Impact of Improved Ice-Front Physics on Simulations of Antarctic Ice Sheet Response to Climate Warming

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While geologic records of past sea level high stands remain poorly constrained, Antarctica is now thought to have contributed more than 10 meters of equivalent sea-level rise during the warm Pliocene (~3 million years ago), and 4-7 m during the more recent Last InterGlacial (LIG; ~130 to 115 ka). This magnitude of Antarctic Ice Sheet retreat during these past intervals (only slightly warmer than today) has been difficult to reconcile in most ice sheet models.

Here, we use a hybrid continental ice sheet-shelf model, with new treatments of 1) the influence of surface meltwater on ice-shelf calving and 2) structural failure of large tidewater cliffs. The ice sheet-shelf model is coupled with high-resolution atmosphere and offline ocean components and used to simulate the Antarctic Ice Sheet response to conditions during the mid-Pliocene and the LIG. The addition of the new physics produces Antarctic contributions to sea-level rise of 17 meters during the warm mid-Pliocene, and 3 meters during LIG, in much better agreement with (albeit uncertain) geological sea-level indicators than our previous simulations.

When applied to long-term future simulations assuming extended RCP greenhouse gas emission scenarios and using high resolution atmosphere and ocean components, the new model physics produce a dramatic retreat of Antarctic marine-based ice over the next 500 years, beginning within a few decades in the Amundsen Sea sector of West Antarctica. In the warmest RCP scenario (RCP8.5), combined retreat of the Amundsen Sea and Siple Coast outlet glaciers results in the near-total collapse of the West Antarctic Ice Sheet (WAIS) within a few centuries, followed by substantial retreat into the deep subglacial basins (Wilkes and Aurora) underlying the East Antarctic Ice Sheet (EAIS). If valid, the new model physics implies Antarctica has the potential to contribute up to 10 m of sea level rise within the next five centuries.

For theme: Modelling of ice and polar ocean (California Dreamin')