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Rock slide deformation measurements with Terrestrial Laser Scanning in inaccessible high mountain areas

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In summer 2007 at the “Bliggspitze” (Eastern Alps, 3453 m.a.s.l.), rock and ice fall events testify to increasing slope activities. At the northern slope of the summit a 400 m by 200 m glacier-covered rock mass slab initiated to move downward. The movement causes strong fragmentation of the glacier and the paragneisic rock mass. This process is documented by multi-temporal Airborne Laser Scanning (ALS) digital elevation models (DEMs) (2006/ 2007/ 2008/ 2009/ 2010) and orthophotos (2003/ 2007/ 2009). Between 2006 and 2007 shear displacement of up to 45 m was measured at the main scarp by ALS DEMs. In the following year (2007/2008) the movement rate at the main scarp reduces to 5 m per year. By means of field observations the deformation at the main scarp can be described as a sliding mechanism. In order to understand the landslide kinematics at the lower part of the slope deformation measurements are required. Ongoing rock fall activities at these slope regions preclude field measurements. Furthermore ALS deformation data at the steeply inclined lower part of the slope involve methodically-related uncertainties.

In order to get more detailed information about the geometry and the temporal deformation behaviour a Terrestrial Laser Scanner (TLS) is used to scan the lower parts including the toe of the slope. Due to the remoteness, inaccessibly and the large extend of the area of interest the measurement by the TLS is challenging. The test side extends over 500 m width and rises from 2600 to 3200 m.a.s.l.. Long range measurement cause large footprint sizes which lead to lower accuracy in the measured coordinates of the TLS scan. Even in summer single snow patches disturb the reflection of laser beams. Furthermore high rockfall activity precludes the installation of reflective targets in the test side.

To minimize shadowing effects, the area was scanned from three scan positions. To register the three scan positions without targets the ICP algorithm of the software RiScanPro was used. The algorithm matches point clouds of the different scan positions into one local coordinate system. Then the point cloud is transformed into a geographic coordinate system. In order to be able to quantify multi-temporal changes in TLS data the error budget from precision and accuracy of the scan and the postprocessing has to be estimated. To analyse slope deformation and movement rates further scans are planned. These data should help to develop a detailed model of the landslide kinematics.