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Monitoring of Grandes Jorasses hanging glacier (Aosta Valley, Italy): improving monitoring techniques for glaciers instability

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Grandes Jorasses serac is an unbalanced hanging glacier located on the south side of Mont Blanc Massif (Aosta Valley – Italy). It stands above Ferret Valley, a famous and most frequented touristic site both in winter and summer. Historical data and morphological evidences show that the glacier is subject to recurrent icefalls which can be dangerous especially in winter, as they can trigger catastrophic combined snow and ice avalanches.
Serac dynamic was monitored in 1997-98 by prof. M Funk (ETH Zurich) by means of temperature and topographic measurement. These allowed to forecast the breakdown within a 2 days time.
Thanks to a monitoring program, a new instability could be recognized in autumn 2008: a crevasse opening in the lower part of the hanging glacier. A new monitoring system was installed recently, consisting of stakes with prisms on serac surface and an automatic total station (theodolite plus distantiometer) sited on the valley floor. Monitoring is based on an empirically based power law (developed by ETH) that describes the increasing displacement rate before collapse. This monitoring system requires to measure displacement rate of the serac continuously. Although the topographic system is so far the state-of-the.art method, it implies some troubles: (i) the difficulty in placing stakes on the steep and dangerous glacier surface; (ii) potential instability of stakes themselves due to snow pressure in winter and surface ice melting in summer; (iii) impossibility to carry out measurement in case of cloudy or stormy weather, which is rather a frequent situation on Grandes Jorasses peak. Moreover, hazard and risk management require some more informations, such as the instable ice mass volume.
New technologies have been applied, and are still under test, to achieve a more reliable monitoring system and a better understanding of the serac dynamics. Close-range photogrammetry techniques have been used, allowing to process helicopter-taken images and obtain quantitative data about the serac volume and crevasses widening.
A low-cost GPS station has been installed in the upper part of the serac, in order to obtain long-term, continuous displacement data even in bad weather conditions. A seismograph has been installed to measure the seismic activity of the serac. The latter, as observed by ETH, significantly evolves before the seracfall; thus, the record of the seismic activity can be used to forecast the break-off.
Finally, a ground-based SAR system has been tested to infer seracs displacement.
Possible avalanches scenarios consequent to an icefall have been calculated by numerical simulation by the SLF Institute of Davos.
In-situ measurement techniques have to be designed to resist often in the difficult environmental conditions (low temperature, frost, wind), dealing, e.g. with power supply and data transmission, and purpose-made technical solutions are often necessary. The development of these techniques will contribute to an improved understanding of the seracs dynamics and provide a more reliable monitoring tool.