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Multi-temporal surface classification of high mountain environments

Patrick Fritzmann (1), Erik Bollmann (1), Rudolf Sailer (1), Johann Stötter (1), Michael Vetter (2,3)

(1) Department of Geography, University of Innsbruck, Innsbruck, Austria, (2) Institute of Photogrammetry and Remote Sensing, Vienna University of Technology, Vienna, Austria, (3) Centre for Water Resource Systems, Vienna University of Technology, Vienna, Austria

Particularly in high mountain environments, data acquisitions covering large areas are often impossible or can be very time consuming and quite frequently dangerous. Since 2001, airborne laser scanning (ALS) campaigns have been carried out regularly at glaciological relevant dates at Hintereisferner (Tyrol, Austria), resulting in a unique multi-temporal data set of the same high mountain area. Previous studies showed that ALS is a well suited method for glacier monitoring. Beside the geometric attributes of the surface, the back scattered signal energy, often referred to as intensity, is contained in the resulting data set. These intensities can be used to classify the surface, which has been done yet on small scale test areas at Hintereisferner.

In this study a novel classification method based only on gridded intensity data, covering an area of 36 km^2, was developed to determine the main surface types (ice & water bodies, snow, firn, rock and vegetation). First of all a correction model was applied to reduce influences caused by scanning geometry as well as atmospheric and topographic influences. Furthermore, to homogenize the multi-temporal data set a normalization method had to be developed to make the intensities of the different data sets comparable, which is a basic requirement for a multi-temporal surface classification. The classification system is based on an statistical approach: Thresholds of each surface class were determined on a single raster and then used to classify other intensity rasters.

To evaluate the surface classification, ground truth data derived from ortho-images and field campaigns was used. The classification results show that in particular ice and water bodies can accurately be classified from intensity data, while other surface classes are less exactly detected due to various factors influencing the intensity. The most limiting factor is the variability in surface reflectance. In particular the grain size of snow and firn surfaces has strong influences on the reflection properties and hence on the classification results. Still, the classification method showed quite good results with regards to surface classes, which are relevant for the estimation of mass balance parameters and thus was carried out for ten different intensity rasters covering the period between 2001 and 2008. The presented classification method provides detailed surface information on high mountain areas which is needed for glaciological, hydrological and morphological issues.