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Integration of multi-temporal airborne and terrestrial laser scanning data for the analysis and modelling of proglacial geomorphodynamic processes

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The actual on-going and predicted climate change leads in sensitive areas like in high-mountain proglacial regions to significant geomorphodynamic processes (e.g. landslides). Within a short time period (even less than a year) these processes lead to a substantial change of the landscape.

In order to study and analyse the recent changes in a proglacial environment the multi-disciplinary research project PROSA (high-resolution measurements of morphodynamics in rapidly changing PROglacial Systems of the Alps) selected the study area of the Gepatschferner (Tyrol), the second largest glacier in Austria. One of the challenges within the project is the geometric integration (i.e. georeferencing) of multi-temporal topographic data sets in a continuously changing environment. Furthermore, one has to deal with data sets of multiple scales (large area data sets vs. highly detailed local area observations) that are on one hand necessary to cover the complete proglacial area with the whole catchment and on the other hand guaranty a highly dense and accurate sampling of individual areas of interest (e.g. a certain highly affected slope).

This contribution suggests a comprehensive method for the georeferencing of multi-temporal airborne and terrestrial laser scanning (ALS resp. TLS). It is studied by application to the data that was acquired within the project PROSA. In a first step a stable coordinate frame that allows the analysis of the changing environment has to be defined. Subsequently procedures for the transformation of the individual ALS and TLS data sets into this coordinate frame were developed. This includes the selection of appropriate reference areas as well as the development of special targets for the local TLS acquisition that can be used for the absolute georeferencing in the common coordinate frame. Due to the fact that different TLS instruments can be used (some larger distance sensors that allow covering larger areas vs. closer operating sensors that allow a denser surface sampling) the different sensor properties (wavelength, resolution, etc., and therefore suitability of targets) have to be considered. Subsequently the multi-temporal analysis of the data sets can be performed. Within this analysis it is important to consider the different instrument properties as well as the different data acquisition geometry (observation direction). The aim is to reach an accuracy of a few centimetre in georeferencing for a single measurement epoch. Furthermore, next to an understanding of the individual measurement process the integration of geomorphological knowledge is essential in order to separate errors of the measurement process from actual dynamic environmental changes. This leads to a multi-disciplinary analysis of the measurement data. In addition to a geometric analysis the radiometric changes of the ALS data will be studied.

The presentation illustrates next to the method and data itself the analysis of multi-temporal proglacial data sets and the obtained accuracy.