EGU22-7964
https://doi.org/10.5194/egusphere-egu22-7964
EGU General Assembly 2022

The long-term sea-level commitment from Antarctica

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With a sea-level rise potential of 58 m sea-level equivalent, the future evolution of the Antarctic Ice Sheet under progressing warming is of importance for coastal communities, ecosystems and the global economy. Short-term projections of the sea-level contribution from Antarctica in the recent ice sheet model intercomparison ISMIP6 range from a slight mass gain (-7.8 cm) to a mass loss of up to 30.0 cm sea-level equivalent at the end of the century under Representative Concentration Pathway 8.5 (Seroussi et al., 2020, Edwards et al., 2021). However, due to high inertia of the system, the ice sheet response to perturbations in its climatic boundary conditions are rather slow. Consequences of potentially triggered unstable ice loss due to positive feedback mechanisms may therefore play out over long timescales (on the order of millennia). Projections of the committed sea-level change at a given point in time, that is the sea-level change which arises by fixing the climatic boundary conditions and letting the ice sheet evolve over several millennia, might differ substantially from the sea-level change expected at that point in time (Winkelmann et al., 2022).

Previous assessments of the long-term contribution to sea-level rise from the Antarctic Ice Sheet have been primarily restricted to a single model and have rarely explored the full range of intra- and inter-model parameter uncertainties. Here, we determine the long-term, multi-millennial sea level contribution from mass balance changes of the Antarctic Ice Sheet by means of two ice sheet models, the Parallel Ice Sheet Model (PISM) and the fast Elementary Thermomechanical Ice Sheet (f.ETISh) model. More specifically, we assess the response of the Antarctic Ice Sheet to atmospheric and oceanic forcing conditions derived from state-of-the-art climate model projections available from the sixth phase of the Coupled Model Intercomparison Project (CMIP6) under the Shared Socioeconomic Pathways SSP5-8.5 and SSP1-2.6 available until the year 2300. The sea-level commitment from the Antarctic Ice Sheet is quantified by branching off at regular intervals in time and running the ice sheet models for several millennia under fixed climate conditions. Key uncertainties related to ice dynamics as well as to interactions with the bed, atmosphere and ocean are taken into account in an ensemble approach.