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Recognition and paleoclimatic implications of Late Holocene glaciation on Mt Taranaki, North Island, New Zealand

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Evidence for the timings of inter-hemispheric climate fluctuations during the Holocene is important, with mountain glacier moraine systems routinely used as a proxy for climate. In New Zealand such evidence for glacier expansion during the Late Holocene is fragmentary and is limited to glaciers in a narrow zone within the centre of the Southern Alps. Recent high precision work in the central Southern Alps at the termini of Tasman, Mueller and Hooker glaciers has documented a series of middle to late Holocene moraine advances which appear to have occurred during classic Northern Hemisphere warm periods. However, there are issues connected to palaeoclimatic interpretation of dated moraines in the Southern Alps, namely that: (1) some glaciers have a calving tendency, and can become detached from climate; (2) large rock avalanche deposits onto a glacier may affect a glacier's mass balance, its frontal variations, and moraine formation, thus obscuring a "true" climatic signal; (3) the termini of the low-gradient long profiles of valley glaciers experience a time-lag of $>$100 years in response to major climate signals. Thus, in order to make suppositions about Holocene climate-driven glacier advances, it is important to determine whether advances in the central Southern Alps do reflect regional New Zealand palaeoclimate, or instead reflect local geomorphological factors. To help address this, we present the first evidence for Late Holocene glacier expansion on the North Island of New Zealand in the form of two unconsolidated debris ridges on the south side of the stratovolcano, Mt Taranaki/Mt Egmont, at $\sim$1920 m asl. The two ridges are aligned north-south along the western and eastern sides of a small basin (Rangitoto Flat), which is formed between the main Taranaki cone (to the north), and the parasitic cone of Fanthams Peak (to the south). The approximate age of the ridges is constrained by dated eruptive events and the relationship between ridge locations and the spatial positioning of adjacent volcanic landforms. We propose the ridges formed as two lateral moraines on the margins of a cirque glacier during the final construction phase of Fanthams Peak between 3.3 and 0.5 ka BP, during Late Holocene time. This time interval accords with published cosmogenic ^{10}Be dating of moraine-building episodes in the Southern Alps, indicating the Mt Taranaki moraines are a response to the same regional climatic forcings. That glacier advances during the late Holocene in New Zealand do appear to reflect regional climate forcing is consistent with contemporary glacier behaviour, as both the Interdecadal Pacific Oscillation (IPO) and El Niño-Southern Oscillation (ENSO) have been important influences on glacier behaviour in New Zealand over the past few decades. Indeed, the IPO switched to a negative mode about 1940 bringing warmer and drier conditions to New Zealand's Southern Alps before reverting to a positive, colder, and wetter mode in 1978. These changes are reflected in New Zealand's glacier length fluctuations.