Author's point-by-point response to referees

This second version of the manuscript follows the modifications we proposed after the first reviews. Accordingly, we mainly followed the suggestions of referee 2 and insisted much more on the operational aspect of our study and completely reformulated the introduction, the discussion and the conclusion.

Overall, we restructured the article according to the following objective: document rockfalls and their triggering factors in the specific context of the *Grand Couloir du Goûter* and to disseminate this knowledge to the mountaineering community in order to promote the adaptation of mountaineers and try to reduce the number of accidents. Our prime objective was therefore not to gain new knowledge about rockfalls triggering factors in high alpine mountains but to acquire knowledge specific for this area, sufficiently precise to help climbers to adapt, while remaining accessible to non-specialists. This last motivation is more highlighted in the introduction, the discussion and the conclusion.

The modifications are presented bellow for each chapter. A very large part of the article has been rewritten; therefore, we did not used the classical "track-changes" in Word, the document was hardly readable, but all the modifications are written in purple in the author's track-changes file.

Title:

According to referee's 2 suggestion and following all the modifications we made, we changed the title for: "Multi-method monitoring of rockfall activity on the Mont Blanc (4,809 m a.s.l.) classic route to promote the adaptation of mountaineers".

Introduction:

The introduction has been completely rewritten. It presents in more details the context which justifies our study and our main objectives: we engaged with this new case study because it is an area with a high accident rate, rockfalls are one of the main factors explaining this accidentology and almost no studies have been undertaken to document this hazard. This justifies the need to acquire knowledge on rockfalls and their triggering factors in the specific context of the *Grand couloir du Goûter* that would be of interest to mountaineers and help them adapt to the local rockfall hazard.

According to referee's 2 suggestion, we have strongly shortened the section 2 (Rockfall triggering factors) and it is now integrated into the introduction and better connected with our objectives and the method.

Study site:

We have removed the section 3.1 "The Mont Blanc massif, the birthplace of mountaineering" and we give more details on the study site and especially on how mountaineers are organizing their ascent and when they have to cross the *Grand couloir du Goûter* and are exposed to rockfall hazard.

We also give more information on the topographical characteristics of the couloir and the preparing and preconditioning factors of rockfalls.

We have also changed the figure presenting the site and the monitoring system. According to referee's 2 comment, we made a knew figure based on the permafrost map from the modelling of Magnin *et al.* (2015).

Method:

A lot of precisions have been added to the method section following referees' comments, especially concerning "Rockfall detection and characterization". The types of signals we recorded and the classification method of seismic signals are described in more details with a new figure to show them and the classification process.

Concerning the "Characterization of the permafrost thermal state" we have add a table presenting the key informations and data for the three ground temperature sensors. We have also removed the CRYOGRID model. We were only using it to show that the active layer is the deepest at the end of the summer season, which has already been shown by other studies such as Magnin *et al.* 2017 or Pogliottio *et al.* 2015. We also give more information on the "Photographic monitoring of snow cover" such as the type of camera, the processing of the data, etc.

Discussion:

We mainly reformulated the discussion according to referee's 2 suggestion. We have reduced the first section where we explain that our work confirms the results of previous studies at the seasonal scale (although this is an interesting result in itself). We focus more on the daily scale for which our results bring interesting elements on rockfall triggering factors and we quantify the correlation between rockfalls and different parameters (rainfall, temperature, frequentation) on a daily scale by computing the cross-correlation function between hourly rockfall rates (R) and other parameters P at the hourly rate. We also changed some of the reference according to referee's 1 comments. We also discuss in more details the effects of rain on rockfall triggering.

We reorganized the figures according to referee's 1 comments. The daily traffic is now included to the main figure of the discussion and the hourly distribution of climbers traffic is included to a new figure supporting the discussion about mountaineers as a triggering factor of rockfall. We give the example of a day when rockfalls are among the least frequent, so for which we can estimate that the natural triggering factors are the least effective (there is no snow in the couloir nor precipitation), and the rockfalls recorded correspond clearly with the traffic.

To meet the objective of our study, which is to acquire knowledge on the hazard of rockfalls in the specific context of the *Grand Couloir du Goûter* and to disseminate this knowledge to the mountaineering community in order to promote their adaptation and try to reduce the number of accidents, we have added two sections in the discussion : "Interest of the acquired knowledge for mountaineers" and "Dissemination of the acquired knowledge to the mountain community and implementation of management measures of the route". We explain what are the key information for mountaineers we acquired, how we disseminated it to the mountain community and we explain that they were used for the implementation of management measures of the route, in particular to reduce the number of accidents.

Finally, we corrected the section "Climate change and future projections" according to referee's comments and we moved it to the end of the discussion but we decided not to remove it. It seems important to us to specify that the situation in the future will probably not improve, which justifies all the more a better consideration of the rockfall hazard for mountaineers in this very frequented sector.