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Quantification of morphodynamic processes in glaciated and recently deglaciated terrain

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Traditional in-situ mapping of morphodynamic processes in Alpine terrain is time-consuming, costly and challenging or sometimes impossible when large areas need to be investigated. Light Detection and Ranging (LiDAR) - as a high resolution mapping techniques - provides the capability to identify and quantify geomorphological process results remotely, efficient and with a high degree of geometric accuracy over large areas.

In general, two main applications using airborne LiDAR data can be identified i) multi-temporal applications that focus on (primarily hazardous) events, by organising new flight campaigns and differencing them with already existing LiDAR data and ii) geomorphometric analyses (including first and second order derivatives of elevation) which are based on mono-temporal LiDAR data analysis.

Both approaches are widely based on digital elevation models (DEM), generated with various point to raster interpolation methods. High resolution digital elevation models (with resolutions < 1 m) guarantee satisfying computational performances but entail a loss of accuracy and of the level of detail in contrast.

The presentation investigates the ability of airborne LiDAR techniques to detect, map and quantify specific geomorphological entities in selected high alpine catchments. Since 2001 airborne LiDAR measurements have been carried out regularly in the Hintereisferner region (Ötztal Alps, Tyrol, Austria). This results in a worldwide unique consistent data record assembling 18 LiDAR campaigns. Additionally multi-temporal data of adjacent regions of the Stubai and Ötztal Alps with prominent rock-glaciers will be analysed. Towards the above mentioned event-related multi-temporal LiDAR altimetry, the LiDAR survey of this study is incorporated in scientific monitoring routines.

The authors focus on glaciated and recently deglaciated (periglacial) terrain and in particular on dead-ice, fluvial erosion/accumulation, rock-fall, small landslides and permafrost features. In order to preserve the high accuracy of the original data the methods concentrate on the analysis of vector point data (LiDAR point cloud) to demonstrate trends of geomorphodynamic induced topographic changes in different temporal dimensions (i.e. from months to years). Finally the presentation aims at defining a process related minimum time span that allows to quantify geomorphic process dynamics beyond system immanent background scatter effects of the LiDAR technique.