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Supraglacial Debris: Where does it come from, where does it go?

Rahel Ganarin, Nico Mölg, Andreas Vieli, and Tobias Bolch
University of Zurich, Geography, Zürich, Switzerland (nico.moelg@geo.uzh.ch)

A warming climate not only affects the glacier melt rates and mass balance, but also favours the formation of supraglacial debris cover on glacier tongues. Debris cover in turn affects melt rates and melt patterns and can thus influence glacier geometry in the long run. Therefore, knowledge about the processes that govern the formation, transport and distribution of debris cover can assist in predicting glacier evolution.
The spatial distribution of debris covers is a function of the debris origin and deposition on the glacier ice and the debris transport away from the deposition location. Few studies have investigated debris extent and thickness distribution holistically, i.e. by including the context of debris origin and deposition as well as debris transport. This study presents an integral assessment of the debris cover of Zmuttgletscher in the western Swiss Alps by combining remote sensing and mass transport modelling for the debris origin and deposition as well as the debris transport paths. These observations are combined with statistically analysed field measurements for the debris thickness distribution.
This study shows that the correct determination of the glacier transport paths is crucial, which act as debris transport units. Only then, integral conclusions about the evolution of a supraglacial debris cover are possible. The debris input via snow avalanches is higher for avalanche deposition areas with a higher relative amount of bare rock wall area in their contributing headwall area. Extracted debris concentrations for these avalanche cones determine the variations in debris thickness patterns on the glacier tongue. Furthermore, decreasing debris emergence rates downglacier are calculated. The statistical analysis of the debris cover thickness measurements yields thicker debris on south-exposed flanks on the glacier tongue compared to north-exposed flanks, as well as increasing debris thicknesses towards the terminus in line with literature.
The findings obtained in this study improve our knowledge of supraglacial debris and contribute important information to the modelling of supraglacial debris cover evolution and dynamics.