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Fully coupled ice sheet-earth system model: How does the Greenlandic ice sheet interact in a changing climate

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As ice sheets belong to the slowest climate components, they are usually not interactively coupled in current climate models. Therefore, long-term climate projections are incomplete and only the consideration of ice sheet interactions allows tackling fundamental questions, such as how do ice sheets modify the reaction of the climate systems under a strong CO_2 forcing?

The earth system model MPI-ESM, with the atmosphere model ECHAM6 and ocean model MPIOM, is coupled to the modified ice sheet model PISM. This ice sheet model, which is developed at the University of Fairbanks, represents the ice sheet of Greenland at a horizontal resolution of 10 km. The coupling is performed by calculating the surface mass balance based on 6-hourly atmospheric data to determine the boundary condition for the ice sheet model. The response of the ice sheet to this forcing, which includes orographic changes and fresh water fluxes, are passed back to the ESM. In contrast to commonly used strategies, we use a mass conserving scheme and do therefore neither apply flux corrections nor utilize anomaly coupling.

Under a strong CO_2 forcing a disintegrating Greenlandic ice sheet contributes to a rising sea level and has the potential to alter the formation of deep water masses in the adjacent formation sites Labrador Sea and Nordic Seas. We will present results for an idealized forcing with a growing atmospheric CO_2 concentration that rises by 1% per year until four-times the pre-industrial level has been reached. We will discuss the reaction of the ice sheet and immediate responses of the ocean to ice loss.