Geophysical Research Abstracts,
Vol. 11, EGU2009-12322, 2009
EGU General Assembly 2009


# Oceanic and Atmospheric forcing of Antarctic Ice Sheet variability through the Plio-Pleistocene

R. DeConto (1) and D. Pollard ()

(1) Department of Geosciences, University of Massachusetts, Amherst, MA, USA (deconto@geo.umass.edu), (2) Earth and Environmental Systems Institute, Pennsylvania State University, University Park, PA, USA (pollard@essc.psu.edu)

A hierarchy of models is being used to explore the climatic and glacial evolution of Antarctica on millennial and longer timescales. Modeling work over the past several years has concentrated on the development of a combined ice sheet-shelf model, the adaptation of a Regional Climate Model (RCM) to the Antarctic region, GCM-ice sheet coupling, and the development of asynchronous coupling techniques allowing long climate-ice sheet simulations on orbital timescales. To complement recent findings by the ANDRILL Program, recent simulations have concentrated on the Plio-Pleistocene, and in particular on Marine Isotope Stage 31 (∼1.07 Ma); a super-interglacial interval when the Ross Embayment appears to have been ice-free and the West Antarctic Ice Sheet (WAIS) was partially or completely collapsed. Here, we show results from GCM, RCM, and ice sheet-shelf models exploring the range of potential surface mass balance forcing and oceanic sub-ice melt in response to orbital forcing and changing Plio-Peistocene greenhouse gas concentrations. Our climate model results generally reinforce the conclusions of prior 5-myr ice sheet-shelf simulations using simple parameterized climate forcing to drive the ice model (derived from deep-sea oxygen isotope records and austral summer insolation), and point to the overriding importance of sub-ice oceanic melt to ice shelf and WAIS variability on these timescales. The GCM and RCM simulations also show that the potential for significant surface melt over the grounded flanks of West and East Antarctic Ice Sheets is minimal, with summer temperatures remaining below the melt point even during the warmest austral summer orbits and at levels of atmospheric carbon dioxide (∼400 ppmv) estimated for the warm early-middle Pliocene period. These results imply that Plio-Pleistocene Antarctic ice sheet variability has likely been driven mostly by changes in sub-ice oceanic melt, rather than by warm air temperatures and surface melt. While the potential for significant melt on the flanks of terrestrial ice sheets appears to be limited, the model does predict significant melt on the lower-elevation surfaces of ice shelves during warm periods. Ice-shelf thinning can lead to loss of grounded ice by the loss of buttressing; however, ice-shelf thinning due to surface melt would have been additive and perhaps subsidiary to that caused by oceanic melting from below. These factors are just beginning to be explored and may include the need for surface-energy-balance models versus positive-degree-day parameterizations. The clear importance of marginal ocean temperatures and sub-ice melt in Plio-Pleistocene WAIS variations highlights the need for more explicit, high-resolution ocean modeling of West Antarctic embayments.