Recent terminus development at debris-covered glaciers in the Southern Alps of New Zealand and implications for future behaviour

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Many glaciers in the Southern Alps of New Zealand that feature extensive debris covers on their lower reaches have undergone a century of downwasting and developed ice-contact lakes. Recent terminus development shows distinct differences between the glaciers. Investigations of several glaciers in Mount Cook National Park between 2000 and 2003 and comparison with earlier studies show that some are largely stationary while other termini continue to retreat at a rate of up to 72 ma^{-1}. Ice loss processes at these glaciers comprise melt under debris, melt of bare ice and calving, both subaerially and subaqueously, the significance of each process differs in space and time. This research shows that in this glacial environment ice-frontal processes have complex inter-relationships that vary between glaciers and in particular between stages of terminus development. Moreover, data from supraglacial ponds and proglacial lakes show that limnological factors become increasingly important with increasing pond/lake size. Changes in water currents and temperature lead to changes in significance and rates of ice loss processes, the most important being the change from melting to predominantly calving. Additionally, external fluvial inflows have been identified to play an important role in terminus evolution. The onset of subaqueous calving in the earlier stages of lake development is a crucial process for the transition to faster disintegration and ice loss, accelerating subaqueous melt. Once a proglacial lake with a calving ice face has been established retreat at slow-moving glaciers is largely controlled by thermal undercutting, while at glaciers with faster ice flow and steeper surface gradient other glaciological factors become more important. However, due to the complex inter-relationships attempts to formulate general relationships between calving or retreat rates and other glaciological parameters may not be feasible. Future scenarios for particular glaciers need detailed site-specific data to be useful. Based on extensive field research, one is presented here for the Tasman Glacier.