Using Past Ice-Sheet Dynamics to Improve Models and Predictions of Future Sea Level

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Abstract

Modern observations of the coupled Antarctic Ice Sheet-ocean-atmosphere-earth system are critical for understanding fundamental ice sheet processes and the complex linkages between these interconnected systems. However, the observational period of both direct (in situ) measurements and remote sensing from satellites is short, relative to the timescales of continental-scale ice sheet dynamics. Furthermore, the modern observational window provides guidance only on processes at play in the relatively cold conditions of the past several decades, and may be less useful in elucidating processes, and magnitudes and rates of change in a climate substantially warmer than today.

Paleo-ice sheet and climate reconstructions and estimates of past sea level provide a critical complement to modern observations. Such reconstructions have recently been key in pushing model development, and have motivated the inclusion of physical processes, like ice-cliff collapse at marine-terminating ice margins, that otherwise might not have been recognized as important from modern observations alone. Here we discuss some of the recent advances in modelling the Antarctic Ice Sheet, and emerging techniques to quantitatively use paleo-ice sheet and sea-level reconstructions from the Pliocene to the present, in order to test, verify, and calibrate model physics used for future projections.

Implications of paleo-constraints on model physics will be shown in future ice-sheet simulations spanning a range of greenhouse gas emissions scenarios, ranging from a fossil-fuel intensive 'business as usual' scenario, to much lower emissions scenarios following the aspirations of the Paris Climate Agreement.

Keywords: ice-sheet models, paleo-model calibration, future projections