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Rapid Holocene thinning of outlet glaciers followed by readvance in the western Ross Embayment, Antarctica

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Reconstructing deglaciation following the LGM provides an opportunity to better understand patterns, mechanisms and drivers of ice sheet retreat. We investigate the former behaviour of two East Antarctic outlet glaciers by combining chronologies of ice extent, offshore geomorphology and numerical modelling. In the Ross Sea sector, geomorphic features preserved on the seafloor indicate that streaming outlet glaciers once extended >100 km offshore of Victoria Land prior to back-stepping towards their modern configurations. In order to adequately interpret the style and causes of this retreat, the timing and magnitude of corresponding ice thickness change is required. New surface-exposure (10Be) data from Mawson Glacier, collected in elevation transects above the modern ice surface, reveal that rapid thinning occurred at ∼6–8 ka. This is broadly coeval with new ages of grounding-line retreat at ∼6 ka and rapid surface lowering recorded at nearby Mackay Glacier at ∼7 ka. Our data also show that a moraine formed near to the modern ice margin of Mawson Glacier at ∼0.8 ka, which, together with other ice elevation data, indicates that glaciers in this region likely readvanced during the Late Holocene. This seems to have occurred despite relatively warm waters near to their termini. We argue that 1) the accelerated thinning of outlet glaciers was driven by local grounding-line retreat through overdeepened basins during the early-mid Holocene, and 2) the glaciers subsequently readvanced, possibly linked to increased accumulation, before retreating to their current positions. Our work demonstrates that non-linear ice sheet retreat was typical of Antarctica's marine-based margins during the last deglaciation – in some locations, however, this trend may have then reversed.