Permafrost long-term monitoring network

WP6 Permafrost and Natural Hazards

Action 6.1 – Method sheet

Terrestrial Laser Scanning (TLS)

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General information	
Category	Remote sensing
Background	LiDAR (Light Detection And Ranging)
Basic principles	
Technology	Laser ranging is based on the transmission/reception of infrared-light signals of very low spatial dispersion and high temporal precision. The time of flight of the laser beam allows distance measurements of several hundred of meters, with centimeter accuracy. Due to the high sensor accuracy, sampling rate and long range, terrestrial laser scanners allow - in combination with precise mechanical devises (rotating mirrors or prism) - a dense 3D survey of large areas in a given field of view. Long range laser scanner operate in the near infrared wavelength either at 905 nm or 1550 nm commonly.
Data processing	The point clouds obtained in the field are processed with specific software (*e.g. InnovMetric* PolyWorks). The first step is to match or align the different clouds of points to form 3D models of the rockwalls. The point clouds are generally assembled from the recognition and matching of "n pairs of points". The alignment can be improved by using a "best fit" tool. The 3D model obtained can be georeferenced, geometrically analyzed, measured and converted into Triangular Irregular Network. Two diachronic models can be compared and changes can be quantified.
Possible applications	
Why?	Detection and quantification of morphological changes, monitoring, quantitative interpretation, displacement rates measurements
What?	Rock walls, rock glaciers, moraines, landslides, glacial debris-cover
Where?	High mountain, inaccessible study objects - Warning: the study object should generally be located relatively below the theoretical range of the scanner
Main results	

- High resolution 3D models (possibly georeferenced)
- Map of morphological changes
- Identification and quantification of mass movements
- Extraction of geometric features for structural and geomechanical analysis

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Main advantages

- Acquisition rates (several thousand points per second) allowing very high resolutions
- High precision (centimeter)
- No complex settings by the operator or long pretreatments
- Easy acquisition
- Measures range: cm-km
- Possibility to get data on subvertical or overhanging rock walls
- Data availability: close to real time

Main disadvantages/problems

- Data processing is fairly long and complex
- Weight and induced logistical problems
- Cost of scanners and their maintenance
- Need of a total absence of clouds in the target area during the acquisition
- No rain, no snowfall during the acquisition
- Very low temperatures (below -10°C) can cause problems (technical problems and ice crystals in atmosphere)
- Highly specific software

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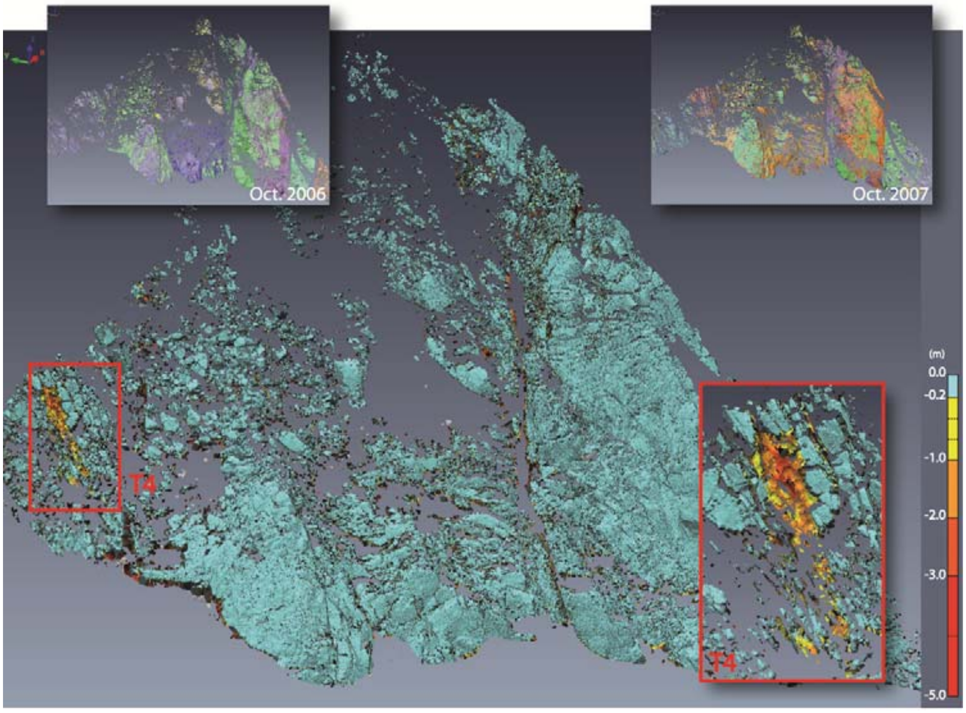
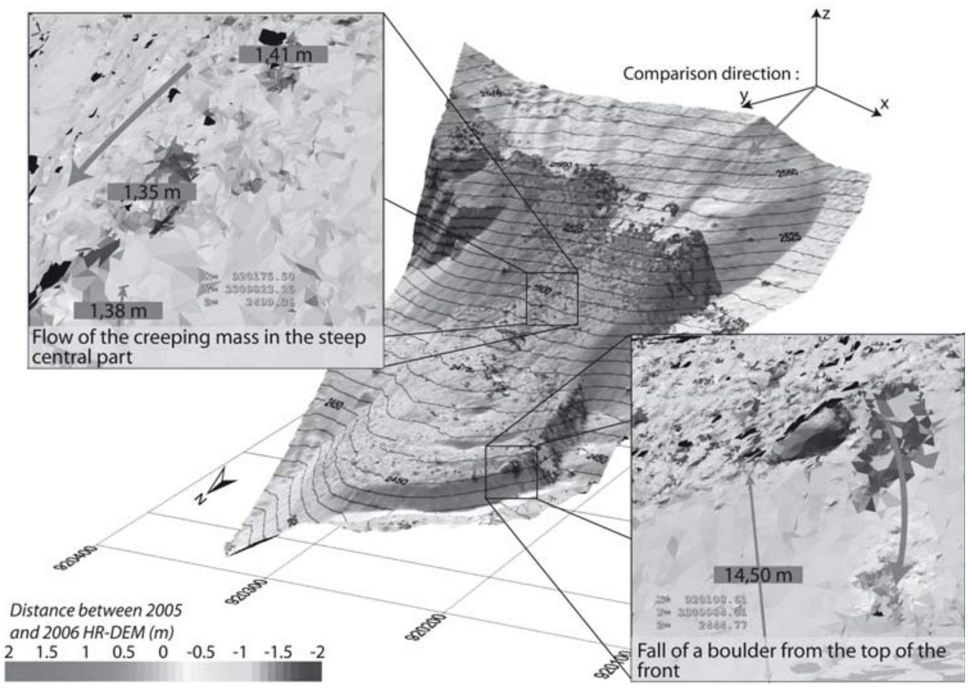


Comparison of the 3D models of October 2006 and October 2007 of the East face of the Tour Ronde (Mont Blanc massif), with the location of the only identified rockfall (T4) between the two dates (Ravanel, 2010).

The terrestrial laser scanner Optech ILRIS 3D in front of the Aiguilles d'Entrèves (Mont Blanc massif).



Map of the differences between 2005 and 2006 HR-DEM of the Laurichard Rock Glacier (Ecrins massif, Bodin et al., 2008). The inserts present some details of typical surface changes, such as the individual movements of boulders in the steep central part or the fall of a block from the front. The downstream progression of the ridge is also clearly visible.