Wānaka Mountain Guides Mountaineering Manual

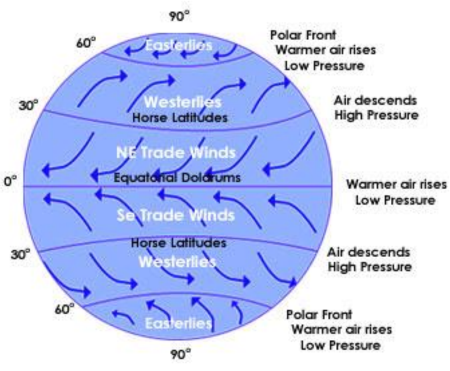
Section 4: Mountain Conditions

Successful mountaineering is as much about understanding the prevailing conditions, how they are changing on an hourly or daily basis and using this to decide on objectives and a strategy. Preparation habits take into account all these factors. The biggest contributing factor is the weather. It is important to have an awareness of what has happened previously and how this has affected travel and climbing conditions, the avalanche hazard and other hazards. Forecasts are a vital tool in deciding when and where to go. It is often all about timing.

Mountain weather

New Zealand is renowned for variable and rapidly changeable weather that can be difficult to predict. It experiences a predominantly maritime climate which means that incoming weather systems are affected by large areas of ocean in all directions.

Being in the Southern Hemisphere at a latitude between 40 and 50 degrees, New Zealand experiences prevailing westerly winds and an irregular procession of weather systems travelling in a west to east direction. These winds (known as the Roaring Forties) are caused by the combination of air being displaced from the Equator towards the South Pole, the Earth's rotation, and the scarcity of landmasses to serve as windbreaks.



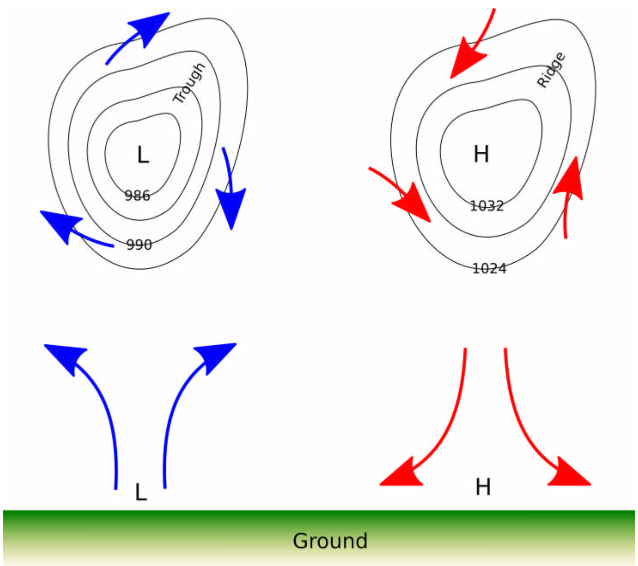
Coriolis effect and global winds

Seasonal fluctuations will dictate the position of these weather systems relative to the country. The interaction of two types of weather systems or pressure cells and the difference in pressure between neighbouring cells will influence the severity of the weather experienced in the mountains. The Southern Alps rise up from sea level on the West Coast to over 3000m in under 30 km and this relief can be a significant factor that further impact local weather effects.

Pressure cells and frontal systems

Low-pressure cells (also known as *Lows*, *Cyclones* or *Depressions*) contain rising air that in the Southern Hemisphere diverges in a clockwise direction around the centre of the cell. A Low is represented upon a weather map as an "L" with concentric isobars enclosing. Air closer to the centre of the Low is at a lower pressure than air further out. Pressure is measured on weather maps using Hectopascals (hPa). The global average is 1013 hPa and the typical pressure range for a Low is between 900 and 1000 hPa. Troughs extend out from the middle of Lows and exhibit similar characteristics as the centre of the low.

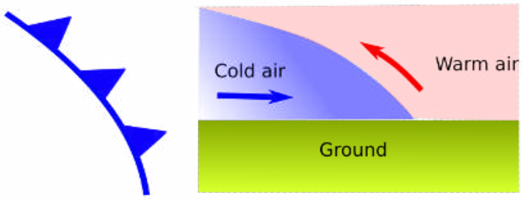
High-pressure cells (also known as *Highs* or Anticyclones) contain sinking air and converging air that in the Southern Hemisphere travel in an anti-clockwise direction around the centre of the cell. Highs are frequently associated with clear skies as sinking air tends to inhibit cloud growth but this can also result in low cloud and fog. A High is represented upon a weather map as an "H", also with concentric Isobars surrounding it but with air nearer the centre being of a higher pressure than air further out. Typical pressure range for a High is 1013 to 1040 hPa. Ridges extend out from the centre of a High similar to troughs in Lows.



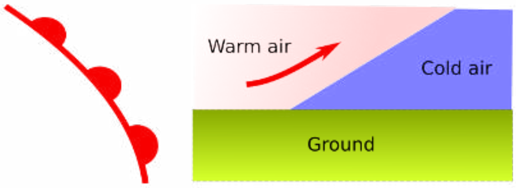
Low-pressure cells with rising and diverging air and high pressure system with sinking and converging air

Frontal systems or Fronts are interfaces between two air masses of different temperatures associated with low-pressure cells. As they travel relative to the ground, they are experienced as sharp changes in temperature and cloud and rain. There can be five types of fronts:

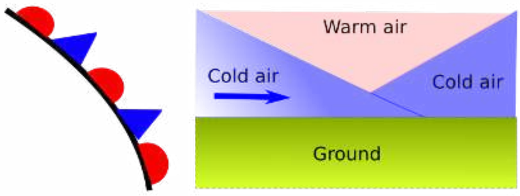
Cold Fronts are represented on a weather map as a line with triangles pointing in the direction of travel. Cold fronts are a wedge of cold air that push (steeply) underneath warmer air masses causing the warm air mass to be lifted. This results in typically a short band of heavy rain (80km), followed by a wider band of showers.



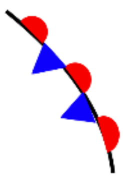
Warm Fronts are represented as a line with semicircles pointing in the direction of travel. Warm fronts slowly ride up and over cooler air masses. Because of the warmer temperature of the incoming warm air mass, warm fronts generally carry more moisture than cold fronts and the band of precipitation can be up to 300 km.



Occluded Fronts are represented as a line with triangles and semicircles pointing in the direction of travel. They are formed when a faster moving cold front catches up with the warm front and they merge. They behave much like a cold front but can contain a greater amount of moisture.



Stationary Fronts are represented by a line with triangles along one side and semi-circles along the other side. They do not appreciably move and commonly become weaker the longer they remain motionless.



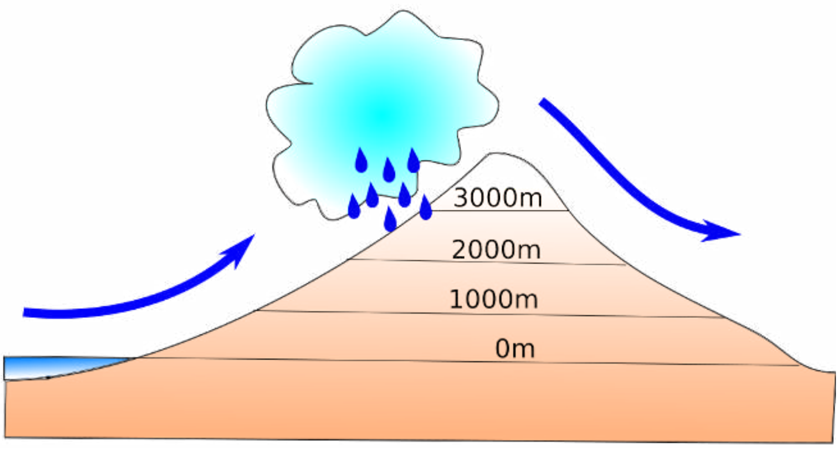
Weak Fronts are represented by a dashed line and can be a weakened version of any of the above fronts.

Lifting mechanisms

What do the elements of the weather map mean and how do they influence the weather in the mountains? The key concept here is lifting mechanisms. These refer to the four processes that cause air to rise. Air that rises within the atmosphere will cool and cooler air has less capacity for holding water vapour. At the elevation where the air mass becomes saturated with water vapour (known as the condensation point), clouds will form which will lead to precipitation.

There are four types of Lifting Mechanisms. *Frontal Lifting* associated with fronts and *Cyclonic Lifting* associated with Low-pressure cells have already been described. The two other types are:

Orographic Lifting occurs when any air flow off the ocean makes landfall and that air mass is forced upwards by the topography.

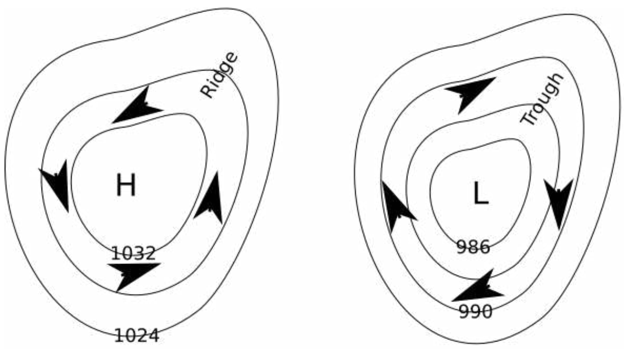


Orographic Lifting

Convective Lifting occurs within stable, High-pressure cells as the sun heats the surface of the Earth causing moisture to be evaporated from the Earth's surface and from which it rises upwards into the atmosphere. This is not so much of a factor in New Zealand and is more prevalent in continental mountain ranges where the uplift is so rapid, the instability quickly leads to thunderstorms. Particularly on the West Coast convective lifting does often result in the 'Jungle Mist' that rises up out of the valleys in the afternoon on fine days to swamp the nevés in cloud.

Wind speed and direction

In the Southern Hemisphere, air travels anti-clockwise around High-pressure cells and clockwise around Low-pressure cells. The velocity of air movement or winds around Lows and Highs is greater when the isobars on the weather map are closer together (large pressure gradient) and conversely slower or occasionally non-existent when the isobars are further apart (small pressure gradient).

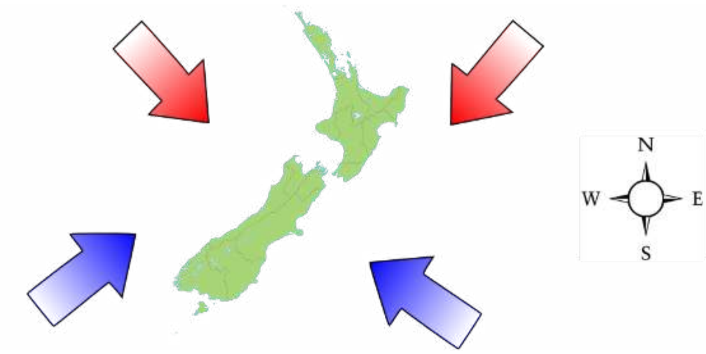


Wind direction around High and Low pressure cells

Local topography will also affect the wind direction on the ground. Winds will be concentrated through low points of terrain (cols or saddles) or get diverted from the prevailing wind direction by steep hillsides. This is similar to water flowing around and over boulders in a stream bed.

Temperature

The direction that winds travel from when they arrive over NZ combined with the relief of the mountains has a significant influence on the weather. Generally air travelling from the tropics to the north of the country will be warm. Air travelling from the south will be cold. The temperature of the air will influence its capacity to hold moisture.

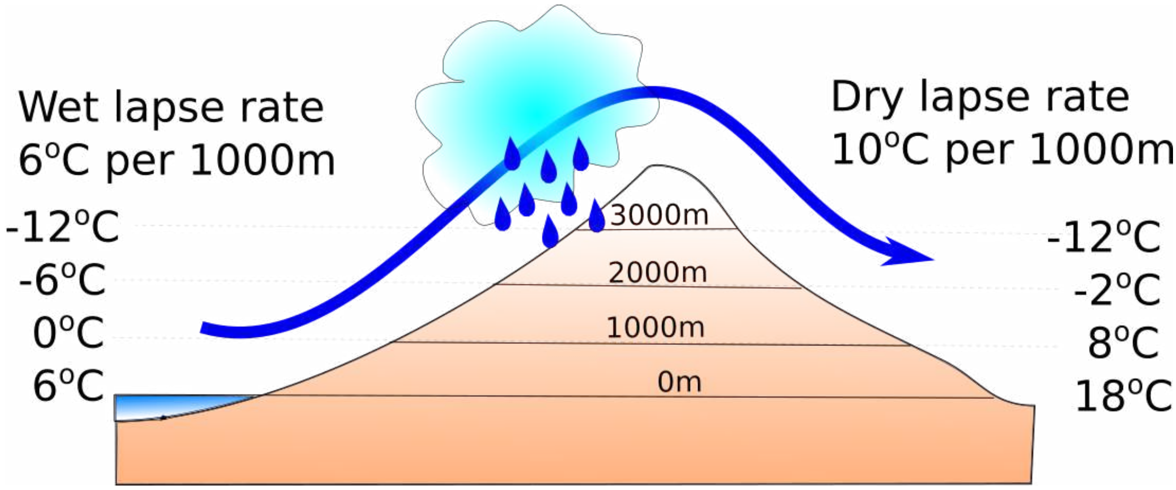


Temperature of incoming air

Lapse rate

It is possible to predict how the air temperature changes with altitude. Wet or saturated air cools at a rate of 6°C for every 1000m that it rises vertically. Dry air cools at a rate of 10°C for every 1000m that it rises or falls. This is known as the lapse rate.

As a saturated air mass undergoes orographic lifting from sea level to 3000 metres it cools by approximately 18 C (6ºC /1000m). As it descends towards the East coast the air mass warms by as much as 30ºC (10ºC /1000m). So the air mass is now dryer and around 12ºC warmer than when it first made landfall upon the West Coast. This process is known as the Föhn effect and helps explain why the plains to the East of the Alps are so dry whilst the West Coast is covered in temperate rainforest and has an annual average rainfall in excess of 5 metres.



Wet and dry lapse rates

Precipitation will fall as snow as low as 200 metres below the free air freezing level or the elevation where the air temperature is at 0ºC. This can be represented on weather charts as an isotherm (a line surrounding the area where the air temperature is 0ºC or below). Precipitation falling over terrain within this isotherm will fall as snow.

Weather forecasting

Weather maps can be either an Analysis or a Forecast. Analysis charts are a diagrammatic representation of the current weather situation based on information from satellite photographs and measurements taken at weather stations[1]. Areas of equal pressure are connected by lines known as isobars (similar to contour lines representing equal elevation on a topographic map). Forecast charts are a computer-extrapolated prediction of the weather chart at a future point in time. A range of computer models are used for this which, depending on the situation will vary

[1] Both Analysis and Forecast charts have a time reference in either New Zealand local time, Eastern Standard Time (EST) or Coordinated Universal Time (UTC). During the New Zealand daylight saving period New Zealand local time is 13 hours ahead of UTC and 3 hours ahead of EST (12 and 2 without daylight saving).

and may diverge in their predictions. The further out the forecast, the less accurate it is likely to be.

Interpreting weather maps

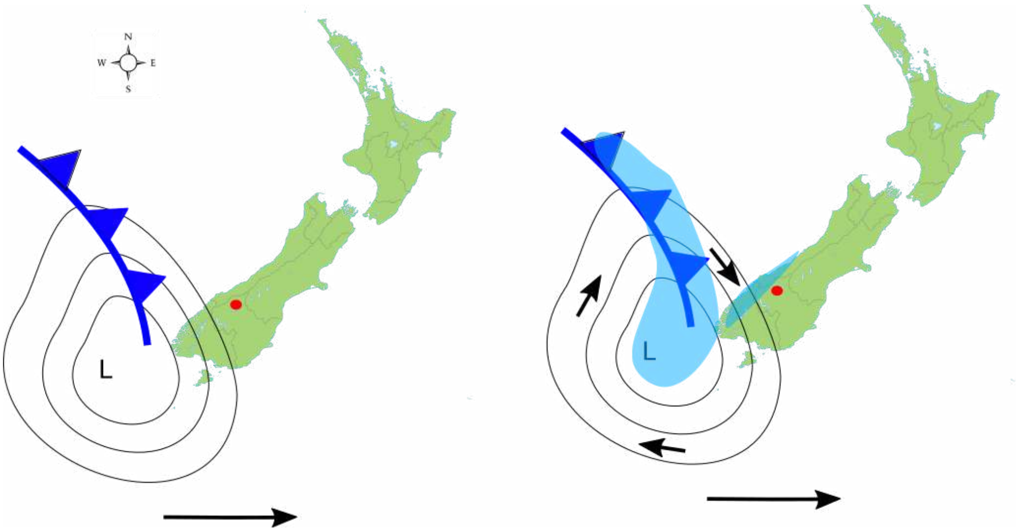
Weather maps describe the conditions in the atmosphere and they need to be superimposed over the topography of the land. The interaction of the pressure cells and fronts determine the weather in the mountains. It is important to understand these effects between different mountain ranges and at a more local scale.

The key factors that need to be considered are:

1. Wind speed and direction
2. Lifting mechanisms
3. Temperature

Example 1

In the first example below a Low and associated cold front approaches the South Island.



1. In Wanaka we are experiencing rising North Westerly winds likely observable as high lenticular clouds (see below).

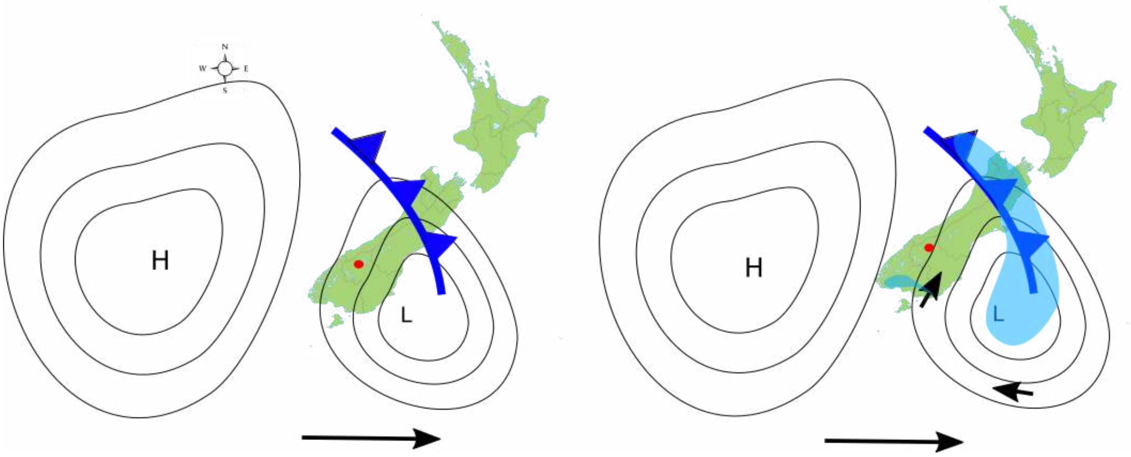
2. Precipitation can be expected from lifting occuring:

- In the centre of the Low over the Tasman Sea (cyclonic)
- Along the cold front over the Tasman Sea (Frontal)
- Along the western side of the main divide (Orographic)

3. If it is 18°C in Wanaka, we can expect it to be snowing to 800m on the western slopes of the Southern Alps.

Example 2

In the second example, the Low pressure system has tracked to the East of the South Island.



1. In Wanaka we are experiencing colder and calmer South Westerly winds.

2. In Wanaka and on the western side of the main divide, there is no precipitation.

There is precipitation:

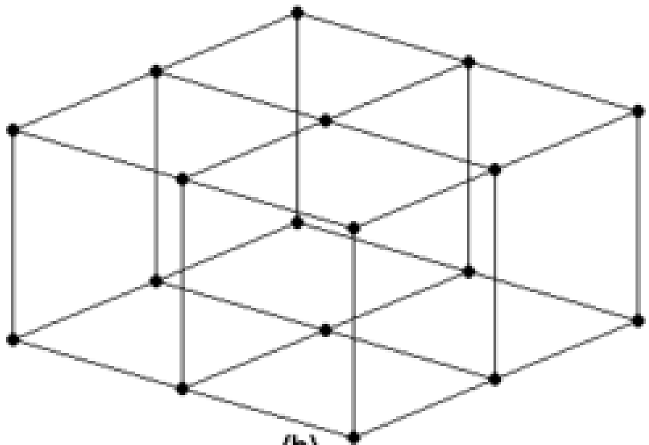
- In the centre of the Low, now over the Pacific Ocean (cyclonic)
- Along the cold front, now over the north of the South Island (Frontal)
- Along the south coast (Orographic)

3. With air arriving from the south, temperatures will be cooler.

A typical 'southerly change' such as this will usually precede the arrival of a High and a period of fine and stable weather setting in across the South Island.

Sources of weather information

Models use governing equations to transfer initial conditions into a forecast. Output depends on resolution and quality of data input. Less weather stations - less accurate and there are not many data points in the Southern Alps and Tasman Sea. More data points increases accuracy but might not deliver a forecast in time.



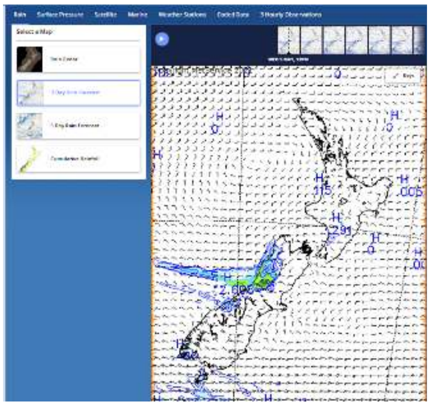
(b)

Location of South Island weather stations

Lower resolution is ok for large weather systems such as hurricanes and fronts. Smaller weather systems (thunderstorm cells, valley fog, convective cloud) fall through the gaps.

Model	**Resolution**	
ECMFW Independent European Agency	9km	Charge for data, 6 hours, most free weather sites use low resolution/small parameter data. Statistically ECMWF performs better than GFS for medium range (3-10 day) forecast
GFS NOAA (US)	22km	Free raw data. The majority of weather applications use this. Compared to other models, GFS can fail in mountain areas and by forecasting clouds and precipitation. However GFS can be more accurate for specific storms

Regional models allow higher resolution and are more accurate 1-3 days ahead (as it neglects a large part of the atmosphere). Still depends on data input at boundaries.



Metservice regional rain model

Forecasting in the field

When in the field, whether or not there is access to an updated weather forecast, observations of the clouds can give an indication and timing of any changes to the weather.

High, thin and wispy Cirrus and Cirrostratus clouds (also known as *Mare's Tails*) is usually an early indicator of an approaching front and is the result of ice crystals being moved by strong winds in the upper atmosphere.

Lenticular clouds (also known as *Hogs' backs*) are lens shaped clouds that form above mountain ranges indicating strong winds at higher elevations and likely incoming precipitation.

Mid and lower level Stratus clouds, sometimes with a regular ripple pattern, gradually develop and thickens indicating incoming rain and snow fall at higher elevations.

Fog and low clouds are common in valleys during periods of fine weather associated with Highs. It can especially be the case in the mornings whilst it is clear at higher elevations and often disperses during the day.

Avalanche assessment

Being able to identify avalanche terrain and assess the indicators of dangerous avalanche conditions will help make good decisions to manage this risk. When entering steeper and more complex terrain then it is important to have assessed the avalanche risk and how to avoid itFinally, being well practised in rescue techniques may help minimise the consequences should a member of your party get caught in an avalanche.

Summer avalanches and mountaineering

Avalanches are most commonly associated with winter but throughout the summer mountaineering season there are times when there is a high avalanche danger in the mountains. By midsummer, the snowpack has gone through a number of cycles of warming and cooling and the layers within it have broken down resulting in a single consolidated layer. When new snow falls, there are only weaknesses on the interface between the new and old snow and within the new snow that may be of concern.

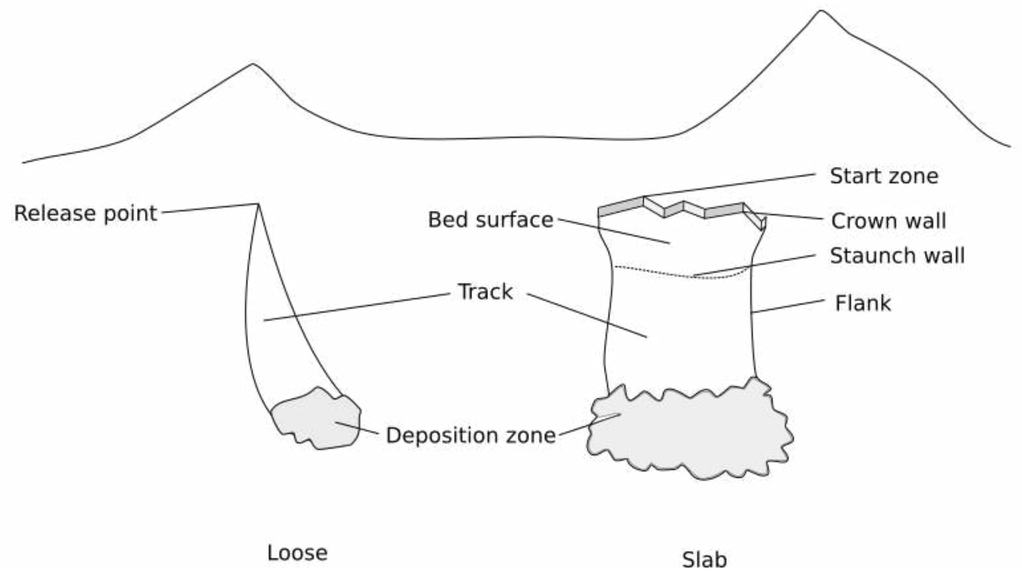
Large snowfalls can happen in summer, often with significant wind, and the avalanche danger will likely increase during and after the event. The generally warmer temperatures during summer will mean that avalanche concerns will stabilise quickly. Staying out of avalanche terrain for at least 24 hours after a summer storm will give a high likelihood of avoiding the worst of the avalanche danger.

Many accidents have happened when mountaineers have not been concerned about avalanches due to the time of year and therefore ignored the warning signs. By the nature of terrain accessed and the equipment carried by mountaineers mean that even small avalanches can have significant consequences. This includes being carried over cliffs or bluff, being tied together by a rope or being anchored by ice axes.

Avalanche types

There are 2 main types of avalanches:

Loose avalanches are also known as point release avalanches as they initiate at a single point and fan out. They are often relatively small, involving either very wet or very dry snow in the upper layer of the snowpack and can be easy to predict. Even a small one can be dangerous if they carry a person into rocks, gullies or over cliffs. They are usually triggered naturally by new snowfall or rapid warming from the sun or rain and are distinctive in appearance by their teardrop shape.



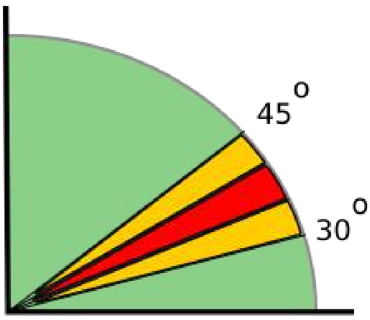
Slab avalanches are generally bigger, posing a bigger danger to backcountry users and can be more difficult to predict. A typical winter snowpack is made up of many layers and an obvious indication of a slab avalanche danger being present are denser cohesive layers of snow over weaker layers. When weak layers are loaded to the point that they fail, the snow slides off in one large sheet.

Slab avalanches that have released are easily spotted because the top of the avalanche will have a crown wall, an easily discernible horizontal line across the slope where the top of the avalanche was. The crown wall can be anywhere from a couple of centimetres to several metres in depth. Below the crown wall there will typically be a smooth slope, known as the track or path, bounded on each side by the flanks. At the bottom of the slope at the end of the run out there will be a pile of blocky debris in the deposition zone.

Avalanche terrain

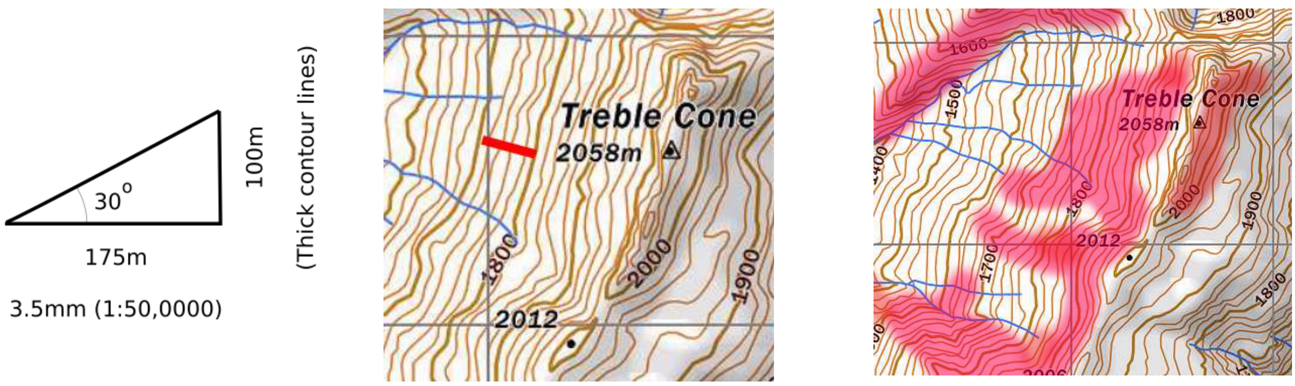
Being able to identify avalanche terrain is the most important skill in avoiding avalanche danger. With some time preparing a route, most areas of concern can be identified before even heading out the door.

Angle



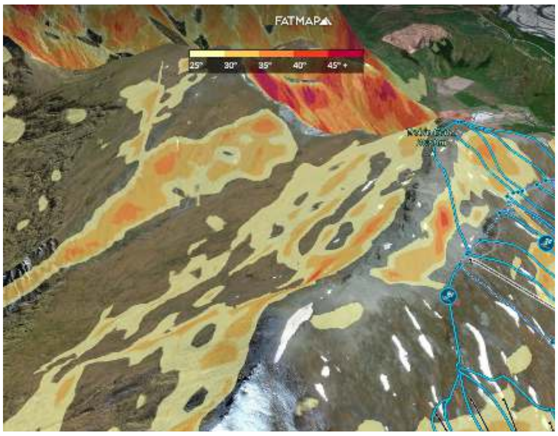
Slope angle is perhaps the most important characteristic of avalanche terrain. Avalanches can occur when the slope angle is between 30° and 45° with slopes between 35° and 40° being the most common. Shallower are generally not steep enough for the snow to slide whilst on steeper slopes, snow will constantly slough and does not tend to accumulate.

Most avalanche terrain can be identified simply by using the contour information available on topo maps. To measure slope angle from a map measure the distance between the thick 100m contour lines on a 1:50,000 scale topographic map. Slopes less than 30°, will have a 3.5mm spacing between these thick contours. Areas with a similar contour spacing will have a similar slope angle. A useful exercise is to shade all slopes that are between 30° and 45° as a prompt to assess the avalanche danger before travelling into these areas.



Assessing slope angle using a topo map

Websites and smartphone apps such as Fatmap® provide powerful tools for assessing avalanche terrain. These can be used as a guide to identify the complexity of avalanche terrain using terrain overlays that highlight slope angles between 30° and 45°.



These can be used as a guide for avalanche decision making and can be further refined out in the field by observation and measuring. Inclinometers or smartphone apps provide accurate slope angle measurements. Otherwise using two ski poles of equal length works well:

1. Lie a pole down on the snow making an indentation;
2. Place the tip of the first pole at the handle end of the indentation;
3. Hold the handle of the other pole next to the handle of the first pole and let it hang plumb vertical;
4. If the tip of the plumb vertical pole meets the tip of the indentation, the slope is 30°.

For every 10 cm beyond (down the hill) the plumb vertical pole hits the surface of the snow, add 3° to the steepness. Subtract 3° for every 10 cm it lands above the tip of the indented pole.

Aspect

The aspect of a slope will determine the slope's position relative to important conditions factors such as loading from the wind or warming from the sun (see Observations below). In NZ north facing slopes will generally be warmer and have more effect from the sun than cold and shady south facing slopes. This is opposite to the Northern Hemisphere. An awareness of what aspect a slope is, is vital and can be determined through studying the map beforehand and having a compass handy when out to confirm the aspect. With this information from the danger forecast particular aspects can be avoided.

Altitude

The air temperature will determine at what elevations precipitation has been falling as snow or rain. Higher elevations will generally receive higher levels of precipitation, stronger winds and colder temperatures. Temperatures will influence how the structure of the snowpack has changed whilst it has been on the ground. Information from the danger forecast will determine at which elevation there is likely to be an avalanche problem.

Terrain traps

Terrain traps are features below that increase the consequence of an avalanche involvement. They include gullys, cliffs, benches, crevasses etc. Terrain traps can make even small avalanches have big consequences.

Trigger points

Trigger points are terrain features or areas within slopes where there is an increased likelihood of triggering an avalanche. Slopes that are gradually getting steeper (convex), especially if the slope is unsupported and ending in a cliff or crevasse, are common trigger points.

Exposed rocks or trees (not common in NZ) provide good anchoring to the snowpack. Buried rocks can however present hidden trigger points being locally weak due to thinner snow depth.

Observations

Observations that are easy to gather from the snow surface or above will be the easiest to gather. Take particular note of observations that are contrary to the perceived avalanche danger, giving an indication that the actual conditions might not match those that were forecasted.

Recent avalanches

Evidence of recent avalanches will give good evidence of a current potential avalanche danger. Slab avalanches that have released within the last 48 hours are very significant since the instability that caused them will most likely still exist in other slopes with similar terrain characteristics. Evidence of slab avalanches can remain for many days or even weeks.

Signs of instability

Signs of snowpack instability including shooting cracks, 'whumpfing', pinwheels or glide cracks. Weak layers within a layered snowpack are sometimes so unsupportive that when they are walked or skied over them they will suddenly settle making a 'whumpfing' sound. This can occur on flat or low angle slopes where there is no avalanche danger but it does give an indication of similar snowpack conditions in avalanche terrain and may even remotely trigger avalanches on adjacent slopes. Sometimes they are accompanied by cracks appearing on the snow surface. On steeper slopes this sudden settling can trigger avalanches.

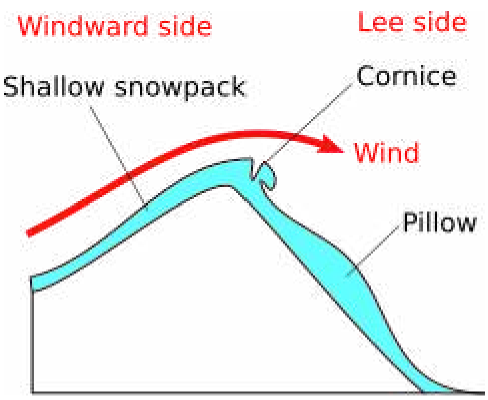
Loading

Avalanche danger will increase whenever additional weight is added to the existing snowpack. This could include new snow, rain and particularly wind (see below). The additional load may overload, or bring the snowpack close to overloading, weakness within the old snow or at the boundary between the new and old snow.

Wind

One of the most common causes of avalanches in NZ, which should be of particular concern to climbers and skiers, is wind. Wind scours snow off the slopes facing into the wind, known as the windward side, leaving a shallow snowpack with an often textured surface. This snow is deposited on the slope facing away from the wind, known as the lee side in a pillow of Wind slab. Wind slab will often have a smooth surface and feel hollow when encountered. If there is loose snow that can be shifted by the wind then there does not need to be new snow for there to be new loading. A small amount of new snow or lots of snow available for transport combined with moderate winds can result in a meter or more of freshly loaded snow on the lee side and a significant avalanche danger. Any time snow can be seen blowing off ridge tops then there is likely new snow loading, and this is very common in NZ.

Along pronounced ridges running perpendicular to the wind direction, snow will often form into cornices, often overhanging the lee side. Any obvious cornice formation should be regarded as an indication of likely wind slab formation on the lee side. Cornices should also be given a wide berth as they can fracture a surprisingly long way back from the crest.



Wind slab formation

Textured surface of windward slopes

Rapid temperature changes

If the upper snowpack is wet due to the warming effects of the sun, above freezing air temperatures or rain, especially if the change has been rapid, then the snow can become unstable. These problems are commonly an issue during the afternoon in late winter.

Rain will add warmth to the snowpack tending the temperature of the snow towards 0°C. The easiest observations of this type of instability are known as pinwheels- little snowballs that roll down the slope, or glide cracks- cracks forming as the snowpack slowly slides down the slope under its own weight. Rain events are common in NZ and whilst people tend not to be travelling in the mountains while it is raining, travelling immediately after a rain event should be avoided, giving the snow time to settle and refreeze.

Sun on snow has a big effect especially during late winter and spring. Snow warming from the sun will be aspect related. Slopes facing North will be hardest hit. Plan travel to avoid these slopes when they warm up later in the day, particularly when there is freshly loaded snow or when warm temperatures of cloud cover has prevented the snowpack refreezing overnight.

Safe travel techniques

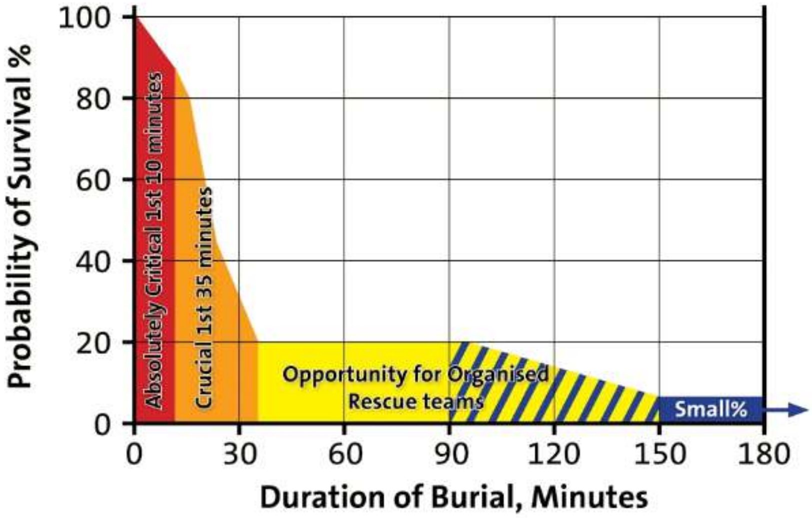
The terrain you choose will greatly affect your safety in avalanche terrain. Avalanche involvements are mostly triggered by another member of the party so regardless of the perceived avalanche danger, applying the precautions of safe travel techniques will further mitigate any risk when travelling in avalanche terrain.

- Spacing
- Visual Contact
- Safe Spots
- Route Selection
- Communication
- Escape Routes

Companion rescue

In order to minimise the consequences of an avalanche involvement, it is vital that all members of the group carry rescue equipment and are trained and practised in avalanche rescue regardless of the perceived danger.

As demonstrated in the chart below, rescue within the first 10 minutes of a burial is essential for the largest chance of successful recovery. Due to this tight timeframe the only chance of live rescue of a buried subject realistically lies with the group on site. Beyond 10 minutes, the probability of a live recovery decreases quickly the longer they are buried.



Underlying generic principles of avalanche rescue

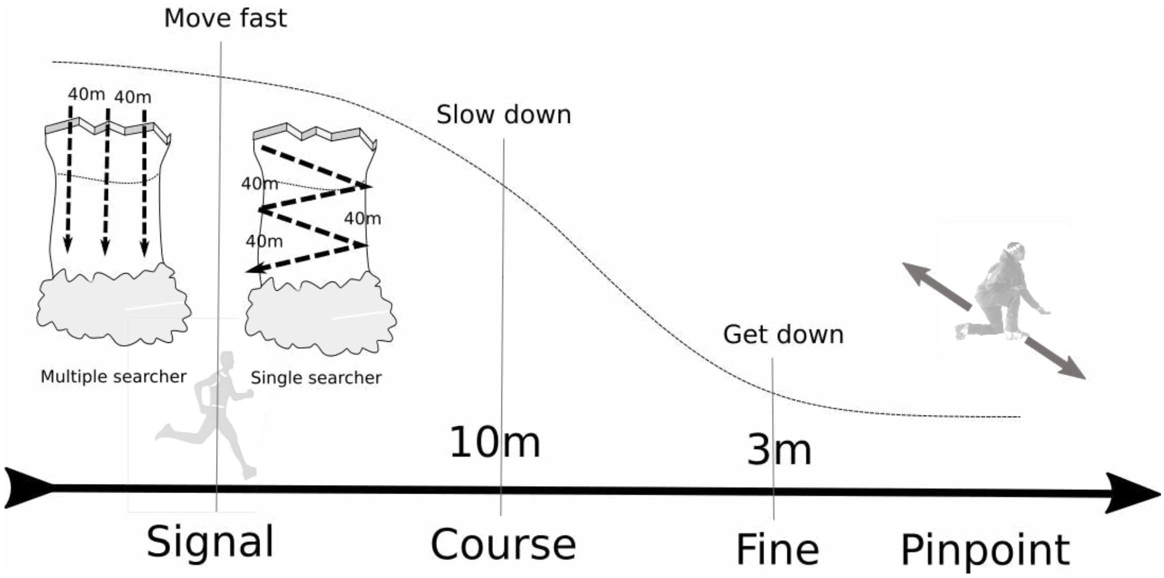
Even when the perceived avalanche danger is low, following a systematic approach to decision making, applying safe travel techniques and being prepared for rescue will provide the greatest possible safety margin.

In order to quickly recover a person, efficient procedures have been developed:

1. Coordinate - Make sure all members of the team are aware of the situation and keep visual of the victim for as long as possible. Keep everyone on site, do not send for help as outside help will be unlikely to arrive within the first 10 minute critical time period. Appoint a leader and other rescue roles. Define your search area through interrogating witness(es), identifying last seen point, surface clues and terrain traps that could be likely burial areas;

2. Risk assessment - Assess safety. Is there risk from further avalanches? Limit more people becoming exposed to risk;

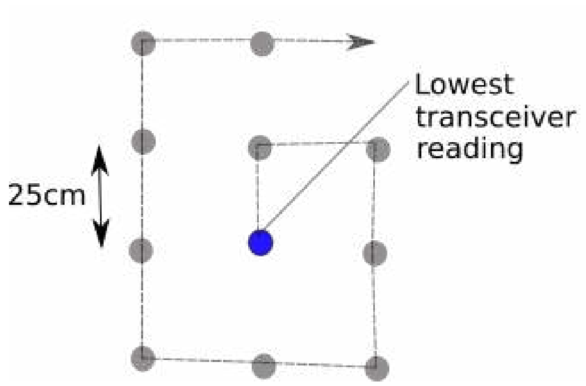
3. Transceiver search - Turn all transceivers to 'SEARCH'. Assign the minimum number of transceiver searchers for the size of the site based on the search strip widths of their transceivers. Begin a Signal search. Move as fast as possible during this phase. When the signal is detected enter the Course search. From 10m, slow down. At 3m move the transceiver to the knee and begin a Fine search and slow down further. Go back and forth along the trajectory to Pinpoint the point of the lowest transceiver reading;

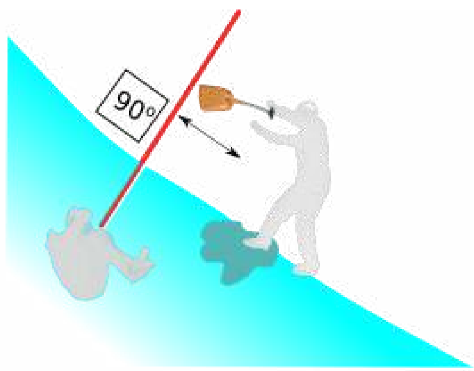


Transceiver search procedure

4. Gear up - Remaining rescuers get ready with probes and shovels and do a visual search or probe clues on the surface;

5. Probe - Once conducted a fine search and within a metre start probing perpendicular to the snow surface. If unsuccessful on the first probe strike, go 25cm uphill and systematically probe outwards in a grid spiral pattern until the buried subject is struck. On a successful probe strike, leave the probe in place;





Grid spiral probing 90° to snow surface and conveyor shovelling

6. Dig - Start digging one shovel length downhill from the probe and dig along the probe. Do not lift the excavated snow but paddle it backward. With more than one rescuer, use a systematic conveyor shovelling technique with the other rescuers in a single line a shovel length below each other, rotating regularly;
7. Patient care - Dig towards the head and uncover the airway. If the buried subject is not breathing, identify evidence of snow in the mouth or an ice lens. Initiate CPR.

Decision making

Having an understanding of where and when avalanches are likely to happen is a start but they are an incredibly complex phenomenon and making accurate assessment of the danger can be difficult and subjective. Avalanches can be a high consequence/low feedback phenomenon. Nothing happens most of the time even if risk reduction methods are applied. This makes it easy to treat the outcome as impossible and tends towards complacency. It is impossible to completely eliminate risk but a systematic and holistic approach can be used to minimise risk.

Depending on how much and the quality of the information is available to make an avalanche danger assessment, there will be an inherent degree of uncertainty. During times of higher uncertainty then it is appropriate to maintain a wider margin of safety and be conservative with decision making.

Overnight

For multi-day trips, shelter, food, water and fuel can be big weight items and require consideration. Consider how much water needs to be carried daily, as it may be more weight efficient to carry a lightweight stove and stop to melt water, rather than carry lots of water. Group items such as emergency items can be spread out amongst the group. Good restorative sleep is important for recovery but for shorter trips, sleeping systems can be scaled down. For example, sleeping in warm layers of clothes will allow a lighter sleeping bag to be carried. Insulation from the ground is more important than from above, especially sleeping on snow, and should be prioritised in the sleeping system. The relatively remote nature of New Zealand mountains means that for most objectives a number of days are required. This means consideration needs to be given to the logistics of prolonged stays in the mountains whether in huts or camping and during bad weather. Consideration also needs to be given to availability and provision of food and water.

New Zealand alpine huts

New Zealand has an extensive system of alpine huts. Most are owned by the New Zealand Alpine Club (NZAC) and managed by the Department of Conservation (DOC). Hut fees can be paid online or at the nearest DOC office.

Due to extreme weather events, having hard shelter nearby is important for longer trips. Almost all huts are first come first served so check with the local DOC office to see how busy a hut is before heading out. It is sometimes good to carry tents or bivy gear in case the hut is full.

Hut etiquette

On arrival at the hut, leave sharp items such as crampons and ice tools in the vestibule and outside the main living area. Do not wear crampons inside the main area. Keep your other belongings organised, either on your bunk or in a cubby hole and not on the table or other communal areas.

On leaving the hut on an alpine start, try to keep noise at a minimum if there are other hut users still trying to sleep. Keep noisy mountain boots off until the last minute, have your equipment organised the night before and do not rummage inside plastic. Don't leave dirty dishes to be cleaned up later, and if leaving the hut at the end of a trip, take all of your waste with you.

Hygiene

In the close confines of a mountain hut, hygiene is particularly important, especially without running hot water. Avoid dipping anything into drinking water tanks or buckets apart from the designated water dipper (this includes water bottles) as this is an easy way to contaminate the water supply.

Use hand sanitiser after using the toilet and prior to cooking. Do not leave any perishable food in the hut when you leave.

Cooking

Most huts do not have stoves but provide an area to use portable stoves. Keep the hut well ventilated while cooking by opening a door or window. Adequate ventilation is important to avoid a build up of poisonous carbon monoxide fumes. Carbon monoxide is odorless and can overcome its victims before they are aware of the danger. To minimise the risk of fire, refill stove fuel bottles away from sources of ignition, preferably outside, and store fuel in the fuel locker if available. Water is usually collected from rain on the roof and stored in tanks. At times the supply can get low so do not waste tank water. This could be at the end of a long dry summer or during winter when the tanks freeze. During the colder times of the year factor on bringing more fuel so snow can be melted for drinking water. It is appreciated if hot water can be prepared for other parties nearing the hut after a long day out.

Intentions and radio schedules

Record your intentions in the hut book before leaving the hut for the day's activity even if other hut users are aware of your objective. In the event of requiring a rescue, this may provide Search and Rescue important information on where to find you, which may expedite a search.

Most huts have a radio with access to DOC and there is a scheduled daily weather update when DOC also records the numbers and parties in the hut. The time of this 'sched' is different for different areas and during summer or winter so check with the local DOC office before heading in. In the Aoraki/Mount Cook National Park the radio will turn on automatically but elsewhere the radio will have to be manually switched on. Nominate a radio operator and give them information on party names and numbers to pass on. Be quiet so that others can listen to the weather information.

Waste management

All rubbish should be carried out of the mountains. Put careful consideration into what food packaging you are taking into the mountains and will have to carry out. Good habits include separating out recyclables whilst in the hills so they are easy to dispose of when you get back to civilization. Do not leave partially empty food containers, gas canisters or perishables, as rubbish can quickly build up. If flying out from a hut it is a good opportunity to clear out any surplus items.

Tenting

In good weather tents will work fine, but in high winds they need protection. Rock or snow walls can be used to protect tents from the brunt of the weather. Heavy snow can build up on tents causing damage, and can require constant maintenance in the night. In extreme weather, tents can quickly become damaged resulting in an exposed situation, so having a nearby crevasse or other shelter option scoped out ahead of time can be essential. It is not safe to cook inside a tent but carefully using a stove in the porch may be required in bad weather. In this case it is good to have a tent that does not allow rain to touch the inner with the porch door open.

Keas are curious birds that can ruin a tent that is left alone for the day. If they are present in an area, the only solution is to break camp each day, secure it and bury it well under rocks.

Campsite selection

Choosing a good campsite (or bivy site) is the key to a comfortable night. Some things to consider are:

Drainage – avoid depressions or potential flood plains near watercourses. Gentle slopes allow better drainage.

Shelter from prevailing weather - position the tent to withstand the expected wind direction, this is difficult if it changes during the night.

Proximity to a water source - such as a stream or patch of snow.

Surface – lumpy tussock or big rocks may take a bit of work to fashion a nice flat surface on which to spend the night. On glaciers, use a probe to check that the site is not over a crevasse. Often right next to a known large crevasse gives good confidence.

Anchoring – Above the snowline pegs will not work, but rocks, snow-filled stuff sacks or bags, ice axes or trekking poles can be used.

Bivying

Bivying (from Bivouacking) is camping without a tent or covering. With a good weather forecast, a bivy can be used to get a head start on a longer route or just to avoid a busy hut. A bivy bag will keep a sleeping bag from getting too wet in case of rain or heavy dew but condensation can dampen the sleeping bag from the inside. To keep out of the wind, rock walls are commonly constructed or it may be possible to find a suitable crevasse to shelter in. The unplanned bivy can occur and should be considered in planning.

Human waste

When staying away from huts or toilet facilities, the management of human waste needs to be considered. In more remote areas or below the bushline it may be acceptable to leave it there where it can decompose naturally. It is important to follow DOC's recommendation and make sure that toileting is done more than 50m from a water course, something that may be quite difficult in a rainforest. Above the snowline, waste can take a very, very long time to decompose and in high-use areas systems for carrying out human waste need to be considered. Human waste left in the mountains is unsightly and a potential health risk, particularly in high-use areas.

A dry bag lined with a biodegradable poo bag is a good way of transporting waste until it can be disposed of in a long drop. Products also exist to solidify and neutralise the smell of human waste so it can be disposed of with normal refuse.

Snow Shelters

In winter, when carrying shovels is standard practice, snow shelters can provide a weatherproof shelter, albeit with a bit of work involved.

Digging snow shelters can be tiring and sweaty work so avoid wearing too many layers that will get inevitably wet. Save some warm and dry clothes to change into once done.

Cooking inside any snow shelter is very dangerous because of rapid carbon dioxide build-up in the small air space available. It is essential to keep them well-ventilated by making a ventilation hole in the roof and keeping it clear. It is never good to sleep with the stove going. When cooking, check regularly that the entrance and the ventilation hole have not been blocked by snow.

Snow mounds

Snow mounds are in effect another sort of snow cave that is particularly useful when on flat terrain with a relatively thin covering of soft snow.

A snow mound is constructed by digging a pit, placing a pile of backpacks, and then burying them with compacted snow. Once finished, the mound can be burrowed into and the backpacks removed, creating a basic snow cave.

Snow cave

Snow caves are remarkably warm and reasonably dry when constructed well, but are time-consuming to build compared to erecting a tent. Once a cave is finished it will not collapse but it can be fragile when being dug. Make sure that one person is always outside with a shovel when people are in the cave digging in case it collapses.

First, a safe slope needs to be selected. To avoid digging in an avalanche path, choose a windward (although these can have shallower snow depths) or short slope.

Begin by tunnelling upwards into the steepest part of the slope. This makes the best use of gravity to carry the excavated material out and away down the slope. Once the tunnel is beyond body length, the sleeping platforms can be constructed by digging upwards. The aim is a smooth rounded ceiling and elevated sleeping platforms so cold air can descend and escape down the entrance tunnel. Sculpt the ceiling into a strong dome shape and avoid any bumps and lumps, as these will lead to dripping. Always keep the snow shovel inside to assist escape if snow fills in the entranceway.

Sustenance

‘Life is brought down to the basics: if you are warm, regular, healthy, not thirsty or hungry, then you are not on a mountain... Climbing at altitude is like hitting your head against a brick wall — it's great when you stop.’ Chris Darwin

Cooking

Liquid fuel (MSR® type) or gas canister (Jetboil® type) stoves are the main options when choosing a stove for cooking. Gas canister stoves are lighter and cheaper and great for shorter length trips and can be incredibly efficient for boiling water quickly. Liquid fuel stoves work best in cold conditions and for longer trips, especially if it is anticipated that snow will have to be melted for drinking and cooking. Melting snow uses a lot of fuel which will have to be accounted for when deciding how much fuel to take. The stove system and menu are closely tied, and the ability to quickly melt snow can save carrying kilograms of water on a long route.

Hydration

Hydration is a vital part of staying fit and healthy in the mountains. Dehydration, which can exacerbate the effects of cold, increases fatigue and impairs cognitive processes. The water carried or available needs to closely match with the requirements of the day. Camelbak® style bladders take up no space when they are empty but can freeze in cold conditions and can leak or malfunction, filling the pack with water. Nalgene® style bottles are great for filling with hot water for use as a hot water bottle at night, but beware of doing this with thinner bottles which can melt and burst. On longer routes a stove can be carried to melt snow, as it is lighter than carrying all the water you will need.

When melting snow, start with some water at the bottom of the pot; otherwise, the snow sublimates and can be lost. If no water is available, heat the snow slowly and try to seal in water vapour with a pot lid or compressed snow.

Nutrition

The modern approach to alpine style can be considered a sprint rather than a protracted siege. On climbs of up to 24 hours in duration, which you might expect in NZ, food is there to keep hunger at bay, stop fatigue and survive.

There is a huge range of sports-specific products on the market that satisfy this niche. The main principles are to have a menu that is palatable, light, quality, robust, compact and cost effective--food that can be easily consumed either on the move or with minimal cooking. Snacks can be stuffed into pockets and pack lids, and water carriers kept handy so water can be consumed regularly and whilst on the go, avoiding unnecessary breaks. As with hydration, lack of supplies can have a detrimental effect on performance.