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Synoptic climate change as a driver of late Quaternary glaciations in the mid-latitudes of the Southern Hemisphere

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Abstract. The relative timing of late Quaternary glacial advances in mid-latitude (40-55° S) mountain belts of the Southern Hemisphere (SH) has become a critical focus in the debate on global climate teleconnections. On the basis of glacial data from New Zealand (NZ) and southern South America it has been argued that interhemispheric synchrony or asynchrony of Quaternary glacial events is due to Northern Hemisphere (NH) forcing of SH climate through either the ocean or atmosphere systems. Here we present a glacial snow-mass balance model that demonstrates that large scale glaciation in the temperate and hyperhumid Southern Alps of New Zealand can be generated with moderate cooling. This is because the rapid conversion of precipitation from rainfall to snowfall drives massive ice accumulation at small thermal changes (1-4°C). Our model is consistent with recent paleo-environmental reconstructions showing that glacial advances in New Zealand during the Last Glacial Maximum (LGM) and the Last Glacial Interglacial Transition (LGIT) occurred under very moderate cooling. We suggest that such moderate cooling could be generated by changes in synoptic climatology, specifically through enhanced regional flow of moist westerly air masses. Our results imply that NH climate forcing may not have been the exclusive driver of Quaternary glaciations in New Zealand and that synoptic style climate variations are a better explanation for at least some late Quaternary glacial events, in particular during the LGIT (e.g. Younger Dryas and/or Antarctic Cold Reversal).

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