SHALLOW BUT STILL LONG: PECULIAR AVALANCHE ACTIVITY IN NORTHERN NORWAY

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ABSTRACT: Between December 3rd and 4th, 2025 some peculiar natural avalanches occurred in Tverrbotn adjacent to the Andersdalen valley, approx. 20 km south of Tromsø in Northern Norway. Weather preceding the event included modest (<20 cm) snowfall amounts accompanied by light to moderate southeasterly winds at ridgetop . This snow fell on a stable snowpack with locally weak, lightly faceted snow surfaces, developed during a period of colder, clear weather in the days prior. Limited avalanche activity was reported in the region following the snowfall, with a single thin, wide crown on a southwest aspect at 900 m serving as a notable exception. Upon investigation of this crown on December 7th, observers discovered multiple soft slab avalanches in an adjacent drainage that had in places ran 6-700 m to the valley floor. These avalanches had very thin crowns (5 to 10 cm) and were accompanied by extensive cracking that propagated into lower-angle terrain, indicating high fracture propagation potential.

Our curiosity was piqued for two reasons. First, our experience led us to believe that the regional weather patterns preceding the event rarely produce noteworthy avalanche activity. While weather and snow conditions specific to the investigated drainage may have controlled these avalanches, they were subtle enough to be no longer evident under observation several days post-event. Second, relatively minor new-snow accumulations and thin slabs nevertheless resulted in comparatively long runouts. Simulating these avalanches can help illustrate how interactions among slab characteristics, propagation potential, and entrainment allow even thin, soft slabs to reach long runouts. We hope this case study illustrates how the analysis of unusual, but by no means extreme, avalanche events can contribute to improved avalanche forecasting in situations characterized by high spatial variability. It also demonstrates how simulation tools can be used to investigate the processes that allow relatively thin slabs to produce unexpectedly long runouts.

KEYWORDS: shallow avalanches, field observations, avalanche modeling.

1. INTRODUCTION

This paper follows the ISSW tradition of presenting case studies that could have caught practitioners and recreationalists alike off guard, like Carter et al. (2006) or Glude (2009).

Here, we examine a localized event during the 2025/2026 season involving relatively shallow, naturally-triggered avalanches around Tromsø. Despite their limited fracture depths, several of these avalanches ran all the way to the valley floor. This makes the events particularly relevant not only to forecasters, but also to those concerned with avalanche hazard mapping, as they highlight the potential for relatively shallow releases to produce unexpectedly long runouts.

From a forecasting perspective, unusual avalanche activity is always worth examining and documenting, especially when it strays far from textbook examples or occurs "unexpectedly." In hazard mapping, where simulations often focus on avalanches with much larger release depths and masses, these avalanches provide a notable example of relatively limited release masses running distances that may warrant consideration in a hazard mapping assessment. Given the available photographic documentation and observations of the runout extent—albeit limited by the darkness of the polar night—we therefore felt that these avalanches warranted closer analysis and discussion.

We hope our analyses help illustrate the importance of avalanche field observations as both input to models representing reality, whether the model in question is a forecaster's mental model of the avalanche conditions or a numerical avalanche simulation tool

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2. WEATHER AND SNOWPACK

A snow profile from November 22 on Gorzelvtinden submitted to the open database Regobs by a recreationalist indicates a fundamentally stable snowpack (Figure 1). In a comment, Duncan notes some uncertainty about whether the faceted layer approximately 70 cm below the snow surface was actually present.

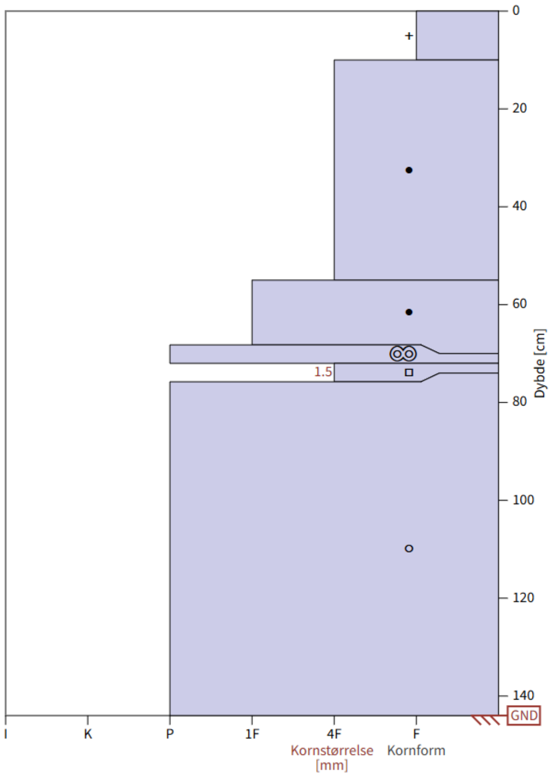

Figure 1: Snow profile from Gårdselvtinden, November 22, submitted to Regobs by user Duncan.

From November 25–29, a warm front brought approximately 20 mm of precipitation to Tromsø MET, with the freezing level estimated at around 300–400 m. During this period, strong to extreme winds from the south to southeast were recorded at Stor-Kjølen, the closest summit-level wind station. From November 30 to December 1, the warm precipitation was followed by cooler air masses, bringing approximately 15 mm of snow water equivalent (SWE) as snow down to the valley floor, accompanied by moderate to strong westerly winds.

From December 1–2, the weather cleared and temperatures dropped due to radiative cooling during the polar night. On the afternoon of December 3, approximately 16 mm of SWE and 10 cm of new snow were recorded at Tromsø MET. During the precipitation event, summit-level winds were from the southeast and did not exceed 10 m/s. On December 4, winds at Stor-Kjølen decreased to around 5 m/s from the east to southeast and remained relatively calm until December 6, when they increased to 10–12 m/s from the south. However, no wind transport was observed in the relevant area during this period, and the snow surface remained soft and undisturbed.

In the first days of December 2025 the Tromø MET weather station at 100 m elevation measured HS = 60 cm, eventually settling to 55 cm in the days leading up to the event. In the start zones at an elevation between 500 and 1000 m, snow heights were typically around 1 m, with large spatial variability due to some wind loading.

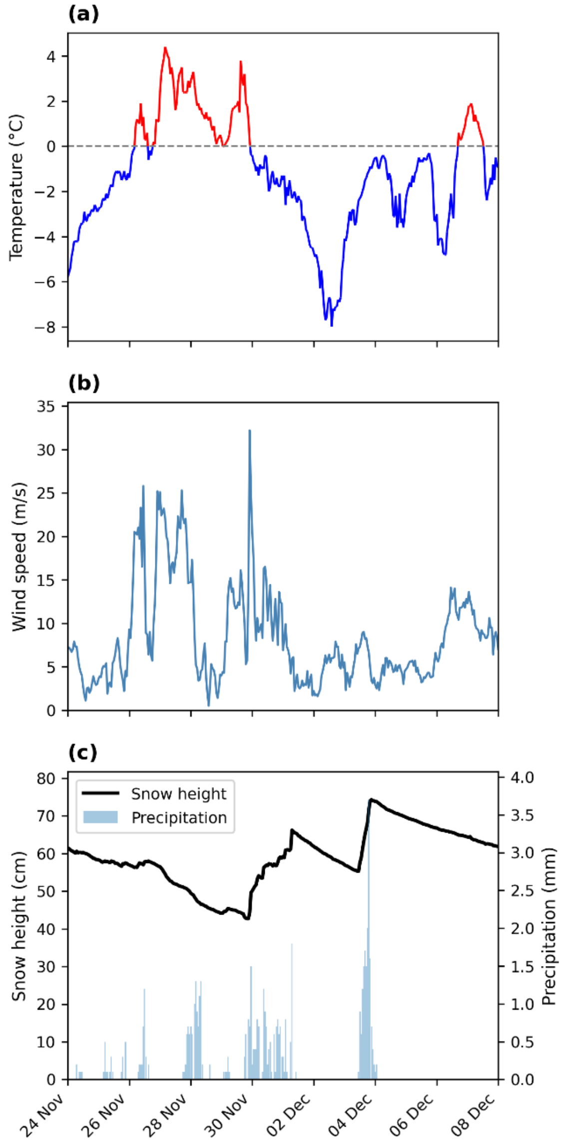

Figure 2: Weather summary for days preceding and immediately following the avalanches. Temperature, snow height, and precipitation are from the Tromsø weather station (100 m) and wind from a mountain weather station (Storkjølen) at 790 m.

3. THE AVALANCHES

The investigated avalanches released following a period of light precipitation under southeasterly flow in the mountains around Tromsø. Ridgetop winds remained generally light in the days immediately preceding the avalanches and new snow totals were modest. Nevertheless, multiple naturally-released avalanches ran to the valley floor, despite initial fracture heights of less than 10 cm. The long crowns and extensive downslope propagation of the observed failures are often associated with thicker, harder slabs and smooth, hard beds surfaces - yet here we observed very soft, thin slabs propagating over long distances both cross- and downslope and running long distances on soft bed surfaces. Our curiosity piqued, we decided to investigate further. Here, we describe our observations and use these observations as a basis for attempting to simulate these avalanches.

On December 6, a recreationalist submitted a photograph showing a long, seemingly thin crown on Gårdselvtinden, at approximately 1000 m asl on a south-southeast-facing slope, about 20 km south of Tromsø in northern Norway. No other avalanche activity was observed in the days following the precipitation event.

On December 7, authors MS and HH travelled to the area to investigate. On the way up the SW face, widespread cracking in the upper 5–10 cm of the snowpack and small avalanches were found on both sides of a shallow south facing gully (Figure 3 and). Upon reaching the avalanches reported on December 6, they were found to be small, with crown height around 10 cm, but showed remarkable propagation across the entire bowl southwest of Gårdselvtinden.

Figure 3: Small and thin avalanches on Gårdselvtinden. (Photo: Martin Stefan).

The avalanches had run a considerable distance on the small slope. The debris were spread widely and thinly and consisted of approximately 3–10 cm clots with a hardness of F–4F. At the time of observation, the slab consisted of small, faceted crystals, and no distinct weak layer could be identified. However, it should be noted that at least 24 hours, and more likely four days, had elapsed between avalanche release and our observations.

Upon further investigation, it turned out that there was also extensive avalanche activity in the drainage immediately to the east of Gårdselvtinden. As can be seen in Figure 4 and Figure 5 the avalanche paths in this area are both longer and wider.

Figure 4. The bowl in Tverrbotn containing the simulated avalanches in Figure 6 and Figure 7. The outlines of the avalanches, particularly the debris, are somewhat visible in this heavily modified photograph taken with a mobile phone in low light conditions. (Photo: Holt Hancock, regrettably)

These observed avalanches had run nearly the full path, in this case reaching the valley floor, and had propagated over large distances both laterally and in the fall line, as evidenced by widespread cracking into terrain that was not steep enough to produce avalanching.

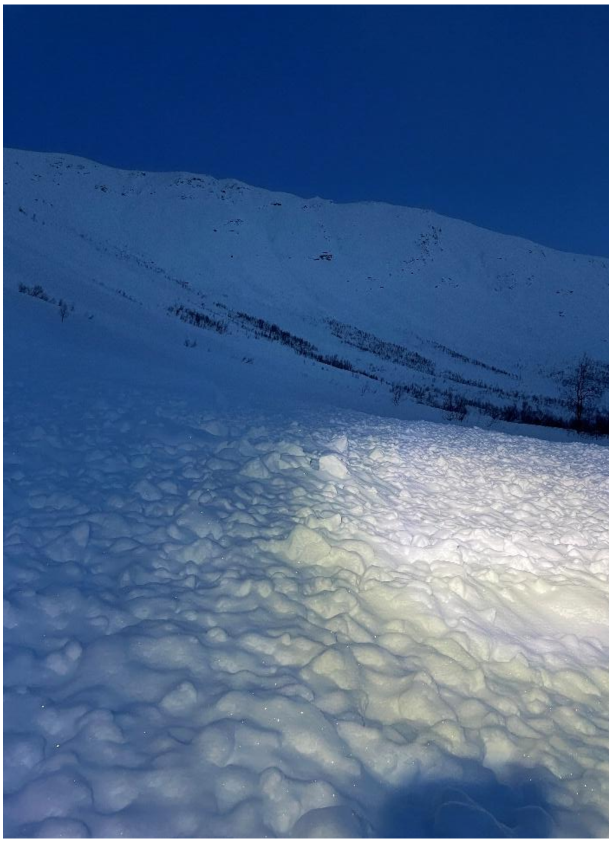

Figure 5: Debris close to the valley floor from one of the paths west in the drainage. The paths further east are visible in the top-to-top right of the photo. (Photo Martin Stefan)

Investigation in the release area suggested the slabs were very similar to the first one, around 10 cm thick, and F hard composed of small, faceted crystals. There was no discernible weak layer at the time of observation.

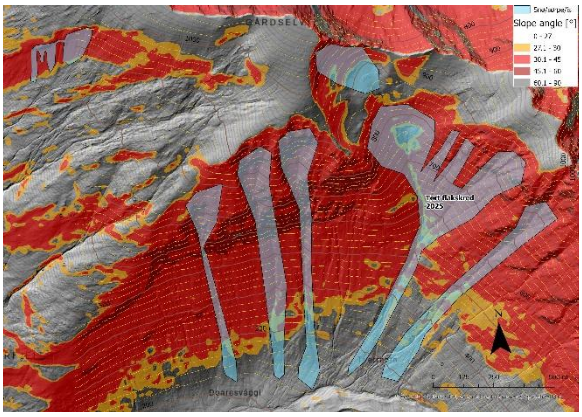

Figure 6: Avalanche outlines, mapped from photos, notes and GPS track.

4. SIMULATIONS

The examples Figure 7 show simulations with SAMOS-AT, using a modified friction law that favors Coulomb-type behavior (μ=0.45, $C_D\rho_a$=0.025 kg m^{-3}, and τ_c=10 Pa), similar to the law proposed for a mass-block model in (Gauer 2020) and to that used in (Gauer et al. 2023).

Release areas were defined using photos and notes from the field visit, with the goal to match the real event as close as possible.

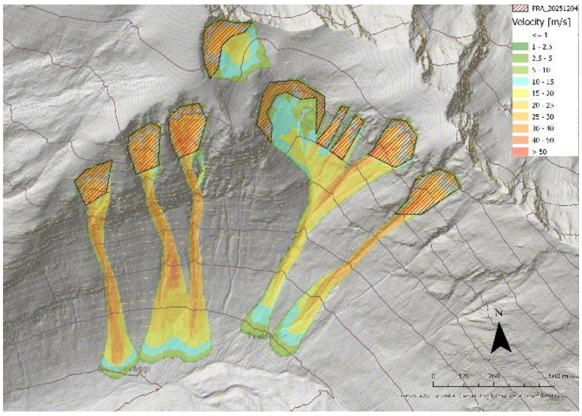

Figure 7 Simulations of avalanche events. The averaged release depth d0 = 0.1 m and density = 100 kg m-3 were also chosen to match what was estimated in the field.

The simulated runout lengths agree reasonably well with the observations. However, the simulated deposition pattern may spread more laterally than was observed. This is a common feature of avalanche simulations, as they rarely explicitly account for lateral constraints imposed by the snowpack.

It is not possible to evaluate the simulated velocity from the runout alone, as the observed runout provides insufficient constraints for selecting the parameters of typical avalanche runout models (Gauer et al. 2023). However, comparisons with other avalanche observations, such as those reported by Gauer (2020), indicate that the simulated velocities may be realistic.

5. DISCUSSION

The weather event that led to the avalanches was, in our experience, a relatively uncommon combination of cold precipitation and easterly flow. Typically, a low-pressure system such as the one responsible for this event would either bring warm precipitation from the southwest or result in little to no precipitation under easterly flow. The trajectory of the low-pressure system required to produce a significant amount of cold precipitation in this area is relatively specific and was therefore somewhat unexpected. Although the operational weather forecast model predicted the precipitation with good accuracy, our previous forecasting experience in the area made us skeptical that the forecast precipitation would verify.

This observation raises a broader question about the role of experience and expertise. In this particular case, someone relying solely on the meteogram may arguably have produced a more accurate forecast than moderately experienced forecasters using the full range of advanced weather tools available to them. This does not necessarily imply that less experience leads to better forecasts. A novice would likely be more prone to overforecasting similar situations, whereas an experienced forecaster may have learned, through repeated exposure, that such weather patterns do not typically produce significant snowfall. However, true expertise may lie in recognizing when a current situation differs from familiar patterns and identifying cues that warrant greater uncertainty in the forecast. In this case, the challenge was perhaps not a lack of available information, but rather knowing when to question an experienced interpretation of that information.

Within limited experience and recollection, we have not witnessed avalanches combining such thin release depths, extensive propagation, soft slabs, and impressive runout distances. It was therefore natural that there was some uncertainty about the nature of the weak layer, with surface hoar proposed as a likely candidate. Without a field investigation eliminating preserved surface hoar in the crown profiles, this hypothesis would may have persisted, potentially resulting in high uncertainty and less precise forecasts—both in public regional forecasts and in local, site-specific assessments for settlements and infrastructure—across the region in the following days and weeks.

Based on the information obtained from the field investigation, our best interpretation is that near-surface facets formed in the days preceding the event acted as the weak layer beneath a very soft, low-density new-snow slab. This slab appears to have formed through preferential deposition or light wind loading during the snowfall immediately preceding the avalanche activity. Faceting in the days between the avalanche release and our observations may have further reduced slab cohesion in our informal tests.

Ideally, a field investigation would also have revealed whether local conditions contributed to the apparent concentration of avalanche activity within this particular drainage. In this case, however, we found no evidence of such a mechanism. Moreover, given the potential for observation bias—the avalanches were observed in this drainage, but limited daylight and traffic in the area mean that similar avalanches could have occurred in any number of other drainages—we cannot determine with confidence whether the avalanche activity was in fact spatially limited.

We believe the above discussion highlights the importance of field observations, and particularly of targeted observations at avalanche sites whenever possible. General snowpack observations are a crucial source of information for avalanche forecasting, but they typically require extrapolation to infer avalanche likelihood and characteristics. Directly investigating avalanche release areas reduces the uncertainty associated with this extrapolation and can help clarify which uncertainties remain, as well as their potential magnitude.

Considering the event from a hazard-mapping perspective, dynamic simulation tools can reproduce avalanches of this type, at least in terms of overall runout length. Reproducing velocity along the path, and particularly the spatial distribution of deposited debris, remains more challenging. As usual, reliable simulation results depend on an accurate definition of model parameters and release areas. In our case, field observations were critical for constraining these inputs.

While well-instrumented scientific observations of avalanche activity (e.g., Gauer and Kristensen, 2016; Sovilla et al., 2024; Steinkogler et al., 2014) provide an important basis for numerical model validation and development, simple field observations of naturally occurring avalanches can provide valuable additional cases for testing and refining model parameters and modelling approaches.

Although the forces generated by a shallow avalanche such as those considered here may not be sufficient to cause structural damage to a sturdy building, these avalanches are nevertheless relevant for hazard mapping under Norwegian regulations (TEK17) when considering the hazard to people in the affected area. The pressure generated by such avalanches can be sufficient to cause considerable harm to people in open terrain. In this sense, shallow avalanches with relatively long runouts may be more relevant to human safety than their limited release volumes and shallow crown depths might suggest (e.g. https://www.framtidinord.no/nyheter/n/KzA2Ey/ingen-skadet-da-skred-traff-hus-paa-arnoey).

ACKNOWLEDGEMENTS

Parts of this study were conducted within the NGI project Applied Avalanche Research in Norway (AARN), funded by the Norwegian Ministry of Petroleum and Energy through a grant administrated by the Research Council of Norway (RCN project no. 359890). MS wants to acknowledge that parts of his contribution were financed by Wyssen Avalanche Control.

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