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# The role of fast processes for the stability of the Greenland ice sheet

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Observations by satellite reveal that the ice discharge of the Greenland Ice Sheet (GIS) is dominated by rather fast ice flow (ice streams and glaciers). However, adequate treatment of such fast processes is far off being fully implemented in contemporary large-scale ice-sheet models mainly for two reasons. First, due to lack of sufficient physical understanding of the processes. Second, because of small spatial scale of Greenland's outlet glaciers and fine features of the bed under the ice streams resolving of which requires very high spatial resolution of the ice-sheet models. At the same time, the lack of proper representations of fast processes leads to considerable deficiencies in simulation even of the present-day Greenland ice sheet. In particular, it is not possible with contemporary ice-sheet models to simulate both spatial extend of GIS and the partition of mass balance between ablation and ice discharge into the ocean correctly. In view of empirical data indicating that recent acceleration of ice streams and outlet glaciers contributed about half of total GIS contribution to the sea-level rise, it is very likely that contemporary ice-sheet models may not be accurate enough for prediction of future sea-level rise.
We present simulations with an improved version of the polythermal ice-sheet model SICOPOLIS coupled to a regional energy-moisture balance model (REMBO). Introducing an ad-hoc parameterisation of fast ice flux, we investigate the importance of fast processes for the simulation of present-day GIS and its stability under different global warming scenarios on centennial to multi-millennial time scales. We also performed a set of steady-state simulations of GIS, which show that the stability range of the Greenland ice sheet in the phase space of atmospheric temperature anomaly is indeed affected by inclusion of fast processes. These results suggest that even a rather simple treatment of fast processes within the classical ice-sheet models based on the shallow ice approximation allows to improve these models and make them more suitable for the prediction of GIS contribution to future sea-level rise.