Geophysical Research Abstracts
Vol. 17, EGU2015-9040-1, 2015
EGU General Assembly 2015
© Author(s) 2015. CC Attribution 3.0 License.

Analysis of subglacial hydrodynamics and ice dynamics through combined terrestrial laser scanning and ground penetrating radar survey

Chrystelle Gabbud (1), Sébastien Rüttimann (1), Natan Micheletti (1), James Irving (2), and Stuart Lane (1)

(1) Institute of Earth Surface Dynamics (IDYST), University of Lausanne, Lausanne, Switzerland (chrystelle.gabbud@unil.ch, sebastien.ruttimann@unil.ch, natan.micheletti@unil.ch, stuart.lane@unil.ch), (2) Applied and Environmental Geophysics Group - Institute of Earth Sciences (ISTE), University of Lausanne, Lausanne, Switzerland (james.irving@unil.ch)

This study shows how high resolution surveys of subglacial channel morphology combined with high resolution terrestrial laser scanner survey of an Alpine glacier help to understand subglacial hydrological forcing of ice dynamics. The study area is the Haut Glacier d'Arolla in Switzerland, an Alpine valley glacier for which subglacial drainage system has been well studied. A new generation of terrestrial laser scanners was used to investigate glacier surface ablation and other elements of glacial hydrodynamics at exceptionally high spatial and temporal resolution. The LiDAR RIEGL VZ-6000 scanner, with a laser 3B specifically designed for measurements of snow and ice cover surfaces, was tested at seasonal and daily scales. The data revealed spatial variations in the patterns of surface melt, controlled by both aspect and differential debris cover at the seasonal scale, and controlled by ogive-related differences in ice surface debris content at the daily scale. More tentatively, intra-daily scale measurements pointed to possible hydraulic jacking of the glacier associated with short-term water pressure rises at the downstream part of the glacier. A ground-penetrating radar (GPR) field campaign was conducted a year later in the location where possible hydraulic jacking had been detected previously. The aims of this campaign were (i) to assess GPR usage for subglacial channel detection; (ii) identify more precisely the channel morphology; and (iii) investigate further the hydraulic jacking hypothesis. 100 MHz antennas were used to map a 240 x 34 m area near the glacier snout where the ice thickness did not exceed 50 m. The corresponding data, after processing, allowed reconstruction of the bed topography and the morphology of subglacial channels in 3D, showing two of the latter in this area. One channel was followed for approximately 20 m upglacier and corresponding morphology estimates were performed. These data allowed for 3D reconstructions of both the bed topography and channel morphology. The channels had much higher aspect ratios than is traditionally assumed in the analysis of subglacial hydrological channels in Alpine systems, such that water is more laterally distributed at the bed than is commonly thought. This could help to explain why hydraulic jacking might occur even in systems with highly channelized subglacial drainage.