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Constraints on ice volume changes of the East Antarctic Ice Sheet and Ross Ice Shelf since the LGM based on cosmogenic exposure ages from Darwin-Hatherton outlet glaciers.

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At the Last Glacial Maximum and during Termination-1 (∼20-10 ka), marine evidence indicates that the grounding line of the West Antarctic Ice Sheet (WAIS) advanced northwards into the Ross Ice Shelf (RIS), blocking drainage of the Darwin and Hatherton outlet glaciers through the Transantarctic Mountains (TM) resulting in significant downstream thickening of glacier profiles. These outlet glaciers provide geological and glaciological records of EAIS expansion through the TMs as well as WAIS fluctuations which together suggest an LGM thickness of ∼800 m lager than today at their confluence with the Ross Embayment. About 80 cosmogenic 10Be and 26Al exposure ages of erratics from 3 locations flanking the Hatherton Glacier (Dubris Valley near the EAIS source region, from Lake Wellman at its midpoint and Diamond Hill at its terminus) taken along transects covering 800 m in differential elevation from ice-sheet contact to mountain peaks documents 2.5 Ma of ice volume evolution of the Hatherton allowing a reconstruction of its quaternary paleo-ice surface. Pleistocene ice thickness is some 800 to 400 meters thicker between 2.5 to 0.5 Ma years ago than today . However at all 3 locations, exposure ages of mapped glacial drifts younger than 0.5 Ma at lower elevations down to current ice margin did not show any evidence for a distinct LGM advance. At Lake Wellman a cluster of mid-elevation moraine boulders from the Britannia Drift, previously taken to demarcate the LGM advance, have exposure ages ranging from 30 to 40 ka. At Dubris Valley, the same drift returned ages of 120-125 ka. At Diamond Hill, the confluence of the Darwin Glacier and RIS, two transects were sampled that cover an altitude range of 1100 meters. Cosmogenic dates show a similar trend to that seen further upvalley - the WAIS was approximately 900 meters thicker than the current Rose Ice Shelf configuration at ∼1.5Ma and with only minor advances in the last 10ka and an absence of any LGM ages. The absence of a LGM signal is perplexing. We suggest the idea that while WAIS expansion during the early Pleistocene was large, LGM ice volume in the Darwin-Hatherton Glaciers was not as large as previously estimated and perhaps little different from what is observed today (at most 50 m above current ice surface). These results raise serious questions about the implications of a reduced East Antarctic ice Sheet at the LGM, and how the Antarctic ice sheets respond to global warming. Similar conclusions from 10Be exposure ages from coastal sites of the East Antarctic Ice Sheet in the Lambert Glacier-Amery Ice Shelf and at the Framnes Mountains also indicate a far reduced LGM ice volume at ∼15ka than previously assumed.