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Primed for retreat: Unprecedented vulnerability of the Antarctic Ice Sheet

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The Antarctic Ice Sheet contains enough ice above floatation to contribute $\sim$57 m of sea-level rise. About a third of that ice rests on bedrock far below sea level, in deep subglacial basins. In places where the bedrock slopes downward, away from the coast (retrograde bed) or where groundling lines terminate in deep water, the ice-sheet margin is susceptible to dynamic instabilities (related to both viscous and brittle processes) that can cause rapid retreat. Here, we use a numerical ice sheet-shelf model that captures these processes to demonstrate that the current configuration of the Antarctic Ice Sheet, with marine-terminating grounding lines poised on the edges of deep subglacial basins, combined with current, early 21st century atmospheric and oceanic temperatures, maximizes the danger of rapid retreat and sea-level rise. The potential retreat rates from the modern state greatly exceed those starting from other past configurations such as glacial maxima and smaller terrestrial ice cover.

We also explore the importance of various negative feedbacks on the pace of retreat, including the effects of mélange, meltwater-climate feedback, and bedrock rebound. We find that today's Antarctic Ice Sheet is capable of contributing faster sea-level rise than at any other time in the ice sheet's recent (three million-year) geologic history, and possibly its entire 34 million-year history. This potential for unprecedented sea-level rise from Antarctica, coinciding with the recent expansion of human population centers and infrastructure along low-lying coastlines maximizes the risk of a future sea-level catastrophe.