Geophysical Research Abstracts
Vol. 17, EGU2015-11825-3, 2015
EGU General Assembly 2015

Can we use ice calving on glacier fronts as a proxy for rock slope failures?

Antonio Abellan (1), Ivanna Penna (1,2), Sergio Daicz (1,3), Dario Carrea (1), Marc-Henri Derron (1), Michel Jaboyedoff (1), Adrian Riquelme (4), and Roberto Tomas (4)

(1) Risk Analysis group, Institut des sciences de la Terre (ISTE), Faculty of Geosciences and Environment, University of Lausanne, Unil-Mouline, Geopolis, 1015 Lausanne, Switzerland, (2) Geological Survey of Norway (NGU), Leiv Erikssons vei 39-Trondheim, Norway, (3) Department, Faculty of Exact and Nature Sciences, University of Buenos Aires, Argentina, (4) Departamento de Ingeniería Civil, Universidad de Alicante, Alicante, Spain

Ice failures on glacier terminus show very similar fingerprints to rock-slope failure (RSF) processes, nevertheless, the investigation of gravity-driven instabilities that shape rock cliffs and glacier's fronts are currently dissociated research topics. Since both materials (ice and rocks) have very different rheological properties, the development of a progressive failure on mountain cliffs occurs at a much slower rate than that observed on glacier fronts, which leads the latter a good proxy for investigating RSF.

We utilized a terrestrial Laser Scanner (Ilris-LR system from Optech) for acquiring successive 3D point clouds of one of the most impressive calving glacier fronts, the Perito Moreno glacier located in the Southern Patagonian Ice Fields (Argentina). We scanned the glacier terminus during five days (from 10th to 14th of March 2014) with very high accuracy (0.7cm standard deviation of the error at 100m) and a high density of information (200 points per square meter). Each data series was acquired at a mean interval of 20 minutes. The maximum attainable range for the utilized wavelength of the Ilris-LR system (1064 nm) was around 500 meters over massive ice (showing no-significant loss of information), being this distance considerably reduced on crystalline or wet ice short after the occurrence of calving events.

As for the data treatment, we have adapted our innovative algorithms originally developed for the investigation of both precursory deformation and rockfalls to study calving events. By comparing successive three-dimensional datasets, we have investigated not only the magnitude and frequency of several ice failures at the glacier's terminus (ranging from one to thousands of cubic meters), but also the characteristic geometrical features of each failure. In addition, we were able to quantify a growing strain rate on several areas of the glacier's terminus shortly after their final collapse. For instance, we investigated the spatial extent of the differential pre-failure deformation, together with its length and duration, showing very similar acceleration patterns than that observed on rock slopes at their 3rd creep stage. We then documented the differential strain rates observed at different parts of the glacier's terminus, and correlated the areas affected with a progressive acceleration on the strain rate with those that had finally calved. Finally, we also observed that, similarly as it occurs on rock slopes, the investigation of the mechanical discontinuities (crevasses) observed at the glacier controlled the different front failure mechanisms observed at the glacier front.

Thanks to the so-built analogies between rock and ice gravity driven instability phenomena, this interdisciplinary research could constitute a great insight in the investigation of RSF endangering human population and infrastructures.