Intra-annual Variations in Ablation and Surface Velocity on the lower Fox Glacier, South Westland, New Zealand.

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Abstract

This study investigates the intra-annual variations in ablation and surface velocity on the lower Fox Glacier, considering spatial and temporal variability of these processes, and looking at the driving forces behind any variability. Over the years the Fox Glacier has been the focus of little scientific research, with the majority of research being conducted on the neighbouring Franz Josef Glacier, on the premise that the two glaciers, due to their close proximity, would exhibit similar behaviour. This study has found that although summer ablation rates on the two glaciers are a similar order of magnitude, winter ablation on Fox Glacier is lower. Surface velocity at Fox Glacier was found to be lower during both summer and winter, with a seasonal decrease in velocity recorded during winter, a characteristic not previously recorded at Franz Josef Glacier.

Large variation was recorded between the summer and winter ablation rates, with daily averages of 129 mm d^{-1} and 22 mm d^{-1} respectively. During summer, debris-cover significantly reduced ablation (50%), and ablation suppression increased as debris thickness increased. In winter this ablation suppression was not so apparent, but during heavy precipitation events, ablation under debris cover was only around half of that occurring on the clean ice surface. Variations in climatic variables were found to account for over 90% of ablative variability during both summer and winter monitoring. During winter, precipitation was found to exert the strongest influence to ablation variability, with significant increases in ablation occurring with heavy precipitation events.

Surface velocity on the lower glacier averaged 0.87 m d^{-1} during summer and 0.64 m d^{-1} in winter, a reduction of 26%. However when recent increases to ice thickness are taken into account, this reduction increases to 32%. Reductions in velocity during winter are related to a decrease in water supply, in particular, water from surface melting. This results in lower subglacial water pressures that in turn lead to a reduction in basal sliding. Spatial variations of a similar magnitude were recorded across glacier and upglacier during both field seasons. Unlike ablation, climatic variables were not found to exert significant influence on velocity variations. However during winter, precipitation events were found to increase velocity by up to 44%. The surface velocity response to precipitation events could be instantaneous, but on some occasions a time lag was present. This temporal variability in the velocity response is related to either

variation in the morphology of the glacial drainage system, affecting the efficiency of water transport to the base of the glacier, and/or to water storage. Both processes influence water pressures in the sub-glacial drainage system, which when increased, can enhance basal sliding.

This study found significant intra-annual variations in both ablation and surface velocity exist on the lower Fox Glacier. Short-term (daily) fluctuations recorded in above processes could be related to variations in climatic parameters like temperature and precipitation. Of particular interest was the relationship between surface velocity and precipitation, with notable increases in velocity associated with heavy precipitation events. However, this relationship was found to be very complex, influenced by not only water quantity, but also time lags between events, and existing drainage morphology, relationships that warrant further study.

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