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Reconstruction and paleoclimatic significance of Late Pleistocene niche glaciation at Mt Aston, Tararua Range, North Island, New Zealand

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Evidence for the timing of inter-hemispheric climate fluctuations during the Pleistocene is important, with reconstructed mountain glacier extents routinely used as a proxy for climate. While valley glaciers extended out from an ice sheet centred on New Zealand's Southern Alps during Pleistocene climate cooling to below present-day sea level, evidence of former glacial activity on the North Island of New Zealand is rare, in comparison. A newly-identified glaciated site is Mt Aston, an isolated cirque-like basin within the Tararua Range on New Zealand's North Island. Previously published cosmogenic isotope ages and paleo-glacier reconstructions of a 3 km-long valley glacier 30 km to the north show that paleo-equilibrium line altitudes (ELAs) increased northwards across New Zealand during the regional last glacial maximum (LGM). Hence, at this latitude (41˚00' S), only topography $>$1300 m above present day sea-level was of feasible elevation to intersect the prevailing south-westerly airflow and to allow niche glaciers to form. In the basin below Mt Aston, a *c.* 0.38 km^2 cirque glacier existed with ELA of *c.* 1290 $\pm$ 10 m above present-day sea level. This paleo-ELA closely approximates the extrapolated ELA trend surface for the regional LGM. The mean glacier thickness of 35 m gives a maximum basal shear stress of *c.* 102 kPa^{-1}, with a mean January temperature at the ELA of *c.* 5.5 ˚C. It is well-established that present-day glaciers in New Zealand are particularly sensitive to climate change, manifested by glacial advances and retreats in response to simple mass balance dynamics. Consistent with this, the paleo-glacier reconstruction implies that rather than simple temperature decreases driving paleo-ELA depression, changes in south-westerly airflow over New Zealand, bringing moisture-laden but cool air, maximized snowfall and minimised winter melt. The corollary is that (1) patterns of Pleistocene glacier fluctuations may be interpreted as responses, in-part, to precipitation-driven changes, and (2) the extent of LGM glaciation on New Zealand's North Island was probably more extensive than previously assumed.