

*THE AVALANCHE SITUATION IN A SPECIAL WINTER.
REVIEW OF THE 09/10 SEASON IN NORWAY*

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ABSTRACT: The 2009/10 season featured significantly different snow conditions compared to the usually maritime snow pack in most of Norway. A stable high-pressure system over large parts of Europe led to low temperatures and limited precipitation in the country. Along the coast a continuous snow cover was observed for several weeks while the mountains received down to 20% of the 1971-2000 normal precipitation values. The snowpack had several weeks to develop extensive layers of depth hoar also in areas where this is usually not observed. The weather situation promoted the development of surface hoar in many locations as well, especially on the eastern side of the mountains. Still, the danger level was moderate most days of the winter. Similar conditions lead to the catastrophic avalanche winter in 1979. Based on that experience awareness was high and both road closures and evacuations were implemented in several occasions when heavy snowfalls were to load the weak base of the well established persistent weak layers. The observed avalanches were often hard slab avalanches of medium size occurring on slopes where avalanches are not observed in normal winters. The five registered fatalities during the past season were all back country skiing accidents and most of the avalanches were at least partly released in the weak base of the depth hoar layers. The daily presence of avalanche observations caused intensive media coverage of the special snow situation. Journalists and the public soon adopted the international danger scale and communication between avalanche experts and the media improved significantly as a result of this season.

KEYWORDS: Avalanche warning, accidents, snow conditions, winter weather

1. INTRODUCTION

In large parts of Norway the winters are often rather mild and wet and the weather is dominated by a maritime climate. Only the most eastern parts of south east Norway and the highlands of Finmark in the North feature continental climate. However, in the past winter season, this pattern was broken due to a long lasting high pressure block, leading the low pressure systems to the south of the country (Fig. 1). This resulted in a winter with clear weather, little precipitation and low temperatures.

While the shops sold a record amount of skiing equipment, the avalanche experts experienced a disturbing winter, with little snow, few reported natural slides (except one avalanche cycle during the end of the season, described below) and almost continuous moderate avalanche danger rating.

At the same time, persistent weak layers of depth hoar developed in large parts of the country and tension increased among the forecasters who prepared for the worse if the extensive layers of depth hoar would be buried in a meter of new snow.

This paper gives a short overview of the weather and snow situation this season and its effects on the forecasting and accident statistics.

2. WEATHER REVIEW

The weather during the last winter was in many respects exceptional. Many records were broken, both in respect to cold temperatures and dryness.

For the country as a whole, the mean temperature was 2.5 °C under the long term mean and only 52% of the normal precipitation was registered (Fig. 2) in the period Dec. to Feb.

On the west part of the country, which usually is the wettest part, only 28% of the normal precipitation was reached, leading to water shortages in the usually rainfull city of Bergen. Although the snow pack was shallow in the higher regions, snow

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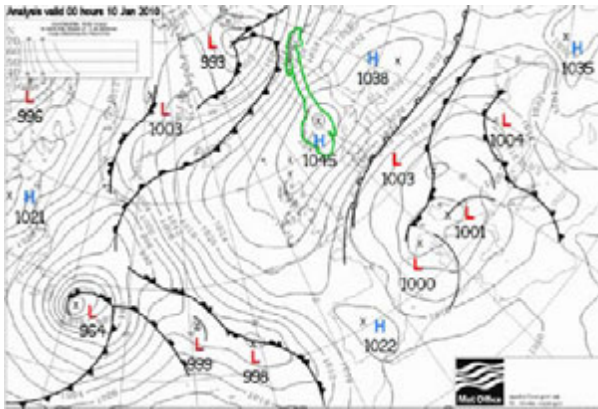


Figure 1: Analysis of the weather systems over Europe 10 Jan 2010. H: High L: Low pressure systems, Norway marked green (Met. Office, UK)

covered the lowlands extended periods along the west coast, a phenomena which has been rare in recent years (Fig. 2).

The second half of the winter was wetter and less cold but the observed precipitation was not enough to reach normal precipitation amounts. Only in parts of Nordland and Troms, more than 200% of the normal precipitation amounts were observed. This was a major cause for slush flows and flooding in the second half of May.

3. SNOW CONDITIONS

The cold and dry conditions had a distinct influence on the snow stratigraphy and created depth hoar all over the country. Areas that usually are covered with 3 – 4 m of snow at the end of the season barely reached 1 m this winter (Fig. 3) causing large temperature gradients in the snow pack.

Together with low temperatures through long periods in the beginning of the winter, constructive metamorphism was the dominating process in most snow packs producing extensive layers of depth hoar (Fig. 4). In addition, surface hoar crystals were reported of many observers during the winter. During an NGI remote sensing project volunteers were invited to report surface hoar leading to 34 observations (Fig. 5).

In northern Norway a period of mild weather in January created several layers of ice and crusts in the snow pack. These persisted until late spring. The snow conditions reminded in many ways of winters that had caused catastrophic avalanche events in the westerns parts of the country (e.g. in

1979) but the additional load of a large precipitation events was never added until the end of the season.

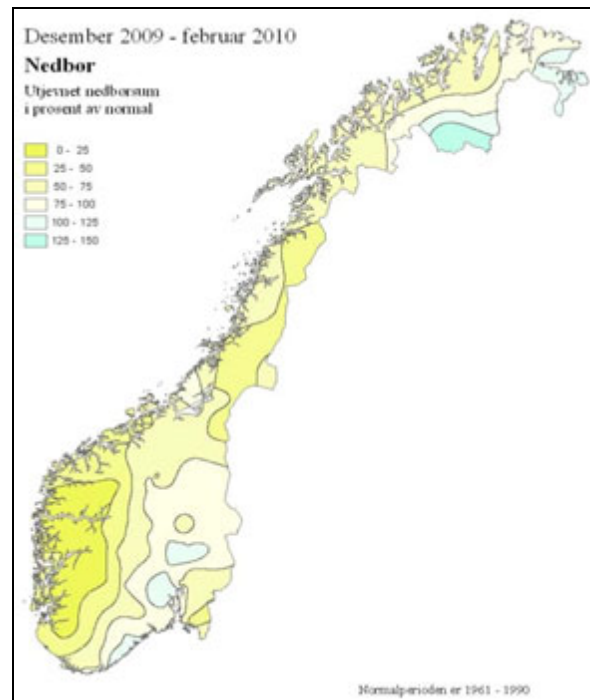


Figure 2: Percentage of normal precipitation in the winter month of December to February 2010 (www.met.no, seasonal report)

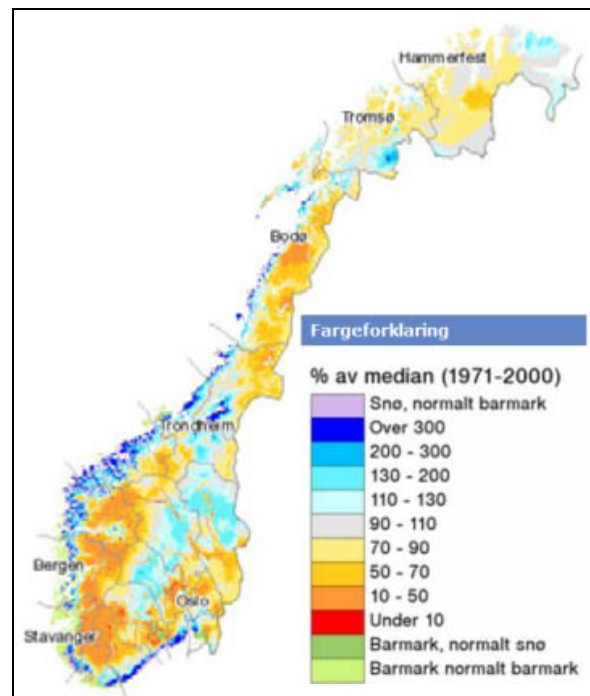


Figure 3: Snow distribution map of Norway showing % of the median 1971-2000 (www.senorge.no)

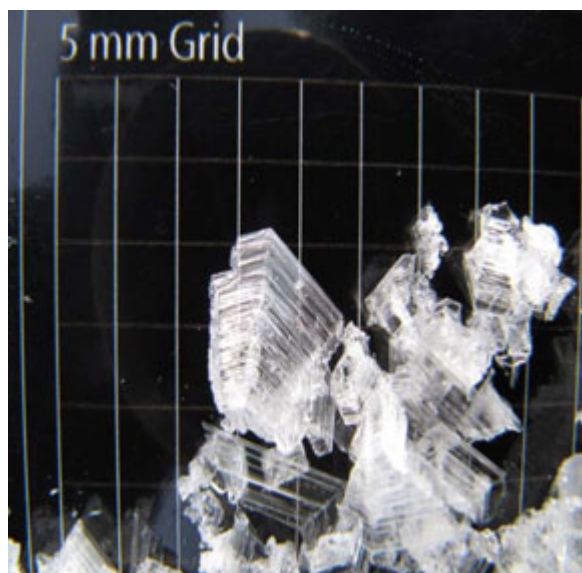


Figure 4: Large depth hoar crystals found near Narvik in February.



Figure 5: Surface hoar near Orvdalen, 15.01.2010 (S. Berge)

4. AVALANCHES

The persistent weak layers of surface hoar and depth hoar all over the country waited under the surface to reveal their weakness under any significant additional load to release. This was surprisingly seldom the case. Only occasionally natural avalanches were reported until the end of the winter. The biggest reported natural avalanche happened on the mountain Hatavarre in Troms 14.02.2010. It reached the road in the valley and barely missed two buildings (Fig. 6).

Of the few reported natural avalanches in the beginning of the season, many were hard slabs failing on weak layers of faceted and depth hoar layers. A common feature of these slides were reports of these events occurring in slopes that by experience “never” had produced avalanches before.

Skier triggered slides on the other hand were numerous and many skiers experienced close calls, among them experienced teams of the mountain rescue groups.

The coastal areas of the country experienced many wet snow avalanches just after the first temperature rise following the long cold period in January and February. In March another mild period released numerous slides in Sunndalen and the surrounding areas.

The end of the season was dominated by a large number of devastating slush flows in the county of Nordland caused by a sudden increase in air temperature to over +15 °C within 48 hours.

5. AVALANCHE WARNING

Avalanche warning in Norway mainly concentrates on object oriented forecasts, both on a regional and local scale. The Norwegian Geotechnical Institute (NGI) issued daily avalanche bulletins for 10 areas such as major infrastructure (e.g. Bergen Railway, roads in western Norway), housing (Northern-Norway) and construction sites in avalanche terrain. A national avalanche warning system for the public in Norway is currently under development.

Due to very little snow in the mountains, the avalanche danger remained at level 2 – Moderate in large periods of the winter. Due to the weak layers of depth hoar and extensive build up of surface hoar, the danger level was increased already at minor snow falls later in the season.

Most likely, the danger level was even as low as level 1 – Low during longer periods where the forecasters chose level 2 – Moderate. The lack of ground observations in many NGI warning areas and the fact that neither level 1 nor level 2 have relevance for the affected objects in the warning areas might lead to an underreporting of level 1 in daily use (Fig. 7).

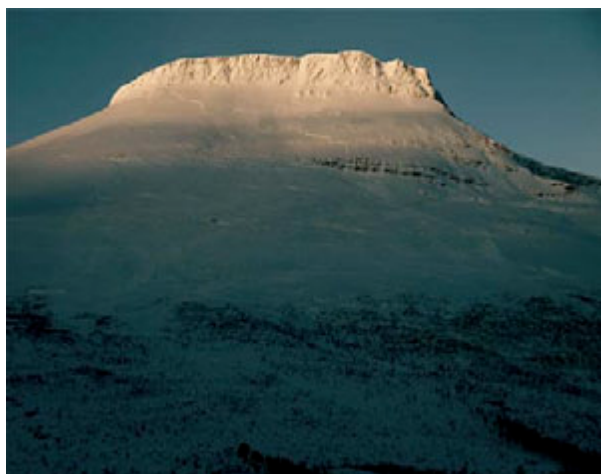


Figure 6: The mountain Hatavarre with the fracture line of the 2nd largest avalanche observed here during the last 70 years (14.02.2010, O. Olsrud).

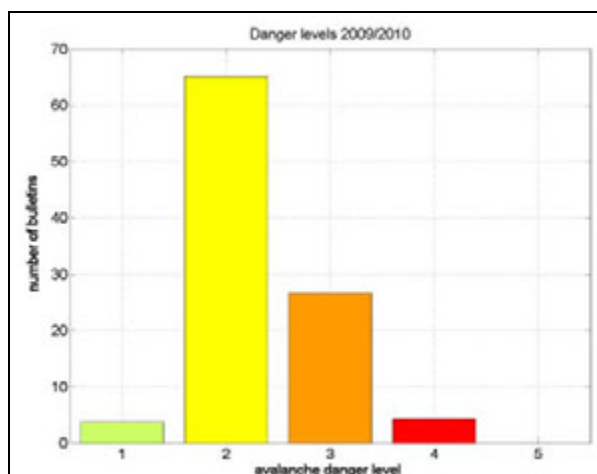


Figure 7: Total distribution of avalanche danger levels in the 09/10 season

Danger level 4 – High was reached in two situations (16.03. Sunndalen and 20.03. Northern Troms) when small low pressures produced locally high precipitation amounts of more than 60 cm within 48h. In these situations several roads were closed and selected buildings evacuated. But no major avalanches were observed.

The experience from previous large avalanche winters told the experts that there were big events waiting if the persistent weak layers were loaded by a heavy new snow fall. The biggest surprise of this season was that this additional snow never came and that the total snow depth remained very low until the end of the season.

Towards the end of the season a major slush flow cycle occurred in the Northern parts of Norway. By this time the regular avalanche warning service at NGI had ended but the public was warned prior to the event by the NVE flood warning services.

6. ACCIDENTS

In total nine persons were killed in avalanches in the season 2009/10. This was the worst season since 2000/01 which had the same number of fatalities. The special snow conditions this winter with the persistent weak layers played a major role in most accidents. All fatalities happened during recreational activities both out of bounds skiing and touring. Table 1 gives an overview over the accidents.

The two first accidents involved single skiers and their disappearance was first recognized hours after the avalanche event. The hunting accident on 10.03.2010 involved a group of three men who most likely remote triggered a small avalanche in a narrow creek valley. None of the group members carried any rescue equipment and the victim died under just 50 cm of snow.

On the contrary, the two victims of the Kvaløya accident 01.04.2010 were experienced skiers with all equipment in place. They had also attended avalanche awareness classes and were well acquainted with the terrain.

Table 1: Overview over the 5 fatal avalanche accidents in 2009/2011

Date	Location	No. persons	Activity	Equipment	Localization	Weak layer	Trigger
26.12.2009	Rauland	1	Out of bounds	H, B , S , P	Organized	depth hoar	Skier
03.03.2010	Tuddal	1	Free rider	H , B , S , P	Organized	depth hoar	Skier
10.03.2010	Tana	1	Hunting, touring	H , B , S , P	Organized	depth hoar	Remote/skier
01.04.2010	Kvaløya	2	Free rider	H, B, S, P	Organized	depth hoar	Skier
16.05.2010	Vefsn	4	Touring	H , B , S , P	Organized / self rescue	Wet snow / slush	Natural/slush

H: Helmet, B: Beacon, S: Shovel, P: Probe

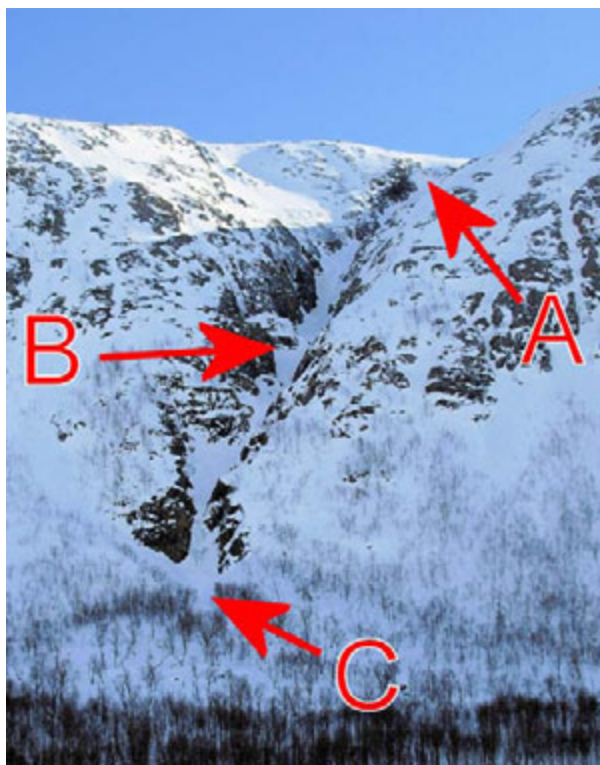


Figure 8: Overview over the fatal accident 01.04.2010 where two free riders were killed. A) ski tracks entering the couloirs, B) fracture line of the avalanche, C) Recovery location of the victims

They misjudged the steepness of a couloir and had to walk it up again after they reached a cliff midway. During the ascent, the avalanche was triggered (Fig 8).

In mid May, exactly one day after the final avalanche warning for the season was issued, a major accident killed 4 persons in 2 consecutive slush flows. An extreme increase in air temperature to more than +15 °C in the northern parts of the country caused intensive melting and numerous slush flows. The accident site was remote and rescue could first start with one day delay due to bad visibility and prohibition of ground transport due to more slush flows and flooding on the route to the site.

7. MEDIA

All kinds of natural hazards and catastrophic events attract a great deal of attention by the Norwegian press and every avalanche accident is fully covered by the media. However, the absence of daily national avalanche bulletins prohibits the

development of a public awareness of the avalanche hazard.

The journalistic angle varies but avalanche accidents are often presented as a natural phenomenon that kills innocent humans by pure chance. Journalists are therefore often taken by surprise, when the avalanche experts tell them that the avalanche danger level at the time was Moderate to Considerable and not “extreme” as often stated in the papers.

During the 09/10 season avalanches and the snow conditions were present in the media almost daily. This increased the contact and understanding between media and avalanche expert significantly. By the end of the season, some journalists had specialized on the avalanche news and started to understand some of the terminology. Also the international avalanche danger scale was more or less adopted by the media.

The experience tells that the continuous presence of snow and avalanche news in the media increases public awareness and improves the communication between experts and journalists. The dissemination of expert knowledge is a major contribution to the prevention of avalanche accidents.

8. CONCLUSIONS

After a long series of relative mild and wet winters in Norway, the season 2009/2010 featured finally a winter with long and cold periods all over the country. The weather situation led to:

- Extended development of depth hoar, also in maritime climate
- Local development of surface hoar
- A general low danger rating
- Hard slab avalanches in new locations
- Remote triggering of avalanches (1 fatality)
- Immediate increase of danger level already at medium snow falls
- No major snow fall was observed to trigger the weak layers
- The persistent weak layers also contributed to the wide spread slush flow activity in May (4 fatalities)
- Improved communication with media and the public due to increased contact through the winter

The last season was in many aspects challenging and lessons learnt will be used as input to improvements of the NGI avalanche warning services.

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