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New constraints on Plio-Pleistocene East Antarctic Ice Sheet thickness: cosmogenic exposure data from western Dronning Maud Land

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Reconstructing past ice surface changes is key to test and improve ice-sheet models. Yet, data constraining the past behaviour of the East Antarctic Ice Sheet are sparse, limiting our understanding of its response to past and future climate changes. Here, we attempt to test whether the ice-sheet margin in western Dronning Maud Land has thinned since the last glacial maximum or whether it perhaps thickened in places due to increased precipitation associated with warmer climates. We report cosmogenic multi-nuclide (^{10}Be, ^{26}Al, ^{36}Cl, ^{21}Ne) data from bedrock and erratics on nunataks along Jutulstraumen ice stream and the Penck Trough in western Dronning Maud Land, East Antarctica. Spanning elevations between 751-2387 m above sea level, and between 5 and 450 m above the contemporaneous local ice sheet surface, the samples record apparent exposure ages between 2 ka and 5 Ma. The highest bedrock sample indicates (near-) continuous exposure since at least the Pliocene, with a very low apparent erosion rate of 15±3 cm Ma^{-1}. However, there are also clear indications of a thicker-than-present ice sheet within the last glacial cycle, thinning ~35-120 m at several nunataks during the Holocene (~2-11 ka). Owing to difficulties in retrieving suitable sample material from the often rugged and quartz-poor mountain summits, and due to the presence of inherited nuclides in many of our samples, we are unable to present robust thinning estimates from elevational profiles. Nevertheless, the

results clearly indicate ice-surface fluctuations of several hundred meters within the last glacial cycle in this sector of the EAIS, between the current grounding line and the edge of the polar plateau. Finally, inverse modelling of the cosmogenic multi-nuclide inventories in bedrock yields estimates of total erosion and ice cover across multiple glacial cycles. Our results show that the EAIS in western Dronning Maud Land was thicker than present during most of the Quaternary, covering sample sites up to 200 m above the present-day ice sheet for ~80 % of this period. Thinning of the ice since the last glacial maximum, combined with a long-term record of thicker-than-present ice, indicate that the ice sheet below the polar plateau in western Dronning Maud Land generally expands and thickens during climate cooling, despite decreasing precipitation associated with a cooler Southern Ocean.