WSL-Institut für Schnee- und Lawinenforschung SLF
WSL Institut pour l'étude de la neige et des avalanches SLF
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# Avalanche Bulletin Interpretation Guide

Edition September 2023

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# Avalanche Bulletin Interpretation Guide

Edition September 2023

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Cover: Powder avalanche (Photo: J. Rocco)

# Content

# The avalanche bulletin

The WSL Institute for Snow and Avalanche Research SLF uses the avalanche bulletin and various supporting products to inform the public about the current snow and avalanche situation in the Swiss Alps and in the Jura. The content of the avalanche bulletin is designed as an informed warning. It is published one to two times a day in winter and primarily contains a forecast of the avalanche danger in the Swiss Alps, Liechtenstein and, when there is sufficient snow cover, the Jura as well.

Additional information about the weather's effects in terms of avalanches and the condition of the snowpack gives users a clearer picture of the current situation and provides a basis for making their own assessment, as the information provided the avalanche bulletin cannot take the place of their own local on-site assessment. The information contained in the bulletin is too general for this because of the limited data it is based on.

## Target audience

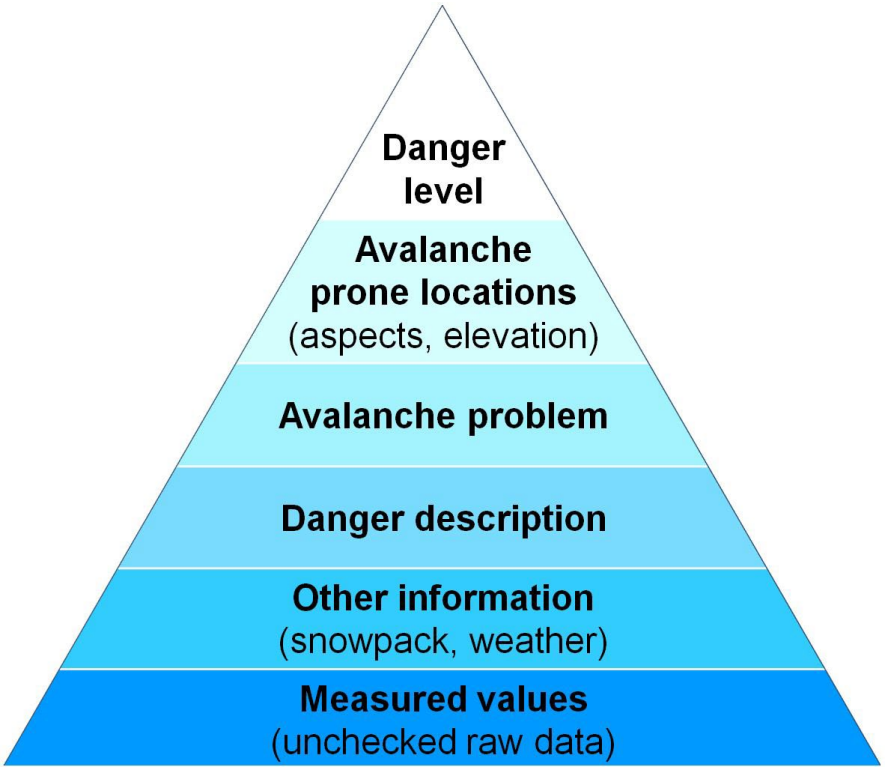
The avalanche bulletin is aimed at all those who are exposed to potential avalanche danger in the mountains in winter, whether in a professional or recreational capacity, and those who are responsible for the safety of others. This includes members of the following groups:

- Avalanche services and committees of the communal authorities and civil engineering offices, as well as the safety services of the mountain railway/cableway operators
- The police and rescue services and the armed forces
- Mountain guides, snow sports instructors and backcountry tour guides
- Residents of mountain villages
- Winter sports enthusiasts away from secured ski runs, such as freeriders, backcountry skiers, snowshoe hikers, mountaineers and ice climbers

When the snow and avalanche situation is relatively favourable, the avalanche bulletin will mainly contain information for winter sports enthusiasts. From danger level 3 (considerable) upwards, information for the avalanche warning services is issued more frequently. At the very high avalanche danger level (level 5), when snow sports are hardly possible anyway, the avalanche bulletin will mainly contain information for the avalanche warning services.

## Structure of the avalanche bulletin

In high season the structure of the avalanche bulletin is based on the 'information pyramid', i.e. the most important comes first (danger level), followed by details of the locations where the danger level applies and then the avalanche problem, the danger description and information about the snowpack and the weather. Finally, measured data can also be displayed. The use of standardized terminology aids both understanding and implementation.




*The most important areas appear at the top of the information pyramid and come first in the avalanche bulletin. Moving down the pyramid, for each level the information becomes more detailed.*

## Individual parts of the avalanche bulletin

The avalanche bulletin consists of a zoomable hazard map, including a hazard description and a section headed "Snowpack and weather". A description of this content is given below. In the off-peak periods and during large snowfalls in summer, the avalanche warning service usually has less information available than in winter. Then the avalanche bulletin is less detailed, and areas with danger level 1 (low) are usually not described.

### *Avalanche danger*

The avalanche bulletin's most important component is its avalanche danger forecast. This comprises the following aspects:

### *Danger level and avalanche prone locations*

The danger of dry and wet avalanches is assessed separately. The danger level indicated is based on the five-point European avalanche danger scale. When there is a moderate or higher danger of dry avalanches (starting at level 2), the points on the scale are also subdivided (-, =, +). In most cases, the endangered aspects and altitude zones are pinpointed as well. If such information is not given, the indicated danger level applies to all aspects and altitude zones. Warning regions are grouped together whenever an identical danger level (in identical aspects

and altitude zones) applies, provided that the avalanche problems are also the same and the dangers can be described appropriately for all the affected regions. The danger description may contain additional information concerning terrain types that are particularly affected.

On the danger map, the maximum expected danger level is shown for each warning region (maximum of dry and wet danger). If the danger level is likely to change during the day, the danger level is normally based on the situation in the morning. In typical springtime conditions, two maps show both the more favourable morning situation and the more unfavourable situation in the afternoon (double map).

### *Avalanche problems*

Often the avalanche danger is classified as falling under one or more of the five 'typical avalanche problems'. Normally the avalanche bulletin assigns the situation to one or more of these categories. The following problems are distinguished:

Dry-snow avalanches

- New snow (considerable snowfall in recent days)
- Wind slabs (snow transported by the wind)
- Old snow (weak layer(s) prone to triggering within the old snowpack)

Wet-snow avalanches

- Wet snow
- Gliding snow

If there is no conspicuous avalanche problem (often when a low avalanche danger (level 1) applies), the situation is described with the text "no distinct avalanche problem".

### *Danger description*

There is a specific danger description for each danger region marked on the map, with the danger of dry and wet avalanches being described separately. The danger description reflects the conditions in the altitude zones and aspects where the danger level applies. Outside these altitude zones and in other aspects it can be assumed that a fundamentally similar, but more favourable, avalanche situation exists. In other words, the avalanche prone locations are likely to be found less frequently in these places. Among other factors, the danger description can contain information concerning the likelihood of release and the size of the anticipated avalanches or relating to the snowpack structure. If necessary, remarks or recommendations for individual groups of users are also provided.

## Snowpack and weather

This part of the avalanche bulletin is only updated in the evening and is made up of the following parts:

### *Snowpack*

The snowpack is the principal determining factor in the formation of avalanches. A general description is given, usually covering both the layering of the snow and the stability. While snow layering is determined by the stratification of the snowpack and the structural properties of its individual layers (grain shape and size, hardness). The snow layering is crucial to snowpack stability. This section also describes the observed avalanche activity if applicable.

### *Weather*

The weather affects the snowpack and therefore how the avalanche dangers develop. Key factors for avalanche danger such as fresh-fallen snow (or rain), air temperature and wind are set out. The description begins with a review of the weather conditions in the immediately preceding period (covering at least the current day), which is followed by the forecast for the validity period of the avalanche bulletin. The danger assessment is formulated on the basis of this weather forecast. If locally the weather until that time has deviated from that described or the actual weather pattern differs from the forecast, this may also affect the anticipated avalanche danger.

### *Outlook*

Based on the medium-term weather forecast, the indicative outlook evaluates the general pattern of the avalanche danger for the two days (in summer and in off-peak periods possibly only one day) immediately after the bulletin's validity period.

## Recommendations

In addition to the danger assessment, the avalanche warning service frequently also issues recommendations. These are generically defined in the danger scale but can also form part of the danger description and be addressed to specific groups of users. These are of course recommendations, not rules. After making his or her own evaluation of the situation on site, the decision as to how to respond to the avalanche danger and what risks he or she is willing to take rests with each individual.

Recommendations for transport routes and settlements are sent to those responsible for the cantonal and communal avalanche warning services, roads, railways, mountain railways/cableways and secured ski runs. 'Safety measures' include avalanche blasting, closure of transport routes, slopes or ski runs, or, in particularly critical conditions, searching for shelters or evacuation routes from individual locations or entire community zones. The safety measures to be taken in a specific situation vary from case to case and are determined by those responsible for public safety.

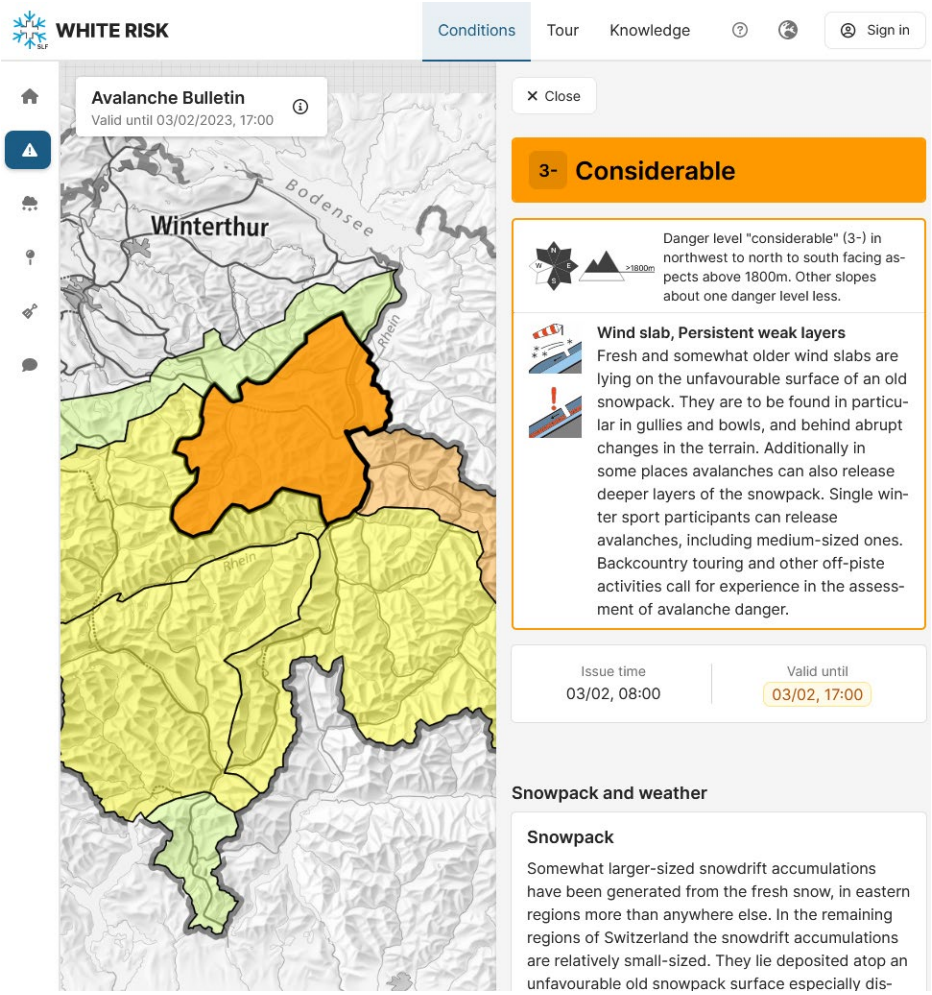
Recommendations for individuals outside secured areas are especially aimed at snow sports enthusiasts away from secured ski runs, for example freeriders, backcountry skiers, snowshoe hikers, ice climbers and mountaineers. 'Conditions' refers solely to avalanche danger, not to the amount of snow, snow conditions (powder snow, breakable crust) or weather conditions (fog, storm) even if these may sometimes pose a potential threat. 'Experience' always means experience in assessing avalanche danger. This is ideally acquired under expert guidance, e.g. in avalanche courses or on guided backcountry tours or off-piste activities.

# Products

## Avalanche bulletin

The hazard map is zoomable. Clicking the map highlights the corresponding regions and opens a window containing the relevant danger description and the text on Snowpack and weather. The hazard map and danger descriptions are issued at 5 pm and, depending on the avalanche situation during the winter, updated at 8 am (see “Publication times and validity”).

The description of snowpack and weather as well as the tendency for one or two following days refers to all of Switzerland and is only updated in the evening.



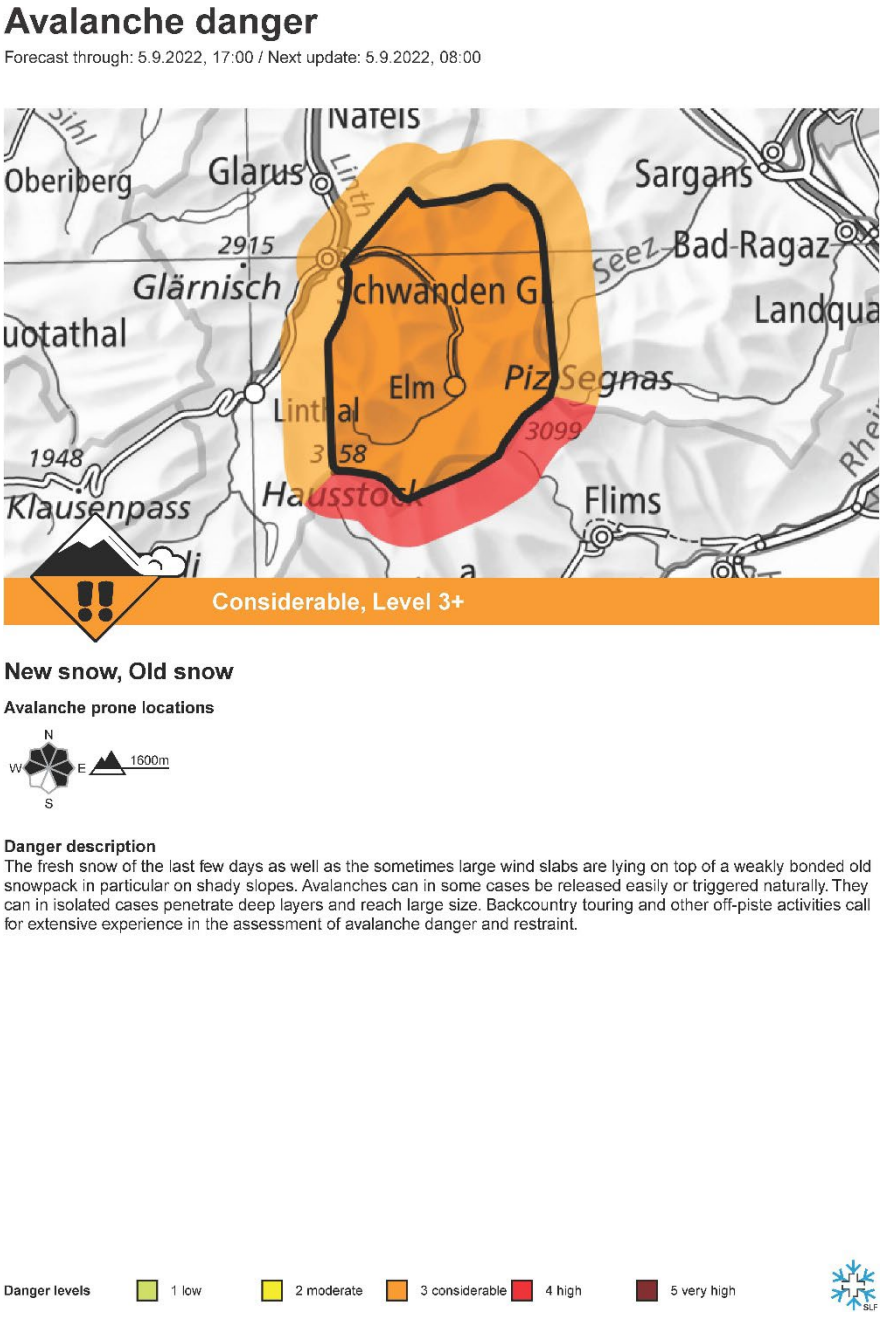

*Hazard map showing a highlighted region and the applicable danger description: For each danger, one or more avalanche problems are indicated, in this case for example "New snow" and "Old snow". "Snowpack and weather" will appear in German at 5 p.m. and in the other languages by 6 p.m. at the latest.*

### Print versions of the avalanche bulletin

Two versions of the Avalanche Bulletin are available in .pdf format for printing:

- Full avalanche bulletin
- Regional hazard maps: Hazard map of a warning region with the danger description, but without "Snowpack and weather". Ideal for display in freeriding regions.

The avalanche bulletin in .pdf format can also be obtained from the archive.



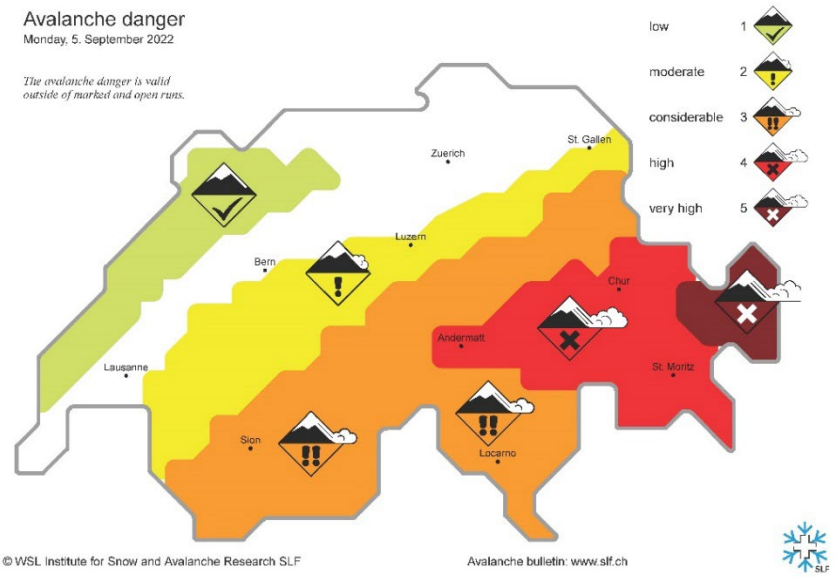

*Example of a print product: Regional hazard map for the warning region Southern Glarus-Sernftal.*

## Icons

Icons provide an initial overview of the avalanche danger.

### Icon map

An icon map is a generic hazard map showing only the danger level. If separate hazard maps have been published for the morning and for the afternoon (double map), there will still only be one icon map, indicating the highest danger facing each danger region.




*An icon map is a generic hazard map showing only the danger level.*

| Danger level | Icon |
|---|---|
| 5 Very high | |
| 4 High | |
| 3 Considerable | |
| 2 Moderate | |
| 1 Low | |
| No danger level | |

*Icons for the various danger levels are standardized throughout Europe.*

## Supporting products

In addition to the avalanche bulletin, the SLF publishes numerous supporting products, such as snow maps, measurements recorded at snow stations, the AvaBlog and winter reports. These are described under the relevant product headings.

# Media used

The SLF uses various media to provide information on the current snow and avalanche situation in Switzerland and Liechtenstein.

### Internet

The SLF operates the website www.slf.ch and publishes all information on the current snow and avalanche situation, background knowledge on avalanche awareness and tools for touring at www.whiterisk.ch. If you also want to use the tour planning part, you have to register and can buy a licence.

Other content such as the archive or knowledge about the avalanche bulletin (interpretation aid) can be found at www.slf.ch.

### App

With the SLF's free White Risk app, information on the current snow and avalanche situation can be accessed quickly and conveniently while on the move. Push alerts notify you of unscheduled bulletins (an additional bulletin in the winter, an avalanche bulletin in summer as a result of the situation) and other important information relating to the avalanche bulletin. The app also contains background knowledge on avalanche awareness and tools for on the go. If you also want to use the tour planning part, you have to register on the internet and can buy a licence (www.whiterisk.ch).

The app is available in four languages (German, French, Italian and English) from the iTunes App Store (for iPhone) or Google Play Store (for Android).

### Radio

In the winter months, SRF 1 broadcasts interviews about the avalanche situation at 4:50 pm each day. Such interviews are also broadcast on many other radio stations in particular just prior to the weekend or in case of increased avalanche danger. In Italian-speaking Switzerland the interviews are organised in cooperation with MeteoSwiss.

### Television

SRF 1, SRF info, RTS, RSI: During each channel's weather forecasts shortly before or shortly after 8 pm. Often on Fridays, but occasionally on other days as well. In particular when there is an increased avalanche danger.

### Natural Hazards portal

The MeteoSwiss app and www.natural-hazards.ch provide an overview of the natural hazards situation in Switzerland. They show the danger levels for all the natural hazards for which warnings are issued (rain, thunderstorms, floods, snow, avalanches, heat wave, frost, slippery roads, wind, forest fires, earthquakes) and provide general information about the individual hazards and how to respond to them. The information for this is supplied by the Swiss federal government's natural hazard agencies, namely the Federal Office of Meteorology and Climatology (MeteoSwiss), the Federal Office for the Environment (FOEN), the WSL Institute for Snow and Avalanche Research SLF, and the Swiss Seismological Service (SED).

### Social media

The avalanche warning service posts messages on Instagram, Facebook and X (Twitter) with the identifier ***whiteriskslf***. The posts complement the information published at slf.ch and at WhiteRisk, but do not replace it.

You can help us to process information methodically and quickly by reporting observations relating to the avalanche situation or accidents not via social media, but with the WhiteRisk app or by way of our website.

# Publication times and validity

## Winter and spring

As a general rule, the avalanche bulletin is published daily at 5 pm and consists of the following parts:

- Forecast of the avalanche danger (hazard map and danger description) for the period until 5 pm the next day (in four languages).
- Description of the snowpack and weather in German, valid until 5 pm the next day. The translations (into French, Italian and English) are available by 6 pm at the latest.

In the winter months in particular, the avalanche danger forecast is updated at 8 am (in four languages) when the evening bulletin indicates danger level 3 (considerable) or higher anywhere in Switzerland. If the highest forecast danger level was 2 (moderate), the publication of a morning update depends on the actual situation. Morning bulletins are usually announced in the previous evening's bulletin.

In principle, an assessment of the avalanche danger can also be issued at other times and without prior notice, but this happens only on rare occasions.

## Summer and autumn

From early summer until autumn, avalanche bulletins are published in case of heavy snowfall, and in late autumn at other times as well if the snow cover warrants it. As in this period the volume of on-site data available is less than in mid-winter, these bulletins are less detailed and shorter.

The criteria for the publication of a summer avalanche bulletin are met if the forecast depth of fresh-fallen snow per precipitation occurrence (normally 1 – 3 days) reaches one of the following values:

- 40 cm at 2500 m or
- 60 cm at 3000 m or
- 80 cm at 3500 m

These values are only intended as a guideline. Whether a bulletin is actually published also depends on the wind, the temperature and the spread and characteristics of the existing snowpack. Furthermore, the snowfall event must affect at least one whole massif; local snow flurries caused for example by individual thunderstorm cells do not count towards this.

# Resources

The avalanche warning service has a wide range of data at its disposal, including measurements, observations, assessments and model results. Only the interplay between them ensures that the avalanche bulletin is as reliable as possible in all the different situations that can occur.

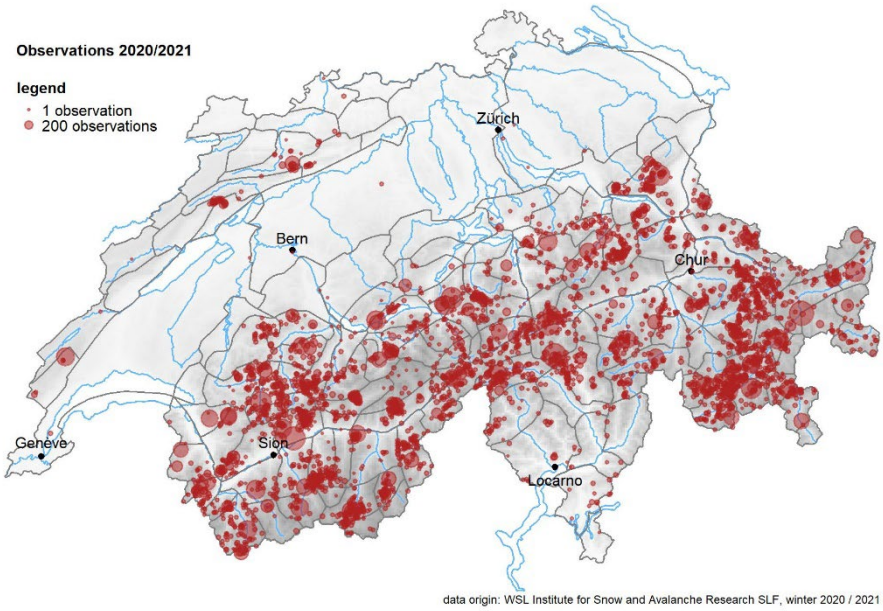
## Measurements

With a view to producing the avalanche bulletin and also for climatological and hydrological purposes, the SLF operates an extensive network of measuring stations. This is set out in more detail on the pages for the current measured values.

## Observations and assessments

Current field data are required to ensure that users can rely on the bulletins, which is why the SLF maintains its own network of observers. The official observers are trained by the SLF, report regularly on their findings and get paid for their reports. Different data may be collected depending on the situation, including for example estimates of fresh-fallen snow and fresh snowdrift, observed alarm signals and avalanches and often also an assessment of the current avalanche danger.

Additional information comes from local safety services, rescue organisations and the police and also of course from winter sports enthusiasts.




*Reports to the avalanche warning service from the field, here using the example of winter 2020/21. The large circles indicate where daily observations were reported. Only a small number of observations originate in the high Alpine regions, the Prealps and the regions south of the main Alpine ridge. In these places the avalanche situation should be examined especially thoroughly in the field (see "Capabilities and limitations of the avalanche bulletin").*

### SLF observers

Some of the SLF observers generally file their reports from one and the same region, which is usually the place where they live or work. Some of these perform measurements at a measuring site as well as providing observations. If possible, these observers report their findings daily throughout the winter, thereby providing basic data coverage for the area in question. The reports are submitted between 6 and 8 am, or in the middle of the day.

### Mobile SLF observers

Other SLF observers move freely within the territory of the Swiss Alps. They submit their reports whenever they have information of interest from their respective location.

### Public reporting

The extent of the Swiss Alps and regional differences mean that the official observers can never cover everything. As a result, the avalanche warning service also relies on reports from private individuals. Therefore, we would like to encourage everyone to submit their own observations – thank you very much!

Time permitting, the avalanche forecasters also search other platforms such as www.bergportal.ch and www.camptocamp.org for avalanche information.

### Avalanches

In addition to the avalanches reported by the observers, avalanche accidents are reported by the rescue services. Furthermore, avalanche maps of various skiing areas and the data from automatic avalanche detection systems are available to the members of the avalanche service.

### Snow profiles and stability tests

Layering and snowpack stability have a major impact on the avalanche danger but are difficult to ascertain. To address this, at the start and middle of the month specially trained SLF observers spread across the Swiss Alps. Each produces around 40 flat-field profiles at set measuring sites and also some 40 slope profiles, using for example stability tests ('Rutschblock' tests) on representative test slopes. The most recent profiles are made available to the public at www.slf.ch, whiterisk.ch and on the White Risk app in the "Snow maps" section.

## Weather forecasts (weather models and edited forecasts)

An avalanche danger forecast is also always based on a weather forecast. Among the products available to the avalanche forecasters to evaluate the short-term weather outlook are:

MeteoSwiss's COSMO 1E and COSMO 2E meteorological forecasting models;

- the European Centre for Medium-Range Weather Forecasts' ECMWF meteorological forecasting model;
- Models of the SLF's operational snow-hydrological service (OSHD).
- various edited weather and precipitation forecasts from MeteoSwiss;
- additional products from other suppliers if need be.

The members of the avalanche warning service are also in regular contact with the forecasters from MeteoSwiss and SRF Meteo, meaning that difficult situations can also be discussed individually at any time.

### Snowpack models

SNOWPACK, the snowpack model devised at the SLF, can be used to draw conclusions about the snowpack based on meteorological data. Alongside other applications, SNOWPACK is used to continuously model the snow layering at every IMIS snow station site throughout the winter. These outputs are used operationally by the avalanche forecasters, for instance to determine the depth of fresh-fallen snow or, when the snow is melting, to forecast wet-snow avalanches. In addition, SNOWPACK and other models form the basis of numerical forecast models constructed using machine learning techniques. Such models have been helping the avalanche forecaster to make their operational assessments since the winter of 2021/22.

### Information in border areas

Avalanche danger transcends national borders. To facilitate a better assessment in border regions, information is regularly exchanged with the neighbouring countries' avalanche warning services. The avalanche forecasters also play an active role in the European Avalanche Warning Services (EAWS) association – also see www.avalanches.org.

## Capabilities and limitations of the avalanche bulletin

The avalanche bulletin features a forecast of the avalanche danger. However, the very nature of forecasting means that the predictions made may prove to be incorrect. While the SLF makes every effort to ensure the accuracy of the website content and information and the White Risk app, it cannot accept any liability for the correctness and completeness of this content and information.

Avalanche danger means mortal danger! Using the information provided by the SLF does not relieve users of their obligation to assess the avalanche situation for themselves on the ground and to act accordingly – see the disclaimer on www.slf.ch, www.whiterisk.ch and the White Risk app.

### Scope

The avalanche bulletin only reports on conditions in outlying, unsecured terrain, i.e. away from the zones secured by mountain railways/cableways or safety services and away from secured ski runs and pistes.

#### Independent assessment

The bulletin only uses general formulations. It cannot assess local conditions and certainly not individual slopes. The correlation that exists between the regional danger level, possible avalanche activity and the relevant consequences (and any action that needs to be taken) must be determined locally by individual users of the bulletin. In this context, snow sports enthusiasts and safety personnel will also need to rely on their own assessment procedures. Such procedures include local weather, snow and avalanche observations; snowpack analyses; examining maps; on-site slope assessment; and individual risk considerations. The safety services may also have access to the results of artificial triggerings of avalanches. All the available information should be taken into consideration before making a decision. Particular attention should be paid to information indicating unstable conditions.

As a rule, the avalanche bulletin indicates the areas (altitude zone and aspect) to which the forecast danger level applies. Any variances, typically concerning the altitude zone or aspect,

have to be additionally determined by the user in the field. Remarks relating to conditions in the high Alpine regions, the Prealps and regions south of the main Alpine ridge demand special scrutiny because in most instances, compared to the data on intermediate and high altitudes in other regions, less information is available in these places. Especially careful consideration is also needed when the weather situation is changing rapidly, because the avalanche bulletin is not always able to describe emerging spatial and temporal variations in the avalanche danger adequately.

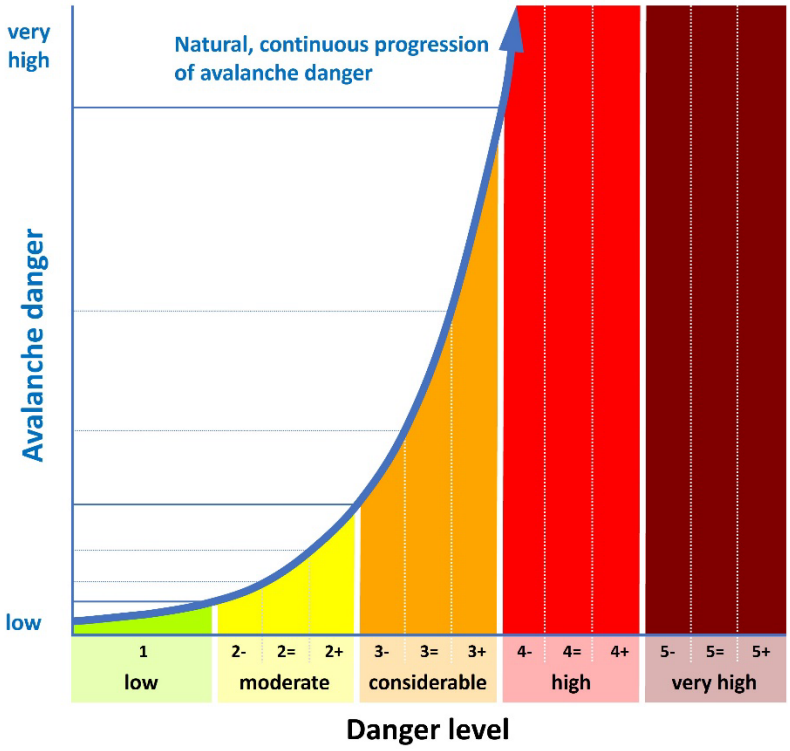
**Reducing the risk with adjustments to behaviour**

Avalanches frequently do not occur by chance, and winter sports enthusiasts away from secured ski runs are usually affected by these as a result of their own behaviour rather than providence. Most avalanche accidents are caused by slab avalanches that are triggered by the victims or members of their group. Every avalanche, even a minor snowslide, can be dangerous. Caution is needed not only in view of the danger of being buried but also because of the injuries avalanches can cause and the danger of being swept along and falling. Ultimately, individual behaviour is crucial to the risk. Defensive behaviour, tailored as closely as possible to the specific situation, reduces the risk. Away from secured ski runs and areas, the following points need to be borne in mind in the mountains in winter:

1. Education and experience: Education and training in avalanche danger assessment, e.g. in the form of avalanche courses, offered by a very wide range of organisations for a variety of education levels. Apart from education, experience in assessing the avalanche danger is essential.
2. Information on the current avalanche danger: Besides the most recent avalanche bulletin and the various supporting products offered by the SLF, which will serve as a basis, personal observations and sometimes also local information from for example mountain railway/cableway operators, mountaineering schools and refuge wardens can provide important information on the avalanche danger.
3. Emergency equipment: An avalanche transceiver, a shovel and a probe are considered standard equipment, and an avalanche airbag is recommended. So that this equipment can be deployed in the midst of the stress of an accident, its appropriate use must be practised on a regular basis. Other important items of equipment are a mobile phone, a pocket first-aid kit and, depending on the situation, a helmet.

# Danger levels

The SLF uses the five-level European avalanche danger scale to denote the avalanche danger. However, in reality the avalanche danger changes gradually. This means there is a range within each level. The subdivisions allow the unfolding danger situation to be tracked more accurately. The avalanche warning service communicates with it where within the range it assesses the current danger.




The danger level depends on a range of variables, in particular the snowpack stability, i.e. the probability of an avalanche triggering; the prevalence of avalanche prone locations; and potential avalanche size. The probability of an avalanche triggering increases sharply as the danger level rises.

A danger level always applies to one region and cannot reflect the peculiarities of a specific individual slope. In addition, the danger level stated in the Avalanche Bulletin is always a prediction and should be evaluated on-site.

## Avalanche danger scale

### Short version

| *Danger level* | *Characteristics* | *Recommendations for backcountry recreationists* |
|---|---|---|
| **5**<br>very high | **Extraordinary avalanche situation**<br>Numerous very large and extremely large natural avalanches can be expected. These can reach roads and settlements in the valley. | You are advised not to engage in winter sports beyond open ski runs and trails.<br>Very rarely forecast.<br>Around 1 % of avalanche fatalities |
| **4**<br>high | **Very critical avalanche situation**<br>Natural and often very large avalanches are likely. Avalanches can easily be triggered on many steep slopes. Remote triggering is typical. Whumpf sounds and shooting cracks occur frequently. | Stay on moderately steep terrain. Heed runout zones of large avalanches. Unexperienced persons should remain on open ski runs and trails.<br>Forecast only on a few days throughout the winter.<br>Around 10 % of avalanche fatalities. |
| **3**<br>considerable | **Critical avalanche situation**<br>Whumpf sounds and shooting cracks are typical. Avalanches can easily be triggered, particularly on steep slopes with the aspect and elevation indicated in the avalanche bulletin. Natural avalanches and remote triggering can occur. | The most critical situation for backcountry recreationists. Select best possible route and take action to reduce risks. Avoid very steep slopes with the aspect and elevation indicated in the avalanche bulletin. Unexperienced persons are advised to remain on open ski runs and trails.<br>Forecast for around 30 % of the winter season.<br>Around 50 % of avalanche fatalities. |
| **2**<br>moderate | **Mostly favourable avalanche situation**<br>Warning signs can occur in isolated cases. Avalanches can be triggered in particular on very steep slopes with the aspect and elevation indicated in the avalanche bulletin. Relatively large natural avalanches are not to be expected. | Routes should be selected carefully, especially on slopes with the aspect and elevation indicated in the avalanche bulletin. Travel very steep slopes one person at a time. Pay attention to unfavourable snowpack structure (persistent weak layers, old snow problem).<br>Forecast for around 50 % of the winter season.<br>Around 30 % of avalanche fatalities. |
| **1**<br>low | **Generally favourable avalanche situation**<br>No warning signs present. Avalanches can only be triggered in isolated cases, in particular on extremely steep slopes. | Travel extremely steep slopes one person at a time and be alert to the danger of falling.<br>Forecast for around 20 % of the winter season.<br>Around 5 % of avalanche fatalities. |

### Full description of the European avalanche danger scale

This scale, introduced by the European Avalanche Warning Services on winter 1993/94, defines the danger level based on the snowpack stability and the avalanche triggering probability. The full description of the scale also includes other columns that have not been internationally agreed relating to typical characteristics, recommendations and consequences.

European Danger Scale with recommendations and additions: see annex.

## Subdivisions

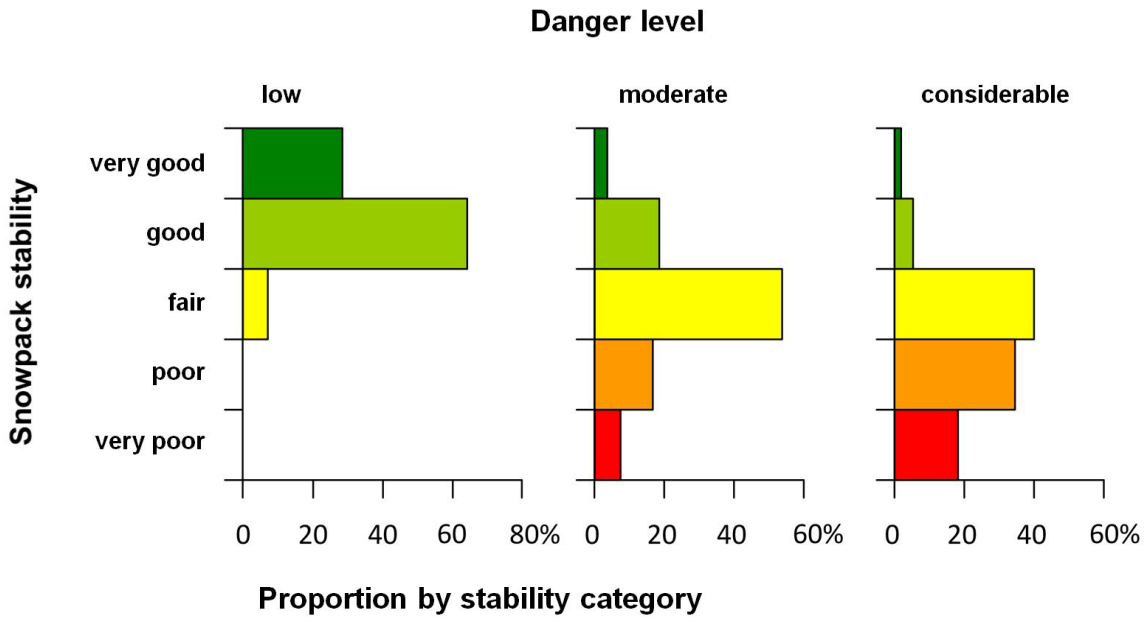
When there is a moderate or higher danger of dry-snow avalanches (starting from level 2), the SLF subdivides the points on the European avalanche danger scale. These subdivisions indicate whether the danger is estimated to be towards the bottom end (-), more or less in the middle (=) or towards the top end (+) of the forecast level.

## Danger levels – a simplified picture of reality

The avalanche danger does not increase in linear fashion from one level to another, but disproportionately. As the danger level increases,

- snowpack stability, and therefore the additional load required to trigger an avalanche, decreases.
- the frequency of avalanche prone locations increases. In other words, there are more places where avalanches can release naturally or be triggered.
- avalanche size increases as well, in particular when the danger level is at the higher end of the scale.

If the additional load required to trigger an avalanche decreases and there are also more locations where avalanches can be triggered, the avalanche triggering probability increases. This is also shown by the stability distribution in the chart below.




*Snowpack stability for danger level 1 (low) to level 3 (considerable). Even at level 2 (moderate) there are locations with poor or very poor stability. As the danger level increases, so does the proportion of locations with poor stability.*

In a typical case, all these influencing variables change as indicated above. This means that in the case of 'low' avalanche danger, usually only small avalanches are triggered in just a few locations and mostly only due to a high additional load, while in the case of 'high' avalanche danger, a lot of avalanches, some of them very large, are triggered or are released naturally (without human influence).

However, there are also atypical situations that do not fit into this picture. These are detailed in the next section.

## Various characteristics of avalanche danger

Also, in the case of less typical avalanche situations the danger level is a measure of the order of magnitude of the avalanche danger. These situations are detailed below along with information about their assessment by the avalanche warning service. As these are atypical situations, no list can ever be exhaustive. In atypical situations deviations from the danger level definition are inevitable. These are set out as far as possible in the avalanche bulletin's danger description.

### Faceted-crystal snowpack

In the case of low avalanche danger (level 1) the snowpack is normally well bonded and stable. However, after long periods of fine weather with shallow snow, another form of snow occurring in mid-winter which makes slab avalanches virtually impossible is the whole snowpack being loose and transformed into faceted crystals. The snowpack is then very weak and there are also weak layers, but the bonded layer on top (the 'slab') is lacking. With no bonded layer a fracture cannot be propagated, meaning that there is no possibility of a slab avalanche forming. This means there is a low avalanche danger (level 1), despite or precisely because of the very loose snowpack. 'Stable snowpack' means 'not liable to trigger slab avalanches' and does not refer to the hardness of the layers.

This situation is not a good omen for the immediate future, given that as soon as it is snowed on, the fresh-fallen snow and fresh snowdrift result in the creation of a 'slab' where one did not exist before. Underneath this is the loose old snowpack in the form of a substantial weak layer. The avalanche danger will increase significantly, generally resulting in a long-lasting old-snow problem.

### Small, easily triggered snowdrift accumulations

Fresh snowdrift accumulations can often be triggered by individual winter sports enthusiasts. The size of the snowdrift accumulations depends not only on the wind but also on the supply of fresh and old snow which can be transported. For only little snow which can be transported, the snowdrift accumulations are usually so small that getting buried by them is unlikely. In this case, level 2 (moderate) is often used despite the high probability of an avalanche release. In such situations the snowdrift accumulations can usually be seen in good visibility by the trained eye. They need to be avoided especially on terrain where there is a danger of falling.

### Old-snow problem with a significant weak layer deep down in the snowpack

The more thickly a weak layer is covered, the more difficult it becomes for a fracture to form there. This is most likely to occur in locations where the snow is relatively shallow or in transitions from shallow to deep snow. In the case of an old-snow problem with a significant weak layer deep down in the snowpack, avalanche prone locations are usually relatively rare.

However, avalanches often reach large size, and are therefore particularly dangerous for winter sports enthusiasts. Therefore, the avalanche danger in the case of an old snow problem can sometimes be considerable (level 3) even if the avalanche prone locations are fairly rare. An aggravating factor is that the avalanche prone locations are barely recognisable in old snow situations, even to the trained eye. In the case of weak old snow, more fatalities can be expected than in the case of the other avalanche problems (at the same danger level).

**'Skier high'**

If numerous large and, in many cases, very large-sized natural avalanches can be expected, the avalanche danger is classified as ‘high’ (level 4). In these circumstances, exposed objects (mostly sections of transportation routes, but also buildings in isolated cases) can be endangered. Alongside this classic ‘road high’ situation there is a further variant of this danger level when, even though very large avalanches are unlikely to occur, there are a lot of places where people can very easily trigger medium and large-sized avalanches. In many such cases, avalanches are released naturally as well. When this ‘skier high’ situation exists, those engaging in winter sports beyond the boundaries of marked and secured pistes are in acute danger. Transportation routes, in contrast, are either unaffected or affected only in isolated cases. When ‘skier high’ applies, the danger is usually described with the subdivision 4- or 4=; in the case of ‘road high’, any of the subdivisions can be used.

**Avalanche activity in case of wet and gliding snow**

Wet-snow avalanches are seldom triggered by people, and in the case of gliding avalanches this is virtually impossible. Therefore, natural triggering is the main cause of such avalanche types even in the when lower danger levels prevail. The maximum possible naturally triggered avalanche activity, based on the defined danger level, relates mainly to wet-snow and gliding-snow conditions and less to conditions involving dry avalanches. In this context large natural avalanches are possible when there is a moderate danger of wet-snow or gliding avalanches. In the case of a situation with dry-snow avalanches, such naturally triggered avalanche activity normally corresponds to a considerable avalanche danger, as then avalanches are also expected to be triggered by individuals.

## Change in the avalanche danger as the day progresses

The avalanche danger changes over time and may not reach or overshoot the boundary between one danger level and another within the period of validity of the avalanche bulletin. Ordinarily the danger increases, for example because snowfall or wind, significantly faster than it recedes again.

If the danger level is likely to change during the day, the level published in the avalanche bulletin and the danger description normally show the situation in the morning. The change (often an increase) is indicated in the danger description. Here are some examples:

- "The avalanche danger will increase and reach level 3 (considerable) in the afternoon." In this case, level 2 (moderate) is marked on the hazard map.
- "Danger level 4 (high) will be reached during the morning." In this case, level 4 (high) is marked on the hazard map.
- "As a consequence of daytime warming and solar radiation, wet-snow avalanches can be expected as the day progresses below approximately 2400 m."

If the avalanche danger is assessed to be level 4 (high) or even level 5 (very high) at night, and then one level lower during the day, the morning rule is deviated from. As when transport routes are endangered, the avalanche danger is also significant at night, the higher avalanche level that applies during the night is given in the evening edition. In the morning edition this is then reduced to the level applying in the morning.

**Double map**

In typical springtime conditions, the danger of wet-snow avalanches along with daytime warming and solar radiation will increase significantly as the day progresses. During the day the danger of dry-snow avalanches will usually only change slightly in these conditions. Thus, while in the morning dry-snow avalanches are the main danger, in the afternoon the main danger is posed by wet-snow avalanches. In this situation, two maps show both the more favourable morning situation and the unfavourable situation in the afternoon. The transition from one map to another cannot be pinned down to a specific time. It depends on the conditions and the altitude and also in particular the aspect. Whereas on east-facing slopes the danger of wet-snow avalanches will already increase during the morning, this usually occurs only later on west-facing slopes.

## Additional information

**Avalanche danger and risk**

The avalanche bulletin describes the avalanche danger, i.e. the likelihood of a release, the expected number and the possible size of avalanches in a specific region, but the exact timing of an avalanche being triggered and the actual length of its starting zone and fracture depth cannot be determined.

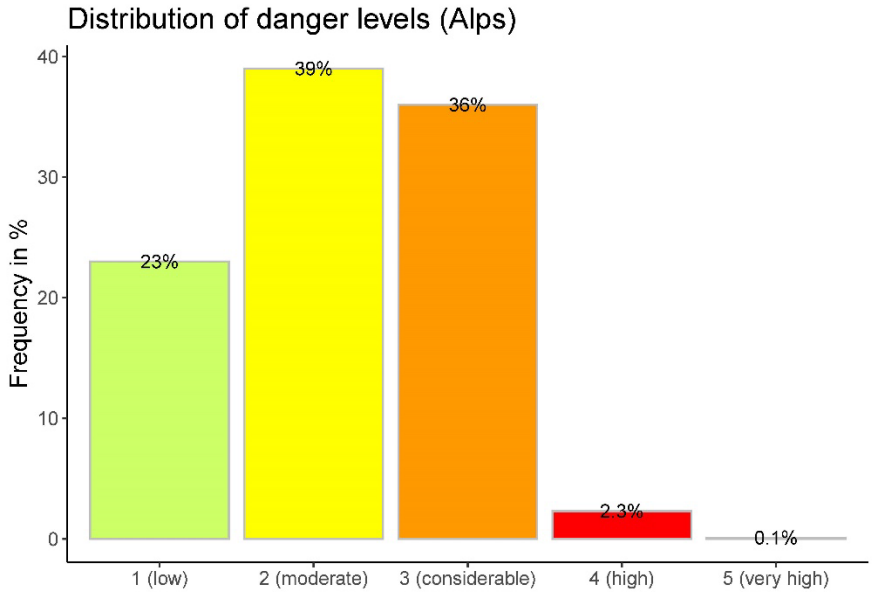
An avalanche danger only becomes a risk (i.e. a probability that damage will occur) if endangered individuals, animals, forest, infrastructure etc. are in the area of the potential avalanche. In the avalanche bulletin, the avalanche danger is assessed regardless of the presence of endangered individuals or objects, i.e. on weekends with fine weather and weekdays with poor weather alike, and for populated areas and outlying terrain alike.

If an avalanche is released somewhere on a glacier during a snowstorm, there would obviously be an avalanche danger, but there would be no risk if there were no people in the surrounding area. If the same avalanche is released on a popular touring route on a sunny weekend, the risk would be much greater. The danger given in the avalanche bulletin may be the same in both cases, but the risk will be different.

Avalanches are a very special natural hazard, since unlike flash floods or earthquakes the 'perilous process' of an avalanche can be initiated by human activity. If anyone comes onto a dangerous slope, the artificial additional load can trigger an avalanche. In the case of more than 90% of the snow sports enthusiasts buried by a slab avalanche, they triggered the avalanche themselves or it was triggered by another member of their group.

### Frequency of danger levels

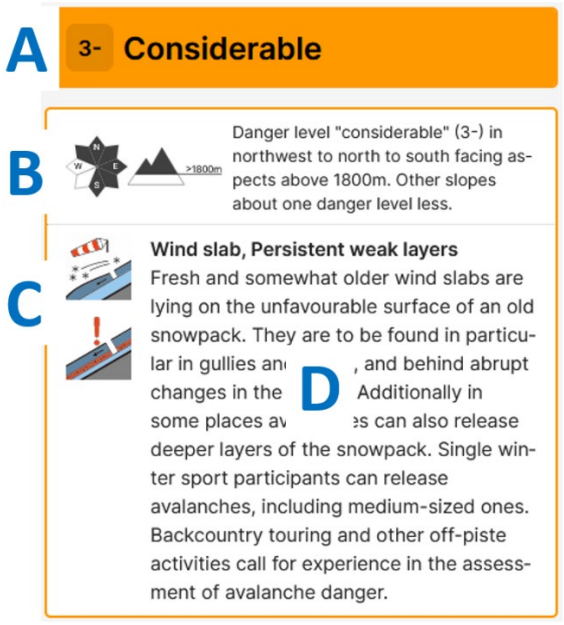
Danger level 2 (moderate) is forecast in the Alps on two out of five days in each warning region. It is the most frequently cited danger level and describes days on which the avalanche danger is about "average". Level 3 (considerable) is forecast on around one in three days. Danger level 4 (high) applies on just 2.2% of winter days on average, and level 5 (very high) is forecast only extremely seldom. In the Jura, the lower danger levels apply more frequently.




*Distribution of danger levels in the avalanche bulletin for the Alps (from 1 December until 30 April) for the winter of 2013/14 until the winter of 2022/23.*

# Typical avalanche problems

The danger description that forms part of the avalanche bulletin cites the predominant avalanche problems as well. The purpose of this is to focus attention on the main aspects. This practice capitalises on the human brain's capacity to recognise and interpret recurring characteristics. Each avalanche problem has a different cause and calls for a specific response tailored to the relevant situation.




*The description contains the following items:*

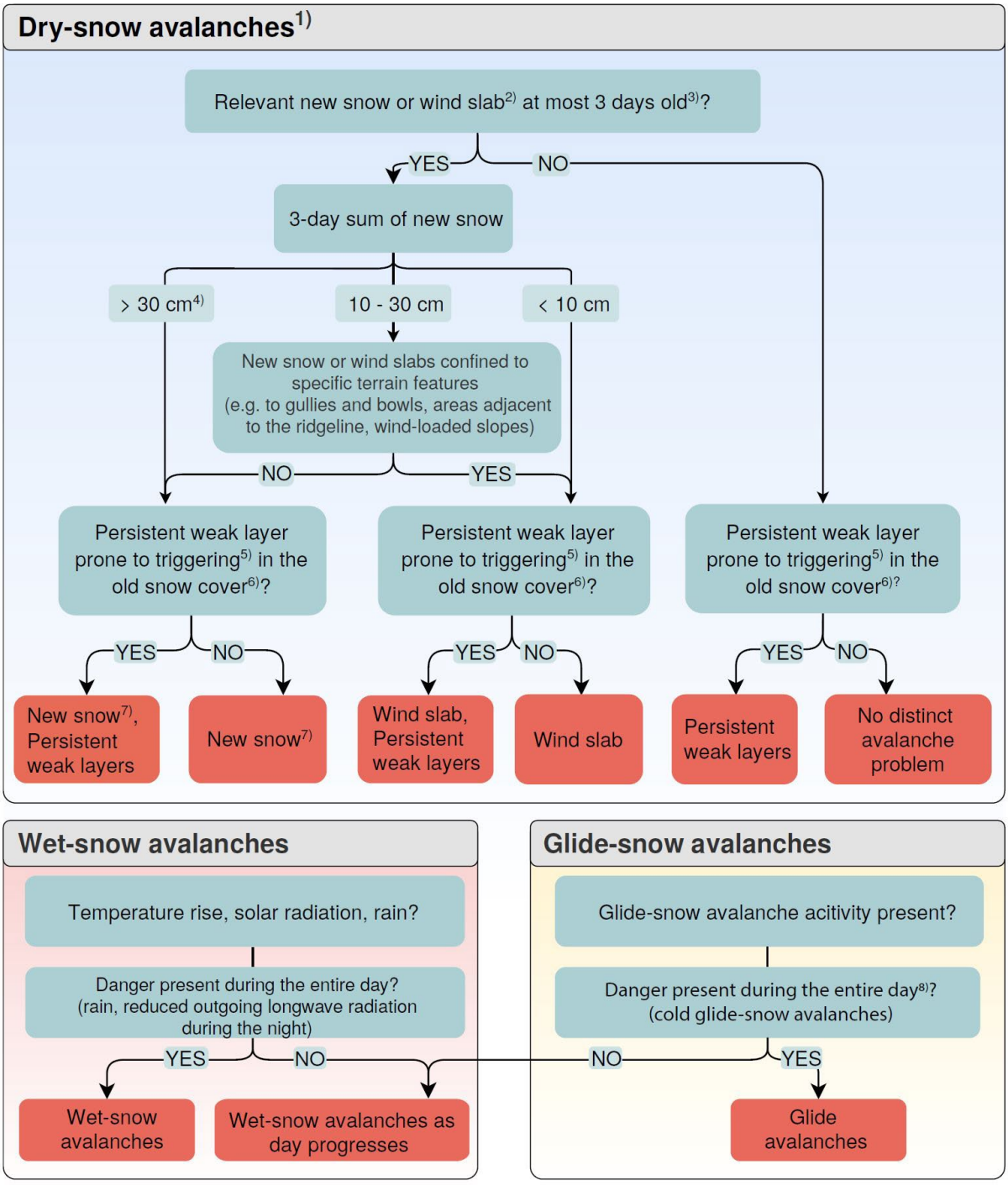
*A) Danger level ("How great is the avalanche danger?")*
*B) Avalanche prone locations ("Where is the danger particularly significant?" Here the danger level applies.)*
*C) Avalanche problems ("What is the main problem?")*
*D) Description ("What are the characteristics of the avalanche situation?")*

Several avalanche problems can occur together. Dry avalanche problems (new snow, wind slabs, old snow) and wet avalanche problems (wet snow, gliding snow) are assessed separately. The avalanche bulletin describes only avalanche problems contributing substantially to the overall danger.

The avalanche problems cited in the avalanche bulletin, and the criteria applied by the avalanche warning service when they are cited, are described briefly below.

## Determining the predominant avalanche problems

The currently predominant avalanche problems are determined using the decision-making tool illustrated below.




1) If in (generally) favorable situations it remains unclear which problem causes the main hazards, "dry-snow avalanches" is used.
2) Relevant layer of new snow or wind slab: The hazard caused by new snow or wind slab has to be equal or higher than the hazard from persistent weak layers.
3) The problem wind slab can prevail for more than 3 days if the wind slabs can still be released and are recognizable as such.
4) If the wind blows in gale-force (average speed > 100 km/h) during the snowfall, use the avalanche problems new snow and wind slab.

5) Criteria, if a weak layer is prone to triggering: The weak layer is at the failure layer of avalanches or identified in snow profiles/stability tests and within the first meter from the snow surface.
6) Weak layer is not at the interface between new snow or wind slab and old snow, so that in case of an avalanche, parts of the old snow release as well. (Otherwise new snow or wind slab is used, and the unfavorable old snow surface is described in the text).
7) If after the snowfall wind slabs were formed that contribute to the overall danger: both, new snow and wind slab are used.
8) Warm glide-snow avalanches (probability of triggering increases during the day) are attributed to the problem wet-snow avalanches as day progresses, because both require the same measures for risk management in the field.

# New snow

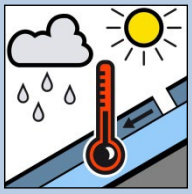
| | | | |
|---|---|---|---|
| What? | Characteristics | The avalanche problem is related to current or most recent snowfall. The amount of additional loading by new snow onto the existing snowpack is the crucial factor of the new snow problem. How critical the loading is, depends on various factors such as air temperature, wind or characteristics of the old snow surface. | |
| | Avalanche type and trigger | • Dry-snow slab avalanches<br>• Dry loose snow avalanches<br>• Natural and human triggered avalanches possible | |
| Where? | Spatial distribution | In general, a widespread presence and often on all aspects. | |
| | Position of the weak layer in the snowpack | *Dry-snow slab avalanches:*<br>Typically between new snow and old snow or within the new snow layers. Occasionally slightly below the old snow surface. In that case, the problem "persistent weak layers" additionally prevails. | *Dry loose snow avalanches:*<br>Start at the surface but the avalanche flow can erode deeper into the snowpack. |
| Why? | Release characteristics | Dry-snow slab avalanches:<br>Failure of newly-formed weak layers within the new snow or due to additional loading by snowfall on existing weak layers (old snow surface or below). | Dry loose snow avalanches:<br>Lack of cohesion between the new snow particles |
| When? | Duration | Typically during snowfall and up to a few days after. | |
| How to manage? | Identification of the problem in the field | The new snow problem is fairly easy to recognize since it affects most of the terrain but the characterization of the associated danger can be very tricky. Consider critical amounts of new snow and recent avalanche activity. | |
| | Travel advice | Dry-snow slab avalanches:<br>Wait until the snowpack has stabilized and the weak layer has gained strength. | Dry loose snow avalanches:<br>Danger of being carried away by small avalanches is more important than danger of burial.<br>Consider consequences in extreme terrain. |

# Wind slab

| | | |
|---|---|---|
| What? | Characteristics | Wind slabs are formed when loose snow in near-surface layers (new snow or old snow) is transported and deposited by wind. |
| | Avalanche type and trigger | • Dry-snow slab avalanches<br>• Natural and human triggered avalanches possible |
| Where? | Spatial distribution | Highly variable but typically on leeward slopes, gullies and bowls, near distinct changes in slope angle, behind ridgelines or other wind-sheltered locations. More common above treeline. |
| | Position of the weak layer in the snowpack | Typically between wind slab and old snow or within the wind slab layers due to variations in wind speed. Occasionally slightly lower in the old snowpack. In that case, the problem “persistent weak layers” additionally prevails. |
| Why? | Release characteristics | The wind slab is an additional load on a weak layer and builds a slab structure that is particularly prone to being triggered. |
| When? | Duration | The wind slab problem can evolve very quickly. The problem lasts typically during the snowdrift event and tends to stabilize within a few days following the storm cycle. |
| How to manage? | Identification of the problem in the field | If not buried by new snow, the wind slab problem can be recognized with training and good visibility. Consider wind signs and locate snow drifted deposits. Typical clues: snow drifted deposits, recent avalanche activity and sometimes shooting cracks or whumpfs. However, it is often hard to determine the age of snow drifted deposits and wind signs do not necessarily imply an avalanche problem (e.g. in absence of a weak layer). |
| | Travel advice | Avoid snow drifted deposits in steep terrain. |

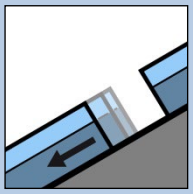
# Old snow (Persistent weak layers)

| | | |
|---|---|---|
| What? | Characteristics | The avalanche problem is related to the presence of one or more persistent weak layers in the old snowpack. These weak layers typically include faceted crystals, depth hoar or surface hoar crystals. |
| | Avalanche type and trigger | • Dry-snow slab avalanches<br>• Mostly human triggered avalanches; natural avalanches are rare, mainly in combination with other avalanche problems.<br>• Remote triggering is possible and crack propagation over long distances is common. |
| Where? | Spatial distribution | The avalanche problem can be widespread or quite isolated. It can exist in all aspects, but is more frequently found on shady, wind sheltered slopes. |
| | Position of the weak layer in the snowpack | In the old snowpack, often deeply buried. However, when deeply buried triggering is less likely, but avalanches may become large. |
| Why? | Release characteristics | Avalanche release occurs when loading exceeds the strength of the weak layer. |
| When? | Duration | Weak layers can persist for weeks to months; possibly even during most of the winter season. |
| How to manage? | Identification of the problem in the field | Persistent weak layers are very challenging to recognize. Signs of instability such as whumpfs are typical, but not necessarily present. Stability tests can be helpful to detect persistent weak layers. Knowledge of snowpack evolution is required and reference to the avalanche report is important. |
| | Travel advice | Travel conservatively and avoid terrain features (e.g. large steep slopes) where consequences of being caught are large (e.g. deep burial). Consider the history of weather and snow cover processes in the area. Be extra cautious in areas with a thin snowpack and at the transition from thin to deep snowpack. The release of avalanches in persistent weak layers are a significant cause of recreational avalanche fatalities. |



# Wet snow

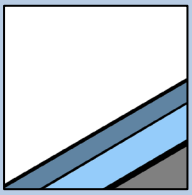
| | | | |
|---|---|---|---|
| What? | Characteristics | The avalanche problem is related to a weakening of the snowpack due to the presence of liquid water. Water infiltrates the snowpack due to melt or rain. | |
| | Avalanche type and trigger | • Wet-snow slab avalanches<br>• Wet loose snow avalanches<br>• Mainly natural avalanches | |
| Where? | Spatial distribution | When water infiltration is due to melting, the problem is often specific to certain slope aspects (solar radiation) and elevations (air temperature).<br>In case of rain on snow, all slope aspects are affected (below the elevation, where snow turns to rain). | |
| | Position of the weak layer in the snowpack | Anywhere in the snowpack, in case of slab avalanches often at pre-existing weak layers. | |
| Why? | Release characteristics | Wet-snow slab avalanches:<br>• Weakening and failure of pre-existing weak layers in the snowpack or release at layer interfaces due to ponding water.<br>• Rain represents also an additional load on weak layers. | Wet loose snow avalanches:<br>• Loss of cohesion between snow crystals |
| When? | Duration | • Hours to days<br>• Rapid loss of stability possible<br>• Especially critical as water infiltrates for the first time deeper down, once the snowpack has warmed up to 0 °C.<br>• Natural avalanches might be more likely in the course of the day, depending on aspect (unless rain is the dominating factor). | |
| How to manage? | Identification of the problem in the field | The wet snow problem is usually easy to recognize. Onset of rain, snowballing, pin wheeling and small wet slab or loose snow avalanches are often precursors of natural wet-snow avalanche activity. Deep foot- or ski-penetration is another sign of increased wetting. | |
| | Travel advice | If the wet snow surface freezes overnight due to clear skies and cold temperatures then develops a strong supporting crust, favourable conditions will usually be present in the morning. After warm, overcast nights, the problem will often be in existence in the morning. Normally rain on new snow creates this problem almost immediately. Good timing and trip planning are important. Consider avalanche runout zones. | |



# Gliding snow

| | | |
|---|---|---|
| What? | Characteristics | The entire snowpack is gliding on the ground, typically on smooth ground such as grassy slopes or smooth rock zones. High activity of glide-snow avalanches is typically related to a thick snowpack with no or only few weak layers. Glide-snow avalanches can occur both with a cold dry snowpack and with a warm moist or wet snowpack. The release of a glide-snow avalanche is difficult to predict, although in many cases glide cracks open prior to release. |
| | Avalanche types and trigger | • Glide-snow avalanches; cold dry or 0 °C-isothermal wet snowpack<br>• Almost exclusively natural avalanches. Human and artificial triggering is very unlikely. |
| Where? | Spatial distribution | Primarily on smooth ground and on slopes of any aspect, but more often on sun-exposed slopes. |
| | Position of the weak layer in the snowpack | Interface between the ground and overlaying snowpack |
| Why? | Release characteristics | Glide-snow avalanches are caused by a loss of friction at the snow-ground interface due to the presence of liquid water. |
| When? | Duration | Days to months; occasionally during entire winter-season. The release can occur at any time during the day. In spring, glide-snow avalanches occur often during the second part of the day. |
| How to manage? | Identification of the problem in the field | The glide snow problem can often be recognized by the presence of glide cracks, which are often pre-cursors of glide snow avalanche release. However, the presence of glide cracks does not indicate imminent avalanche release, which is nearly impossible to predict. Avalanche release without pre-existing glide cracks is also common. |
| | Travel advice | Avoid areas close to glide cracks. |

When none of the avalanche problems is distinct (often when a low avalanche danger {level 1} applies), the situation is described with the text "no distinct avalanche problem".



**No distinct avalanche problem**

This is not a specific avalanche problem. It is a very inconclusive scenario, without a clear pattern that a user could follow to lower consequences. Any avalanche type is possible. Do not consider the absence of a typical avalanche problem as safe conditions. Normal caution is still advised.

## Avalanche prone locations

Avalanche prone locations can exist in all aspects and altitude zones as a general rule, but in many cases they are not evenly distributed. If they are to be found more frequently in certain aspects and altitude zones than in others, this is stated in the avalanche bulletin. The indicated danger level applies to slopes that satisfy both criteria – altitude zone and aspect. Example: "Danger level "moderate" (2+) in west do north to northeast facing aspects above 2000 m." If this information is not given, the indicated danger level applies to all aspects and altitude zone.

For slopes that do not satisfy both criteria (altitude zone and aspect), it has become customary in backcountry touring to assume the danger to be one danger level lower. This rule of thumb has proven reliable but, like every rule, is subject to exceptions. It can be applied when planning backcountry tours, but does not replace a careful assessment in the open terrain.

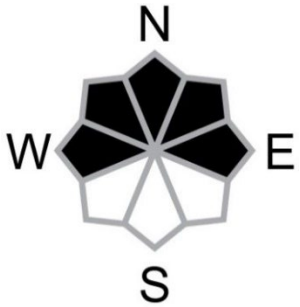
If the avalanche prone locations are concentrated in certain types of terrain (e.g. in gullies, adjacent to ridgelines, or in areas with shallow snow cover), this is mentioned in the danger description as far as possible.

Most fatal avalanche accidents occur on slopes whose gradient, aspect and altitude meet the criteria mentioned in the relevant avalanche bulletin. This analysis disregards the danger level prevailing on the day when the accident occurs.

### Slope aspect

A **north-facing slope** falls to the north. If you are standing on a mountain summit looking towards the north (with the sun behind you at midday), the north-facing slope lies immediately below you. In mid-winter, steep north-facing slopes are not exposed to any direct solar radiation. A **south-facing slope** falls to the south and also receives regular sunshine, even in mid-winter.

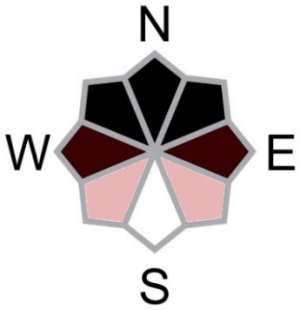
In most cases the slope aspects that are particularly affected are indicated in the avalanche bulletin and, if possible, also illustrated in graphical form.




*Particularly affected areas are coloured in black (in the illustration west to north to east-facing slopes)*

**Marginal areas**

Conditions change gradually rather than abruptly from one aspect to another. Therefore, the edges of the area coloured in black are not clearly defined boundaries, but show marginal areas that cannot be clearly assigned to either the favourable or the unfavourable area.




Particularly affected aspects (in black): In a segment of about one eighth of the compass, either the more or the less favourable avalanche situation may apply.

## Altitude

References to particularly affected altitudes are generally made in increments of 200 m. In the case of dry-snow avalanches, the altitude above which there is an increased number of avalanche prone locations is usually cited. For wet-snow avalanches, the cited altitude is the one below which they are most likely to occur.

**Definitions of altitudes**

**Low altitudes:** below approximately 1000 m

**Intermediate altitudes:** between approximately 1000 m and 2000 m

**High altitudes:** between approximately 2000 m and 3000 m

**High alpine regions:** above approximately 3000 m

The **tree line** is also used as a reference. This denotes the transitional area between forest land, which is sheltered from the wind, and open Alpine terrain, which is exposed to the wind. The tree line is situated at the transition between intermediate and high altitudes. It lies at approximately 2200 m in Central Valais and Engadine, at around 2000 m in the other Regions and at about 1800 m in the Prealps.

**Marginal areas**

Conditions change gradually rather than abruptly from one altitude zone to another. Therefore, the given altitude is not a clearly defined boundary but shows a marginal area that cannot be clearly assigned to either the favourable or the unfavourable area.


*Particularly affected altitudes (in black): In an altitude range of often about 200 m up or down, it is quite possible that either the more or the less favourable avalanche situation could occur.*

## Slope gradient

The steeper the slope, the higher the probability that an avalanche will release.

The slope gradient category given in the avalanche bulletin indicates that there is an increased number of slopes with at least that gradient that are affected. The indicated values (e.g. "steeper than 35°") must, of course, be assumed to be approximate. They are to be regarded as guidelines, and transitional areas must be treated with caution as well. If no gradient is given, it can

generally be assumed that steep slopes, i.e. slopes with a gradient of around 30° or more, are meant.

**Definitions of slope gradients**

| | | |
|---|---|---|
| **Extreme, very steep terrain** | | Particularly unfavourable, for example as regards gradient, terrain profile, proximity to ridge lines or characteristics of the ground. This is mostly used in the avalanche bulletin in connection with danger level 1 (low). |
| **Extremely steep** | Steeper than 40° | 43% of fatal skier-triggered avalanches |
| **Very steep** | Steeper than 35° | Long-term average: 82% of fatal skier-triggered avalanches |
| **Steep** | Steeper than 30° | 97% of fatal skier-triggered avalanches |
| **Moderately steep** | Less than 30° | 3% of fatal skier-triggered avalanches |

## Shady and sunny slopes

Shaded or **shady slopes** are more prevalent in mid-winter (when the sun is low in the sky) than in spring (when the sun is higher). Depending on the extent of the shadow cast by the near horizon, slopes with any aspect, not only north-facing ones, may be shady. Usually settling and bonding require a long time on such slopes. Conversely, sun-exposed or **sunny slopes** are more common in spring than in mid-winter. The snow on sunny slopes usually settles and bonds more quickly.

## Wind-loaded slopes

Windward slopes face the wind. Snow falling on these slopes is usually blown away. **Leeward slopes** face downwind (away from the wind). Snow blown off the windward slopes is deposited here, forming a 'snowdrift accumulation'. Leeward slopes often have many times the average snow depth and are therefore sometimes called '**wind-loaded slopes**'. Windward and leeward slopes are found not only near mountain summits but also on slopes a considerable distance away from the ridge line. In such situations, the wind can be diverted by the terrain and deviate significantly from the naturally prevailing direction.

## Terrain profile

Sometimes, especially in relation to snowdrift, a more detailed description of the particularly affected terrain profiles is provided:

- **Gullies and bowls**, concavities in the slope
- **Areas adjacent to the ridge line**, so especially slopes near the ridge and the summit
- **Slopes behind abrupt changes in the terrain:** These are often also a considerable distance away from the ridge line.
- **Bases of rock walls:** These are often very deeply covered in snowdrift.

If the principally affected terrain profiles are limited, the avalanche prone locations are usually somewhat spatially limited and relatively easy to locate – at least by experienced individuals when there is good visibility.

As regards the prevalence of avalanche prone locations, the following sequence generally applies:

- (Very) steep slopes: Avalanche prone locations can be expected on all (very) steep slopes of the indicated aspect and altitude. As well as areas adjacent to the ridge line and in gullies and bowls, slopes considerable distances away from the ridge line are affected.
- Wind-loaded slopes: Avalanche prone locations can be expected, in particular, on steep slopes of the indicated aspect and altitude where there is (fresh) snowdrift. This includes gullies and bowls filled with snowdrift.
- Gullies and bowls/areas adjacent to the ridge line: Avalanche prone locations are found in increased numbers in gullies and bowls/adjacent to the ridge line with the indicated aspect and altitude.

# Avalanche types

## Slab avalanches

Slab avalanches have a distinct fracture line. They can only occur when a bonded snow layer (the 'slab') lies on top of a weak layer. Initially when the avalanche is triggered, a small fracture, or initial failure, arises in the weak layer, and this is then quickly propagated along the layer. The extent of this propagation depends largely on the characteristics of the weak layer and those of the slab. As a result, the entire slab releases over a large area.

*Slab avalanche*

Slab avalanches can occur in dry or wet snow, even long after any snowfall. They can be released naturally (without human assistance), or by any point inside or even outside the slab (remote triggering).

Slab avalanches are the most dangerous avalanche type, accounting for over 90% of avalanche fatalities. They can quickly reach a high speed. If skiers trigger such an avalanche, they often find themselves right in the middle of it and are frequently caught by it.

## Loose-snow avalanches

Loose-snow avalanches have a distinct trigger point from which they fan out as they plummet downhill and the released snow sweeps more and more snow with it. This type of avalanche often occurs during or shortly after snowfall or when the snow warms up a lot. In the case of dry (powder) snow, this usually requires a 40° gradient at the trigger point. Especially in wet snow, these avalanches can reach considerable sizes in persistently steep terrain.

Loose-snow avalanches are often released naturally. They claim fewer than 10% of avalanche fatalities, with many of these occurring in the summer with mountaineers in the steep terrain being swept away, causing them to fall. Normally, snow sports enthusiasts triggering a loose-snow avalanche are not buried by the snow, as the avalanche sweeps under them.

*Loose-snow avalanche*

## Gliding avalanches

Like slab avalanches, gliding avalanches have a distinct fracture line, but here the whole snowpack slides away. This is only possible on a smooth substrate, typically consisting of grass or slabs of rock. The steeper the slope, the more likely the snow is to slide.

Gliding avalanches can be a major problem for transport routes particularly in snowy winters. For winter sports enthusiasts, they are of less importance as they are not triggered by people but are released naturally. A prerequisite for such gliding snow is that the very base of the snow, at the interface with the ground, is moist, meaning there is little friction. In this context there are two ways in which water enters the lowermost layer:

*Gliding avalanche*

- In mid-winter, the snowpack is generally cold and dry. Then the snowpack becomes moist from below: the warm ground melts the snow lying above it, or the snow sucks water out of the moist ground. In mid-winter, gliding avalanches are possible at any time of the day or night.

- At some point in springtime, the whole snowpack warms up to 0 °C. This allows melt water and rain to seep through the entire snowpack and means that its base is moistened from above. In these conditions, gliding avalanches often occur in the typical wet-snow avalanche periods and their frequency increases in the latter part of the day.

Often, but by no means always, the gliding of the snowpack begins slowly, starting with gaps ('glide cracks') forming within it. These can suddenly lead to a gliding avalanche. It is impossible to predict exactly when this will happen, so it is best to avoid staying close to (whether above, adjacent to or below) glide cracks for any longer than absolutely necessary.

## Avalanche sizes

The European avalanche warning services divide avalanches into five size categories (based on the Canadian classification). The avalanche size is defined, among other things, by the potential damage caused.

Under this definition, fatal **'skier-triggered avalanches'** are often classified as 'medium' or (barely) as 'large' avalanches and reaches considerable dimensions, being typically 150 m in length and having a slab size of some 50 m by 80 m and an average slab thickness of around 50 cm. This is equivalent to a slab volume of approximately 2000 $m^3$ or around 400 tonnes.

**Size 1: Small avalanche (sluff)**

**Potential damage**

Unlikely to bury a person, except in unfavourable runout zones
In extreme terrain there is a danger of falling.

**Runout**

Stops on a steep slope

**Typical dimensions**

Length: < 50 m
Volume: 100 $m^3$

*Small avalanche (sluff)*

**Size 2: Medium avalanche**

**Potential damage**

Can bury, injure or kill people
Many avalanches that kill people are classified as 'medium'.

**Runout**

Can reach the end of the relevant slope

**Typical dimensions**

Length: 50 – 200 m
Volume: 1000 $m^3$

*Medium avalanche*

**Size 3: Large avalanche**

**Potential damage**

Can bury and destroy cars, damage trucks, destroy small buildings and break a few trees
Many avalanches that kill people are classified as 'large'.

**Runout**

Can cross flat terrain (well below 30°) over a distance of less than 50 m

**Typical dimensions**

Length: Several hundred metres
Volume: 10,000 $m^3$

*Large avalanche*

**Size 4: Very large avalanche**

**Potential damage**

Can bury and destroy trucks and trains.
Can destroy fairly large buildings and small areas of forest. Very large avalanches can occur at danger level 3 and are typical of danger levels 4 and 5.

**Runout**

Traverses flat terrain (well below 30°) over a distance of more than 50 m.
Can reach the valley floor.

**Typical dimensions**

Length: 1 – 2 km
Volume: 100,000 $m^3$

*Very large avalanche*

**Size 5: Extremely large avalanche**

**Potential damage**

Can devastate the landscape and has catastrophic destructive potential.
Typical for danger level 5.

**Runout**

Reaches the valley floor
Largest known avalanche

**Typical dimensions**

Length: > 2 km
Volume: > 100,000 $m^3$

*Extremely large avalanche*

# Additional load

Avalanches can be triggered naturally (without human influence) or by an artificially applied additional load.

## Naturally triggered avalanches

When an avalanche bulletin warns of naturally triggered avalanches, these could be slab, loose-snow or gliding avalanches. The main triggers for these are, for example, the load caused by snowfall or rain, decreasing firmness of the snowpack because of warming or moistening, and a change in the slab. When an avalanche bulletin does not explicitly warn of naturally triggered avalanches, this does not mean they can be completely ruled out.

## Additional load

Information given about additional load in the avalanche bulletin refers to dry slab avalanches.

- An artificial additional load is applied not only, for example, by winter sports enthusiasts and snowmobiles/groomers but also by avalanche blasting (i.e. explosions to provide protection from avalanches).
- Natural additional loads are fresh-fallen snow and rain and also collapsed cornices and ice debris. These can subject the snowpack to a very high load, thereby triggering avalanches even in fairly favourable conditions.

The definitions used by the European avalanche danger scale distinguish between 'low' and 'high' additional loads. From danger level 3 ('considerable') upwards, avalanches can even be triggered by a low additional load, whereas up to level 2 ('moderate') in general a high additional load is required.

**Low additional load**

- Individual skiers or snowboarders making gentle turns, not falling
- Individual snowshoe hikers
- Several of the above winter sports enthusiasts with spacing between them

**High additional load**

- A fall or a jump
- Two or more winter sports enthusiasts standing close together
- Snowmobile/groomer
- Avalanche blasting
- Collapse of a cornice, ice debris

Information on the additional load is helpful, but these are only rough guidelines which should not be accorded undue significance in the assessment. As a rule, the probability of an avalanche being triggered increases with rises in the additional load. This means that with a higher additional load there are more trigger points than with a lower one. The following aspects also need to be considered:

**Size of the load**

The load on the snowpack will differ depending on the individual and how he or she is moving about on the snow and on the conditions: often it will be greater on the descent than on the ascent and violent short turns or jumps will exert a greater load than big turns.

**Punctual or large area**

A slab avalanche can be triggered when a weak layer breaks over a sufficiently large area (initial failure). The punctual load of a pedestrian may lead to a fracture lower down in the snowpack but over a smaller area, meaning that sometimes this will not be propagated. This is particularly true when the person concerned treads deeply into the snow. Therefore, depending on the snowpack, the load of a pedestrian may be more or less dangerous than the more extensive load of a snowshoe hiker or a skier.

**Spacing distances**

Spacing distances avoid the loads of various individuals overlapping. As the depth increases, an additional load is spread over an ever larger area, so that the additional load per unit area is reduced. The area of influence is the largest in the case of a low-lying weak layer or a hard slab but as a rule is still less than one square metre. As a result, the areas of influence of individual backcountry ski tourists ascending one after another do not usually overlap, and so having spaces between them only slightly reduces the load on the slope. However, as these spaces are mainly about helping to reduce the risk of multiple individuals getting buried in the snow, they are nevertheless a sensible precaution to take.

### Other influences on the danger level

The danger level does not depend solely on the load required to trigger an avalanche but also on the frequency of avalanche prone locations and the avalanche size. Where, for example, only a few avalanche prone locations or only small avalanches are to be expected, sometimes the danger level may still be 2 ('moderate') if only a small additional load is needed to trigger an avalanche (also see 'Small, easily triggered snowdrift accumulations' in the section 'Danger levels').

## Division into regions

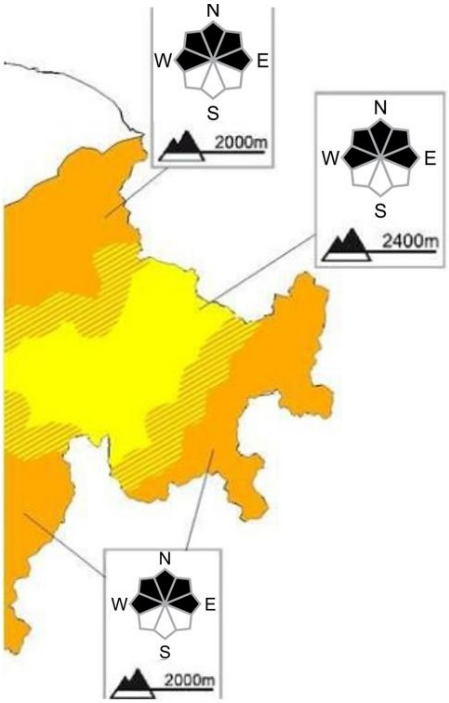
For the purposes of the avalanche bulletin, the Swiss Alps are divided in alignment with the warning regions used by the other federal natural hazard agencies (MeteoSwiss, Federal Office for the Environment (FOEN), Swiss Seismological Service (SED)). Groups consisting of several warning regions are formed, generally by applying climatological or political criteria, yielding overarching region names (see the maps below).

Great care is required when interpreting references in the context of backcountry tours in regional border areas. For example, the Jungfrau region is usually accessed from the north (northern flank of the Alps or Bernese Oberland), but the backcountry touring area mostly lies in Valais.

### Marginal areas

There are no clearly defined boundaries between two regions with different danger assessments (e.g. different danger levels or different frequencies of avalanche prone locations) but instead transitional areas which in many cases cannot be clearly assigned to either avalanche situation. This means that in a marginal area several kilometres wide, it can be assumed that either the more or the less favourite situation may apply.

Those undertaking backcountry ski or snowshoe hiking tours in such areas should therefore consult the avalanche bulletin for both regions in question.



## Warning regions (the 149 smallest units)


**Western Part of the Northern flank of the Alps**

1111 Vaud Prealps
1112 Pays d'Enhaut
1113 Aigle - Leysin
1114 Bex - Villars
1121 Jaun
1122 Gruyère
1211 Western Bernese Prealps
1212 Eastern Bernese Prealps
1213 Hohgant
1221 Niedersimmental
1222 Gstaad
1223 Wildhorn
1224 Lenk
1225 Iffigen
1226 Adelboden
1227 Engstligen
1228 Diemtigen Valley
1231 Kandersteg
1232 Blüemlisalp
1233 Lauterbrunnen
1234 Jungfrau - Schilthorn
1241 Brienz - Interlaken
1242 Grindelwald
1243 Schreckhorn
1244 Hasliberg - Rosenlaui
1245 Guttannen
1246 Gadmertal
1247 Grimsel Pass
1311 Vouvry
1312 Monthey - Val d'Illiez

**Central Part of the Northern flank of the Alps**

2111 Pilatus
2112 Schwarzenberg
2121 Glaubenberg
2122 Engelberg
2123 Melchtal
2124 Gersau
2131 Rothenthurm
2132 Ybrig
2133 Stoos
2134 Bisistal
2211 Schächental
2212 Uri Rotstock
2221 Meiental
2222 Maderanertal
2223 Northern Urseren
2224 Southern Urseren

**Eastern Part of the Northern flank of the Alps**

3111 Northern Glarus
3112 Southern Glarus-Grosstal
3113 Southern Glarus-Sernftal
3114 Central Glarus
3211 Appenzell Alps
3221 Toggenburg
3222 Alpstein - Alvier
3223 Flumserberg
3224 Sarganserland
3311 Liechtenstein

**Valais**

4111 Emosson
4112 Génépi
4113 Val d'Entremont - Val Ferret
4114 Conthey - Fully
4115 Martigny - Verbier
4116 Haut Val de Bagnes
4121 Montana
4122 Val d'Hérens
4123 Arolla
4124 Val d'Anniviers
4125 Mountet
4211 Leukerbad - Lötschental
4212 Turtmanntal
4213 Konkordia region
4214 Riederalp
4215 Leuk
4221 Lower Visp valleys
4222 Zermatt
4223 Saas Fee
4224 Monte Rosa
4225 Mattmark
4231 Northern Simplon region
4232 Southern Simplon region
4241 Reckingen
4242 Binntal
4243 Northern Obergoms
4244 Southern Obergoms

**Northern and Central Grisons**

5111 Northern Prättigau
5112 Southern Prättigau
5113 Western Silvretta
5121 Calanda
5122 Schanfigg
5123 Davos
5124 Flims
5211 Northern Tujetsch
5212 Southern Tujetsch
5214 Obersaxen - Safien Valley
5215 Val Sumvitg
5216 Zervreila
5221 Domleschg - Lenzerheide
5222 Schams
5223 Rheinwald
5231 Albulatal
5232 Savognin
5233 Avers
5234 Bivio

**Central Part of the Southern flank of the Alps**

6111 Val Bedretto
6112 Upper Valle Leventina
6113 Val Blenio
6114 Upper Valle Maggia
6115 Lower Valle Leventina
6121 Lower Valle Maggia
6122 Riviera
6131 Lugano area
6132 Mendrisio area
6211 Alto Moesano
6212 Basso Moesano

**Engadine / eastern Part of the Southern flank of the Alps**

7111 Corvatsch
7112 Bernina
7113 Zuoz
7114 St Moritz
7115 Val Chamuera
7121 Samnaun
7122 Eastern Silvretta
7123 Sur Tasna
7124 Val Suot
7125 Val dal Spöl
7126 Val S-charl
7211 Val Bregaglia
7221 Upper Val Poschiavo
7222 Lower Val Poschiavo
7231 Val Müstair

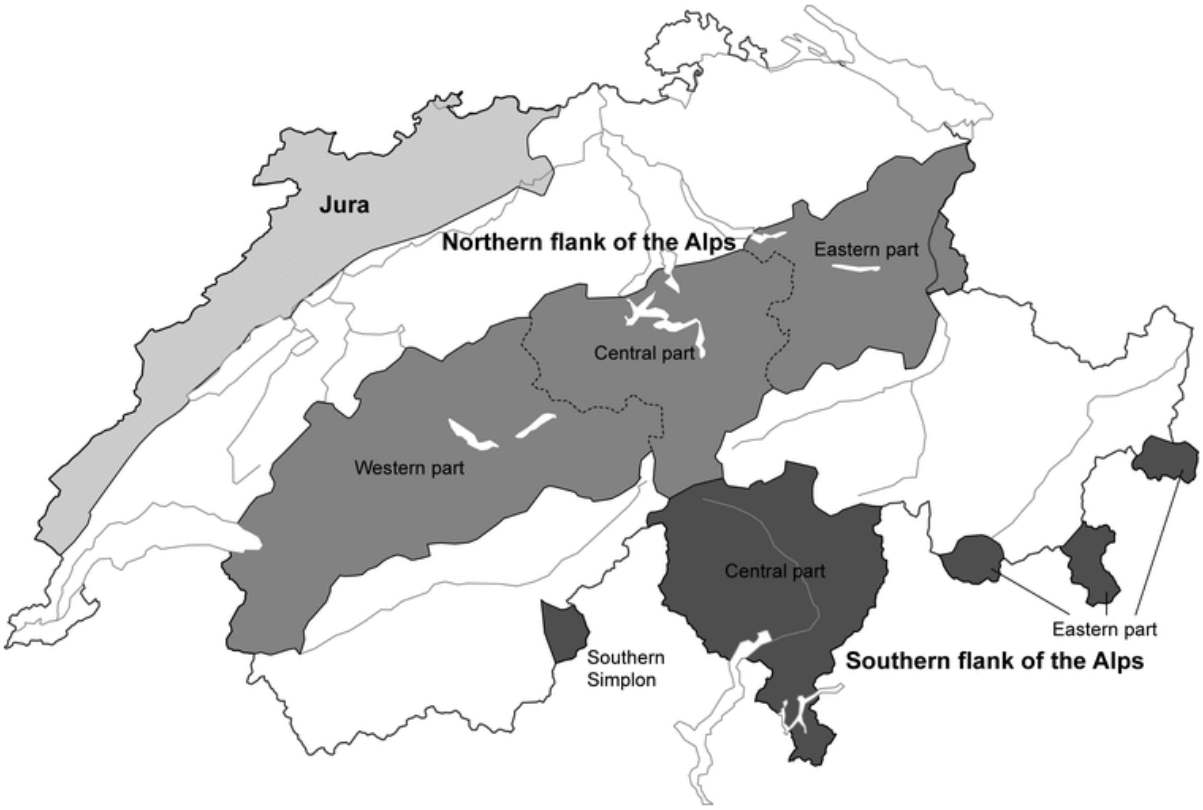
**Jura**

8111 Saint-Cergue
8112 Vallée de Joux
8113 Yverdon - Bevaix
8114 Val de Travers
8211 Val de Ruz - Colombier
8212 Bienne - Neuchâtel
8213 Vallon de Saint-Imier
8214 Moutier - Tavannes
8215 Thal
8216 Olten - Gösgen
8221 La Chaux-de-Fonds - Le Locle
8222 Franches-Montagnes
8223 Ajoie
8224 Delémont - Bellelay
8225 Laufental
8226 Basel
8227 Oberes Baselbiet
8228 Rheinfelden

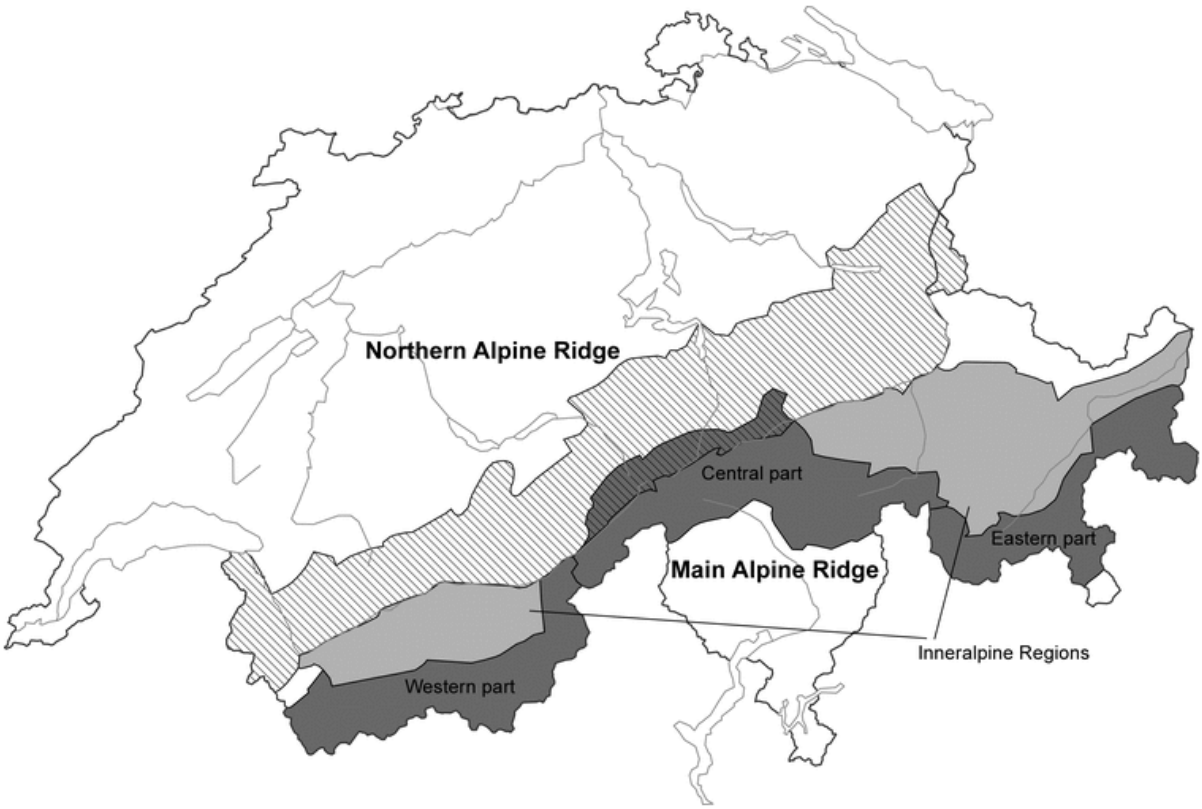
**Swiss plateau**

9111 Western Swiss plateau
9211 Central Swiss plateau
9311 Eastern Swiss plateau

**Northern and southern flanks of the Alps, and the Jura**



**Main Alpine Ridge, Northern Alpine Ridge and Inneralpine Regions**




The **Main Alpine Ridge** extends from Val Ferret via the Great St Bernard, Monte Rosa, Simplon, Gotthard, Lukmanier, San Bernardino, Maloja and Bernina passes to beyond Val Müstair.

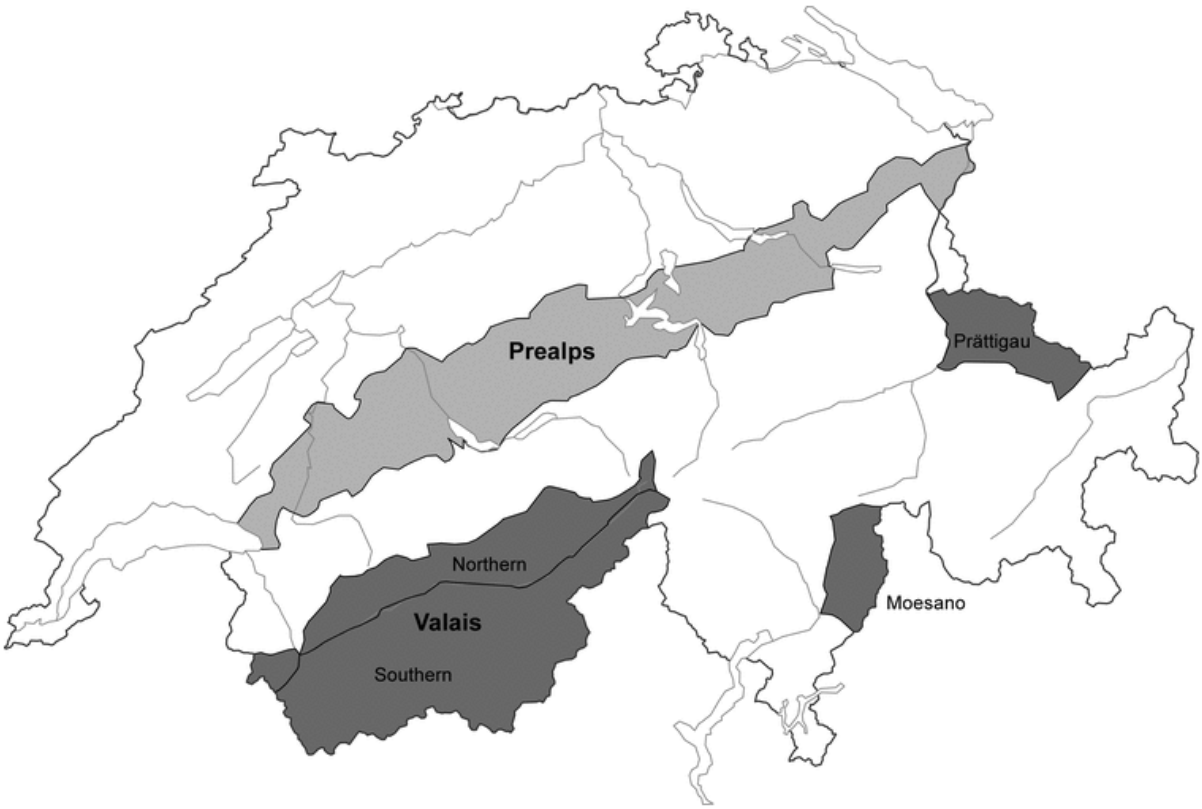
The **Northern Alpine Ridge** covers a belt running from the Dent du Midi via the Wildstrubel and Jungfrau regions and Gotthard, Tödi and Vorab to Liechtenstein.

The **Inneralpine Regions** encompass the regions between the Main Alpine Ridge and the Northern Alpine Ridge, namely those of Central Valais, and parts of Northern and Central Grisons and Engadine.

## Major political regions

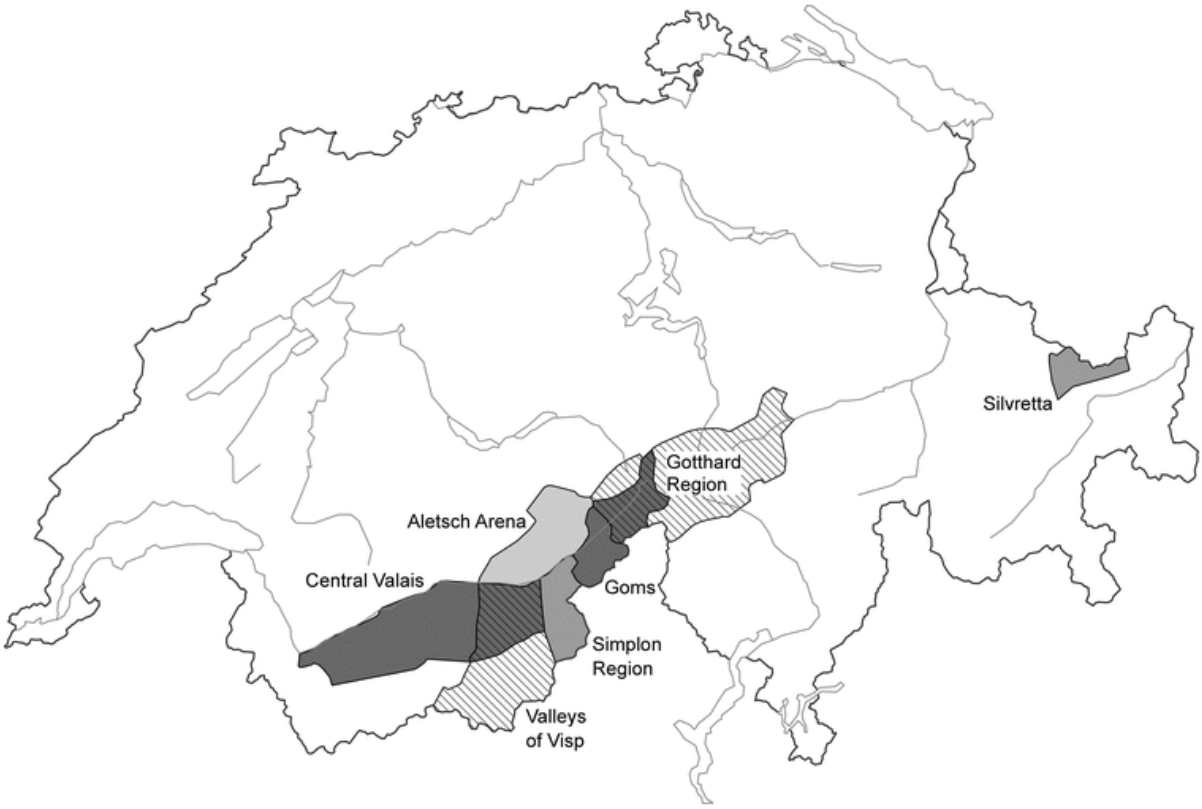
The **Grisons southern valleys** consist of Val Mesolcina and Val Calanca (collectively Moesano), Val Bregaglia, Val Poschiavo and Val Müstair.

**Political subregions 1**



**Political subregions 2**

The **Gotthard region** consists of Obergoms, the Grimsel region, Urseren, Tavetsch, the Upper Valle Leventina and Val Bedretto.



## European danger scale with recommendations and additions

| | | European danger scale | | | | | |
|---|---|---|---|---|---|---|---|
| **Danger level** | **Title** | **Snowpack stability** | **Avalanches: size, incidence, probability of release** | **Additional characteristics** | **Recommendations for backcountry recreationists** | **Implications and recommendations for transportation routes and settlements** | **Forecasting frequency and percentage of deaths** |
| **5 very high**  | **Extraordinary avalanche situation** | The snowpack is poorly bonded and largely unstable in general. | Numerous very large and often extremely large natural avalanches can be expected. | Heavy snowfall | You are advised not to engage in winter sports beyond open ski runs and trails. Respect closures. | Avalanches can travel large distances, including beyond the extent of familiar paths. Transportation routes and settlements can be seriously endangered. Extensive safety measures are usually required. | Very rarely forecast. Around 1 % of avalanche fatalities. |
| **4 high**  | **Very critical avalanche situation** | The snowpack is poorly bonded on most steep slopes. | Triggering is likely even from low additional loads on many steep slopes. In some cases, numerous large and often very large natural avalanches can be expected. | Remote triggering is typical. Whumpf sounds and shooting cracks occur often. Critical amount of new snow exceeded or heightened likelihood of wet-snow avalanches. | Stay on moderately steep terrain. Heed runout zones of very large avalanches. Unexperienced persons should remain on open ski runs and trails. | Avalanches can travel large distances, in particular within familiar paths. Exposed objects (mostly sections of transportation routes, but in isolated cases also buildings) can be endangered. Consider taking safety measures. | Forecast only on a few days throughout the winter. Around 10 % of avalanche fatalities. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **3 considerable**  | **Critical avalanche situation** | The snowpack is moderately to poorly bonded on many steep slopes. | Triggering is possible even from low additional loads particularly on the indicated steep slopes. In certain situations some large, and in isolated cases very large natural avalanches are possible. | Whumpf sounds and glide cracks typically occur, but not in all cases. Remote triggering can occur. In many cases the critical amount of new snow is reached, fresh snowdrift accumulations exist over a wide area, or the snowpack is either prone to triggering due to persistent weak layers or is being weakened by water infiltration. | The most critical situation for backcountry recreationists. Select best possible route and take action to reduce risks. Avoid very steep slopes with the aspect and elevation indicated in the avalanche bulletin. Unexperienced persons are advised to remain on open ski runs and trails. | In individual cases exposed objects (mostly sections of transportation routes) can be endangered. Here, consideration should be given to taking safety measures. | Forecast for around 30 % of the winter season. Around 50 % of avalanche fatalities. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **2 moderate**  | **Mostly favourable avalanche situation** | The snowpack is only moderately well bonded on some steep slopes; otherwise well bonded in general. | Triggering is possible primarily from high additional loads, particularly on the indicated steep slopes. Very large natural avalanches are unlikely. | Warning signs can occur in isolated cases. Weak layers in the snowpack are prone to triggering in some places. Fresh snowdrift accumulations are mostly shallow or cover only small areas. | Routes should be selected carefully, especially on slopes with the aspect and elevation indicated in the avalanche bulletin. Travel very steep slopes one person at a time. Pay attention to unfavourable snowpack structure (persistent weak layers, old snow problem). | Very little danger. | Forecast for around 50 % of the winter season. Around 30 % of avalanche fatalities. |
| **1 low**  | **Generally favourable avalanche situation** | The snowpack is generally well bonded (or entirely loosely packed) and stable. | Triggering is generally possible only from high additional loads in isolated areas of very steep, extreme terrain. Only small and medium natural avalanches are possible. | No warning signs present. Small fresh snowdrift accumulations can exist in isolated cases. | Travel extremely steep slopes one person at a time and be alert to the danger of falling. | No danger. | Forecast for around 20 % of the winter season. Around 5 % of avalanche fatalities. |

**Additional information and definitions**

- The avalanche bulletin usually describes areas where the danger is most significant in greater detail (e.g. elevation zone, aspect, topography, etc.).
- Slope angles:
  - very steep, extreme terrain is especially unfavourable as regards the slope angle, topography, proximity to ridgelines or ground conditions
  - extremely steep: steeper than 40°
  - very steep: steeper than 35°
  - steep: steeper than 30°
  - moderately steep: less than 30°
- Additional load (artificial triggering):
  - high (e.g. group of skiers without spacing, snowmobile/groomer, avalanche blasting)
  - low (e.g. single skier, snowboarder or snowshoe hiker)
- Natural: without human influence
- Avalanche sizes: extremely large / very large / large / medium / small
- Aspect: the compass direction which a downward slope faces
- Ski runs: marked pistes and descents
- Trails: marked snowshoe and winter hiking trails
- Experience: experience in assessing avalanche danger means the ability to obtain and correctly interpret external sources of information, e.g. the avalanche bulletin, and one's own observations with regard to avalanche danger, and to respond correctly in accordance with the situation.
- Warning signs include: recent avalanches, whumpf sounds or shooting cracks
- Critical amount of new snow: 10-20 cm when conditions are unfavourable, 20-30 cm when conditions are fair and 30-50 cm when conditions are favourable
- Exposed: especially exposed to danger, e.g. section of road in steep terrain within range of even medium avalanches