A test of climate controls on glacier snowlines in the Southern Alps of New Zealand: Beryllium-10 dating of permafrost-derived rock glacier lobes in the Ben Ohau Range

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ABSTRACT: Glacier reconstructions based on well-dated moraine sequences in the Southern Alps of New Zealand indicate that snowlines were depressed by as much as 240 m below modern values during the early Holocene, implying colder-than-present atmospheric temperatures in the southwest Pacific region coeval with the hypsithermal warm period in the Northern Hemisphere (*1-3*). At face value, asynchronous glacier behavior between the hemispheres is consistent with direct insolation forcing as well as warming due to the effects of southward migration of the intertropical convergence zone since the early Holocene. However, it has been argued that snowline changes in the Southern Alps reflect changes in precipitation and not temperature (*4, 5*), despite glaciological evidence to the contrary (i.e., *6*). Here, we propose to test the relative control of air temperature, summertime insolation changes, and precipitation, on Southern Alps snowline variations by developing an independent Holocene ^{10}Be chronology of relict permafrost-derived rock glaciers. Permafrost-derived rock glaciers are sensitive recorders of mean-annual temperatures. Thus, by comparison to the record of New Zealand glacier snowlines, a chronology of rock glacier activity in the Southern Alps could simultaneously test the importance of mid-summer insolation, precipitation, and mean-annual atmospheric temperature (i.e., driven by local SSTs) on Southern Alps glacier behavior.