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How do ice sheets impact on climate sensitivity and ocean meridional overturning circulation?

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ASTER is a research project supported by the Belgian Science Policy Office. The overall objective of this project is to identify a range of possible climate and sea level change scenarios over the next three millennia that are coherent with the past evolution of the Earth system and to understand the causes of this range of projections. To reach this goal, we use LOVECLIM, a global three-dimensional Earth system model of intermediate complexity. Namely, some key physical parameters of LOVECLIM are varied within their range of uncertainty in order to provide an ensemble of parameter sets resulting in contrasted climates. In a first step, we employ a version of LOVECLIM in which the ice sheet and carbon cycle components are not interactive. Three types of experiments are performed. First, a pre-industrial control run allows us to check that the simulated climate is in agreement with observations. Second, the atmospheric CO2 concentration is increased by 1% per year during 70 years from its pre-industrial value and then kept constant (at twice the initial value), which allows to determine the climate sensitivity of the model. Finally, a freshwater hosing experiment is conducted in which an additional freshwater flux of 0.0002 Sv is added each year in the North Atlantic Ocean. Such an experiment allows to quantify the response of the Atlantic meridional overturning circulation (MOC) to a freshwater perturbation. We selected 9 parameter sets that lead to a climate sensitivity ranging from 2 to 4°C and a MOC reduction ranging from 20 to 60% after 1000 years of simulation. The phase

space (MOC vs. temperature) is homogeneously covered. In a second step, the fully coupled LOVECLIM model (i.e., with interactive ice sheet and carbon cycle components) is utilised with the same 9 parameter sets and the three series of experiments are repeated. By thoroughly comparing the results from the two sets of experiments, we evaluate the impact of interactive Greenland and Antarctic ice sheets on the climate sensitivity and on the MOC response to a freshwater perturbation. We also investigate the feedbacks mechanisms responsible for the differences in response.