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Accuracy of long-range Terrestrial Laser Scanner point clouds for documenting the topography and structure of cliffs: a benchmark at the Mont Saint-Eynard (Chartreuse massif, France)

Pierrick Bornemann (1,2), Antoine Guérin (3), David Amitrano (4), Jean-Philippe Malet (1), and Michel Jaboyedoff (3)

(1) Institut de Physique du Globe de Strasbourg UMR 7516, CNRS / Université de Strasbourg, Strasbourg, France, (2) Laboratoire Image Ville Environnement UMR 7362, CNRS / Université de Strasbourg, Strasbourg, France, (3) Risk Analysis Group, Institute of Earth Sciences, Faculty of Geosciences and Environment, University of Lausanne, Switzerland, (4) Laboratoire ISTerre UMR 5275, CNRS / Université Grenoble Alpes, France

The Mont Saint-Eynard cliff is a 7 km long cliff located to the immediate North East of the city of Grenoble (French Alps). It corresponds to the Western edge of the Chartreuse massif. Its morphology consists of two sub-vertical limestone cliffs separated by a forested ledge, with the lower cliff being 240m high and the upper cliff being 120m high.
The cliff is located directly above a densely populated area and is affected by frequent rockfall events, which has led to regular surveying and monitoring campaigns using both aerial and Terrestrial Laser Scanning (TLS) data well as terrestrial multi-views photogrammetry.
A benchmark campaign consisting of simultaneous acquisitions of point clouds with three long-range TLS devices (Optech ILRIS-3D, Optech ILRIS-LR, RIEGL VZ-2000) has been carried in October 2016 on common areas from the same base station.
The objectives of the benchmark were (1) to document the intrinsic quality of the TLS devices, (2) to test several methodological approaches for the point cloud registration, and (3) to quantify the quality of the registered point clouds to represent the structures of the cliff at several spatial scales.
The point cloud alignment and best-fit registration are performed with the open source software CloudCompare and the commercial softwares PolyWorks and RiSCAN PRO. The filtered and registered point clouds are then compared in terms of accuracy (errors, point density) and reliability of the measurements for each laser scanner. For this purpose, we derive and compare quantitative metrics on each point cloud, based on their respective density, roughness, position deviation, and position along cross-sections in order to assess the data noise for each measurement device. The quality of the representation of the relief is further compared in relation to the cliff surface roughness.
The final point clouds are then compared with structural information (i.e. dip angle / dip direction along the line of sight) calculated with the Coltop 3D software in order to link surface morphology and measurement accuracy.