Geophysical Research Abstracts
Vol. 16, EGU2014-11556, 2014
EGU General Assembly 2014

Mechanisms producing warm-climate ice retreat in East Antarctic subglacial basins

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Geological data indicate that global sea level has fluctuated on O(10,000) to O(1,000,000) year time scales during the last ∼25 million years. Peak levels are uncertain, but some estimates suggest high stands of ∼20 m or more above modern, for instance during the mid Pliocene. If correct, this implies substantial variations in the size of the East Antarctic Ice Sheet (EAIS). However, climate and ice-sheet models have not been able to simulate significant EAIS retreat from continental size, given low proxy atmospheric CO_2 levels during this time. Here, we use a continental Antarctic ice-sheet model with two new mechanisms based on previous studies and observations: (1) structural failure of large tidewater ice cliffs, and (2) enhanced ice-shelf calving due to meltwater drainage into crevasses.

With atmospheric and oceanic forcing representing Pliocene warm periods, the new mechanisms greatly accelerate the expected collapse of marine ice in West Antarctica, and also cause drastic retreat into 3 major East Antarctic subglacial basins, producing ∼15 m global sea-level rise within a few thousand years. Basic results are presented, along with details of the cliff-failure numerics, and a simple parameterization of the clogging effects of ice melange in narrow seaways, which aids in ice-sheet recovery after colder climates resume.