Simple model of mélange and its influence on major retreat episodes in a large-scale Antarctic ice sheet model

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Abstract

Theory, modeling and observations point to the prospect of runaway grounding-line retreat and marine ice loss from West Antarctica and major East Antarctic basins, in response to climate warming. These rapid retreats are associated with geologic evidence of past high sea-level stands, and the danger of drastic future sea-level rise. Rapid calving of ice from thick grounding lines generates substantial downstream mélange (floating ice debris). It is unknown whether this mélange has a significant effect on grounded ice dynamics during major Antarctic retreats, through clogging of seaways and back pressure at the grounding line. Observations in Greenland fjords suggest that mélange can have a significant buttressing effect, but the lateral scales of Antarctic basins are an order of magnitude larger (100's km compared to 10's km), with presumably much less influence of confining margins. Here we make a first attempt to include mélange as a prognostic variable in a 3-D Antarctic ice sheet-shelf model. Continuum mechanics is used as a heuristic representation of discrete particle physics. Water depth is included as a factor, to capture the restricting effect of shallow sills. We will examine the influence of the new mélange component in simulations of rapid Antarctic retreat, during the warm mid-Pliocene and in future warming scenarios.

Keywords: ice-sheet models, melange, Antarctic