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Antarctic ice dynamics amplified by Northern Hemisphere sea level forcing

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A longstanding hypothesis for near-synchronous evolution of global ice sheets over ice-age cycles invokes an interhemispheric sea-level forcing whereby sea-level rise due to ice loss in the Northern Hemisphere in response to insolation and greenhouse gas forcing causes grounding-line retreat of marine-based sectors of the Antarctic Ice Sheet (AIS). Recent studies have shown that the AIS experienced substantial millennial-scale variability during and after the last deglaciation, with several times of recorded increased iceberg flux and grounding line retreat coinciding, within uncertainty, with well documented global sea-level rise events, providing further evidence of this sea-level forcing. However, the sea level changes associated with ice sheet mass loss are strongly nonuniform due to gravitational, deformational and Earth rotational effects, suggesting that the response of the AIS to Northern Hemisphere sea-level forcing is more complicated than previously modelled.

We adopt an ice-sheet model coupled to a global sea-level model to show that a large or rapid Northern Hemisphere sea-level forcing enhances grounding-line advance and associated mass gain of the AIS during glaciation, and grounding-line retreat and AIS mass loss during deglaciation. Relative to models without these interactions, including the Northern Hemisphere sea-level forcing leads to a larger AIS volume during the Last Glacial Maximum (about 26,000 to 20,000 years ago), subsequent earlier grounding-line retreat and millennial-scale AIS variability throughout the last deglaciation. These findings are consistent with geologic reconstructions of the extent of the AIS during the Last Glacial Maximum and subsequent ice-sheet retreat, and with relative sea-level change in Antarctica.