EGU21-4649
https://doi.org/10.5194/egusphere-egu21-4649
EGU General Assembly 2021

Uncertainty assessment of a permanent long-range terrestrial laser scanning system at an Alpine glacier

Annelies Voordendag[1], Christoph Klug[1,2], Rainer Prinz[1], Martin Rutzinger[2], Georg Kaser[1], and the SCHISM Team[*]
[1]Institute of Atmospheric and Cryospheric Sciences, University of Innsbruck, Innsbruck, Austria
[2]Institute of Geography, University of Innsbruck, Innsbruck, Austria
[*]A full list of authors appears at the end of the abstract

Terrestrial laser scanners (TLSs) are increasingly used to monitor glaciers. Recent developments enabled longer ranged and more frequent measurements. The quality of these high resolution topography data, especially in high mountain environments, has not been assessed in detail up to now. An automated and permanent long-range TLS system is installed at Hintereisferner glacier (Ötztal, Austria) with the aim to detect changing snow surface patterns due to wind drift.

The scanner is controlled from Innsbruck and data is transferred daily. The system covers 66.5% of the glacier area and scans can be conducted on demand in very high frequency (e.g. daily or hourly measurements). The measurement distances range between 660 and 4600 m and with an angular step width of 0.01° (vertical and horizontal), this leads to a point spacing of 35 cm at a distance of 2 km and a resulting point cloud of approx. 43 million points. The point cloud is converted into grids with a 1 meter resolution.

Two main error sources of the system are indentified. First, the TLS used at Hintereisferner, a Riegl VZ-6000 is influenced by movements that cannot be corrected with the internal inclination sensors of the scanner. Small fluctuations in the roll and pitch of the scanner (ca. ±0.02°) result in deviations in decimetre range on the glacier. The movement of the scanner increases with increasing turbulent kinetic energy (TKE) measured with a nearby 3D sonic anemometer.

Second, atmospheric conditions at the glacier influence the laser beam way. The TLS operates by emitting light pulses and measuring the time of flight for the pulse to return. The pulse travel time changes depending on the atmospheric properties. The changes of pressure, temperature and humidity in the atmosphere differ from accumulation zone to glacier tongue and influence the pathway between TLS and the glacier surface, leading to an uncertainty in the scanning data in centimetre range.

The permanent and automated long-range TLS system promises high potential for the glaciological and environmental sciences, given the decimetre accuracy at a high spatiotemporal resolution. The first results of permanent TLS system at Hintereisferner show the ability to detect changing snow surface patterns and indicate the possibility of geodetic glacier mass balance

acquisition.

SCHISM Team: Brigitta Goger, Tobias Sauter, Thomas Mölg, Christina Schmid