EGU23-15613, updated on 15 Apr 2024
https://doi.org/10.5194/egusphere-egu23-15613
EGU General Assembly 2023

Sensitivity of the Antarctic Ice Sheet evolution to different Earth structures using a coupled 3D GIA - ice-sheet model under different future climate scenarios

Caroline van Calcar[1,2], Jorge Bernales[2], Tijn Berends[2], Wouter van der Wal[1,3], and Roderik van de Wal[2,4]

[1]Faculty of Aerospace Engineering, Delft University of Technology, Delft, The Netherlands
[2]Institute for Marine and Atmospheric research Utrecht, Utrecht University, Utrecht, The Netherlands
[3]Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft, The Netherlands
[4]Department of Physical Geography, Utrecht University, Utrecht, The Netherlands

The projected decay of the Antarctic Ice Sheet (AIS) over the coming centuries will lead to uplift of the Earth's surface due to Glacial Isostatic Adjustment (GIA). GIA slows down grounding line migration and therefore has a stabilizing effect on the ice sheet evolution. GIA acts on timescales of decades to centennial depending on the magnitude of the mantle viscosity. The mantle viscosity is several orders of magnitude higher in East Antarctica than in West Antarctica and varies with one order of magnitude within West Antarctica. Studies of the AIS evolution over the last glacial cycle have shown that including lateral variations of the Earth's mantle viscosity can lead to 1.5-kilometer thicker ice in West Antarctica at present day. However, current projections do not include GIA, or they use a laterally homogeneous GIA model. One study applied a uniform high mantle viscosity under East Antarctica and a uniform low mantle viscosity under West Antarctica and showed that, on longer timescales of hundreds of years, mass loss projections of Antarctica may be underestimated because spatially uniform GIA models overestimate the stabilizing effect of GIA across East Antarctica. We developed a coupled GIA - ice-sheet model using the ice-sheet model IMAU-ICE, and a 3D GIA finite element model that includes lateral mantle viscosity variations, and a seismic model to determine the patterns of the viscosity. The results of projections for two IPCC scenarios show that including lateral variations in the Earth's mantle viscosity leads to local ice thickness differences of up to 600 meters in West Antarctica 2300. The results underline and quantify the importance of including this local feedback effect in ice-sheet models when projecting the long-term sea level contribution from Antarctica.