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Glacial history and behaviour of Mackay Glacier, Transantarctic Mountains

Richard Selwyn Jones (1,2), Andrew Mackintosh (1,2), Kevin Norton (2), Nicholas Golledge (1,3), and Christopher Fogwill (4)

(1) Antarctic Research Centre, Victoria University of Wellington, Wellington, New Zealand. (richard.s.jones@vuw.ac.nz), (2) School of Geography, Environment & Earth Sciences, Victoria University of Wellington, Wellington, New Zealand., (3) GNS Science, Avalon, Lower Hutt, New Zealand., (4) Climate Change Research Centre, University of New South Wales, Sydney, Australia.

The configuration of Antarctic ice sheets is inherently linked to changes in climate and the encircling oceans. Direct observations of Antarctica have shown that changes are possible on the timescale of years to decades (Pritchard et al., 2012), but ice sheets also respond on longer timescales. Understanding the changes that occurred since the Last Glacial Maximum (LGM) is therefore vital for evaluating longer-term drivers of ice sheet changes.

The Ross Sea embayment drains both the marine-based West Antarctic Ice Sheet (WAIS) as well as some of the East Antarctic Ice Sheet (EAIS) through the Transantarctic Mountains. At the LGM, grounded ice extended to the outer continental shelf (Shipp et al., 1999; Anderson et al., 2002). Timing of the subsequent deglaciation currently indicates that deglaciation in the Ross Sea Embayment initiated at ca. 14 ka (Licht et al., 1999), continued during the Holocene and slowed and/or stopped in recent millennia. To the east of the Ross Sea Embayment in West Antarctica, surface-exposure dating indicates thinning was underway by 11 ka (Stone et al., 2003) and in a similar manner to the Ross Sea, continued throughout the Holocene.

A very rapid and large global sea level rise, known as Meltwater Pulse 1a, occurred during the last global deglaciation, between around 15 and 14 ka. Existing chronologies appear to indicate that Antarctic deglaciation slightly post-dated this event (e.g. Stone et al., 2003; Bentley et al., 2006; Mackintosh et al., 2011). In contrast, relative sea level evidence (Deschamps et al., 2012) and reinterpretation of geological data (Carlson & Clark, 2012) suggest that Antarctica was a significant contributor. Further direct constraints on the timing of deglaciation from Antarctica are required to test these competing hypotheses.

This project aims to better reconstruct the configurations of the EAIS and WAIS in the Transantarctic Mountains region at the LGM, specifically of the Mackay Glacier system which has not previously been studied in this manner. Mackay Glacier is critical because its response on glacial-interglacial timescales is likely modulated by changes in grounded ice volume in the western Ross Sea. The Ross Sea sector contained a large amount of the excess ice volume in Antarctica at the LGM, and hence is also an important area to search for a possible Antarctic contribution to Meltwater Pulse 1a. We present the geomorphology of glaciated nunataks and >50 cosmogenic surface-exposure dates that record thinning from elevation transects at 3 locations down Mackay Glacier. The deglacial thinning chronology is being used, together with a series of mapped offshore grounding-zone wedges, to constrain a 1-dimensional numerical flowline model investigating the time-transgressive glacial dynamics. The model will help to evaluate the mechanisms that forced ice sheet retreat between the LGM and present-day.