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# Dynamic fluctuations of an East Antarctic outlet glacier since the Pliocene

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Understanding past changes in the Antarctic ice sheets provides insight into how they might respond to future climate warming. The degree to which Antarctic ice sheets expanded and contracted under past climates remains uncertain, especially prior to the Last Glacial Maximum. During the Pliocene and Pleistocene, geological data show that the East Antarctic Ice Sheet likely responded to glacial and interglacial cycles by remaining relatively stable in its interior, but oscillating at its marine-based margin. It is currently not clear how outlet glaciers, which connect the ice sheet interior to its margin, responded to these orbitally-paced climate cycles.

We present new ice surface constraints from Skelton Glacier, an outlet of the East Antarctic ice sheet, which drains into the Ross Ice Shelf and over the AND-1B drill site. Our multiple-isotope (10Be and 26Al) data indicate that currently ice-free areas adjacent to the glacier underwent substantial periods of exposure and ice cover in the past. We determine the probable ice surface history implied by our data by adopting a burial-exposure modelling approach, driven by orbitally-paced oscillations of the ice margin (as recorded at AND-1B) over the period from the Pliocene to the present day. This analysis shows that: 1) the glacier surface has likely fluctuated since at least the Pliocene; 2) the ice surface was >200 m higher than today during glacial periods, and the glacier has been thicker than present for $\sim$75–90% of each glacial-interglacial cycle; and 3) ice cover at higher elevations possibly occurred for a relatively shorter time per Pliocene cycle than Pleistocene cycle. While it is hard to determine the magnitude of surface lowering during interglacial periods, our data shows that the duration of deglaciation, relative to glacial expansion, was similar in both the Pliocene and Pleistocene. These results are then compared to glacier flowline simulations to help better understand how glacier surface elevation changes corresponded to shifting ice dynamics under past contrasting climates.

Our analysis links new onshore data of ice surface elevations from an East Antarctic outlet glacier with offshore evidence of the ice margin that is recorded downstream of the study area. Large glacial-interglacial fluctuations in ice extent occurred at the marine-based ice margin of the East Antarctic Ice Sheet, in response to the evolving climate and bed topography since at least the Pliocene. We show how such changes can be manifested upstream as surface elevation changes of outlet glaciers over this time. The scale of these ice surface fluctuations during the Pliocene and Pleistocene can be used to better inform ice sheet models that simulate long-term ice volume, and corresponding sea level contribution, over glacial–interglacial cycles.