

Accidentology of the normal route up Mont Blanc between 1990 and 2017

Jacques Mourey
Olivier Moret
Philippe Descamps
Stéphane Bozon



May 2018



Table of contents

Introduction	3
1. Methodology and field of application of the study	4
2. Variation in the number of accidents each summer between 1990 and 2017	6
3. Accident severity	6
4. Profiles of the individuals attended to	7
• Nationality of the individuals attended to	7
• Supervision by a professional.....	8
• Roping up	9
5. Accident characteristics	10
• Accident locations and their consequences	10
• Accident causes	11
• Accident times	12
• Direction of travel.....	13
6. Accident types are partly conditioned by their location	14
Rockfalls: two main causes.....	15
7. The rise in the number of accidents could be explained by the route’s increasing popularity.....	16
8. 2017, a particularly deadly summer: detailed study of visitor numbers and accidentology	17
• Accidentology and average daily visitor numbers.....	17
How to optimise the timing of crossings	18
Conclusion.....	19
Summing up.....	20

Cover photo: O. Moret



Aiguille du Goûter (3,863 m). In the center, the Grand Couloir du Goûter. (© J. Mourey)

Introduction

This study is the fruit of collaboration between the Dynamic Environments and Mountainous Regions Research Laboratory (EDYTEM, Savoie Mont-Blanc University), the Petzl Foundation and the French mountain police force in Chamonix (PGHM). Its main objective is to gain a better understanding of the accidents that occur on the normal route to the summit of Mont Blanc (4,809 m), the highest peak in the Alps.

Mont Blanc's so-called "normal" route is one of the most popular mountaineering routes in the world. It is used by some 17,000 climbers each year. It does, however, feature a number of major hazards, particularly where the route crosses the Grand Couloir du Goûter at 3,270 metres — also known as Death Gully — and the climb up the ridge to the Aiguille du Goûter (3,863 m). This is a very rocky part of the route. The use of rock climbing techniques (hand and foot holds) is required in some sections and there is significant exposure to falling rocks. These factors have resulted in a large number of accidents, as presented in the first edition of this study published in 2012 (available from the Petzl Foundation website, www.fondation-petzl.org). Between 1990 and 2011, 291 people were the subject of rescue operations between the Tête Rousse refuge (3,187 m) and the Goûter refuge (3,830 m). The severity rate was extremely high: 74 people were killed and 180 injured.



The normal route to the summit of Mont Blanc, where it crosses the Grand Couloir du Goûter.
(17/06/2017, © J. Mourey)

This update to the study published in 2012 extends the analysis to 2017. The aim is to better understand the causes of traumatic accidents that take place in this zone, so as to provide decision-support tools for the authorities, mountain professionals and amateur mountaineers alike.

1. Methodology and field of application of the study

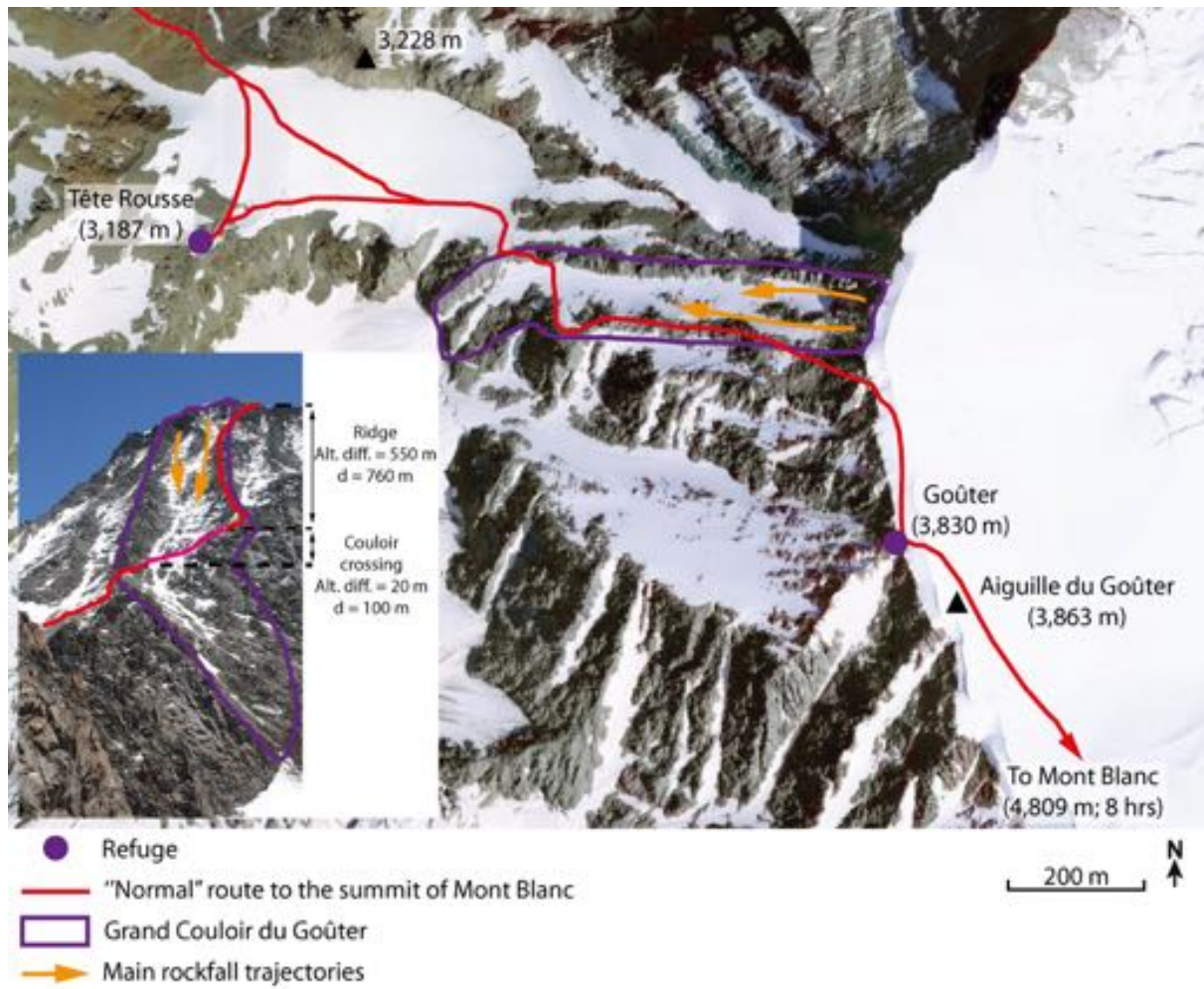
The methodology used for this research is identical to that employed for the 2012 study. It involved carrying out an exhaustive inventory of traumatic accidents occurring on the section located between the Tête Rousse refuge and the Goûter refuge, by examining the reports that rescuers drafted after each incident one by one.

Operations conducted by rescue services downhill from the Tête Rousse refuge or uphill from the Goûter refuge, as well as those performed in the landing areas adjacent to these buildings, were not taken into consideration. While more numerous, the issues dealt with in these landing areas were generally less serious (acute mountain sickness, ophthalmia, frostbite, etc.) and were not directly conditioned by technical difficulty or by the dangers inherent to the Grand Couloir and the ascent to the Goûter refuge.

The main types of information for which the reports were examined were the location (the crossing of the couloir or the climb up the ridge) and time of the accident, its causes (rockfalls, falls, stranding through lack of technical ability, illness or exhaustion), its consequences for the victim(s) (death, injury or neither) and their profile (gender, age and nationality).

However, it is important to point out that this information is not always provided in reports and, when it is, its accuracy can vary. The information was gathered by a large number of rescuers, whose primary role is not to perform accidentology studies, but to save victims and note down their observations for future administrative or even legal purposes. The location of some accidents is sometimes difficult to pinpoint due to the inability of the victims or witnesses to provide specific details about their circumstances. Moreover, some accidents occur because mountaineers are alone and there are no witnesses. As a result, it is important to remain cautious when interpreting the data. Although the number of deaths recorded is reliable, the accuracy of the details regarding the circumstances and locations of accidents cannot always be verified. The degree of reliability of the data is specified in certain sections of the study.

This research made use of the data generated by a visitor counter set up a few metres before the couloir's crossing. The device allowed the use of this route to be quantified and qualified (direction of travel) in terms of the number of crossings between June and September 2017, with an accuracy of $\pm 4\%$. It is important to specify that the results produced by this instrumentation refer to the number of crossings and not the number of individuals.



Map of the couloir, its crossing, the ridge and the refuges (IGN, 2018).

2. Variation in the number of accidents each summer between 1990 and 2017

Between 1990 and 2017, the PGHM performed 347 rescue operations in response to accidents occurring between the Tête Rousse refuge and the Goûter refuge, i.e., an average of around 13 operations per summer season. A slight upward trend can be noted between 2015 and 2017, when the number of operations averaged 18 (Fig. 1).

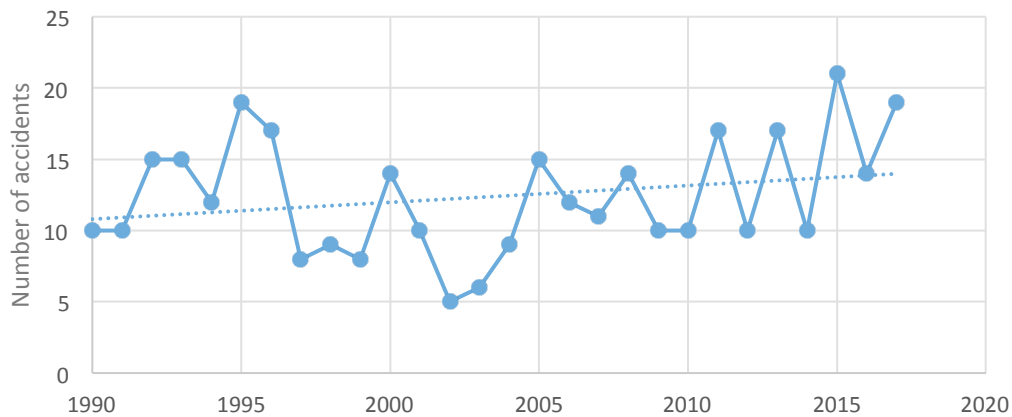
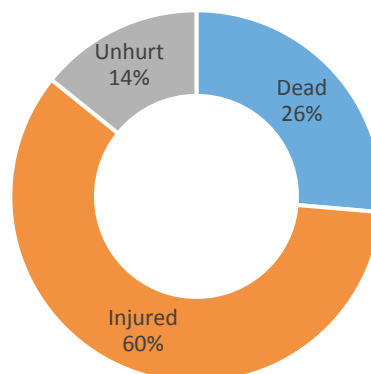


Figure 1. Variation in the number of rescue operations as a result of traumatic accidents between the Tête Rousse refuge and the Goûter refuge in 1990-2017.

3. Accident severity

The accident severity rate was very high: 102 (26%) people died – i.e., an average of almost four deaths (3.7) per year – 230 (59%) were injured and only 55 (14%) were unhurt.



The increase in the number of deaths, injuries and uninjured victims (Fig. 2) was in line with the rise in the number of rescue operations (Fig. 1) over the period. There was a great deal of interannual variability in the number of deaths, which ranged from 0 (1999, 2016) to 11 (2017), with an average

of 3.7 per year. The number of injuries per year varied between 1 (2003) and 14 (1999), with an average of 8.5 per year.

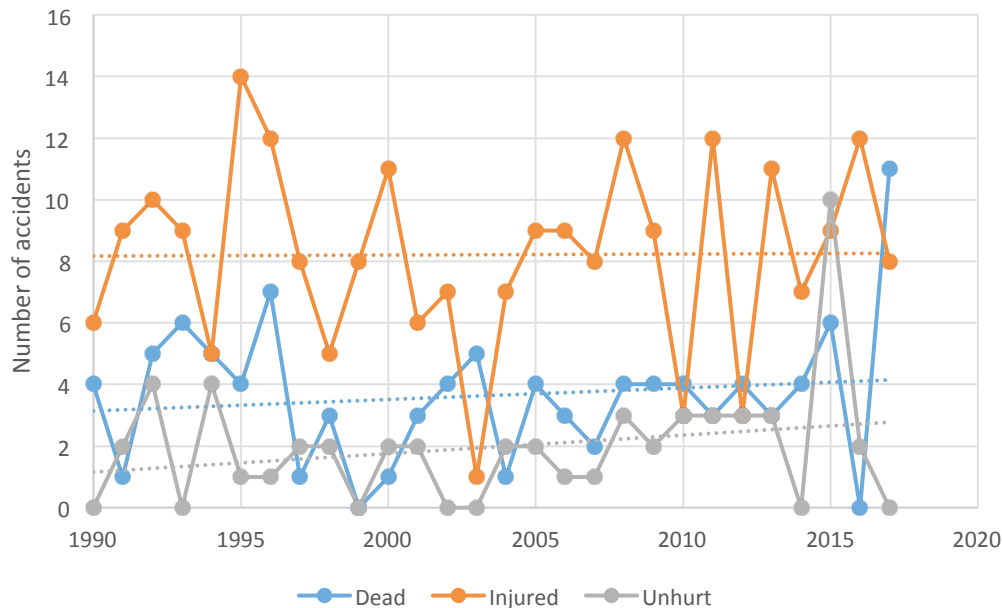


Figure 2. Variation in the number of victims killed, injured and unhurt between 1990 and 2017.

4. Profiles of the individuals attended to

Average age: 40

Gender: men 82%, women 18%

It is worth noting that there was an increase in the average age of the individuals attended to over the period. The average age of the victims was 36 between 1990 and 1999, and 44 between 2008 and 2017. This increase is comparable to that of the average age of the European population (EUROSTAT, 2017). The over-representation of men remained constant over the entire period. This reflects the over-representation of men in mountaineering as a whole.

- **Nationality of the individuals attended to**

Victims of 37 different nationalities

Between 1990 and 1999, individuals of 22 different nationalities were the subject of rescue operations. The French accounted for 28% of victims. Citizens of countries bordering France (Italy, Spain, Belgium, United Kingdom and Germany) accounted for 45%. The remaining 27% hailed from 14 other European countries, including the Czech Republic (6%), Poland (3%) and Denmark (2%).

Between 2000 and 2008, individuals of 26 different nationalities were the subject of rescue operations. The French accounted for just 18% of victims. Citizens of countries bordering France accounted for 35%. The remaining 47% of victims were mainly from Eastern Europe (notably Poland with 9%).

Lastly, between 2009 and 2017, individuals of 25 different nationalities were the subject of rescue operations (Fig. 3). The French accounted for 25% of victims (up 7 points from the previous period), while citizens of countries bordering France were less represented (27% of victims). Conversely, the proportion of victims hailing from Eastern Europe increased (Czech Republic, 7%; Poland, 10%; Lithuania, 3%), while Russians appeared in the statistics for the first time and accounted for 4% of the total. The number of victims from the Far East also increased (Japan, 4%; Korea, 4%).

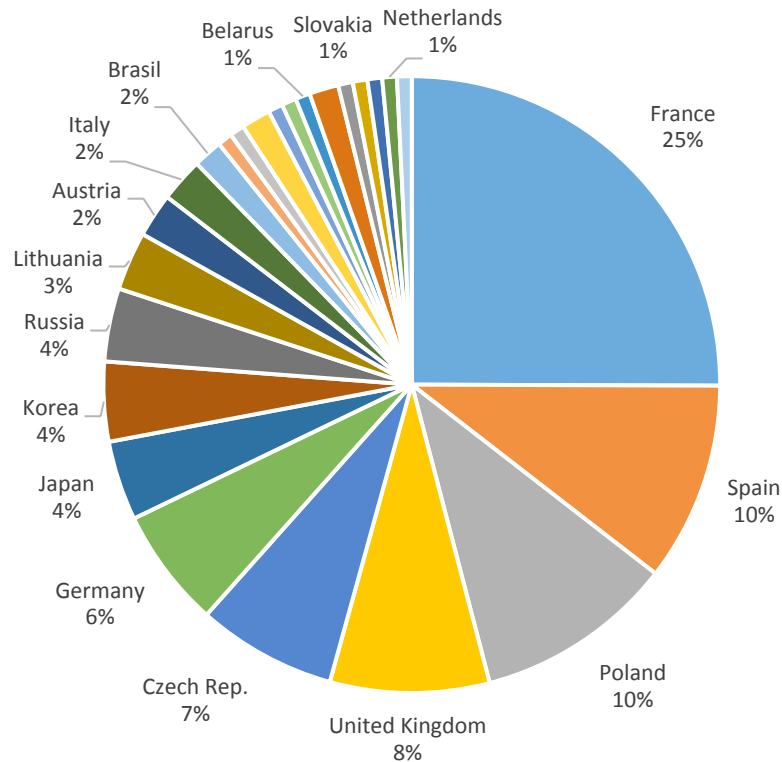


Figure 3. Country of origin of accident victims over the period 2009-2017.

The expanding range of nationalities of the individuals attended to suggests **that the ascent is becoming more international**, with Eastern European nations and Russia being increasingly represented in the data. Over the entire period, around one-quarter of the victims attended to were French.

Meanwhile, individuals from 24 countries lost their lives over the period. **17% of the deceased were French**, 12% were from the Czech Republic and 10% were German.

- **Supervision by a professional**

84% of accident victims were amateurs who were not under the supervision of a professional.

9% were the clients of guides (including one death from falling) and the remaining 7% were professionals (high-mountain guides, police officers and military personnel in training).

The figures suggest that groups supervised by professionals are less likely to have an accident. However, this interpretation should be viewed with caution insofar as the proportion of individuals on Mont Blanc who are under the supervision of a professional is not known precisely.

- **Roping up**

Information on whether or not the victims were roped up when an accident occurred is available in just 38% of reports. Nonetheless, over the period 2012-2017, 83% of accident victims were not roped up in those cases where this information is available. Moreover, 47% of these victims were killed, the majority on the ridge.

Over the course of the period, only five of the victims who were roped up lost their lives.

While we do not know the exact proportion of victims who were roped up, it is not unreasonable to suggest that being roped up is a factor that limits the severity of accidents when the individuals are proficient in the techniques of roped mountaineering. However, poor use of ropes can be an aggravating factor (entire groups of roped climbers might fall, the rope may cause rock falls, etc.).



Mountaineers not roped to each other (on top) and roped to each other on the cable (below), crossing the Couloir du Goûter (2011 © S. Lozac’hmeur)

5. Accident characteristics

- **Accident locations and their consequences**

An accident's location is the point at which the accident takes place, not the point at which the victim is attended to. In many cases, rescuers have no detailed information about the location from which the victim has fallen (lack of witnesses, victim in shock or memory loss as a result of the trauma). This study distinguishes between accidents that took place strictly within the 100 metre stretch comprising the crossing and those that occurred on the ridge. No location was specified for 28% (114) of the accidents recorded, i.e., 21 deaths and 73 injuries. In these cases, the location was stated as “unknown”. As regards the few accidents that took place either between the crossing of the couloir and the Tête Rousse refuge or on the Payot ridge, the location was stated as “other”. Overall, the location of the accidents could be determined with a good degree of accuracy: 71% of accidents took place either during the crossing (35%) or on the ridge (36%).

Of the 347 rescue operations conducted (1990-2017), 35% (122) related to accidents that occurred during the traverse across the couloir (31 deaths and 85 injuries) and 36% (132) related to accidents that took place on the ridge (50 deaths and 73 injuries) (Fig. 4). Thus, almost as many accidents occurred on the ridge as during the traverse across the couloir. **However, the severity of accidents (i.e., the number of deaths) was greater on the ridge.**

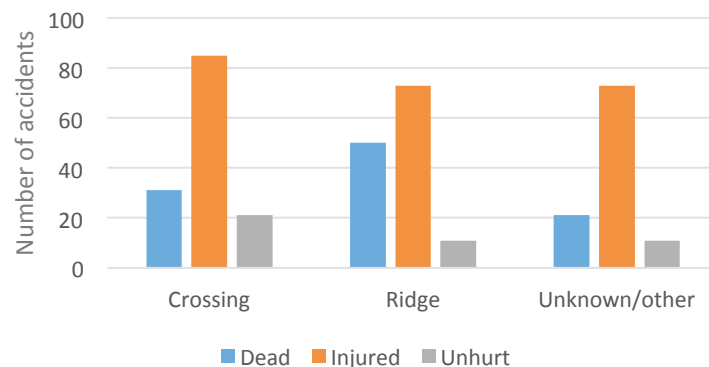


Figure 4. Consequences of accidents depending on their location.

In addition, although the interannual variability is high, **the number of accidents during the crossing appears to have fallen overall, while it has more than tripled on the ridge** (Fig. 5) over the period as a whole. Greater awareness of the risks relating to the traverse across the couloir probably explains the fall in the number of accidents during the crossing. The dangers and technical difficulty of the climb up the ridge are often likely to be underestimated or overlooked by mountaineers.

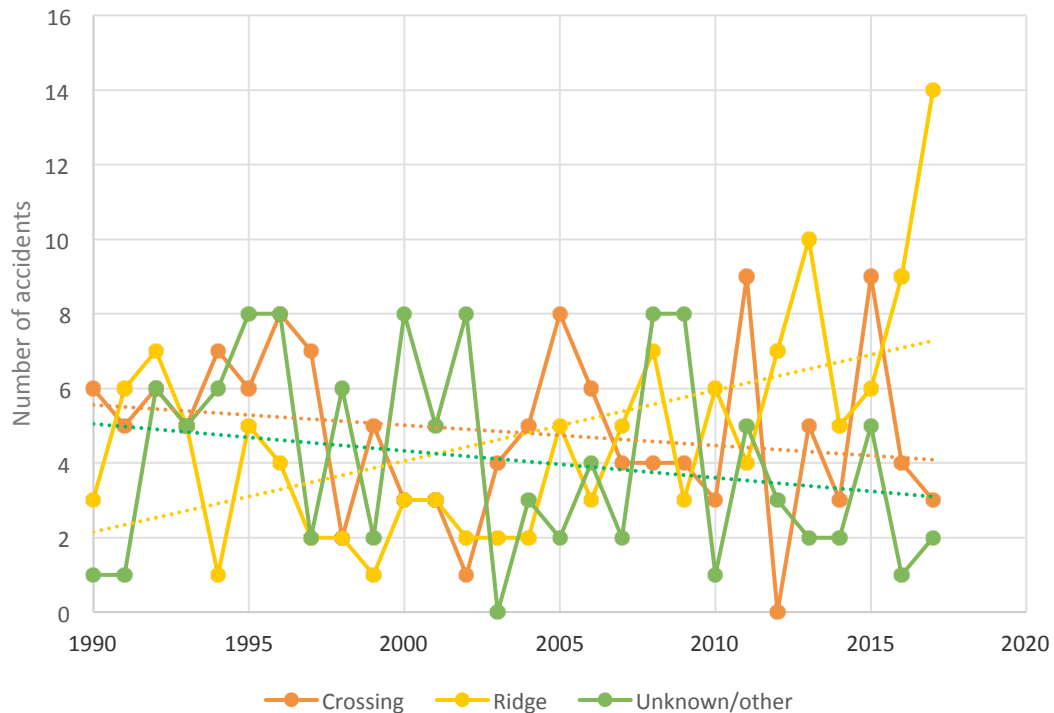


Fig. 5. Variation in accident locations — crossing of the couloir, ridge or unknown/other.

- **Accident causes**

The causes of accidents are not easy to determine based purely on the reports produced by the rescue services. In many cases, there is a complex chain of events and witnesses are sometimes lacking. For example, falls can occur for a variety of reasons: technical errors, rock falls, tiredness, inappropriate equipment, lack of ropes, incorrect route, etc. Moreover, when the official cause is a rockfall, the victim may subsequently have fallen in the couloir. On the other hand, the cause of a fall may have been a rockfall, but the rescuers might not have recorded it as such.

Furthermore, in cases where a rockfall is clearly identified as the cause of the accident, it is difficult to determine whether it was triggered naturally or by a group of mountaineers located uphill. Thus, a degree of uncertainty invariably remains in data on the causes of accidents.

What can be stated is that **rockfalls are certainly an important factor, because they are the direct cause of at least 29% of accidents** (Fig. 6) and are partially to blame for **the falls that lead to 50% of accidents**.

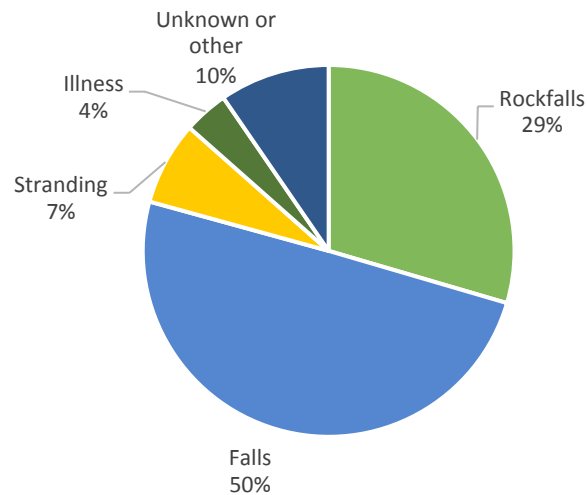


Figure 6. Causes of accidents

Throughout the period studied, all the causes of accidents occurred in more or less constant proportions and falls were to blame in the majority of cases (Fig. 7). **However, it is interesting to note the rise, after 2007, in the number of individuals becoming stranded due to a lack of technical ability.** In 2015, five rescue operations were conducted for this reason.

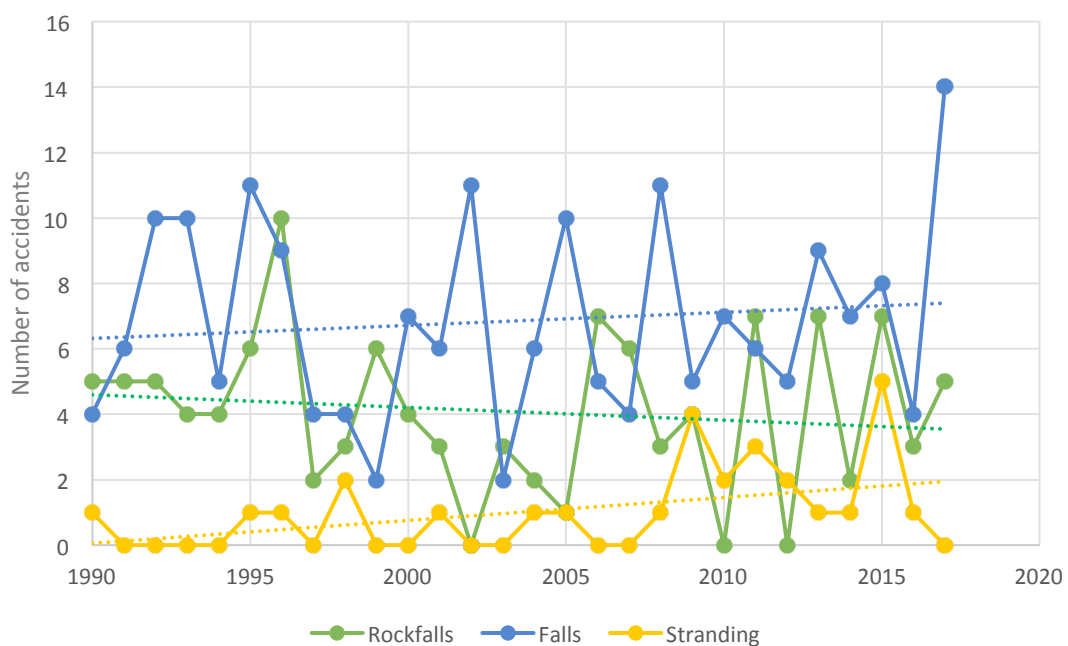


Figure 7. Variation in the number of accidents caused by falls, rockfalls and stranding due to lack of technical ability between 1990 and 2017.

• Accident times

On average, the rescue services were called at 1.10 pm. The calls were made at the same time on the ridge (1 pm) and at the crossing of the couloir (12.58 pm). Accidents whose location was unknown took place later, at 2.15 pm on average.

- **Direction of travel**

60% of accidents took place during the descent and 40% during the ascent. According to the study by Alpe Ingé (2012), which is available at the Petzl Foundation website, and as confirmed by the data from the visitor counter, the normal route of the Goûter was used more frequently in the downhill direction (53%) than in the uphill direction (47%). Indeed, some groups descend via this route after having climbed using other routes, including the Trois Mont Blanc, the Aiguille de Bionnassay and the high-commitment routes on the Italian side.

As regards the crossing of the couloir, as many accidents took place during the ascent as they did during the descent. However, **on the ridge, 70% took place during the descent.** It is interesting to note that this trend applies throughout the period studied.



Mountaineers crossing the couloir. (11/07/2017, © J. Mourey)

6. Accident types are partly conditioned by their location

61% of accidents resulting from rockfalls took place during the traverse across the couloir.
45% of accidents due to falls took place on the ridge.

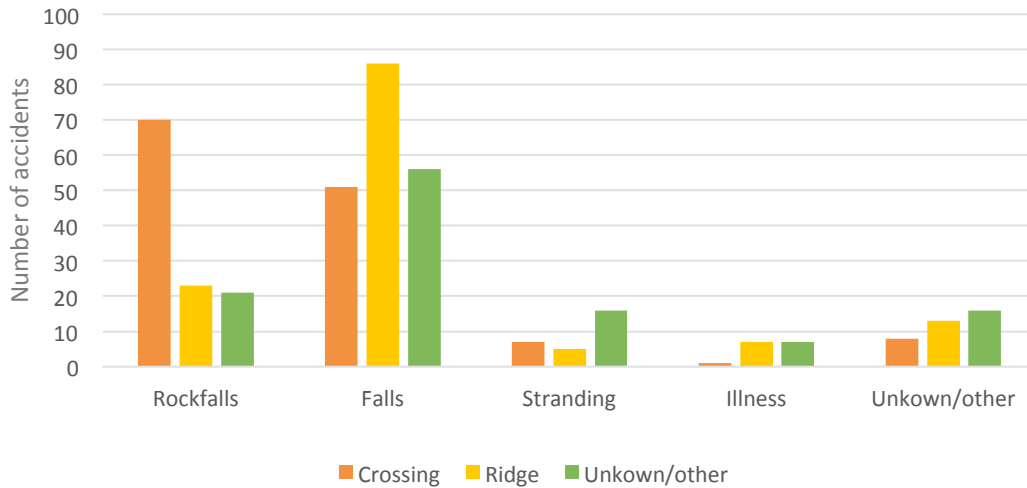


Figure 8. Consequences of accidents depending on their location.

It is fair to state that the percentage of accidents linked to rockfalls **during the crossing of the couloir is underestimated**, primarily because a proportion of the accidents recorded as falls are directly caused by mountaineers being hit by falling rocks, but also because the risk of rockfalls prompts climbers to cross the couloir as fast as possible — and in some cases to avoid falling rocks by running — which leads them to make technical errors that cause them to fall.

In the traverse across the couloir, the number of accidents caused by rockfalls halved over the period (Fig. 9), while there was a slight increase in the number of accidents linked to falls and stranding due to lack of technical ability.

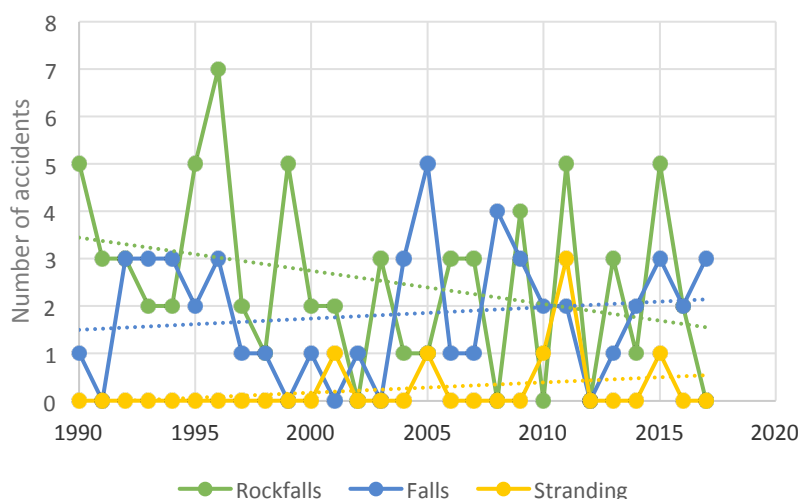


Figure 9. Variation in the number and causes of accidents during the crossing of the couloir.

On the ridge, the number of accidents due to falls doubled over the period (Fig. 10), with an average of 3.8 per year. The number of accidents caused by rockfalls was lower (0.8 per year on average), especially in comparison to the crossing of the couloir.

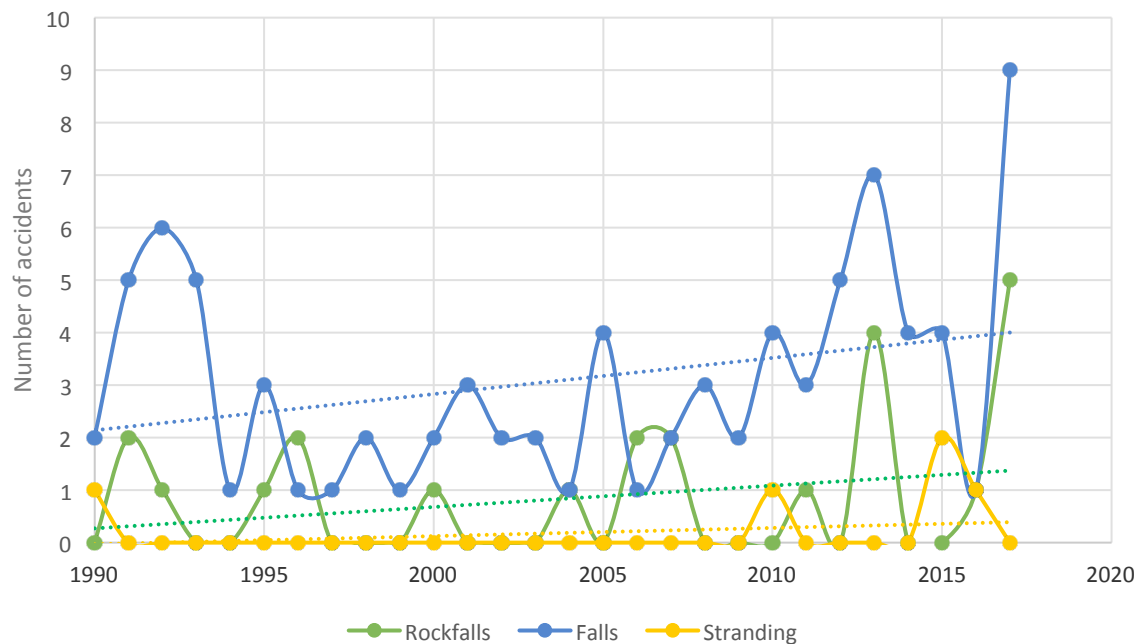


Figure 10. Variation in the number and causes of accidents occurring on the ridge.

Rockfalls: two main causes

The leading cause of rockfalls relates to the geomorphological nature of the mountain face. Indeed, the latter is comprised of highly fragmented gneiss, which increases the likelihood of falling rocks and blocks, especially when we consider that the steepness of the slope makes it very precarious (average slope of around 40°). What's more, the risk of rockfalls has grown due to the degradation of the local permafrost (land that is frozen continuously for at least two consecutive years and which plays a stabilizing role) and the increasingly rapid disappearance of snow from the couloir. These geomorphological processes are both linked to climate change. As a result, the probability of these phenomena occurring is increasing and the volumes of rock displaced are sometimes considerable. A scientific study is currently underway to better understand these processes and their impact on rockfalls.

The second cause of rockfalls is the presence of mountaineers, who are liable to trigger rockfalls that can affect groups located downhill or who are crossing the couloir.

The study by Alpe Ingé (2012) showed that 75% of rockfalls take place between 10 am and 4.30 pm and that the most critical time slot is between 11 am and 1.30 pm (it accounts for 34% of the events observed), with a rockfall occurring every 17 minutes on average. However, this study makes no distinction between rockfalls occurring naturally and those triggered by mountaineers.

7. The rise in the number of accidents could be explained by the route's increasing popularity

As indicated in the first part of this study, the number of accidents tended to increase between 1990 and 2017. This rise could well be linked to the rise in the number of mountaineers who use the route.

The most accurate piece of data for estimating any increase in the number of individuals using the route is the number of overnight stays at the Tête Rousse and Goûter refuges. It is worth noting, however, that this data has certain limitations: these overnight stays do not include campers, ascents performed in just one day and those who climb Mont Blanc via other routes, but descend via the normal route. Moreover, climbers sometimes sleep in both refuges and are therefore counted twice. Nonetheless, this information provides a telling indicator.

Indeed, **the rate at which the number of overnight stays in the refuges increased between 1995 and 2017 (0.5%) is identical to the increase in the number of accidents between 1990 and 2017 (0.5%)** (Fig. 11). This correlation suggests that **the increase in the number of accidents is linked to the increase in the number of individuals using the route.**

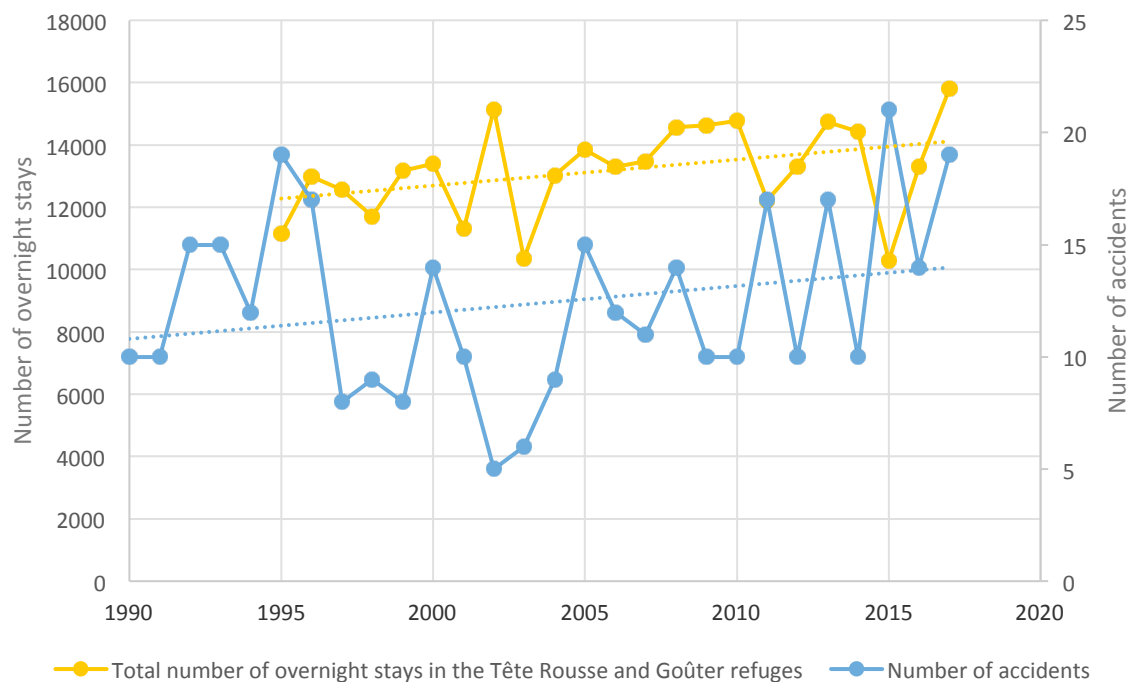


Figure 11. Variation in the total number of overnight stays at the Tête Rousse and Goûter refuges between 1995 and 2017 (left) and variation in the number of accidents between 1990 and 2017 (right).

Over the entire period, the following data was recorded:

- **One death per 4,952 overnight stays (Goûter refuge and Tête Rousse refuge combined).**
- **One accident per 1,219 overnight stays.**

8. 2017, a particularly deadly summer: detailed study of visitor numbers and accidentology

A particularly high number of accidents took place in the summer of 2017 (20 in total, compared with an average of 12) and the severity rate was also very high: 11 people were killed and 8 injured.

From 1 June to 30 September 2017, there were 29,182 crossings of the couloir. The average frequency of accidents was one per 1,535 crossings and there was one death every 2,652 crossings.

On average, 35 people lose their lives each year while mountaineering in France during the summer season (source: SNOSM). In 2017, deaths between the Tête Rousse refuge and the Goûter refuge accounted for around one-third (31.4%) of mountaineering fatalities in France.

How can such a high number of accidents be explained? Was it due to rockfalls, the weather, a lack of ability on the part of climbers, inadequate equipment or information, high visitor numbers, or other factors entirely?

Based on the information available, we know that five of these accidents, including two deaths, were reported as being caused directly by rockfalls, and that thirteen accidents, including eight deaths, were caused by falls during the crossing or on the ridge, although it is not known whether these were caused by rockfalls. However, the number was not significantly higher when the couloir was dry or during intense rockfall periods. What the results do show is that there is a strong correlation between high visitor numbers and the increased occurrence of accidents. On average, the couloir was crossed 202 times a day ($\pm 4\%$) during the 2017 summer season.

- **Accidentology and average daily visitor numbers**

Over the course of each day, the traverse across the Grand Couloir is generally negotiated at around three peak times (Fig. 12). The first two are around 2 am and 6 am. These correspond to departures from the Tête Rousse refuge by those heading to the summit. The third spans from 9.30 am to 2.30 pm, with the highest peak at 11.30 am. This is the time slot during which the vast majority of individuals make the crossing. This includes both individuals who are descending from the summit and those who are climbing to the Goûter refuge from Nid d'Aigle, where the first train arrives at 8.30 am.

Daily average: 202

Monthly average: 6,139

Busiest days:

- Sunday 13 August: 638
- Monday 03 July: 584
- Friday 08 September: 567

Breakdown by direction of travel:

- Downhill: 53 %;
- Uphill: 47 %.

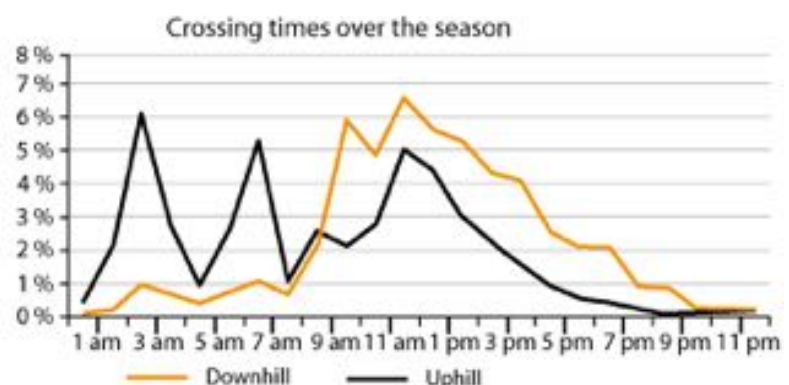


Figure 12. Visitor numbers at the Grand Couloir du Goûter and number of crossings between May and October 2017. The data has an accuracy of $\pm 4\%$.

Figure 12 shows that a majority of climbers cross the couloir at the worst possible time, when rockfalls are most frequent (between 11 am and 1:30 pm).

In 2017, the majority of accidents took place during the descent and in the afternoon (2.41 pm on average), when climbers are at their most tired, when visitor numbers are at their highest and when rockfalls are at their most intense. Only three accidents took place during the 2 am and 6 am peak times, when rockfalls and visitor numbers are at their lowest.

How to optimise the timing of crossings

Based on these results, leaving from the Tête Rousse refuge in the morning (between 2 am and 6 am) allows mountaineers to cross the couloir early, when visitor numbers and rockfalls are at their lowest. However, this probably means descending in the late morning/early afternoon, i.e., when visitor numbers and rockfalls are at their highest.

Climbing directly to the Goûter refuge from Nid d'Aigle is somewhat problematic, because it requires climbers to cross the couloir in the late morning. However, such a schedule allows them to reach the summit early in the morning and to go back down the couloir earlier than if leaving from Tête Rousse.

Mountaineers can reduce their exposure to hazards by sleeping at the Tête Rousse refuge before the climb to the summit of Mont Blanc and at the Goûter refuge after. However, this requires an extra overnight stay, which sets additional logistical and financial constraints.

Conclusion

The data and results presented in this study allow two major causes of accidents to be identified: falls and rockfalls. However, this study highlights a **complex situation in which the area's geomorphological conditions, visitor trends on the route and the profiles of climbers are all inextricably linked**. The result is a large number of accidents, many of them deadly.

Several key conclusions can be drawn from this research:

- The apparent rise in the number of accidents over the period seems to be linked to the route's increasing popularity.
- The causes of accidents are changing: while still significant, the proportion of accidents resulting from rockfalls is falling, giving way to accidents caused by falls and individuals becoming stranded due to a lack of technical ability.
- Any efforts made to inform visitors and prevent accidents must take into account the quite specific profile of mountaineers on this route (a high number of foreigners and varying levels of ability), as exemplified by the campaign entitled "*Le Mont Blanc, une affaire d'alpiniste*" ("Mont Blanc, the preserve of mountaineers") (brochures are available from the Chamoniarde and Petzl Foundation websites). Some of the messages sent out by the campaign seem to be heeded by only a minority of visitors, notably the recommendations relating to being roped up and secured, and the specific advice provided regarding the use of the fixed cable during the crossing.
- The majority of visitors traverse the couloir at the time of day when rockfalls are the most frequent.
- It should be noted that the number of accidents on the ridge is increasing rapidly, to such an extent that, for several years now, it has exceeded the number of accidents occurring during the crossing of the couloir.
- Rockfalls are not the only factor that explains the high number of accidents in this area. Visitor trends and the various ways of approaching the ascent (overnight stays in refuges, arrival by train) must also be taken into account.

Summing up

- An average of just under 13 rescue operations per summer season.
- Between 1990 and 2017, 102 people were killed (26%), 230 were injured (59%) and 55 victims escaped unhurt (14%) out of a total of 387 individuals attended to (347 rescue operations).
- The traverse across the couloir and the climb up the Goûter ridge alone accounted for an average of almost four deaths per year.
- The victims were of 37 different nationalities and the trend is towards greater internationalisation.
- Few of the mountaineers involved in accidents were under the supervision of a professional.
- Only a small number of mountaineers who were roped up were involved in accidents.
- The number of accidents in the crossing of the couloir has fallen overall, while the number on the ridge has increased significantly.
- Accidents due to rockfalls took place chiefly on the 100 metre stretch across the couloir.
- The increase in the number of accidents correlates with the number of individuals using the route.
- The risks inherent to the traverse across the Grand Couloir and the climb up the ridge to the Goûter refuge have made these sections major black spots for mountaineering in France.

Accidentology of the normal route up Mont Blanc between 1990 and 2017

This study is the fruit of collaboration between the Dynamic Environments and Mountainous Regions Research Laboratory (EDYTEM, Savoie Mont-Blanc University), the Petzl Foundation and the French mountain police force in Chamonix (PGHM).

Its main objective is to gain a better understanding of the accidents that occur on the normal route to the summit of Mont Blanc (4,809 m), the highest peak in the Alps.



© O. Moret

Contacts:



Laboratoire EDYTEM

Jacques Mourey
jacques.mourey@univ-smb.fr

Université Savoie Mont-Blanc
Bâtiment Pôle Montagne
5 bd de la Mer-Caspienne
73 376 Le Bourget-du-Lac Cedex



Fondation Petzl

Olivier Moret
Secrétaire général
omoret@fondation-petzl.org

Cidex 105 A – ZI Crolles
38 920 Crolles



Peloton de gendarmerie de haute montagne

Lieutenant-Colonel Stéphane Bozon
stephane.bozon@gendarmerie.interieur.gouv.fr

Caserne Anselme
69 route de La Mollard
74 403 Chamonix-Mont-Blanc