EGU2020-19740, updated on 27 Jan 2023
https://doi.org/10.5194/egusphere-egu2020-19740
EGU General Assembly 2020
© Author(s) 2023. This work is distributed under
the Creative Commons Attribution 4.0 License.

Antarctic ice dynamics - from deep past to deep future

Ricarda Winkelmann[1,2], Torsten Albrecht[1], Julius Garbe[1,2], Jonathan Donges[1,3], and Anders Levermann[1,2,4]

[1]Potsdam Institute for Climate Impact Research, Potsdam, Germany (ricardaw@pik-potsdam.de)
[2]Institute of Physics and Astronomy, University of Potsdam, Potsdam, Germany
[3]Stockholm Resilience Centre, Stockholm University, Stockholm, Sweden
[4]Lamont-Doherty Earth Observatory, Columbia University, New York, USA

The Antarctic Ice Sheet has undergone extensive retreat and re-advance in its glacial-interglacial history. With progressing anthropogenic climate change, the associated ice dynamics and feedbacks could further lead to persistent and potentially irreversible ice loss from Antarctic drainage basins in the future.

Process-based models, in combination with paleo and modern records, provide the tools to reconstruct the glacial-interglacial history of the Antarctic Ice Sheet, to improve our understanding of the involved processes and critical thresholds, and to better anticipate possible future pathways.

Here we present simulations of the Antarctic Ice Sheet over the past two glacial cycles using the Parallel Ice Sheet Model PISM. As the conditions in particular at the base of the ice sheet are weakly constrained, and proxy data for the climatic forcing over the last glacial cycles is sparse, we assess the sensitivity of the model response with respect to the choice of boundary conditions. We further conduct an ensemble analysis in order to systematically constrain uncertainties with respect to representative model parameters associated with ice dynamics, climatic forcing, basal sliding and bed deformation.

Based on the insights into the dynamic threshold behavior and estimates of the ice sheet's contributions to global sea-level changes in the past, we investigate the long-term future stability of the Antarctic Ice Sheet under different levels of global warming. We show that the ice sheet exhibits a multitude of temperature thresholds beyond which ice loss into the ocean becomes irreversible. Each of these thresholds gives rise to hysteresis behavior, meaning that the currently observed ice-sheet configuration cannot be regained even if temperatures were to be reversed to their present-day levels.