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Vegetation on alpine rockglaciers in relation to surface velocity and surface structure

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Active rockglaciers are widespread through the Alps and are regarded as reliable indicators for the occurrence of permafrost. Surface movement of active rockglaciers occurs due to different factors, such as permafrost creep, topography and changes in hydrology. The movement patterns on rockglacier surfaces are therefore of very heterogeneous intensity. This results in the formation of a differentiated surface relief on active rockglaciers.
Both, surface movement and the complex micro-relief have a strong influence on vegetation patterns on rockglaciers, but this influence has only been quantified in small scales, due to the scarce availability of reliable spatial data on rockglacier surface velocity. The airborne laser scanning technology provides spatial data of high accuracy and can be used to calculate surface changes or surface movement, if a multi-temporal dataset is available.
During this study, data of four study sites in the Stubai and Ötztal Alps in Tyrol, Austria (the well investigated rockglaciers in the Äusseres Hochebenkar, Inneres Reichenkar and Innere Ölgrube and several less investigated rockglaciers in the Schrankar) from two airborne laser scanning flight campaigns (2006 and 2009) of the project C4AUSTRIA could be used.
In all study sites, vegetation cover, plant species, grain size of the rock debris and the percentage of fine grained material (clay, silt and sand combined) were assessed in 3x3m squares at roughly all 15m on several transects along and across the rockglaciers. The total vegetation cover and the cover of each distinct species was estimated visually, while the percentage of fine grained material was assessed as well as the mean grain-size of the debris in the squares. In addition, the biggest diameter and the exposition of the biggest thallus of Rhizocarpon geographicum in each square was measured. At the start and the end of each transect, adjacent stable areas were also mapped. In total, over 600 squares were considered, 541 of them located on rockglaciers.
SAGA-GIS was used to calculate digital elevation models for the years 2006 and 2009 from airborne laser scanning point clouds, which were used to calculate vertical differences in the surface of rockglaciers. Furthermore, hillshades of those digital elevation models were used to determine surface movement.
Surface velocities were set into relation with all field data, particularly with the total vegetation cover and the percentage of fine-grained material.
Results show an increase in vegetation cover with a higher percentage of fine grained material, but a decreasing vegetation cover with higher rates of surface velocity. Those two effects are overlaying each other, which complicates an interpretation. Nevertheless, conclusions on the relation of vegetation patterns and surface movement and structure on rockglaciers are possible.