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Applying iterative closest point algorithms and full waveform data analysis to improve the accuracy of terrestrial laser scanning measurements for snow depth observation

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The application of terrestrial laser scanning (TLS) for snow depth observation has been presented by the author in previous works. Snow depth observation in potentially dangerous avalanche-starting zones is vitally important, both in terms of avalanche-prediction and dimensioning of permanent protection measures. Unfortunately, some limitations and error sources do exist in precisely monitoring the spatial snow depth distribution on slopes using TLS. New technical and software developments concerning TLS features allow better methods of analysis and improvement in the data quality. Crucial steps for achieving reliable data are the registration process and changing meteorological and snow pack conditions.

In this respect the newest TLS device, a RIEGL LPM-321 was tested. The following technical features were improved: 1) measuring range: up to more than 4000 m, 2) beam divergence: 0.8 mRad, 3) scanning speed: 1000 Hz. Furthermore an iterative closest point algorithm has been used to improve the registration process. Full waveform data analysis was applied to examine the behavior of the laser beam under changing meteorological and snow pack conditions.

The objectives of the study are to specify to what extent the new developments mentioned above improve the accuracy of the spatial snow depth measurements. For the first time, an iterative closest point algorithm has been used to improve the registration process and full waveform data analysis was applied to TLS measurements of the snow pack. The results clearly show that the accuracy of the measurement improved using those particular tools. Results of the measurements taken at several test sites in the Austrian Alps are presented.