM2.1) includes a of bi-directional coupling with the Community Ice Sheet Model (CISM2.1) over the Greenland Ice Sheet. With this model we can assess ice sheet and climate interactions at a previously unprecedented level of detail. Furthermore, routing of ice sheet meltwater and calving into the ocean, as well as adaptive ice sheet topography enables studies of the impact of a changing ice sheet on future atmospheric and ocean circulation patterns.

Here we present the CESM2.1-CISM2.1 simulations under ISMIP6 guidelines that have been analyzed to date. Four simulations will be carried out: 1) a pre-industrial control steady state simulation (*piControl-withism*), 2) a 500-year simulation with a 1% yr^{-1} increase CO_2 up till the value of 4 times the pre-industrial concentration (*1pctCO$_2$to4x-withism*), 3) a historical simulation 1850-2015 (*historical-withism*) and 4) a future evolution simulation following the emission scenario RCP8.5 and its extension to year 2,300 (*ssp585-withism*). In the analysis, we focus on key features of the global and polar climate: the time evolution of the North Atlantic Meridional Overturning Circulation strength (NAMOC), the Greenland surface albedo, surface melt and surface mass balance (SMB), and the dynamical ice sheet change and contribution to eustatic sea level rise.