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Antarctic contribution to sea-level rise during the Last Interglacial and future centuries

Robert DeConto (1) and David Pollard (2)

(1) Climate System Research Center, Univ. of Massachusetts, Amherst, MA, USA (deconto@geo.umass.edu), (2) EMS Earth and Environmental Systems Institute, Penn State Univ., State College, PA, USA (pollard@essc.psu.ede)

Substantial retreat of the Antarctic Ice Sheet during past warm periods including the Pliocene and some Pleistocene interglacials has been difficult to reconcile in most ice sheet models. This includes the Last Interglacial (LIG; ∼130 to 115 ka), when Antarctica is now thought to have contributed +4 to +7m of equivalent sea-level rise. Here we use a continental ice sheet-shelf model with new physics accounting for structural failure of large tidewater ice cliffs and the influence of surface meltwater on ice-shelf calving. Coupled with high-resolution atmosphere and ocean components, the model is used to simulate the Antarctic Ice Sheet under Pliocene, LIG, and future conditions. The new model simulates an Antarctic contribution to sea-level rise of ∼15m during peak mid-Pliocene warmth and ∼4.25m during the LIG, in approximate agreement with (albeit uncertain) geological sea-level indicators.

When applied to long-term future simulations assuming extended RCP greenhouse gas emission scenarios and using high resolution atmosphere and ocean components, the same model physics show a dramatic retreat of Antarctic marine-based ice over the next 500 years, beginning within a few decades in the Pine Island Bay sector of West Antarctica. In the most extreme RCP scenarios, subsequent retreat of the Siple Coast margin results in the near-total collapse of the West Antarctic Ice Sheet (WAIS) within a few centuries, followed by retreat into the deep subglacial basins underlying the East Antarctic Ice Sheet (EAIS). Antarctica is shown to contribute up to 9m of sea level rise within the next five centuries. Under such high greenhouse gas conditions, atmospheric warming alone is sufficient to cause substantial ice retreat, without any influence from ocean warming and sub-ice melt. Conversely, in the absence of increasing atmospheric temperatures, very little ocean warming (<0.5 C) is required to trigger substantial WAIS retreat, even if present-day atmospheric temperatures are held constant. Given current rates of ocean heat uptake, this has serious implications for future commitment to sea level rise regardless of future greenhouse gas emissions.