Geophysical Research Abstracts
Vol. 19, EGU2017-11640, 2017
EGU General Assembly 2017

Millennial-scale Vulnerability of the Antarctic Ice Sheet to Localized Subshelf Melting

Daniel Martin (1), Stephen Cornford (2), Antony Payne (2), Esmond Ng (1), and Stephen Price (3)

(1) Lawrence Berkeley National Laboratory, Computational Research Division, Berkeley, United States (dfmartin@lbl.gov),
(2) University of Bristol, (3) Los Alamos National Laboratory

The Antarctic Ice Sheet (particularly the West Antarctic Ice Sheet (WAIS)) is potentially vulnerable to modes of dynamical thinning driven by climate forcing. As warm circumpolar deep water (CDW) intrudes into the cavities under the ice shelves, it thins and weakens the ice shelves, compromising their ability to buttress the flow of their feeder ice streams. Both models and observations have borne out the idea that reduced buttressing can lead to rapid upstream thinning, grounding-line retreat, and even the onset of Marine Ice Sheet Instability (MISI).

We present a systematic examination of millennial-scale Antarctic vulnerability to scenarios of extreme ice-shelf melting. In each scenario, we model localized CDW intrusion by applying an extreme ice shelf ablation to a different, limited region while evolving the full continental Ice sheet for 1000 years. In this way, we can isolate the degree of vulnerability of the ice sheet to localized forcing. We also explore the response to melt forcing in selected combinations of sectors. This results in a clearer picture of where the ice sheet is susceptible to subshelf-melt-driven retreat. We find, for example, that WAIS is vulnerable to warming in the Amundsen, Weddell, and Ross Seas – strong melting in any of these regions may be enough to eventually cause WAIS collapse. Other sectors show some vulnerability, but with less impact than WAIS collapse. Results of this experiment also allow us to examine the validity and limitations of regional modeling vs. whole ice sheet modeling. The model has been initialized to match observations of current-day ice thickness, topography, and ice velocity using Bedmap2 as a starting point for a mass-conservation approach.

We also comment on model resolution requirements for accurately simulating Antarctic grounding line retreat in realistic configurations. Use of the BISICLES adaptive mesh refinement model allows us to sufficiently resolve the grounding line dynamics of each scenario while keeping the total computational cost to a tractable level.