GOOD AVIATION PRACTICE

Mountain Flying

CIVIL AVIATION AUTHORITY OF NEW ZEALAND

Mountain Flying

No matter where you fly in New Zealand, at some stage your flight will be affected by the mountainous terrain that makes up over half of this country. The forces of nature have a greater impact and pilots who operate amongst the mountains have developed a special set of skills and knowledge to help them survive.

Those 'flat-landers' who wish to fly amongst mountainous terrain must develop these skills and appreciate the factors involved. To ensure a safe and enjoyable flight you need to collect the knowledge, attain the skills and above all, know your own limitations and those of your aircraft – then stick to them.

Preparation

As for any flight into an unknown area, preparation is the key to a successful journey. Too many pilots venture into mountainous areas without preparing themselves properly. A healthy respect for these areas and an understanding of their peculiarities and pitfalls could save your life.

Weather conditions

A good up-to-date weather briefing is essential. Weather in the mountains can change very quickly, so being aware of any trends will help. Actual weather reports are a great help, especially if you can get them from people in the area. Generally, conditions for flight in mountainous areas are better in the morning. In the afternoon there is more cloud build-up and stronger wind.

Terrain

The size and scale of the terrain can be difficult to appreciate. An aircraft is a very small dot on the landscape, an important point to remember with respect to both the power of nature, and other aircraft. You will be a tiny speck on their surroundings.

Make a very careful study of charts during your pre-flight planning. Get an idea of which way the land lies so that you have an overall mental picture of the terrain before you set off. Then, should you find yourself in a situation of deteriorating weather and high cockpit workload, you will be able to answer the question "If I cross that pass, will it take me out to lower terrain?"

Studying the map carefully will also give you an appreciation of the steepness of glaciers and mountainsides. This can dissuade you from attempting to climb or descend through gaps in cloud cover. The slope of valley floors or glaciers can be difficult to judge and is frequently under-estimated. The old top-dressing adage of "don't fly up a valley you haven't previously flown down" is one you should stick to.

An ever-present danger in valleys is wires. These can be strung across any valley, and often from a ridge down to the valley floor. Remember to keep a sharp lookout if operating below the ridges.

Plan your route according to the terrain and the wind effect. Your route will not be a straight line, but should follow the ridges with the up-flowing air where possible.

Mountainous terrain can be particularly difficult to navigate around and more than one trip is needed to completely familiarise yourself with the terrain. Get some instruction on both high level and low level navigation.

The navigation workload in the mountains increases significantly in poor weather, and can be very daunting to even the most experienced pilot. Eliminate some of this stress by good pre-flight planning.

Pre-flighting the aircraft

In addition to your normal pre-flight items make sure all the lights are working. In areas of high traffic density, such as over the glaciers and around Mt Cook, aircraft are much easier to spot with their lights on.

Avoid carrying unnecessary payload; this will ensure you have the maximum performance available. Check that all payload is adequately secured as turbulence in the mountains may be stronger and more persistent than you are used to.

Make sure you have a clean windscreen – and use vertical cleaning strokes (this helps you avoid confusing any marks on the windscreen with wires when operating in poor visibility and at low level).

Pre-flighting the pilot

Before you take off, set your limits. What visibility limits will you place on yourself? What cloud base limits? What wind strength and direction limits? What is the latest time you can depart in order to arrive in plenty of daylight? Have you completed the I'M SAFE checklist?

Write all these down, plus any more you can think of. This way the decisions have been made before you get airborne. Now challenge yourself to stick to them.

Getting all the Information

Talk to the professionals

Get some advice and some practice before you go. Don't pick just anyone though; search out the people who have the most to offer. Many who routinely operate in mountainous terrain will be more than happy to pass on some advice. They may even be able to give you some dual instruction before you go – or come along on the flight – but don't count on them always being available.

Always get a local area briefing from a local instructor.

Know your aircraft and its limitations

If you need to, take some time to refamiliarise yourself with your aircraft's performance. What distance over the ground does your aircraft cover in a rate one turn? What's the distance for a rate two turn? What speed do you use for reduced visibility? What is the best angle of climb speed? How is your aircraft performance and handling affected by altitude and turbulence?

One last run-through of aircraft speeds and emergency procedures will never be wasted time.

Conditions in the Mountains

All mountainous terrain can be subject to severe and rapidly changing weather conditions. Weather is therefore a very important consideration when flying in the mountains. An understanding of at least the major airflow patterns is necessary for pilots intending only to overfly at higher altitudes.

Wind

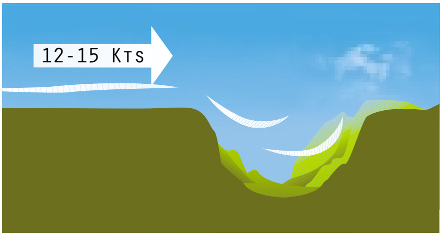
Wind of some sort is usually present in any mountainous area. Intelligent assessment of its strength and direction will help flights to be planned for the probable smoothest route.

It is useful to visualise the airflow as water. Think about how water would flow over the terrain; where it would accelerate through passes, divert along valley floors before being forced over a ridge, how it would pour over ridges, and how rapids of turbulent flow would occur where flows mixed or tumbled over obstructions.

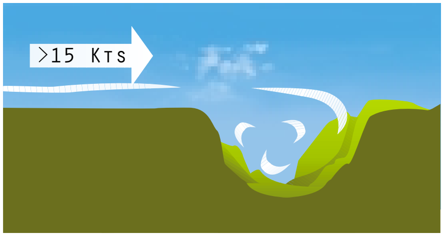
Remember that upper level winds will not always give a clear expectation of valley winds. Other cues such as wind lanes on water, tussock or bush; or flying across valleys and perceiving drift are ways that the valley winds can be estimated.

Downdraughts and turbulence will generally be found on the lee side of features and will increase in severity and extent with increase in wind strength.

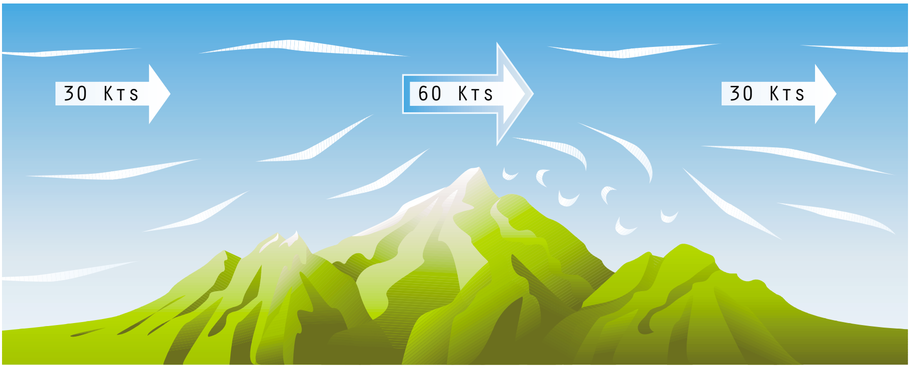
Below 12-15 knots the wind flow is generally predictable.



Above 15 knots the patterns alter and become more difficult to predict.



Once the wind gets above 15 knots you will need to focus more on wind lanes on water or tussock/bush, than upper cloud movement or winds.



When the wind is above 15 knots flight below the ridgelines in the lift side of the valley could be more comfortable, however, flight at lower levels is unwise without the specific knowledge, training and experience that we cannot hope to cover fully here.

Flight at higher levels can give a false sense of security so be aware that the wind is likely to be stronger with altitude, and any associated turbulence more severe.

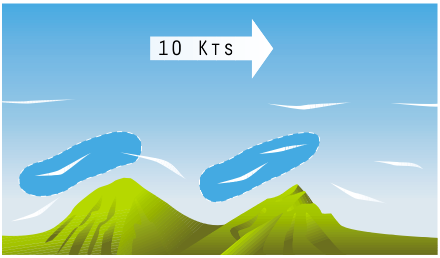
Updraughts and downdraughts

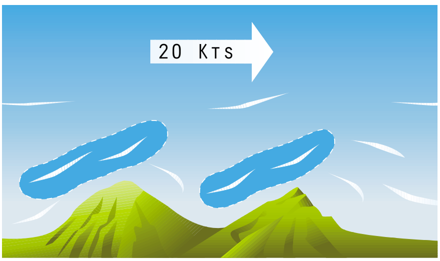
For pilots unfamiliar with mountain flying, the strong vertical movements on windy days can be very daunting.

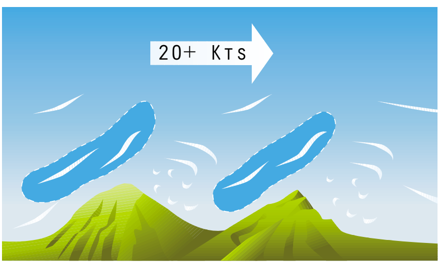
Downdraughts, which may exceed 3000 ft/min, are usually the main problem, but updraughts can also be a problem.

On the upwind side of larger mountain ranges the air tends to be smoother and up-flowing. When you want to climb, make full use of updraughting air by assuming the best-rate-of-climb configuration and staying in the updraught as long as practicable.

If a downdraught is encountered, move out of the down-flowing air as soon as possible and try to locate the adjacent up-flowing air (usually by turning upwind or downwind). Do not try to outclimb downdraughts.







Turbulence

Any obstruction to airflow will produce mechanical turbulence. Low hills, buildings and trees will produce small-scale turbulence – mountain ranges naturally cause large-scale turbulence. The intensity of turbulence on the lee side of obstructions varies with such factors as wind speed, the direction the air flows across the terrain, and the size and shape of the obstruction.

It is possible to experience wide speed fluctuations in turbulence. Maintain an aircraft attitude for a safe mid-range airspeed (manoeuvring speed), and hold that attitude rather than chase the airspeed.

Large variations in wind strength and direction, known as windshear, can also have a very significant effect on flying conditions.

Before any flight in mountainous terrain, ensure all on board have their seatbelts tightly fastened. It is worth remembering that your passengers may have less tolerance for turbulence than you do – so don't overdo their exposure to any rough air. Ensure all luggage is well restrained. Turbulence can occur without any warning especially if you are inexperienced in reading the signs.

Mountain waves

When the wind blows at or near right angles to a mountain range, or high isolated peak, the air is naturally disturbed, as it must go around or over the obstacle. Mountain waves form quite frequently when air is forced over an obstacle. There are two further conditions that must be met before mountain waves will form:

- A low-level wind of at least 15 knots which increases in strength with height.
- A generally unstable atmosphere at low levels with a stable layer at a higher altitude.

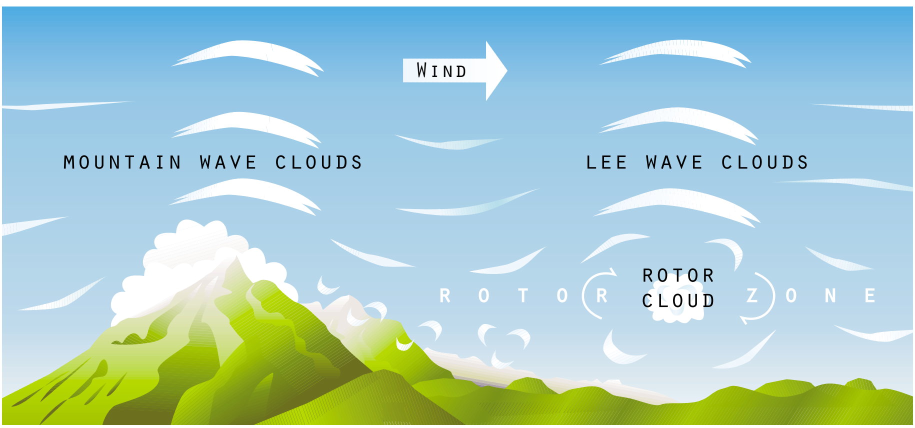
If the air has sufficient moisture, then the crest of these waves may form a lenticular (lens-shaped) cloud. Although the clouds appear to be stationary, in reality they are continually forming on the upwind side and dissipating on the leeward side. Generally, smooth strong updraughts can be found on the windward side of these clouds.

On the leeward side of these clouds the air is descending as quickly as the air on the windward side is rising. These descent rates may be too great for passenger comfort (and pilot peace of mind!).

If the leeward side of the lenticular cloud is ragged you can expect there to be severe turbulence downwind of these clouds.

When the wind becomes strong, moderate to severe turbulence will be encountered on the lee side, from the surface to well above the mountain tops. In the Southern Alps quite severe lee turbulence can be experienced several miles downwind of some peaks.

Most mountain waves in NZ result from prevailing westerly winds, but wave systems can be encountered whenever there is sufficient wind and terrain to generate the wave disturbance. Glider pilots use this to great effect for their soaring so if you have a gliding club near you, check with them and they will be able to explain more about lee wave systems.



Rotors

A rotor is a large closed eddy that forms in the lee of a mountain range or any obstacle in the airflow and is an area of severe turbulence. Rotors are usually found under the crests of mountain waves, often within 3000 feet vertically of the generating ridge. The wind below the rotor will be in the reverse direction to the general flow. Updraughts and downdraughts in a rotor have been measured at over 5000 ft/min. Rotors can sometimes be recognised by ragged, wispy bits of cloud beneath a mountain wave cloud but if there is insufficient moisture for cloud formation, rotors may be invisible. Lines of rotor will lie perpendicular to the wind flow; ie. in a westerly flow, the rotor line will be orientated north/south.

In these conditions keep the airspeed below the maximum manoeuvring speed (V_A).

Cloud

Conditions can change rapidly and cloud can form very quickly. A slight change in temperature towards the dew point can produce almost instant cloud. It can rapidly build up around passes and crossing points.

Beware of rapidly forming cloud.

In fine weather, thermal heating and associated cloud build-ups are common along the tops of mountain ranges and on the upwind side of the ranges. These tend to be at their maximum between 2 and 3 pm and usually die down in the late afternoon, disappearing by 6 to 7 pm.

Season

In winter there is more snow, so there is more to see in a scenic sense, but because of the snow cover, it will be harder to identify glaciers and passes. There is less definition – ridges and passes are more uniform in appearance. In winter, storms are more severe, but on fine days there is less wind and less cloud. The air is more stable, with good clear visibility, and aircraft performance is better in the cooler conditions.

Changeable weather

Because conditions can alter with subtle changes of wind strength and direction, it should be obvious that a watchful eye must be kept on the weather conditions, both at the flight planning stage and throughout the flight. Keep a close watch ahead and behind. A sudden deterioration could prove a major problem. If in doubt – back out early.

Lighting

Different lighting conditions can create definition and depth perception problems in the mountains.

The position of the sun can cause areas of deep shadow, especially in valleys, into which it is difficult to see. This can occur in the early morning or late in the day when the sun is low on the horizon, and is more marked in winter. In snow covered areas there is flatter, harder lighting in the middle of the day.

Anticipation of the sun's position is also important so you are not surprised by it as you come around a ridge or peak. This can happen at any time below the ridgeline, so have your avoiding action planned.

Whiteout

There is always a certain lack of definition on snow surfaces, but this worsens very quickly when sunlight becomes subdued. When a large unbroken expanse of snow has the direct light reduced by an overcast sky, it blots out all trace of surface texture or shadows. It merges hollows and snow-covered objects into a flattened white background. In addition, cloud and sky have the same apparent colour, so horizon discrimination is lost and the face of the ground disappears. It becomes impossible to judge height and distance. It also becomes impossible to see any patches of lower cloud.

Whiteout conditions are likely when operating up glaciers below a solid cloud ceiling. In the lower sections of the valleys there is nearly always plenty of rock, tussock or shingle to provide good terrain perception. Further up towards the head of the glacier, pilots must be alert to perception problems and must turn back down the valley before the safe visual cues start to disappear.

Contrast

An illusion of contrast occurs when dark coloured rocks or ridges are visible above the snow. It can trap a pilot by giving the impression that good contrast conditions exist, when in fact it is still difficult to estimate the aircraft's current height above the ground. This is a real trap for helicopter pilots.

Brightout

In snow-covered areas brightout occurs with a clear sky and bright overhead sunlight conditions. No shadows are cast because of the bright reflection from the snow. This can give a false representation of what you are flying over and cause partial disorientation. There is virtually no visible definition, and as a result hummocks and ridges will appear flat on unmarked snow. Again this can be a problem for helicopter pilots.

The most important principle for flying in snow areas is that you progress according ***to what you can see***. The worst trap is attempting to proceed because there appears to be ***nothing*** ahead; this is the classic feature of whiteout conditions – the seeming void ahead and below.

The worst areas are those of total snow cover, such as the upper névé areas of glaciers, and other areas immediately after heavy snowfalls.

Flight in these conditions is only safe when the pilot is familiar with the area, and has sufficient reliable visual cues to determine the position of valley sides and the surface below.

Common illusions

Relative scale

When you are amongst large mountains it is very difficult to accurately judge scale and distance. Mountains seem a lot closer than they actually are, simply because they are so much larger than you are. It's hard to imagine that some of the crevasses in the glaciers would swallow an aircraft whole, leaving no trace at all.

The only way to confirm your distance from the terrain is by picking out features on the surface, such as tussocks, trees or bush that your mind can accurately judge the size of. This will help you work out how far away you are and give you an indication of your size relative to the mountain. It is important to be able to judge your distance from the terrain, it is the only way to tell if you have allowed enough room for a reversal turn.

Sometimes when you are in mountainous terrain in strong winds, you need to be up close to the terrain as it could be the safest place to be. However, you should not be venturing close to terrain without any instruction or guidance beforehand.

Hidden obstacles

A common perception problem, of which pilots should be constantly aware, is the tendency for snow-covered faces and ridges to merge with each other. Mountain faces in the distance, with a mix of rock and snow, can very easily mask the presence of a much nearer ridgeline of rock and snow merging against the background.

The classic situation is the aircraft climbing towards a mountain range a few miles away that is slightly higher than the aircraft, and an intervening ridge of similar cover merges visually with the more distant face. Because there is very little relative movement between the two ridgelines and poor distance perception with featureless snow covered terrain, the nearer one can be mistaken for part of the more distant face.

The same effect can occur when following the side of a snow-covered valley where ridgelines extend out from the main valley profile. It is very important to maintain good visual contact with the bases of approaching ridges, and with valley profiles, so that a complete picture of the terrain ahead is correctly perceived.

The situation is more pronounced in overcast or shadow, but can still be a problem in full sunshine.

False horizons

The frequent lack of a defined external horizon can create aircraft attitude and airspeed problems. When flying amongst the mountains, or anywhere the horizon is not visible, the pilot must imagine that horizon. Mountain-flying training, with instructors experienced in the mountains, is essential to recognise the need for this skill, experience some of the pitfalls and have practice at attaining it. This skill is not in-built and must be learnt. Without this ability, maintenance of attitude is compromised, manoeuvres in a valley are hazardous, decisions are compromised and performance and safety are eroded.

Relying on your instruments alone won't work. In a confined space with reduced visibility the eyes must be outside and performance must be interpreted by nose attitude and then confirmed with instruments. With reduced altitude and space the lag in instruments is too great to rely on them implicitly. If pilots try to follow the artificial horizon, they will only ever react to the instruments, when they could have their eyes outside and be anticipating the attitude changes.

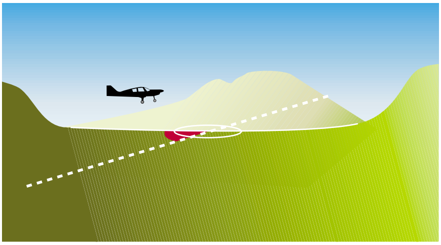
A common trap the inexperienced fall into is using a ridgeline as the horizon and unintentionally climbing the aircraft. The horizon goes through the base of the mountains, not the ridges. It can be easy for pilots to use a sloping ridgeline as the horizon, thereby flying the aircraft with a bank angle.

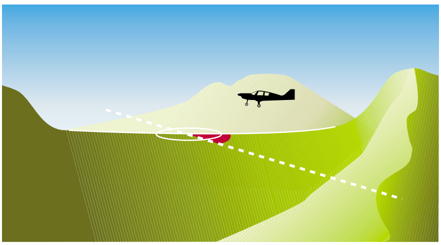
In bush clad areas there is a good high level horizon – the bush line. In NZ the bush grows up to an altitude of around 3500 feet and is a good means of locating a horizon in steep mountainous terrain.

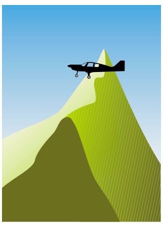
Manoeuvring adjacent to sloping terrain makes it more difficult to judge bank angles. The trap is to over-bank, which invites unwanted descent and reduction of stall margins. Scan the necessary instruments to ensure you are achieving the bank and speed you want. Make the first part of the turn relatively steep then roll out as the turn progresses and a new horizon comes into view.

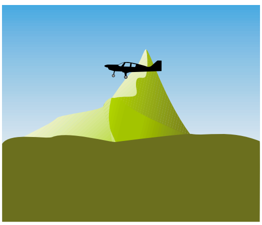
Flying Techniques

There is no substitute for practical, basic, mountain flying training. If you can get some, do so. Do not rely on what you read here to be enough.









Ridge crossing

Saddle crossings are a compromise of many issues. Try to approach to cross at 45 degrees with the saddle on your left. This offers

- the best view of the approach and the other side of the ridge.
- a shallow approach angle and therefore shallow escape angle. In sink or turbulence you have a minimum angle of bank required to turn away, therefore less wing loading and lower stall speed.

Your escape must be through a shallow angle downhill and downstream.

If the position of a ridge or a spur denies an escape route to the right, then a right to left crossing with the ridge on your right may be necessary. Always have the best escape route available.

Choose a knife-edge ridge as opposed to a flat ridge, which requires a prolonged period to cross.

Approach level, with your speed under control (below V_A), with your hand on the throttle in anticipation of windshear, which, if present, will occur at the ridge crossing.

Always make sure you have adequate terrain clearance before crossing a ridge. With a constant nose attitude, if you are seeing more terrain behind a ridge then you will clear the ridge, but make sure you have sufficient height to provide a safe margin. If you are seeing less terrain behind a ridge, then you won't clear it and you must turn away to gain more height before making another attempt.

Do not approach in a climbing attitude where low speed means you have less margin above the stall. Do not cross in a descending attitude, high speeds can cause structural damage in turbulence.

Valley flying

Normal recommended mountain-flying technique is to fly on the downwind side of a valley. This means the aircraft is flying in smoother updraughting air. If a 180-degree turn becomes necessary, it is made into the wind, requiring less distance over the ground. Bear in mind that downdraughts may be encountered on the lee side of any terrain.

Remember that the wind strength and direction in a valley can vary markedly with height. At low level the wind may be down a valley while nearer the tops of the ridges it may be across the valley.

When operating in areas where other traffic is likely (and this applies to many common routes in New Zealand), it is preferable to fly on the righthand side of the valley if possible. If this is not wise because of turbulence or downdraughting air for example, be aware of the likelihood of meeting other aircraft, and maintain a particularly good lookout. Make frequent position reports for the benefit of other aircraft.

Never attempt to climb up or down a glacial valley under a cloud layer – even if you can see it is clear at the head of the glacier. There are two problems: the cloud often shelves down along the contour of the glacier; and the slope of the glacier may exceed the performance capabilities of your aircraft.

Entering a valley

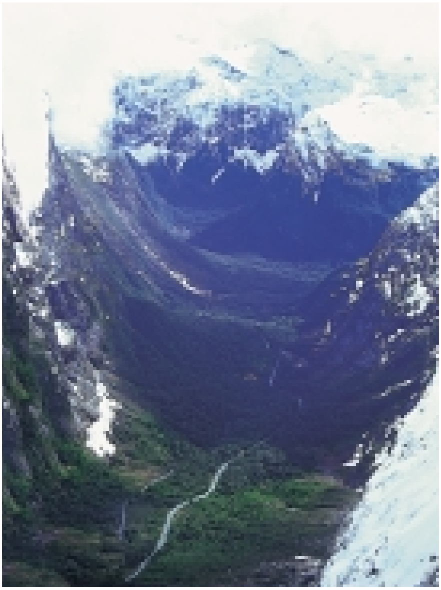
When entering a valley, always double check with the compass and map to ensure you are in the right valley. This simple check could have prevented several accidents in New Zealand where aircraft have ended up in a narrow or dead-end valley – sometimes with fatal results.

Know whether the valley climbs and what altitude you will need to clear the pass or ridge at the end. Once again, if in doubt use the old top dressing adage, “never fly up a valley you haven’t previously flown down”.

Flight up a valley, keeping the escape route open, may be necessary in certain circumstances to assess an unseen saddle at the head. Do not attempt this without the training and experience necessary to help make a safe plan.

Turning

Always position yourself in a valley so that you will have enough room to turn around if needed. You need 5 – 7.5 seconds to see, evaluate, decide and execute. If you are in sink and at low level, this time plus any time taken to move over in the valley will be longer than you have. In narrow valleys commit to one side or the other, preferably the righthand side for the reasons mentioned above. Under no circumstances position yourself in the middle of the valley, no-man's-land, where reactive decisions are required. The only exception to this is when you are in a large valley where turning radius is not an issue – in this case anywhere right of centre is appropriate.



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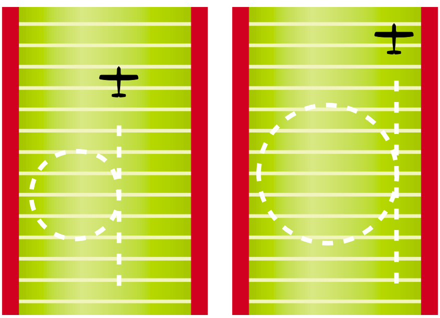
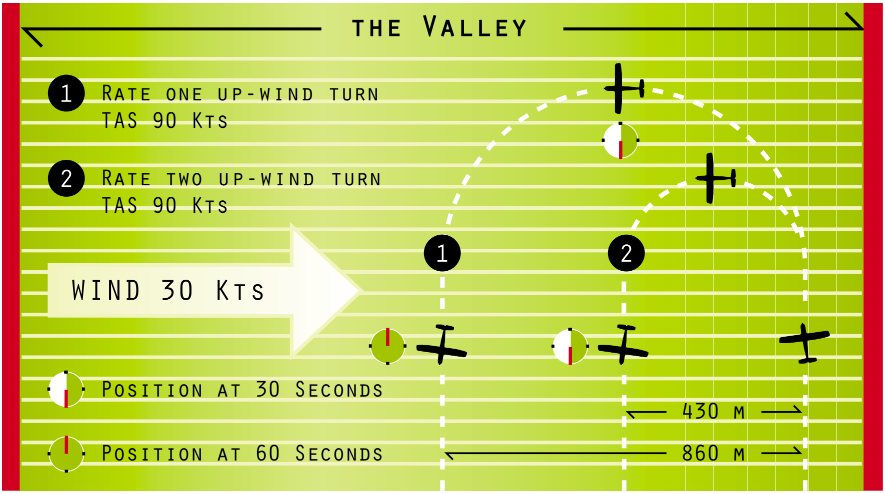


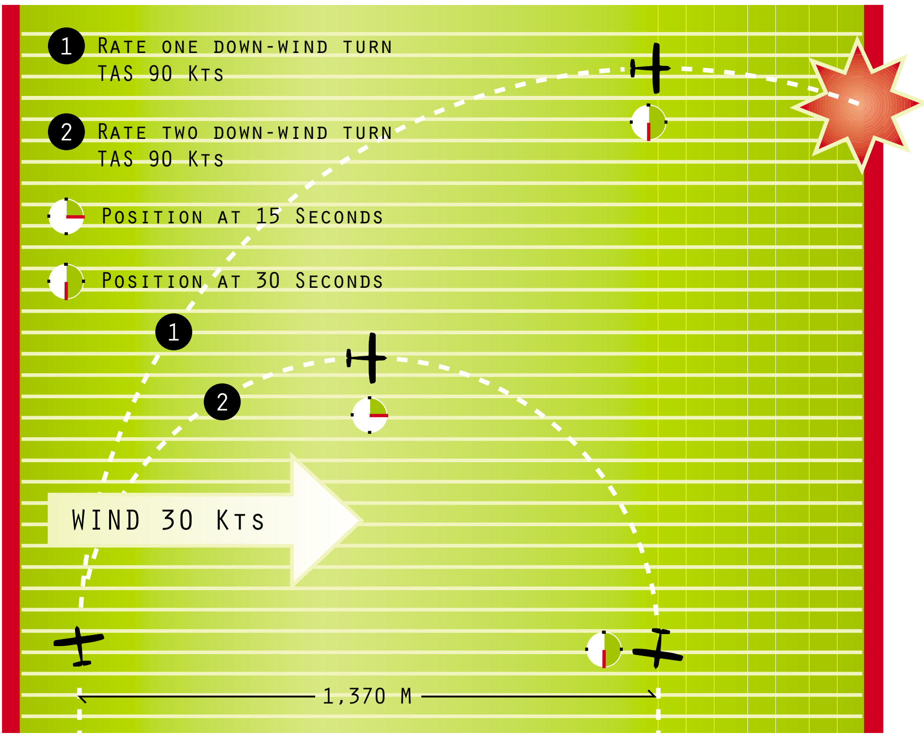
Positioning to one side of the valley leaves maximum room to turn.

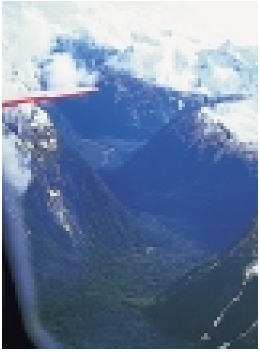
Leaving maximum room to turn also means less bank angle is needed, therefore, less wing loading and a lower stall speed. When executing the turn control the speed; too much power translates into too much speed that means a greater radius. Use only enough power to keep your airspeed to one that allows a controlled turn with an appropriate radius. If the space is confined, make check turns of 360 degrees to ensure an escape route remains open. Use the reduced visibility configuration to enable slower speed and smaller turn radius. A controlled climbing or descending turn can also reduce your turn radius significantly.

During the lookout before the turn remember to superimpose an imaginary horizon line onto the background.

If, when in the turn, airspeed decays with full power applied, lower the nose to convert height to airspeed. Know which way the stream or river runs; downstream leads out of the valley or towards lower terrain. Downstream leads to bigger rivers, lakes, roads and towns.


THE VALLEY
1 RATE ONE UP-WIND TURN
TAS 90 KTS
2 RATE TWO UP-WIND TURN
TAS 90 KTS
WIND 30 KTS
POSITION AT 30 SECONDS
POSITION AT 60 SECONDS
430 M
860 M


1 RATE ONE DOWN-WIND TURN
TAS 90 KTS
2 RATE TWO DOWN-WIND TURN
TAS 90 KTS
POSITION AT 15 SECONDS
POSITION AT 30 SECONDS
WIND 30 KTS
1,370 M



At maximum-all-up weight the aircraft will not perform as well, turn radius will be greater and rate of climb is reduced. Most accidents occur because of a stall in the turn or because the pilot attempted to out-climb terrain. Both are directly linked to poor horizon recognition.

Escape routes

The golden rule of mountain flying is to ***always have an escape route***. The aircraft must never be placed in a situation where there is insufficient room to either turn back safely, recover from an encounter with turbulence or downdraught, or to make a successful forced landing in the event of an engine failure.

Never enter a narrow valley without being certain that there is an escape route available.

Remember Murphy's Law of mountain flying: when you need to turn back, it will be through sink, turbulence and a tailwind – so make sure you have the performance available to do it safely.

Downstream leads to bigger rivers, lakes, roads and towns.

Altitude

Density altitude and aircraft performance

One aspect of mountain flying that requires particular attention is aircraft performance. A pilot must keep in mind when considering the performance characteristics of the aircraft that these figures are dependent on the density altitude that exists. At times density altitude will differ substantially from the actual elevation.

Low atmospheric pressure, high temperature, and high humidity all result in a decrease in air density and an increase in density altitude. Density altitude is pressure altitude corrected for temperature. Most navigation computers will work out density altitude. Practice a couple of examples before you need to work it out.

Aircraft performance, especially climb performance, is reduced with increasing altitude. Avoid placing your aircraft in a situation where the power margin, while adequate at low altitude, is insufficient at a greater height.

A lightly loaded aircraft is best, but be sure to carry sufficient fuel for unplanned diversions – the terrain is generally uninviting for a forced landing.

Helicopters

Density altitude increases tend to have a more marked effect on helicopter performance, and will affect helicopters as follows:

- Control effectiveness reduces with increasing density altitude.
- For a given indicated airspeed, the true airspeed (TAS) and therefore inertia is higher. As the air is less dense, rotor response will be slower. Cyclic movements will be larger and rotor response slower when selecting a new attitude.

- To achieve the total rotor thrust required for flight, collective pitch settings will increase with increasing density altitude. Less collective will be available to control a descent and autorotative performance is also degraded.
- The tail rotor also requires an increase in pitch to counter torque and will be less efficient with an increase in density altitude.
- In general the helicopter will be more unstable because of the reduced air density.
- The helicopter will be more susceptible to retreating blade stall due to the increase in blade pitch on the main rotor.
- As the TAS increases with the increasing density altitude, the turning radius will increase when a constant indicated airspeed (IAS) is maintained.
- The rotor rpm in autorotation is higher at higher density altitudes. Therefore, more collective is required to control rotor rpm in autorotation and less is available on touchdown.
- As the rotor is less efficient at higher density altitude, the power required will increase and this combined with reduced engine power can cause a serious problem. It is essential that flight manual data be consulted before attempting a landing at high altitude.

Approach and landing

Always join overhead a strange aerodrome to check for runway layout, wind, traffic and terrain. With mountain airstrips the constraints of the surrounding terrain will dictate how this is best done. Follow as close to a standard pattern as possible, although a precise circuit pattern may not be practicable. Make sure you know the elevation of the place you are going to land at. Check you have sufficient landing and takeoff distance available.

An approach and landing at altitude must be flown with accurate control of airspeed and rate of descent. Use the same speeds as you would for a landing at lower altitudes. If the conditions are gusty add a ***small*** amount to the approach speed. The true airspeed and groundspeed will be higher because of the density altitude. The higher groundspeed will also lead to the glideslope being flatter when holding a 500 ft/min descent rate. Use full flap and be prepared to raise the flap if you need to go around. If you are approaching a one-way strip have a go-around point decided well out from the strip.

It is not unusual for pilots to find themselves approaching the intended landing site with an excess of altitude. This may occur for a number of reasons: a natural tendency to seek the reassurance of altitude; the location of the landing area in relation to surrounding terrain; the desire to extend the distance seen ahead; or simple failure to recognise identifiable landmarks near the landing site. Take care not to get too high – lowering the nose and developing a high rate of descent and/or excessive speed will prevent a good landing.

If runway slope and surrounding terrain are a factor, land uphill. If you are doing a touch-and-go do so downhill.

On final approach to an aerodrome with an up-slope, a visual illusion occurs because the pilot's eye interprets the up-sloping ground as level. This illusion fools the pilot into believing that, relative to the touchdown point, they are higher than

they actually are and that the attitude is more nose-down. To compensate for this it is common for pilots to fly lower and slower than necessary.

Uneven terrain around an aerodrome will make it difficult to correctly judge the attitude when relying entirely on visual cues. Because of this and the visual illusion above, the airspeed indicator needs to be monitored closely throughout the approach and the scan needs to be wider than normal, taking into account the surrounding terrain.

A bad approach will rarely end in a good landing. Because power is adversely affected by altitude (acceleration is slower) when power is needed it should be applied as early as possible. Set yourself up so that the go-around decision can be made early.

When landing uphill the flare needs to be exaggerated. The aircraft needs to be flared beyond a level attitude to contact the up-slope at the correct angle.

Takeoff

At high altitude aerodromes density altitude factors must be considered. Even when the aerodrome is not at a high altitude, the nature of the surrounding terrain can mean that the aircraft should be flown to its maximum available performance until a safe altitude and position is reached.

Full power should be maintained after takeoff until a safe height and distance from terrain is reached. Remember that speed = control.

When taking off from a down-sloping strip only rotate to level attitude; remember you are travelling downhill and if you rotate to what would be the normal position on a flat runway the aircraft could stall.

Human Performance

Workload

A high cockpit workload, resulting from the requirement for greater than normal navigational accuracy and a constant lookout for other aircraft, can result in reduced mental capacity to make decisions and handle new tasks or problems.

To pilots who are inexperienced in mountain flying, the physical and mental stresses can be severe, and they may steadily erode the capacity for sound judgement and action. Thus, when the destination is reached, the pilot's ability to cope with problems is at its lowest ebb, while the demand on your capabilities is at its greatest. Careful preparation will help alleviate this high workload.

If you plan on using GPS to assist with your navigation task, remember it can not recognise when there is terrain between you and your destination. Do not be over reliant on GPS; it is an aid, not a replacement for basic navigation skills. It also has the potential to distract you from critical heads-up time if you have to spend time looking down to operate or interpret it.

Hypoxia

At higher altitudes lack of oxygen can cause hypoxia. Below 10,000 feet a healthy pilot should not be affected significantly by hypoxia. If the pilot is unwell, (or a smoker) they will be more susceptible to hypoxia. Even at heights of 5000 to 8000 feet the brain will generally not work as efficiently as it does at sea level. This is particularly so if there is a difficult and unfamiliar mental task to perform or a complicated emergency to deal with.

Hypoxia can be very subtle in its onset. Because the brain is not working properly it may take some time before the pilot recognises the problem. Obviously this can be very dangerous, especially where the symptoms can result in a feeling of wellbeing combined with a loss of self-assessment, and poor judgement.

In New Zealand, flight between 10,000 and 13,000 feet is allowed for a maximum of 30 minutes without oxygen. If you plan on taking advantage of this be alert to the dangers of hypoxia.

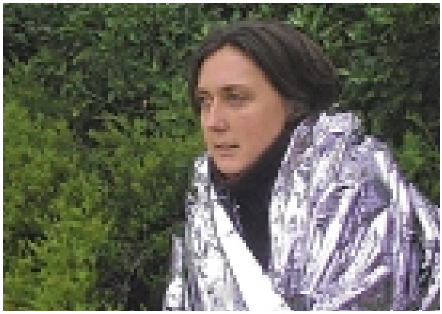
Other considerations

We have already mentioned that the likelihood of turbulence is greater in the mountains. Flying in turbulence will add to your fatigue and may possibly nauseate you. Know when to call it quits so you are not left trying to fly while fighting off airsickness.

When flying at altitude the air is drier so be alert to dehydration on longer flights.

Glare is also greater, there are less atmospheric pollutants and reflections off cloud and snow-covered terrain are strong. Wearing a good pair of aviation sunglasses is a simple fix for this.

With the cooler air at altitude, the use of cabin heat is more likely. Make a regular check of your carbon monoxide detector to ensure there are no dangerous gases leaking into the cockpit.



Survival Equipment

There is no need to carry a pack full of everything you would need to survive in the bush, although if you want to there are plenty available to invest in. There are some small things, however, that you can carry to help make a difference.

- A small book on survival techniques.
- Waterproof matches, a cigarette lighter or some way of lighting a fire.
- A survival blanket (which is fairly cheap and doubles as a reflective surface) or plastic rubbish bag.
- Pocket knife.
- Whistle.
- Small candles (birthday type are ideal). (A soft plastic comb can also be a good flame source.)
- Fish hooks and fishing line.
- Something reflective, if you don't have a space blanket.
- Small compass.
- Container to keep everything in that can double as a heat-proof water container.

A Few Pointers from the Pro's

- File a flight plan.
- Study charts carefully for terrain height and good reporting points. Prominent peaks make good reporting points.
- Get and use as much weather information as you can. Check winds, especially at altitude.
- The wind will tend to be a prevailing westerly above 10,000 feet.
- Don't go when upper winds are forecast over 25kts. Winds will be much stronger over mountain passes.
- Don't go in doubtful weather.
- Always have enough altitude to allow you to glide to a 'safe' landing area.
- Know the wind direction and logically apply this to your flight path. There can often be abrupt wind direction and velocity changes in the mountains.
- The horizon may be hard to see, remember it is near the base of the mountains not the peaks. If you follow the peaks as your horizon you will climb.
- Remember the effects of density altitude. Takeoff and climb will take a lot longer.
- Approach passes and ridges at a 45-degree angle.
- If you find yourself in a downdraught keep the nose down to maintain a safe airspeed. If you have enough altitude continue through it as most downdraughts are followed by an updraught.
- Fly on one side of the valley, not down the middle. Flying on the downwind side will keep you in the upgoing air and provide room to turn around if need be.
- Don't fly any closer than necessary to abrupt changes of terrain. Dangerous turbulence can be expected with high winds.
- Get as much advice as you can from someone who knows what they are talking about. The local mountain operators would rather spend 15 minutes giving you a briefing on their area of expertise than 15 hours rescuing you.
- Get some training before you go. There are not many areas of NZ where the land is too flat to get any experience. The ranges do not need to be 10,000 feet high, just enough to lose sight of the horizon.
- Fly to your ability and don't be over enthusiastic. Better to turn back early than attempt it too late.
- Lastly and most importantly: always have an escape route.

Personal Minimums Checklist

Before your trip into the mountains, decide on your personal minimums. Complete this checklist and then on the day compare the actual conditions with your minimums. If they are better - then have a safe trip. If they are not - try for another day.

Pilot

Experience/Recency

Takeoffs/landings	___	in the last	___	days
Hours	___	in the last	___	days
Mountain flying training	___	hours in the last	___	days

Planning

Charts and publications	confirmed current
Flight plan and log	completed
Terrain	Studied for lie of land
Route	___ options plotted

Physical

I - Illness	No symptoms
M - Medication	None or safe medication
S - Stress	None in last ___ days
A - Alcohol or drugs	None in last ___ hours
F - Fatigue	___ hours sleep in the last 24
E - Eating	In the last ___ hours
- Hypoxia	Flight above 10 000 feet?

Personal

Decision making strategies	Escape routes noted and briefed

Aircraft

Fuel reserves

VFR day	___ hours

Performance

Density altitude	Additional performance available
Temperature	Hot and high?
Payload	Only what you need
Gross weight	Within limits and distribution
Performance charts	Completed for takeoff and landing

Experience on type

Number of take-offs and landings ⬭ hours in last 90 days

Familiar with airspeeds V_A V_Y V_X

Aircraft equipment

Comms	Familiar with system
GPS	Familiar with operation
Survival pack	Appropriate and available
Clothing	Suitable for terrain being flown over

Environment

Weather

Reports and forecasts	hours old
Wind	kts
Cloud base	feet
Visibility	kilometres

Aerodrome conditions

Density altitude	feet
Runway length takeoff/landing	metres
Surface conditions	Checked and suitable

External Pressures

Trip planning

Allowance for delays minutes

Alternative Plans for Diversion or Cancellation

Notification of people you are meeting

Passengers briefed on alternative plans in case of diversion or cancellation

Modification or cancellation of social plans (reservations)

Arrangement of alternative transport (airline, car etc)

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