Mountaineers exposed to rock falls in the Grand Couloir du Goûter (Mont Blanc massif)
An interdisciplinary monitoring system for a better hazard assessment

Jacques Mourey1, Pierre-Allain DuVillard1,2, Marco Marcier1,3, Guilhem Marsy1,4, Ludovic Ravel1, Antoine Rabatel5

1 Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, EDEYTEM, 73000 Chambéry, France, jacques.mourey@univ-smb.fr
2 IMSRM, Parc Pré Millet - 680 Rue Aristide Bergès, 38330 Montbonnot, France
3 Univ. Grenoble Alpes, Institute de Géographie Alpine, CNRS, PACTE, 38041 Grenoble, France
4 Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, LISTIC Polytech Annecy-Chambéry, France
5 Univ. Grenoble Alpes, CNRS, IRD, Grenoble INP, IGE, UMR 5001, 38000 Grenoble, France

An important risk of rock fall on the classic climbing route to the Mont Blanc (4809 m a.s.l.)

• The crossing of the Grand Couloir du Goûter, at 3270 m a.s.l., and the ascent of the Goûter ridge are very exposed to rock falls. Between 11 am and 1.30 pm, there is on average one rock fall every 17 minutes (Alpes Ingé, 2012).

• Between 1990 and 2017, 347 accidents occurred in this sector with 102 fatalities and 230 injured persons. On average, there are 3 fatalities and 8 injured persons per year. 30 % of the accidents are directly due to rock falls.

Therefore, in order to better understand and characterize the hazard due to rock falls, 3 monitoring systems have been implemented:

• 4 rock surfaces temperature sensors
• An automatic camera taking 4 pictures a day
• A device to measure the number of climbers (Mourey and Ravelan, 2018).

1. Rock surface temperature sensors to characterize the local permafrost conditions

- 4 rock surface temperature sensors (10 cm depth) (Geoprecision PT 1000)
- A positive ground temperature between May and October 2017, at 3345 m a.s.l. (C1)

2. An automatic camera to study the snow cover and its possible control on rock falls occurrence

- In 2017, there was no snow in the couloir during 48 % of the summer period, which favored rock falls frequency

3. A pyroelectric sensor to quantify and characterise the frequation (Mourey and Ravelan, 2017)

Between May and October 2017, the couloir was crossed 29 162 times

Daily average: 202 crossings
Monthly average: 6 139 crossings

Maximum number of crossings per day
- 638, Sunday the 13th of August
- 584, Monday the 3rd of July
- 507, Friday the 28th of September

53 % of the crossings are on the way down
47 % on the way up

The majority of the climbers are crossing the couloir between 10 am and 3 pm, which is the period of the day when rock falls are the most frequent (Alpes Ingé, 2012)

Crossing data: what are the most favorable contexts to accidents ?

Summer 2017:

• Numerous accidents (20) counting 11 dead and 8 injured persons
• Accidents mainly occurred during the periods of important frequation
• The climbers follow periods of good weather disregarding rock fall activity

Outlooks:
• July 2018: 4 seismometers are going to be installed in order to characterize rock falls more precisely (Dietze et al., 2017)