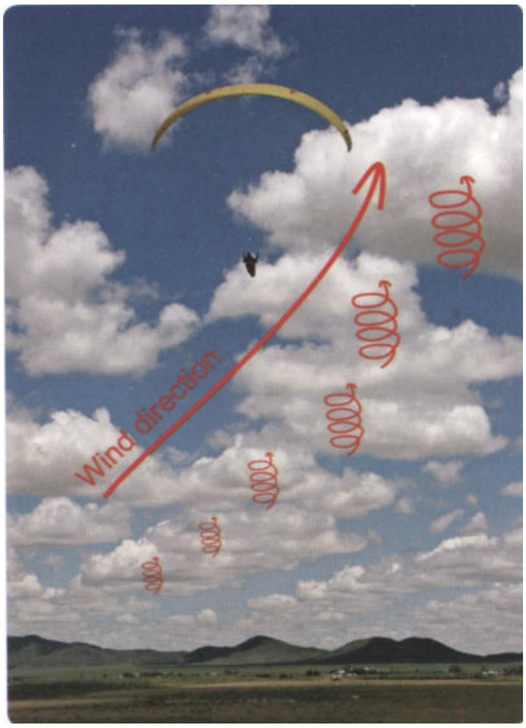
Dolphining requires performance, the better the performance the easier it is. The picture shows the new Atos „Cage" - almost purpose-built for successful dolphining.
Picture: Willi Tacke / Flying Pages

Picture 4.8 The best climbs can be found under the darkest area of the cloud.



Picture 4.7 Cloud street formation over De Aar, South Africa. Thermals and the wind direction drawn in.

Picture 4.9 Cloud street formation over the flatlands. Similar to picture 4.7, but with four cloud streets. Compare with the situation in illustration 4.39, page 133.

Picture 4.10 Wind sculpted cumulus cloud. The wind is coming from the right and the best climbs can be expected under the windward/right hand side of the cloud. If at all possible we approach this cloud in a way that takes us straight there without leading us through the increased descending just downwind of the cloud (left).

Picture 4.11 On the left hand side the cloud has already begun to shows signs of dissipation. If there is still climbing to be found it will be under the right side, however since the cloud has no clear cauliflower structure it is probably already dead.

Sometimes the wind speeds decrease again above a certain altitude - in these cases the best climbs may be found on the side facing away from the wind. If the cloud is already showing signs of dissipation (picture 4.11) the climb has most likely abated here - in these cases it is imperative to aim for the areas still unaffected by the dissipation. These signs are generally not as clear to see as in the example shown here.

Hint:
When flying cross country we generally approach all clouds straight on, but if we're aiming for a cloud in a head wind we must first fly through the increased descent on the downwind side of it. In these cases it may often be worthwhile to fly a large curve around the descent area - this costs less altitude than a direct approach.

Cloud associated dangers

Paraglider and hang glider pilots are not allowed to fly into clouds, but at times it can happen before you know it! Inexperienced pilots often get so excited about their thermal flight that they forget to remain alert and maintain a safe distance to the cloud above them.

Cloud problems:

- To get sucked in may cause instantaneous orientation loss. Some pilots actually fly deliberately into clouds when on XC flights, in order to gain extra altitude before big valley crossings etc. But in my view this generally doesn't pay as the loss of orientation frequently leads to panic and thus to inability to follow the best route even with GPS. Aside from this, big, thick clouds often impede signal reception to the extent that the GPS looses its bearings, and then you're REALLY lost.

- Danger of collision with other pilots

- Danger of collision with mountains

- Danger of collision with IFR-approved aeroplanes.

- Inability to watch out for cloud overdevelopment, and the risks involved in flying in or near cumulonimbus clouds (freezing to death, suffocating due to lack of oxygen at

Picture 4.12 Big cumulus cloud. Flying under such clouds involves a great risk of getting sucked in. Make sure you fly towards the edge well before reaching cloud base.

Picture 4.13 Once the lightning begins and you're still in the air you have made a wrong decision somewhere. Even full-sized passenger aircraft avoid thunderstorms so it is no surprise that we must be extremely careful with them when flying our flimsy crafts.

high altitudes, getting struck by lightning

The larger the cloud grows the bigger the risk of getting sucked in becomes - and once inside we have no way of knowing if the cloud is turning into a CuNim. An example: Suppose that we have a cloud base at 2500m, and the inversion putting a lid on cloud growth lies at 5000m. This means that the cloud may grow 2.5km thick - from beneath, such a monster looks dark and dangerous!

The climb rates right beneath such clouds may easily double compared to the rest of the thermal. This great increase in lift is caused by the energy released into the system th-

Picture 4.14 Similar to the cloud from 4.12 but this time photographed from a distance. From beneath the cloud in the centre of the picture the view will be just like in picture 4.12. These are the kind of clouds that overdevelop and grow into CuNims.

rough the condensation process, where heat stored from the evaporation is released again. This extra heat accelerates the climbs right under, and inside, big clouds. There is more about this mechanism in chapter 9.

A pilot coring a steady 6m/s thermal all the way to cloud base may suddenly encounter 12m/s right under the cloud - a real problem if the pilot hasn't remembered to move close to the edge in time. I recommend the spiral dive (for paraglider pilots) to escape such a strong lift, but bear in mind that many pilots have reported difficulties initiating spiral dives when they were in a strong lift. A hang glider cannot reach these descent rates but may more effectively outrun the strong lift by diving for the edge.

Hint:
The closer you get to cloud base the further out towards the edge of the cloud you should fly, preferably on the upwind side if there are no obstacles around. In the mountains, and on days where cloud base is beneath the peaks, you aim for the valley side of the cloud, where a brief visit inside is less consequential, see picture 1.39.

Note that big, shallow clouds do not have the same extreme climb rates associated with them and are thus easier to avoid. Only when the cloud's vertical expanse goes beyond maybe 1000m we have to be aware of the development, both to avoid getting sucked in and to see if it turns into a CuNim. Gliders may fly around CuNims where paragliders and even hang gliders would find themselves in deep trouble.

Picture 4.15 Large but shallow cumulus clouds. These clouds indicate excellent thermal conditions with no particular dangers. However, anyone flying under the middle one would still probably encounter strong lift and surely see a great and dark cloud overhead.

Picture 4.15b After 10 minutes inside the cloud the condensation starts running down the lines. The brake line becomes a small inversed fountain, the water soaks first the gloves, then sleeves and back of the pilot. If it is cold the water freezes and thick layers of ice may form, see picture above.

Gust fronts

Another cloud-related danger in the air is the so-called gust front preceding showers, originating from overdeveloped cumulus or cumulonimbus clouds. A gust front behaves like a small, local cold front by expanding in all directions and pushing the surrounding air up and away.

Gust fronts may extend to upwards of 30km from their source, but even small showers coming from overdeveloped cumulus clouds will often have their own little mini cold fronts preceding them. The cold air wedges in under the surrounding air and lifts it up (just as it happens on a larger scale when real cold fronts come through) and may trigger extensive thermal development in their path. This may sound just great, but the turbulence caused by the strong cold wind mixing with the surrounding air is not for the faint of heart.

Picture 4.16b A fully formed thunderstorm seen from a distance of about 30km in Bassano, Italy. This one caused immense gust fronts to come through at Bassano, a clear indicator of how careful one must be with these phenomena. A few daredevils were seen flying backwards at around 10km/h, so we can deduct that the wind speeds were in excess of 50km/h - remember this was at least 30km from the cloud.

Picture 4.16a : Spot the glider. In the south central Alps the XC season begins in April. The glider is right in front of the famous „Drei Zinnen" in the Dolomites, Italy.

Pictures 4.17 All pictures show clouds that are good indicators for a very unstable atmospheric situation. Visible storm clouds are the least of our problems - we should go and land before it is too late - but embedded in thick cloud cover, or hidden by smog or poor visibility they are far more unpredictable. On the south side of the Alps we often encounter very hazy conditions where storms may creep up on us - the two last pictures are from this region and clearly show how difficult it may be to assess the situation.

Picture 4.18 On a day like this, where a strong inversion a few hundred metres above the cloud base level effectively stops any overdevelopment, the clouds will remain small. Right beneath these clouds they may still look somewhat dark but there is no risk of overdevelopment, and the day may turn blue later if cloud base rises further and goes above the inversion. The photo shows the Pustertal with the Zillertaler Alps.

No thermals without sun - but are there still dangers?

By Volker Schwaniz

Inexperienced pilots will be excused for thinking that as long as the sky is overcasts and no sunlight is seeping through to feed thermals, there'll be no danger from overdeveloping clouds. They may think that without the influx of energy from the sun to the ground there'll be no thermals, and with no thermals there'll be no clouds suddenly growing alarmingly big. This deduction is quite reasonable at first glance, but it is wrong.

Stratus layer clouds are often the visible indicator that the atmosphere is severely unstable; so unstable in fact that even the diffuse light making it through the cloud cover may be enough to feed overdevelopment and turn it into showers and cumulonimbus clouds!

Besides, the stratus layers may make imminent weather changes, like the arrival of a cold front or a trough, invisible to the pilot observing from beneath. Any of these scenarios adversely influence the flying conditions, often to a dangerous degree - and the cloud layer keeps it invisible to the observer!

In mountainous regions air getting pushed over elevations by the wind will be cooled down and heat will be released, and if the air mass is sufficiently unstable this extra energy influx will be enough to trigger cloud overdevelopment and so-called orographic showers/cb's.

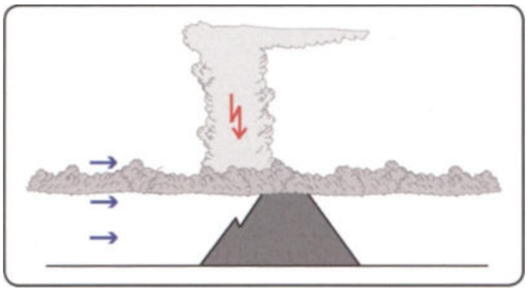


Illustration 4.23 An orographic storm brewing above the stratus layer. Danger!

The unexpected thunderstorm - learning from misshaps

By Volker Schwaniz

Some time ago I received an email from a pilot who needed an explanation to an incident he had gone through.

The pilot had been flying a soaring site on an overcast early summer day. After a while he noticed that the skies at the opposite end of the lake in front of him were growing darker and he decided to land, however as he was approaching the lakeside landing he noticed that there were already whitecaps forming. Suddenly gusts of 40-50km/h were blowing through. He was lucky and survived the unavoidable crash with only minor injuries, but he was eager for an explanation.

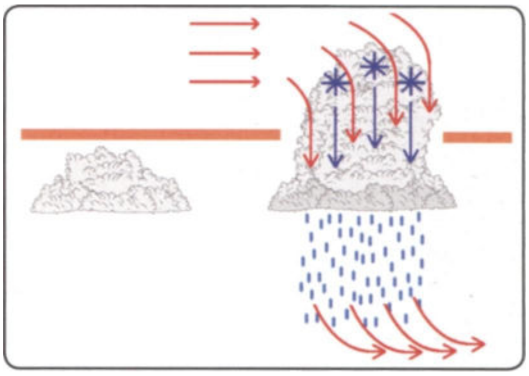


Illustration 4.24 On the left a normal cumulus cloud that is being stopped from overdeveloping vertically by the high-pressure inversion (see chapter 3). On the right an unstable situation combined with high humidity in the air. The inversion is too weak to stop the vertical (overdevelopment and the cu rapidly turns into a cb.

The pilot's mistake was that he underestimated the instability of the airmass he was dealing with. The airmass would have been unstable to the extent that even without direct sunlight, storms could still form, while

remaining hidden from his view by the cloud cover. The dangers are caused by the rain (wet paragliders often behave in an unpredictable manner) and gusts, which are known to be particularly vehement on days with tall clouds and a strong wind up high.
In the example described above the pilot "only" had to deal with the gusts originating from the embedded storm. Sometimes it may be more than that.

Picture 4.25b We have summer storms, cold front storms and also orographic storms as described in

Picture 4.25a Summer storms may brew fast but nonetheless don't just materialise out of nowhere. The reasonable pilot lands before things get critical.

Picture: Bruce Goldsmith

Picture 4.26 Beautiful Cumulus Castellanus are fantastic to watch but indicate an extreme likelihood of storms later in the day. It could be in an hour, it could be in five hours, but mostly it will come. On such days the pilot must remain very alert and keep watching the development very carefully. At the time of the exposure the skies are still perfectly flyable.

Escaping from clouds

Generally pilots should avoid touching the cloud base. This is best done by repeatedly looking up while thermalling, always attempting to estimate the remaining distance to the cloud. This is not easy in the beginning! If you're unsure of how far you still have to go, fly out on the upwind side of the thermal/ cloud and get a look from a different perspective - if it turns out you still have a good margin, you can always fly back in. By doing so you will be slowly approaching the cloud at your own pace, and you'll be learning lots about assessing cloud distance.

Sometimes novice thermal pilots find themselves getting overly enthusiastic about the whole endeavour and suddenly end up uncomfortably close to a fat cu sucking like a vacuum cleaner. The best trick is to hightail for the edge of the cloud, possibly even with the ears tucked in and stomping the speed bar as hard as conditions allow. If this proves insufficient to remain out of the cloud, b-lining or spiral diving for a few hundred vertical metres and then repeating the hightailing from above should work. Note that if you're doing these things together with a group of other pilots you must make sure you're not colliding with anyone whilst battling the excessive lift.

The hang glider pilot has an advantage in this situation, as he may simply pull the bar in and dive out at high speed. Should he he miss that point he'll be in a worse place than the paraglider though, as he'll find it even harder to maintain a steady heading AND he may even find it hard to avoid suddenly flying upside down. The paraglider is better in this respect as it is almost like a flying gyroscope; after all the pilot is ALWAYS beneath the canopy. The hang glider is not so lucky and will be more careful next time!

Picture 4.27 Big cu over the Zugspitze, Germany. With clouds this big the pilot must be very alert in order to make sure he flies out of the strong lift and towards the edge in time.

Picture 4.28 In order to escape from clouds sucking too much, the paraglider pilot pulls in his ears and pushes the speed bar, and the hang glider pulls in and dives out.

Illustration 4.29 Large cumulus clouds being fed by strong thermals often develop domes at their base. The hang glider in the picture knows that the dome indicates strong lift and flies there.

Experience:
When the airmass is very unstable the summer storms may arrive as early as around noontime. I once sat on takeoff inside a cloud waiting for a window to launch in. After 45 minutes the window finally appeared, but by then we didn't dare to launch anymore as there was no way of knowing how big the cloud had grown in the mean time. It turned out to be an excellent decision as the lightning began only 5 minutes later!

Cloud domes

Illustration 4.29 shows a cloud dome as they frequently occur on the on the base of strong, fat cu's. The dome may be up to 150 metres "deep", i.e. the edges of the cloud are 150 metres lower than the centre. The dome develops because the condensation process is somewhat delayed in fast rising thermals. If the pilot remains in the thermal long enough to go up into the dome (illegal in controlled airspace) then the only way out is through the lower edges of the cloud. Compare also to picture 1.12.

Hint:
If you notice a cloud with a dome forming you can be sure to find strong lift under it. IMPORTANT: Do not take the thermal all the way to cloud base!!

Inversions domes on blue days

Flatland pilots have reported dome formation into inversion layers when flying on blue days. The strong thermals make dome-shaped indentations in the inversion layer, and when there is smog these domes are visible from the side (not from beneath). The higher the pilot is the easier the domes are to see and use as thermal markers. Picture 1.19, page 34, shows an inversion where domes will be easy to notice.

Picture 4.30 "Blue Domes" occur on smoggy blue days with strong thermals. They can be recognised by the mist surrounding them and are excellent thermal markers.

Judging cloud size

Once we have climbed to cloud base or thereabout it becomes very hard to see how big an adjacent cloud is. To get an idea of this we need to use another trick, by looking at the cloud shadow on the ground. If the shadow is full of holes it is safe to assume that the cloud is already dissipating and that it is of no use to us any longer.

***Picture 4.31** We judge the size of a cloud from the air by looking at its shadow on the ground. The picture shows the Valais, Switzerland.*

Hint:
Judging distance correctly in the air is very difficult and the pilot in front of us who looks as if he is already approaching the opposite side of the valley may only be searching for a thermal a bit further out from the ridge. It is important to train the eye to become more accurate in distance assessment - not easy, but experience helps. And it makes it much easier finding the lift that someone else indicated and than left.

Judging the distance to the next cloud

The cloud shadow is also useful for judging the distance you need to reach the next cloud. To do so you need to take the cloud base and the sun's position into account. On clear days the clouds will look closer - this is a phenomenon that is well know by the residents of Munich, as strong fohn days where the air is completely clear always makes it look as if the Alps, 70km (43miles) to the south, are literally on the outskirts of town.

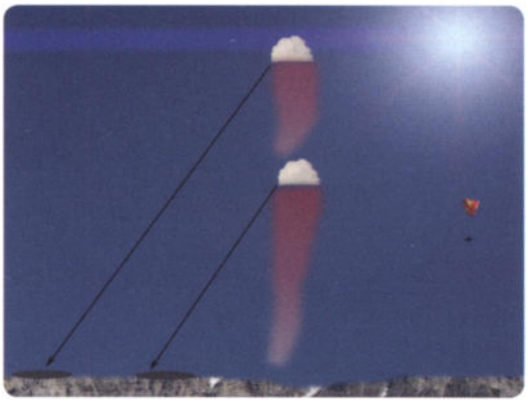


***Illustration 4.32** By watching the cloud shadow on the ground you may attempt to assess the distance to it. In this illustration both thermals are at the same distance. The pilot sees the shadow and attempts to connect it with the right cloud. The higher the cloud base, the further away the cloud shadow will be (provided the sun is not in zenith). The lower the sun sinks the more distinct this effect becomes.*

***Picture 4.33** Low clouds are easier to connect to their shadows on the ground. The higher the cloud base, the harder it gets to estimate the distance to the next cloud.*

Brasil. Pilot: Helmut Eichholzer. Picture: Martin Scheel / azoom.ch

Flying in BKN cloud conditions

Plenty of clouds in the skies are not necessarily a sign of plenty thermals too. If the high-pressure inversion is weak it takes longer for it to dissolve all the clouds forming, and they may remain in the skies long after the lift has died. The same thing happens when the air is very moist; the clouds last long after the thermal has stopped.

On such days the challenge is to identify the clouds still working, where the feeding thermals are still active.

Pictures 4.34 and 4.35
Many big clouds in the skies, and sadly also many that are not marking lift. It is much easier to fly when the clouds dissipate as soon as their thermal dies.

Cloud streets in the mountains

A long sun-facing ridge may have an almost uninterrupted cloud street sitting above it for hours. Xc pilots love this view, because it means fast going with little or no need for thermalling for long distances at a time.

Picture 4.36 An impressive looking cloud street in the Innvalley, Austria. Every sun-facing slope produces lift, and every thermal has its cu. Over the valley the skies are completely clear.

Dolphin flying under cloud streets

Dolphin flying, or dolphining, is the fastest and most efficient way to make some distance when flying xc. When dolphining the pilot simply flies straight, braking in lift and accelerating in a descent. The trick is to adjust the speed exactly so that the net altitude remains the same over time, and this is something that takes a lot of practising.

Near the cloud base we speed up and increase our descent rate so that we avoid getting sucked in. Lower down we may choose to fly closer to min. descent in order to get the most out of the lift at hand. By constantly changing the amount of speed bar we push or even the amount of brake input we attempt to remain roughly within the area of the best climbing, normally quite close to the cloud base. Once we have this dialled in we can experience some very satisfying flying.

Illustration 4.37a and 4.37b Further dolphining explanation: Under the darker cloud areas we reduce speed (and descend) to take advantage of the lift, and if the cloud base comes too close we speed up again. When there's no lift we fly at the speed for best glide (hands up). If the descent increases we speed up even more by using the speed bar, and when we again meet lifting air we slow down, but we don't thermal.
We only start thermalling again when we have lost contact to the good lift band and need to get back up where the best lift is.
Sailplane pilots use dolphining to optimise their distance/time ratio, just like we do. But they go further whilst doing it - flights of more than 3000km have been logged using dolphin technique in wave conditions.
Blue line: min descent, red line: accelerated

Cloud streets over flatlands

If the conditions are right, cloud streets may even form over flatlands. Just as in the mountains these are the days when the lucky pilot can really go far in a short time.

The necessary conditions for cloud street formation in flatlands are as follows (according to M. Kreipl, see the bibliography in the back)

- While the wind direction must remain pretty constant at all levels the wind speed should increase with altitude
- The wind strength should be highest in the upper 1/3 of the space between the ground and the top of the cloud

- There should be an inversion present at an altitude corresponding to the cloud base; the clouds must have vertical room for a healthy development but they cannot be allowed to grow too big. An inversion around 1000m above the condensation level is probably right

When all these conditions are met we can expect the distance between the cloud streets to be 2.5 to 3 times the distance ground-cloud top. If the clouds grow to 3000m above ground the next cloud street will probably be app. 7-9km away, and the cloud streets will be aligned with the wind.

Hint:
Two things to consider when utilising cloud streets to fly in the flatlands:
- If the gap between two clouds in a street is greater than the distance to the next parallel street it is probably wiser to change streets,
- If your bearing is at an angle to the cloud streets it pays to go as far as possible along the streets and change street when a gap in your current street appears.

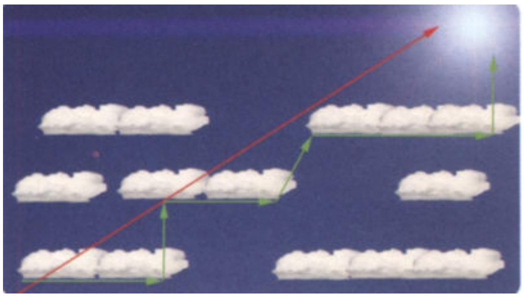


Illustration 4.38
The planned direction (red) and the most efficient line (green). The gaps in the cloud streets are used to change streets and move in the desired direction. Big gaps in cloud streets are also better negotiated by changing street than by attempting to cross large blue holes.

Hint:
The distance to the pilot you're looking at is much shorter than you think! As a rule of thumb he is half as far away as you think and then still a bit closer!

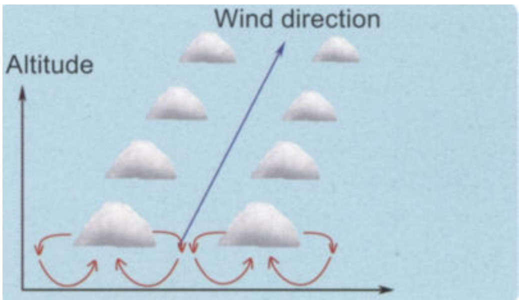


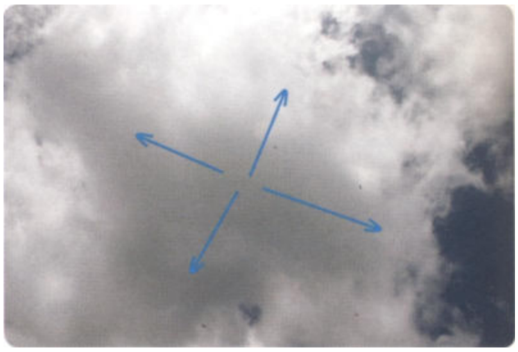
Illustration 4.39
Compare also to pictures 4.6 and 4.9, page 118, a simplified illustration of the air movement around cloud streets. This illustration also serves to illuminate why the jump from one cloud street to the next should always be done perpendicular to the wind direction (as shown in Illustration 4.38) to avoid spending more time than needed in the descent between the streets.

Picture 4.40 These two pictures were taken within two seconds of each other. Notice how far the cloud has drifted in the second shot by looking at the treetops at the bottom. The wind is far too strong for flying, and if it is still quiet at ground level it is only because the wind has not come down there yet. Cloud drift tells us a lot about wind velocity and direction.

What else can clouds tell us

Cloud spotting should become a passion for the keen pilot. It helps us when assessing lurking dangers but it also tells us a lot about the quality of the day.

Picture 4.41 It is not often that the wind direction is so easily ascertained as in this shot.



Picture 4.42 Forming cumulus expand in all directions. If we only watch a part of such a cloud it would be easy to misjudge the wind direction! It is important to know that the cloud expansion has nothing to do with the wind direction - this is seen from the cloud drift!

Hint:
Try to become accustomed to watching clouds form and dissipate. Train yourself by keeping an eye out for cloud wisps and try to predict if they are forming or dissipating when you see them. Keep watching the wisps to see if your prediction was correct.

Picture 4.43 On thermally active days the first cumulus start forming around 8-9AM. If there are plenty around earlier than that, the day will be too unstable and probably overdevelop early. There's still a chance that the flying will be good for a few hours before the overdevelopment sets in, but we must watch the conditions carefully.

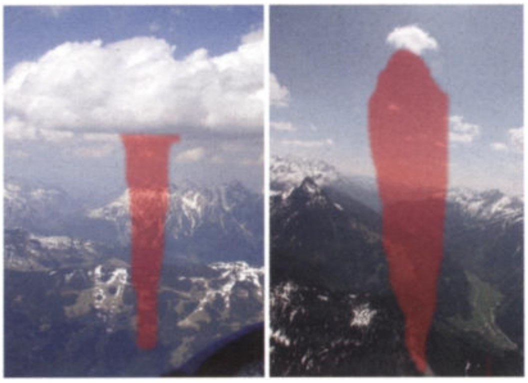
Picture 4.45a When the day is not blue thermals will be topped by cumulus clouds. It follows that areas with no clouds will also have no thermals! If you're flying along a mountain ridge with clouds lining it all the way and you come upon a place where there is no cloud it is highly likely that you have found the place where the ridge is being flushed by the valley wind. To cross such sections you need to climb as high as possible in order to have sufficient altitude to get across. Once you descend down into the wind the descent gets unbearable and there's nothing to do but change valley side ASAP to soar up on the other side, where the valley wind hits the ridge.

Picture 4.44 On good days the clouds will form, then float for some time before they dissipate. Clouds that are in the process of either building or evaporating will look fringy and puffy, and good cumulus have a flat bottom and a cauliflower top. If all the clouds in the skies are looking torn and uneven it means that the wind is strong, maybe too strong for flying.

Picture 4.45b Dolphining is not solely a cloud street strategy - on uninterrupted ridges it may be possible to speed up the XC flight in a similar manner.

Picture 4.46 One should always attempt to connect cloud and cloud source, among other things to get a better understanding of the thermal generating properties of diverse soils. The tropical pilot will have an easier time of that since the sun is more vertically overhead. On no wind days the cloud shadow will thus be covering the area that produced the thermal!

Hint:
Never stop observing clouds; sunbathing, working in the office, driving (!), whenever! It is interesting, and it'll make you a better pilot. When you are earth-bound you generally have more time to follow the life cycle of the clouds you are observing - once airborne this is much harder.
How long does the cloud last from the moment you notice it till it has disappeared again? And equally important; how long till the same area produces the next cloud?



Picture 4.47 Does a big cloud always indicate a hefty thermal? And does a hefty thermal always have a big cloud? No, a small cu may have a strong thermal beneath it, and if the conditions favour the growth of the clouds even a small thermal may be topped by a monster cloud, see left illustration.

Picture 4.48 Judging the distance to other pilots flying ahead is extremely difficult. One thing is for sure: They are closer than they appear! The better we become at judging distance the easier it will be to find the thermals that the other pilots recently left.

Hint:
In order to discern whether a cloud is growing or collapsing I use a special technique: While thermalling I look in the direction I wish to continue. If there is a cloud there that looks promising I check it out briefly, then I continue my circle without looking at it again. Only when I'm again facing the same cloud in my circling (15-20 seconds is pretty normal for a full 360 in a thermal) I check it again. After a few turns I have a good idea of how it is developing.

Picture 4.49 An evening shot (9PM) of the NW facing ridges in the Otztal/Austria. Notice that the clouds indicate continued thermal activity even at this late hour.

Picture 4.50 Turbulence made visible. The clouds tell us that there is a rotor turning left.

Picture 4.54 The E-W oriented Inn Valley in Austria is not very good when the wind is from the North. The south-facing slopes are in the lee and get turbulent. The clouds overshadow the very slopes which should produce the thermals we need to get high, as clearly seen in this photograph.

Picture 4.56 How would you fly to get to this cloud? The sun is shining from the right onto the slope and the upper wind is also blowing from the right. Both indicate that the cloud should be approached at its right end (arrow).

Picture 4.55 If the airmass is very unstable, thermals may form even under overcast skies. This shot was taken during the Bavarian Open in Berchtesgaden, Germany. One hour later the storm arrived.

Picture 4.57 A stunning leeside view at Adams Peak, Sri Lanka. On the windward side of the mountain a 35km/h wind was blowing and thanks to the condensation the air movement was clearly visible on the lee side. The wind was getting deflected by up to 200 degrees vertically by the ridge!

Picture 4.58 A cold front pushing through a pass. It goes fast, and it is only really visible once it is too late. Within minutes the conditions become unflyable. On this day the wind was suddenly gusting to 70km/h at the landing site.

The drying process after rainfall

With input from Volker Schwaniz

To be able to judge how soon the conditions will turn favourable again after a rainy spell we need to know something about the new airmass replacing the rain. If it is a dry, warm airmass it can absorb very large amounts of humidity in a very short time.

Hint:
When after a rainy spell I find myself driving towards a flying site I always try to estimate how much precipitation the area has received. From my home I can reach the Ennstal/ Austria or the Arlberg/Austria in about two hours, and I always try to go for the one where the least rain has fallen, as this is the place where the drying will be faster.

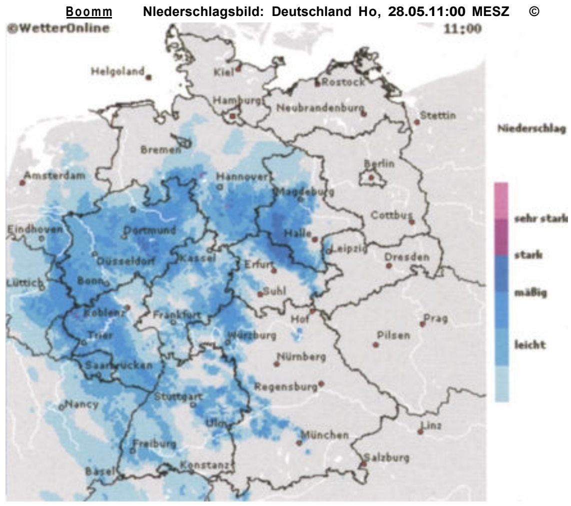


Illustration 4.60 A radar image showing precipitation quantities for Germany. These are available as small animations from www.wetteronline.de. Look for similar services offered by the meteorological services of your country.

If the high pressure travels fast and replaces the through very quickly the drying of the soil and air happens fast, however when this occurs we can often observe the rising humidity getting caught under the inversion and creating a cloud cover, so that the best conditions are still a few hours away.

Picture 4.59 Lots of post frontal moisture in Valais, Switzerland. The high-pressure is already there and the shape of the clouds indicate a light northerly flow. Around 1PM we were already at 2500m - this area dries faster than the north side of the Alps.

The time for the drying process also depends on the geogrphical location. In the Alps for example the following applies - these trends are probably applicable to most mountainous regions.

The Northern Alps

After rain we often get what we call post frontal weather, with NW flow pushing the air up against the north side of the Alps. On the first day after a frontal passage the cloud cover is thick and there may still be showers on and off. On the second day after the front the conditions will have dried out sufficiently for flying.

The high mountains

The weather improvement sets in sooner than on the north side but it still takes a while for the moisture to evaporate from the valleys. On the second day of the high pressure the conditions are back to normal.

Southern Alps

The NW flow pushing the clouds up against the flanks of the Northern Alps creates a Foehn like effect on the south side of the Alps. This very dry air removes all moisture very quickly, and the conditions may be good to great right from the first day after a frontal passage, in spite of heavy rainfall. Beware of the north wind, if it gets too strong the conditions become dangerous.

If there's no north flow the drying will take longer, similar to the process in the abovementioned regions.

Picture 4.61 Zillertal, Austria. The thick clouds at ridge height, also seen in picture 4.59, are rapidly disappearing.

Flatland versus hill country

If there is some wind to help with the evaporation the conditions may be fine already on the first day after heavy rains. The cloud base remains relatively low due to the high water content in the air, but small XC flights should be possible. On bigger hills we may observe a similar effect to the amassing of clouds on the north side of the Alps, with overcast skies and some tendency towards rain, but it will be on a smaller scale.

Experience:
The Drautal/Greifenburg in Austria is renowned for developing good flying conditions in spite of having thick, deep cloud in the morning. I have often seen the basis hover around the bottom of the ridge in the morning around 8, only to rise to 1800m at 11AM and have us laughing out loud from 2700m at 2PM!

Picture 4.62 Same arena as in picture 4.61 but three hours later. It is rare to have the conditions dry out so fast after a frontal passage, and in spite of the promising looks the day was pretty average. Even at its peak the valley wind reached only 20km/h in places where it often is twice as strong.

Chapter 5: Clouds and weather

In order to practise paragliding in a safe way some weather knowledge is essential. Knowing a little about clouds, and what they tell us about the current weather situation, is particularly important.

If we can read the clouds correctly we can often tell if the weather is suitable for flying or not, but only the very experienced can predict something meaningful about the development over the next 12 hours just from watching clouds. For this reason understanding basic clouds does not replace the glider forecast, it does however supplement it well.

If my book can help you to become more attuned to the reading of clouds much of what I set out to do with it will have been fulfilled.

There's a German website with great cloud pictures at www.wolkenatlas.de

Cloud formations and what they tell us

Cirrus (Ci)

Picture 5.1 Isolated Cirrus formation

Origin:

Cirrus occurs when there is turbulence at high altitudes. The turbulence could be caused by large differences in wind direction at different altitudes or by the lifting of one airmass over another as it happens when a warm front approaches.

Significance:

In the Alps the occurrence of isolated Ci coming from easterly directions, as shown in picture 5.1, indicates that the current high pressure influence will remain, or even strengthen in the near future. If the Ci fields are thicker and they are approaching from the west (picture 5.2) it means that a warm front is approaching, or that we'll soon (within 12-36 hours) find ourselves sitting right under an occlusion. If we have access to a barometer we will also see a decreasing tendency for the air pressure, and finally the increased humidity will cause the cloud base to lower.

A thick cirrus cover approaching from the southwest means that the high-pressure is being replaced by a trough and may indica-

Picture 5.2 Cirrus approaching from the west and covering the skies indicates the arrival of a warm front.

Picture 5.3 Cirrus coming from the southwest. If we look to the north we will see a situation like in picture 5.4. Two days later it was raining on the south side of the Alps and there was a light Foehn influence north of the Alps.

The 10 most important cloud types

Name	Abbreviation	Alti.	Remarks
High Clouds	Prefix "Cirro"	6-11 km	Made up of ice crystals
Cirrus	Ci		Isolated ice-crystal clouds
Cirrocumulus	Cc		High piled (cumulus) clouds
Cirrostratus	Cs		Layer cirrus clouds (stratus=layer)
Mid-level clouds	Prefix "Alto"	2-6 km	
Altostratus	As		High layerclouds
Altocumulus	Ac		High piled (cumulus) clouds
Low clouds	No prefix	0-2 km	
Stratocumulus	Sc		Layer clouds with cumulus deve-lopment
Stratus	St		Layer clouds
Cumulus	Cu	bis 6 km	Thermal cloud
Clouds with great vertical expansion		0-11 km	
Nimbostratus	Ns		Rain clouds (nimbo=rain
Cumulonimbus	Cb		Storm clouds

te the transition to a situation where there will be increased cloud cover on the south side of the Alps and Foehn on the north side within the next 24-48 hours.

Picture 5.4 At the Speikboden, Alto Adige, Italy. This picture belongs together with 5.3 and shows the view to the north from the same observation point and - time.

Cirrocumulus (Cc)

Picture 5.5 The occurrence of Cc in the skies is a good indicator that the airmass is unstable.

Origin:

Generally Cc clouds precede warm fronts. They are caused by the general lifting of the oncoming airmass up onto the present one, or by a thickening of already present Ci clouds.

Significance:
The arrival of Cc clouds indicates an increasing instability in the airmass. As such they may be the first warning of upcoming thunderstorms. They may however also dissolve again and allow the high-pressure situation to remain. If they appear isolated the latter is the case.
When thick, wavy Cc layers approach from the west a weather deterioration within the next 6-12 hours is on its way, if it is a cold front it may come even faster.

Cirrostratus (Cs)

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Picture 5.6 In the foreground some thin Cs clouds, progressively getting thicker with depth.

Origin:
When a humid airmass gets lifted up, or when Cirrus clouds grow thicker.

Significance:
Generally announces the arrival of a warm front.
Halos visible around the sun or the moon, or a secondary „sun" next to the normal one (picture 5.8) are signs that there will be precipitation soon. The front will arrive in 12-24 hours.

Picture 5.7 Rapidly thickening Cirrostratus clouds.

Picture 5.8 Secondary sun visible on the right Cs cloud.

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Contrails/condensation trails

Picture 5.9 If the contrails are dissolving again the high-pressure influence will continue.

Origin:

Contrails are a combination of water droplets from the combustion and sooty particles, produced by jet engines, which form iced particles. Both are necessary for the enriched surrounding air to condensate. Caused by the aeroplane as it moves through the air at a certain hight band. Humid surrounding air allows the contrails to grow, whereas in dry air they will dissolve rapidly again.

Significance:

If the contrails remain in the sky long after the plane has passed, and maybe even grow, it is a good sign that the atmosphere is getting increasingly humid, and that the weather is about to change to the worse. On days when the contrails form, then disappear rapidly again, the high-pressure situation can be expected to continue.

Altocumulus (Ac)

Origin:

When a warmer airmass pushes itself up onto a colder one, through convection or through turbulence in extremely unstable air layers. They may occur when rain clouds dissipate and transform into Altocumulus.

Significance:

The most important thing to know is that Ac fields spreading out are a sure sign that the weather is about to change to the worse. However if they appear near the perimeter of an intermediary high-pressure they may mean nothing at all!

Minor Ac fields passing through due to the winds at altitude have no impact on the local weather apart from a passing weakening of thermal strength.

Altocumulus Lenticularis, lenticular clouds (pictures 5.11 to 5.14) are a different kettle of fish altogether. They are the classical Foehn indicators. On the north side of the Alps Foehn is generally followed by a trough with rain and bad weather, whereas on the south side post-Foehn may mean fast improvement.

Picture 5.10 Altocumulus or lamb clouds. As pretty as they are, they are generally messengers of an imminent weather deterioration. This is particularly the case when they are as thick as in this photo, where they indicate a very great instability at their altitude.

Picture 5.11 Lenticularis clouds seen from the Kaiser range in Tirol, Austria. Direction of view is SW.

Altostratus clouds (As)

Picture 5.15 A cold front announces its arrival with a line of As coming from the NW. In this case a prefrontal Foehn situation is keeping the front on hold, but it is a loosing battle.

Origin:

- Arrivals of cold fronts. The cold airmass pushes under the warmer air already present, causing the warm air to lift and humidity to condensate.
- Thick Altocumulus may also turn into Altostratus.
- Dissipating Nimbostratus goes through an As phase before disappearing completely.
- The same goes for decaying Cumulonimbus.
- Large fields of incoming As may have been formed elsewhere and blown in by the high-altitude winds.

Significance:

As a general rule, As clouds indicate the arrival, or the presence of, a poor-weather spell. Thickening As layers are a good indicator that there will be precipitation within the next few hours.

Stratocumulus (Sc)

Picture 5.16 Stratocumuli indicate a weather improvement with rising pressure and general drying tendencies. In this case the clouds have formed in the warm, humid air behind the receding warm front. Although they look really promising the lift under them will not be sufficient for thermalling as the thermals are very weak.

Origin:
Stratocumulus form when there is either convection or turbulence in saturated layers at mid levels. They may also be remainders of other cloud forms (Nimbostratus or Stratus), or they may be Cu's overdeveloping horizontally.

Significance:
If they look as in picture 5.16 they indicate an oncoming weather improvement. There is still plenty of excess humidity around, the cloud base is low and the thermals still too weak, but the situation is improving.
However, if they look more like the ones in picture 5.17 then there are showers, or at least overcast skies, where they are. Depending on the direction the weather is travelling it may or may not influence our own situation.

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Picture 5.17 Bands ofStratocumuli. In this case they are the precursor to an approaching cold front.

Stratus (St)

Picture 5.18 Stratus layer. In this case as high fog in the Alps.

Origin:
- High fog fields, as seen in picture 5.18, develop when the ground cools down through radiation, and the overlying air follows suit until the dew point is reached. In the winter this effect may last for days in the Alpine valleys, but above the high fog it may be perfectly flyable!
- Ground-level fog develops in the same way. The only difference is that the fog remains earthbound.
- A cloud shrouding a mountain may also be a Stratus cloud.
- Sinking Stratocumulus layers (Sc).

Picture 5.19 Ground fog forms due to air being cooled by a cold soil. When the dew point is reached the water content condensates and the fog forms.

Significance:
- Not a bad sign itself. For the day to turn into a really good one the sun must burn away the Stratus fields so that thermals may form.
- If the Stratus fields arrive from somewhere else, or if their origin is the sinking of Stratocumulus, the weather will deteriorate further and rain will prevail.
- Very thick Stratus layers will turn into Nimbostratus.

Nimbostratus (Ns)

No need for long explanations - it is raining, and the rain will last. Nimbostratus follows days of Altocumulus formation caused by the arrival of a warm front. During stationary lows the total Nimbostratus cover is the most common view.

Picture 5.20 Nimbostratus - rain, and lots of it for longer than we dare to imagine it.

Cumulus (Cu)

Picture 5.21 Cumulus clouds. The one in the background already has a well-formed base whereas the front one is still in its forming phase. The eagle shows the way, the pilot follows, with 4m/s (800 ft/min) integrated climb rate.

Origin:

Cumuli are thermal clouds. Warm air rises, reaches the dew point and moisture condensates to form the cumulus cloud. The drier the air, the higher the cloud base. When the air contains much moisture the clouds will grow big and wide, and if there's no inversion to stop the development vertically, thunderclouds will form.

Cumulonimbus (Cb)

Picture 5.22 A summer storm is just a Cu gone mad. As the cloud dumps its large quantities of rain or hail, strong vertical wind movements occur. The downdrafts caused by the falling precipitation hitting the ground and spreading out radially from the impact zone as strong gust fronts with associated turbulence. The cold air pushes under the prevalent warmer summer air and triggers very large areas of lift, possibly forming the next thunderstorm cell. Flying near such clouds is dangerous, both due to the turbulence caused by the gust fronts, the extensive lift and the risk of new Cb's forming right over one's head.

Origin:

A cumulus cloud gone mad, continuing to grow because there is no inversion above the dew point to stop it. Thunderstorm clouds also occur along cold fronts where the triggering impulse is the cold air pushing under the warmer air around.

Significance:

- In a way, summer thunderstorm Cb's are a sign that the weather is nice! For some brief moments while the cloud is dumping, flying is absolutely out of the question. Once the rain has stopped and the Cb dissipated, the weather is usually fine again.
- Frontal storms indicate the arrival of a cold front. Cold fronts travel fast and bring strong turbulence, hail, wind and general misery for any pilot still in the air. Picture 5.23 shows one of the wildest cold front arrivals in recent years.

Picture 5.23 One of the most powerful cold fronts to hit my home town in recent years, with extreme hail and wind strengths.

Picture 5.24 The transformation of a Cu into a Cb. At the moment the only danger is getting sucked in from beneath, and anyone watching from a distance like that of the photographer is still perfectly safe. But this may change in minutes.

Picture 5.25 It doesn't get much closer to the base. In the background the Aletsch Glacier, Switzerland.

Brasil. Picture: Ozone / Olivier Laugero

What can we learn about the weather from observing the wind?

As a supplement to the personal weather forecasting the winds can give important hints as well.

- In the Alps, low clouds coming from the south and high clouds from the northwest indicate a warm-weather spell.
- The opposite situation, with low clouds from the northwest and high from southwest, indicates a cold spell.

Picture 5.26 Sustained gusty winds from the east in the northern Alps indicate a prolonged high-pressure situation.

- During high-pressure spells along the northern perimeter of the Alps it is common to have winds gusting with variable strength from the east. If these winds prevail during the entire day the high-pressure will remain in place, but if the wind direction turns to west a period of changeable conditions is due. A decreasing easterly wind at night is a good sign.

Bild 5.27 The pilot is waiting for a head wind. It whould be nice if the valley wind would reach up to the launching site.

- During high-pressure days the valley winds will characterise the mountain regions and the sea breeze the coast.
- If the wind in the northern hemisphere turns left during the day the weather is about to change to the worse. If the skies clear during this process the situation is defined as an intermediate high-pressure, which rarely lasts very long.

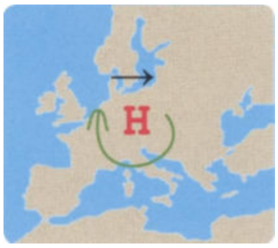


Illustration 5.28 The high-pressure travels from west to east, and the wind directions follow clockwise around the centre of the high-pressure. In the Dolomites for instance the winds start around the north turning first east, then south. This entire process takes a *couple of days.*

When we know where the wind is coming from we can also come up with an idea about where the airmass is coming from and use it for our own forecast

- The wind strength increases with altitude due to wind gradient. The Coriolis effect causes the wind to turn to the right (northern Hemisphere), by as much as 30-40 degrees in the mountains and 15-20 degrees in the flats.
- So when the wind is turning right, from west to northwest, it means that there is drier air arriving and the skies are about to clear.
- If the wind turns even further, from northwest to north to northeast, we get cool dry air from the Russia. Prolonged periods of nice, flyable weather!
- Further turning to the right, from east to south, means the intrusion of humid Mediterranean air. The clear spell is drawing to an end and the cloud base gets lower.
- From south to west means the air is co-

Picture 5.29 In the Dolomites the direction of the high winds reveals the cloud base altitude. North and east means dry air and high cloud base whereas southerly directions mean lower cloud base and imminent rain.

ming from the Atlantic again. Humid air and rain.

- Strengthening wind from the west tells us of the arrival of the next frontal system.
- If during prolonged periods of rain the wind suddenly increases, the weather is just about to improve.

NOTE: All these rules are for Alpine pilots. There is a good chance that something similar is observable at your home sites, all you need to do is to pay attention, take notes and maybe discuss things with more experienced colleagues.

The Coriolis Effect:
Named after the French physicist C.G. de Coriolis (1792-1843) who described it in 1835, the Coriolis effect is the observation that an object moving perpendicular to the rotation of a sphere (for example, moving north or south on the earth which rotates east-west) will not travel in an apparent straight line, but will curve in a specific direction. This is called the Coriolis effect because the wind is not actually changing direction; it's the earth that's moving below it*

- When the situation is normal, the high winds in the Alps are turned 30-40 degrees to the right by the combination of Coriolis effect and ground drag. However, if we observe a greater diversion than these 30-40 degrees it is a sign that there is an influx of warmer air up high, which will cause the thermal activity to slow down or even stop if the thermals are weak. This can be a good thing on very unstable days where the risk of overdevelopment is great - the stabilising effect of the warm-air influx puts a lid on things and keeps the day flyable for longer.

Thanks to the Coriolis effect all winds in the northern Hemisphere are diverted towards the right, and in the southern Hemisphere towards the left.

- If the high-altitude winds are diverted left instead of right it means that there is an influx of cold air up high, a so-called cold-air advection. This makes the atmosphere increasingly unstable so that the thermal activity increases; thermals get stronger and last long into the evening. Under these circumstances even a small ray of sunlight is enough to trigger a good thermal. Up to a point such cold-air advection is our friend, but if it becomes strong the conditions will quickly overdevelop and the flying will be shut down.

"Thanks to http://teacherresourceexchange.org/science/coriolis/no-coriolis.php

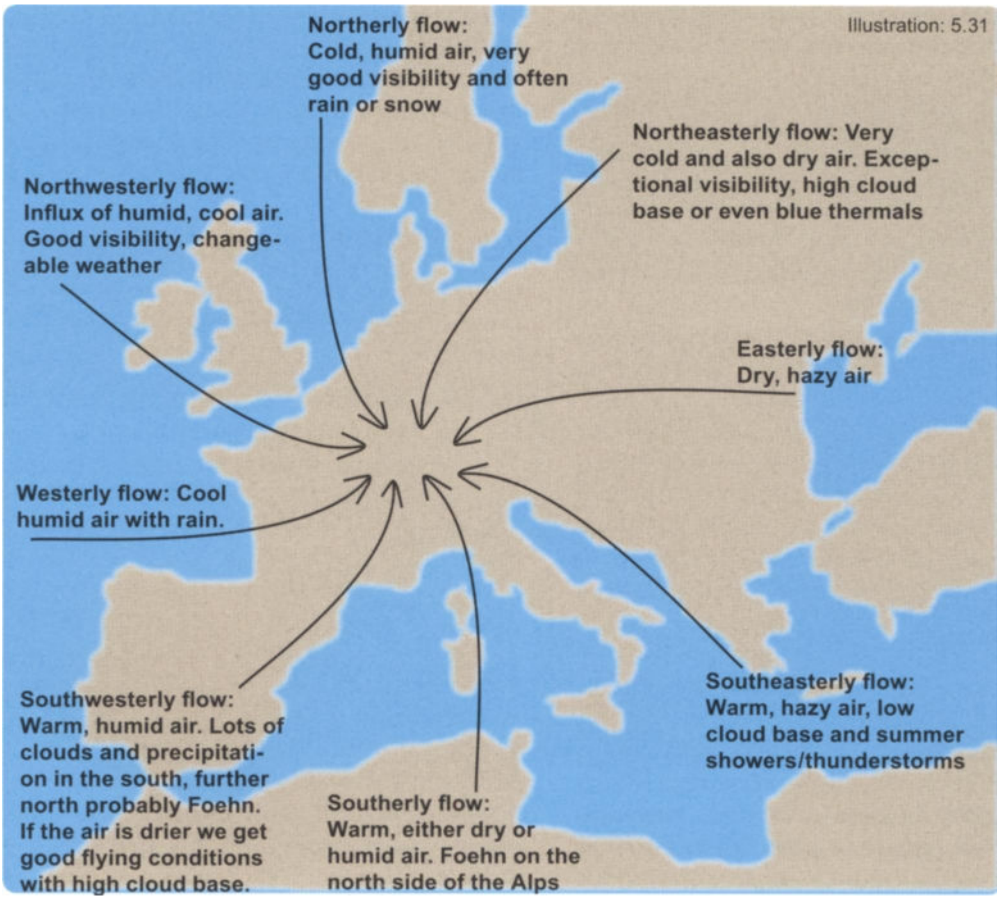
- When there is warm air influx at ground level, the conditions become unstable and the thermals strengthen accordingly.

- Cold-air influx at ground level, for example valley winds or sea breezes cause the atmosphere to stabilise and the thermal activity to decrease or cease altogether.

Picture 5.30 Cold-air advection in the Pustertal, Austria. The last sunrays of the day generate surprisingly usable thermals, and the visibility is spectacular.

Central European weather scenarios

Central Europe is located more or less exactly at the southern extreme of the polar airmass influence. This means that the troughs pass right through - sometimes a bit further north, sometimes a bit further south, but generally influencing the weather we get. This is the reason for the changeable weather patterns we get. Sometimes we get polar air from the north, then a teaspoon of high pressure from the Azores. In the following illustration the different situations, and their likely consequences, are described.



Dangerous weather

If we disregard collisions due to poor visibility there are really only two weather-related dangers to paraglider and hang glider pilots:

1. Strong winds
2. Turbulence

Hang gliders can be flown faster than paragliders and therefore have an advantage. Compared to f.ex. sailplanes the advantage is however quite small, so in the following we shall not discern between hang- and paragliders. Sailplanes are often able to fly around, or escape from, summer showers or cold front shower lines, whereas we really don't stand a chance.

Picture 5.32 This photo was taken on Sardinia, Italy, off the coast of Alghero. The power in such weather phenomena should not be taken lightly.

Strong wind and turbulence may be caused by a number of factors:

- Summer- or frontal storms, with all their associated troubles, gust fronts, extreme climb rates and strong precipitation. Beware of uncontrollable turbulence resulting from all this.

- Cold front passages, with high winds and strong turbulence.

- All downdraughts as they occur in the Alps: Foehn, Bise, Mistral and Bora. All are characterised by high wind speeds and the turbulence that follows. Simply put, strong winds means strong turbulence. Every area has its own protected enclaves and the experienced pilot knows where to go and when to find flyable conditions in spite of a generally unflyable forecast. Note that this is a risky game as all downdraughts may suddenly break into a normally protected valley.

- Stronger winds higher up. In the German/Austrian glider forecasts they speak of "turbulence at peak altitude". This is not to be taken lightly.

- Turbulence caused by thermals. These may become very strong at times and beginners disregard this at their own peril. Hang gliders don't normally collapse but the bar may be torn out of the pilots' hands in extreme cases, or the wing may tuck. Collapses as such are not dangerous on paragliders but in extreme turbulence they may soon become dangerous.

- Wind sheer is generally not as turbulent as strong thermals. When two strong winds meet, and mix with some thermal turbulence, it may nonetheless become too much for us.

- Strongish but flyable winds may double when blowing through passes and other funnelling ground features. A strong but

Picture 5.36 Well-known winds in Europe and around the Mediterranean Sea. The most universally known downdraught is the Foehn but all strong winds cause dangerous turbulence in the lee of mountains. There will always be protected valleys or areas but there are no guarantees - if the wind speed increases it may also break into areas previously thought to be sheltered. The glider forecasts speak of "peak level turbulence" and mean it!

Picture 5.37 Soaring at Rainbow Beach, Australia. When flying near the sea we can easily follow the wind strength development by looking at the surface. If the surface is calm we continue to fly. Once the first whitecaps appear the wind has increased to about 20km/h (11kn), and when the whitecaps become abundant it is time to land!
The clever pilot does not concentrate only on the water near his landing but looks far out to sea in order to get a longer warning of things to come.

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Chapter 6: Thermal centring techniques

We've all heard some hotshot telling stories of how he cored the thermal and spiralled up inside the narrow core. Let it be said right away; this is a bit of an exaggeration, it does however capture the feeling one gets while doing it rather well.

When thermalling in large even lift we try to circle as flat as we can to minimise the descent (all wings descend more in a turn than when going straight), whilst in strong, narrow lift we need to remain inside the core and our own descending becomes less relevant, so the bank angle is increased. However at all times it pays to fly with the least possible descent rate to optimise the climbing. On paragliders we brake both sides slightly to achieve min. descent, then increase the brake input somewhat on the inner side while weight-shifting into the curve as well - flat, efficient turnes should be the result. The weightshifting causes the wing to distort along the centre cell - we get the well-known little "step" in the top surface. The step causes a skewing of the total lift vector over to the weight shifted side, and it is this skewing that makes the wing turn.

Thermals are rarely totally smooth. But sometimes we do come across homogenous, strong cores - Bubbles with 6 to 8 m/s (1200 to 1600ft/min) climb rate have been centered this way in a really smooth manner. To bad that such situations are the exception.

Picture 6.2 Coring together in harmony - at 180 degrees to each other, turning flat and efficiently and approaching cloud base with a friend.

The general rule of thumb is: Strong thermals = strong turbulence

Picture 6.1 Weight shift causes the wing to distort along the centre cell. This in turn causes a skewing of the total lift vector over to the weight shifted side, and it is this skewing that makes the wing turn.

Picture 6.3 Felix Wolk and Javier Olivan doing a syncro spiral.

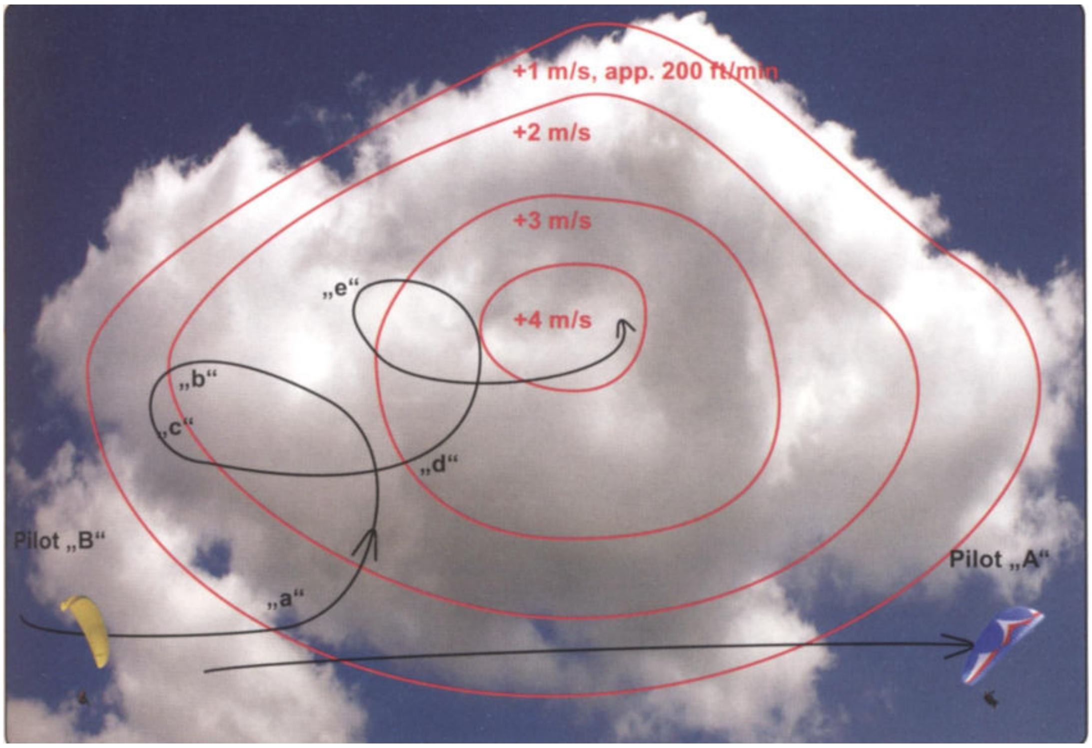


Illustration 6.4 Efficient coring made easy: If the climb rate decreases, turn tighter (back to where you came from), if the climb rate increases, open up the turn. If the climb rate is constant, maintain the curve - unless someone else is climbing better near by!

How to find the best lift

In Illustration 6.4 the core of the thermal has climb rates of about 4m/s and is situated approximately in the middle of the thermal column, with the climb rates progressively decreasing towards the edges. If a pilot enters the lift zone without turning, eventually he will exit again - just as is the case for pilot A in the illustration. While crossing the thermal pilot A will have felt one side of his wing lifting more than the other, because this side was in the better lift - he will have been sitting somewhat askew in his harness. To efficiently use the thermal, the pilot must turn towards the side that produces more lift - just as pilot B does at "a". After a short while pilot B, with the help of his vario, feels that the lift is getting weaker so he is about to leave the better part of the thermal (at "b") and he immediately turns hard to get back into the good lift ("c"). By now the vario will be getting progressively louder and pilot B opens up his turn somewhat (at "d") in or-

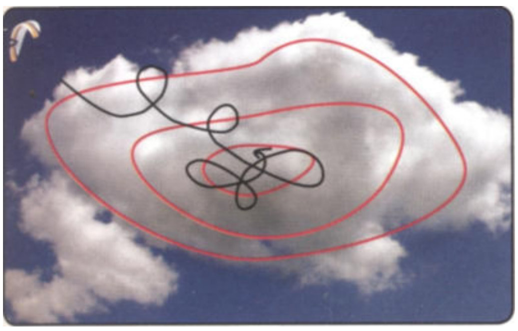


Illustration 6.5 This method ALWAYS works, even when we have initially turned the wrong way. In this illustration the pilot has missed the good core three times but still finds it eventually, simply by using the technique described above

der to explore the size of this better climb. He just misses the best core, flies out of the good stuff at "e", and turns sharply to get back in - and in this attempt hits the 4m/s core! Now he knows how much to expect and can turn as sharply as is needed to remain in the core.

ummary - finding the best lift:

Climb rate decreasing > turn tighter
Climb rate increasing > open up the turn
Climb rate remains constant > circle radius should also remain constant

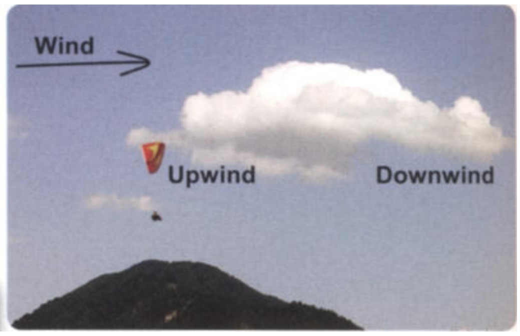


Illustration 6.6 Climb rates are almost always better closer to the upwind side of a thermal.

There is a reason why the big raptors always circle in thermals; it is the most efficient way. Never attempt to fly figure-eights, always make your course adjustments carefully, without too much impulse, fly the circles cleanly without sharp edges, because edges mean increased descending. Never brake too much - the wing climbs best when flown at min. descent, which with most paragliders means brakes around shoulder height.

Hint:
When I encounter lift while flying straight I always keep flying straight until the lift begins to decrease again, then I turn into the wind for my first circle.

Upwind and downwind of the thermal

On no wind days there is no lee and no upwind side to a thermal. But as soon as we get any wind, the best climbs are usually to be found upwind, nearer the windward side of the thermal. Besides, falling out of a thermal on the upwind side is far preferable to falling out the downwind - simply turn back and fly with a tailwind into the thermal again.

Total Energy Compensation, TEC

Most modern varios have a TEC setting where we can filter out the "lift" caused only by changes in our velocity. If we fly fast and then brake hard, some of the excess energy is converted into altitude and we might think that we have encountered a great thermal. Setting the TEC of the vario correctly can filter out such "fake thermals".

Picture 6.7 A high-end modern vario with TEC options built in.

Hint:
If I am flying with a tailwind and encounter lift I will normally start my first circle quite soon after entering the lift, to stay in the better, upwind part of the thermal. On the other hand, when entering lift while flying with a headwind I keep going straight for longer in the hope that I go all the way into the juicy upwind section of the thermal.

Important thermalling insights

Do not change turn direction

Every time we turn we must re-centre, and all the changing of bank angles „confuses" the vario so that it may beep where there's no lift and give sink alarm where there's no increased sink - only when the circles are smooth once more, the vario can be relied upon again.

Hang gliders flying with both a speed probe and a TEC vario are better able to filter all this „noise", whereas on paragliders the speed sensor gets too much pendulum effect to be reliable during changes of turn direction.

Picture 6.8 If the thermal core is very narrow the pilot must fly tight circles with plenty bank angle. This is often the case down low, whilst higher up the thermal will generally expand and thus become easier to centre. Picture shows the Mount Olympos in Greece.

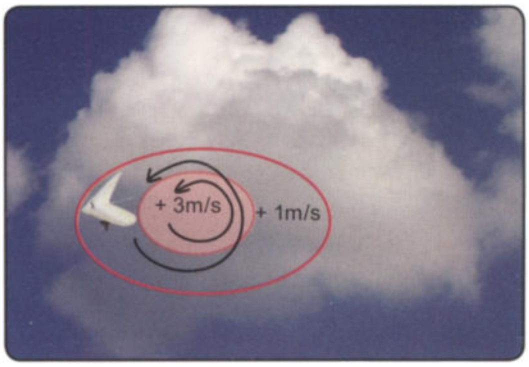
Circle radius changes should be undertaken really smooth

Lets take an example: The pilot has done a full circle, but half the circle was flown in 2m/s lift and the other half had 3m/s. The next circle he will attempt to move a little further in the direction of the stronger lift, WITHOUT big control inputs. Perhaps he is now able to do three quarters of a circle in 3m/s lift - so the next circle is again moved a bit off to the side where the stronger lift is. If this does not improve the situation, the thermal is too narrow for a full circle at the present turning radius, and it probably pays to tighten up the circle somewhat.

1 m/s is approx. 200 ft/min

When to turn tight and when to turn flat?

When thermalling, the objective for most pilots is getting up as fast and efficiently as possible. To do this we fly with as little descent as we can, however at min. descent we can't tighten the turn very much. We often encounter stronger cores that are too small to remain in if we keep turning as flat as we can. In these cases it may be worthwhile to increase bank and accept the higher descent rate involved, simply to stay in the stronger core. The higher bank angle also



Picture 6.9 If the thermal core is small and strong we can optimise our climbing by sacrificing some of our descent rate in order to remain in the stronger core. This is done by increasing the bank angle and turning tighter.

loads up the wing more and makes it more resistant to collapses, and finally remaining in a homogenous airmass is usually more comfortable than flying in and out of strong lift all the time. Having said that, some cores simply are too small to do a full circle in them regardless of the bank angle. To optimise our climb under these circumstances we may be forced to fly in and out of the cores - we then try to get as much as possible of our circle inside the strong core.

A further advantage to turning tight in stronger lift is that it is easier to orient oneself when not loosing the core all the time.

In the beginning it is difficult to know exactly when it pays to increase the bank and decrease the turning radius. The vario and experience help a lot! If you have the opportunity you can easily practise using a different turn radius for different thermal strengths - the vario beeps will tell you which angle is the most efficient for your thermal.

What to do when one falling out of the side of a thermal?

The first thing to reflect upon is whether you fell out on the lee side or on the windward side. In both cases you need to turn around quickly, but if you fell out on the lee side the next turn should be a big, open ..searching" one, whereas if you fell out on the windward side it is usually enough to get back in and immediately bank up sharp again. If finding the thermal again is proving difficult, try to be alert to even the slightest variations in descent - if the descent is decreasing, expand the circle in that direction, if the descent is increasing turn around and search in the opposite direction.

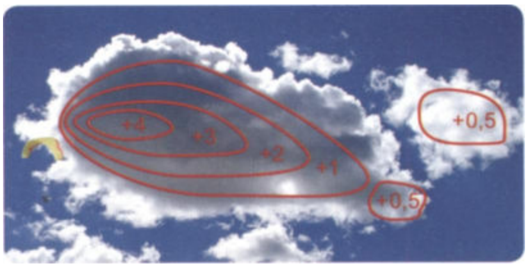


Illustration 6.10 The core of the thermal is almost always closer to the upwind side. If we're coming from the leeward side we continue to fly straight until the lift decreases - this will take a while, as we're both travelling against the wind AND have to fly further. When coming from the windward side (the yellow glider) we start turning almost immediately after hitting lift. If the lift is looking like this thermal we can expect to work hard to remain in the core.

If you fall out on the lee side in strong winds it may not be worthwhile searching for too long against the wind, as there will surely be increased descent right next to the thermal and it can be quite hard to get through this and back into the thermal. If you were going with the wind anyway, and there seems to be other options near by, you may want to consider just heading for them instead.

Picture 6.11 iThermalling on a tandem is somewhat harder than on a solo wing, due both to a greater turning radius and higher forces required to steer.

Picture 6.12 Having some flying mates around makes thermalling much easier, especially on blue days. When someone looses the thermal he can quickly relocate it simply by joining the others!


Manilla, Australia. Picture: Martin Scheel / azoom.ch

Hint:
When flying XC you need to have a good understanding of the maximum available altitude on the day, regardless of it being a blue or a cloudy one. This knowledge will help you to decide if it pays to spend time searching for that thermal you just lost, or you should rather be heading along, if you loose it close to the max. altitude and you're not just about to go on a big transition, by all means just continue instead of wasting any more time searching.

Cores of different strengths next to each other

If a long ridgeline is facing into the sun, the entire slope may lift of as one very large lifting area with many different embedded cores. The cores will often have different climb rates, depending on the area that feeds them.

Let us take a hypothetical example: Two thermals form close to each other, one has three degrees excess temperature compared to the surrounding air, the other only two. The former will obviously rise faster, and if we're on the slower one it pays to move over to the faster rising thermal - provided we know of it, which we can only do if someone else near by is climbing faster than we are.

If the better thermal is further away it may not pay to move to it - not only do we loose time and altitude on the way there, we also loose time locating the best core in the new one. However, if the better thermal is on our intended course line I have actually often been lucky while gliding from one core to another one, by finding an even better one on the way there!

But assuming there wasn't such a new bonanza thermal on the way, the whole process of changing thermals will usually cost more than it gains in terms of rapid height gain. Besides, thermal cores often tend to join into one big core higher up - if that is the case then it is often possible to expand the search radius within the thermal in order to join the better core.

Hint:
If a pilot near by is riding the express elevator we must join him as soon as possible. When flying with other pilots i often wonder why so few join me when I locate something good.

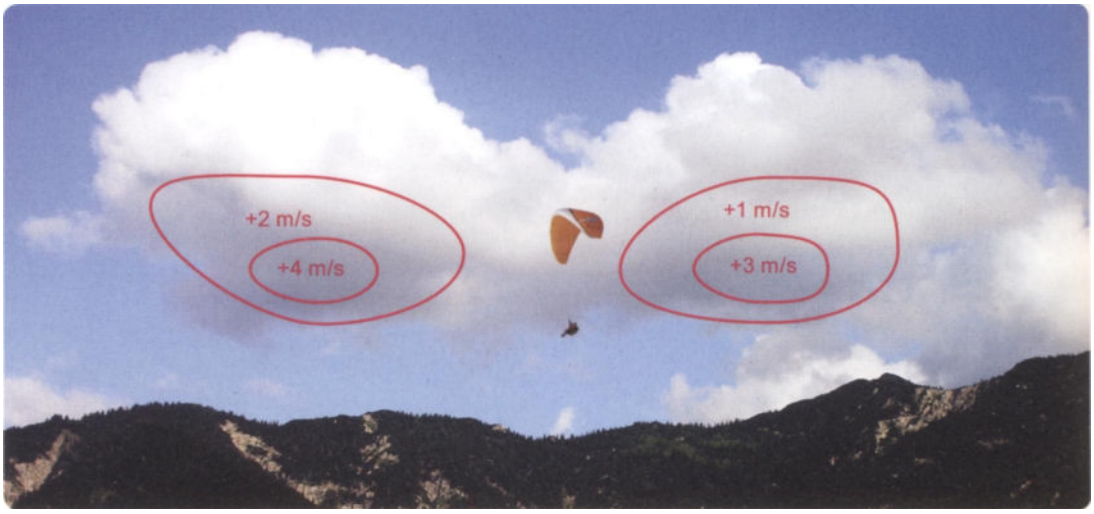


Illustration 6.13 When thermals of varying strength are located close to each other it pays to move from a weaker to a stronger one. If however the distance between them is greater than a short glide it will often be better to stay in the one you have - mostly the climb rates are equalised up higher anyway.

Brief Summary:
If everybody is in comparable lift, some slightly stronger, some weaker, changing core is not worth it. But if the invisible hand suddenly plucks someone close by up, move there immediately!

Experience:
Once while thermalling in front the notorious Wank in Garmisch-Partenkirchen/Germany I finally found a good core which gave me 5m/s integrated climbing. I stayed with it until about 300m beneath the cloud base where I headed out - or so I thought. Instead I flew right into the proper core, which was no less than 10m/s! If only someone had been in it I could have seen it a lot earlier.

Hint:
When circling in a weak thermal I am very aware of everything in the surrounding air that may point to a better climb. This can be other pilots, birds, leaves, dust, spiderwebs, anything really. As soon as something is going up faster than me, I go there.
In strong thermals my strategy is different - there I simply concentrate on optimising my climb.

Reversing the turn direction in a thermal

This is something that should generally be avoided as we always join an already existing gaggle by turning in the same direction, however there are situations where reversing is inevitable. Lets say two cores join, each with their gaggle of pilots in them turning opposite ways, or a gaggle dissolves, then joins forces again albeit turning the opposite way this time.

These are just examples of situations where there's no avoiding a turn direction reversal.

***Picture 6.14** If a pilot is climbing faster than another in the same thermal it may be due to the vortex effect described in picture 1.16. In any case one of the pilots must now reverse his turn direction, and in this case where the lower pilot came last he should do it.*

The clever reversal method

Thermals drift with the wind, and in narrow thermals it can be tricky to do a direction reversal without falling out of the side. The trick is to move to the upwind side, where falling out of the side is less critical,

Falling out of the downwind side is only critical in strong winds and strong thermals, as can be seen from the track „C" in Illustration 6.15.

Experience:
Once in a comp I got it just right and could use the vortex ring to catch up to a gaggle above me very fast. Unfortunately I had to reverse my turn direction and, during the reversal I fell out of the lee side of the thermal. I quickly lost 500m and felt very frustrated. Nowadays I always take care to position myself right before doing something like this.

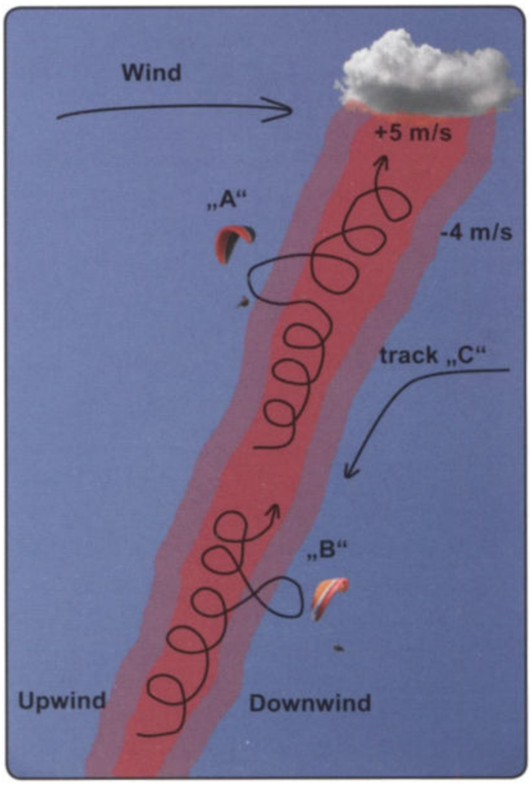


Illustration 6.15 Cross section of a windblown thermal. Pilot A is turning left then flies out the upwind side to reverse his turn direction. From there he flies with a tailwind back into the thermal, with minimal altitude loss.
Pilot B does his reversal on the lee side and must battle a head wind to get back into the thermal. Notice that this isn't always even possible if the wind is strong and the thermal likewise. The following thing happens: The pilot flies as in C, against the wind, to re-join the thermal but finds himself being flushed in the sinking air just downwind of it.

If there's no wind there's also no upwind and downwind, so a direction reversal may be done anywhere.

„Bouncing off" the side of a thermal

If we approach a strong thermal head on our wing gets pitched back, sometimes very much so. Hang gliders pull in to accelerate whilst paragliders release the brakes to counter this back-pitching motion - but the hang gliders are far more efficient at this, and in extreme cases paragliders may even enter a deep stall. If this happens, the pilot must first solve the deep stall (see page 20), then decide the next course of action. There are several possibilities:

1. To fly somewhere else - this thermal is too strong to be fun anyway. Beginners should always choose this option.

2. Try to enter again, this time flying at higher speed - ½ speed bar is usually enough. Chances are we'll get in this time, but we may suffer an asymmetrical collapse in the process.

3. Fly around the thermal and try to enter it from the other side.

Picture 6.16 Sometimes the wing may be pitched back quite far when it meets the rising air inside the thermal. In extreme cases paragliders may enter a deep-, or even a full stall, due to this pitching motion. If this happens, first solve the problem, and then consider if this thermal is ok for you.

Illustration 6.17
The mouth of the Zillertal Valley, Austria. In the afternoon the valley wind flows over the low ridge in the foreground from the left (blue arrow). Thermals may still form on the lee side and get pushed towards the middle of the valley. Once they get higher they encounter the higher-altitude winds (red arrow) and are pushed in a new direction.
On days when the valley wind is strong the lee side of the small mountain gets dangerous due to rotor - and the thermals are totally blown apart as well.
A late XC pilot coming from the Achensee may still make the crossing provided his altitude is sufficient to arrive above the yellow line, where the mountains are high enough to be above the valley wind influence.

blue line: valley wind
red line: wind in the high

Wind shears

Even good pilots struggle with wind shears. It is simply not easy to climb in conditions where there are wind shears, the thermals get broken and often weak. To get through one must use all the tricks in the book, take every little puff of lift and feel one's way around the air with all senses on full alert. Once through, you are rewarded by good climb rates again.

Lets take an example: There's not much wind at any level, but around 2500m there's a noticeable wind shear. We have already bounced off it several times, getting to the same altitude then loosing the lift. Next time we open up our search pattern somewhat in order to try and locate the thermal again, all the time looking for nature's subtle hints, like butterflies, spiders' webs, leaves and birds. It is easy to think that the thermal won't go any higher, but perhaps there's a cloud base way above, giving evidence to the opposite.

If this is the case, or if there are pilots up above the difficult layer, it gets easier. Simply try to visualise which cloud belongs to which thermal and draw an imaginary line between them - that is the area where the thermal should be.

Hint:
If I'm all alone in the air and encounter difficult climbs like the one mentioned above, I sometimes close my eyes in order to be able to concentrate 100% on feeling the air and listening to the vario.

Hint:
Most pilots tend to look at the ground while thermalling, especially when they are low. This allows them to monitor the drift quite accurately - if the thermal is drifting it is easy to see on the ground. But there may be wind shears changing the drift direction, and following a thermal through these can be really hard if you're looking at the ground. Instead, I try to pretend that I'm really high and simply concentrate on feeling the thermal. This works well for me!

Hint:
Low down all thermals suck in air from their surroundings. The attentive pilot will notice this lateral movement of the air, both by watching his GPS and by feel. If you feel that you're being pulled in a certain direction, go with the flow and you'll find the thermal!
Higher up the opposite is the case - before encountering a thermal we'll generally feel a slight head wind combined with increased descent rates - all due to the vortex ring structure of the thermal column.

Hint:
If we don't keep concentrating on centring the thermal we will normally fall out of the lee side. The reason for this is that the wind pushes us slightly more than it pushes the thermal, so if we just make perfectly round circles they'll eventually fall outside the lifting area

Rules for sharing thermals

Thermal flying has its own set of rules:

- The pilot who finds the thermal decides which way to turn in it
- The right hand pilot has right of way
- The faster climbing pilot has right of way

The middle rule has the interesting implication that if we join a gaggle turning left then they must give way to us! Since nobody likes to be pushed out of a thermal by a newcomer it is however much better to join in the way shown in Illustration 6.18.

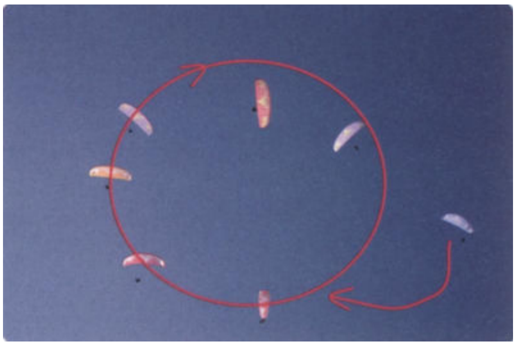


Illustration 6.18 A pilot joining a gaggle of thermalling colleagues should never insist on his right of way. It is much better to do a gentle curve that allows us to slot into the open space, always bearing in mind that if it wasn't for this gaggle we might never have found the thermal in the first place!

If everybody behaved like this in thermals we could avoid many dangerous situations and bad feelings between the pilots.

Experience:
Beginners often know no better and violate every single rule mentioned above - make sure you are not one of them.


Karakoram, Pakistan. Picture: Ozone / Philippe Nodet

Thermalling with different types of aircraft

It is not uncommon to be sharing a thermal with hang gliders, paragliders and sailplanes. To avoid conflict and danger, all parties involved should understand the specific limitations of each other aircraft involved.

Paragliders can't see much behind and below themselves. They can core really tight.

Hang gliders can't see anything above themselves. They also have the ability to core tightly, however their speed in the thermals is higher.

Sailplane pilots can't see anything beneath themselves. They fly very fast (around 100km/h when thermalling) and can't turn so tight.

When paraglider and hang gliders share a thermal with sailplanes it makes things easier for all if the former turn relatively tight so that the sailplane(s) may circle around them. If someone has to reverse turn direction, politeness dictates that it should be the textile pilots as sailplanes need VERY big thermals to reverse without falling out.

Due to the enormous performance advantage of sailplanes they are unlikely to share your thermal for long anyway, as they generally spot something better far away in the distance and just hightail it over there.

Picture 6.20 Sailplane pilots have excellent outlook forwards and upwards, but little or none downwards and towards the back.

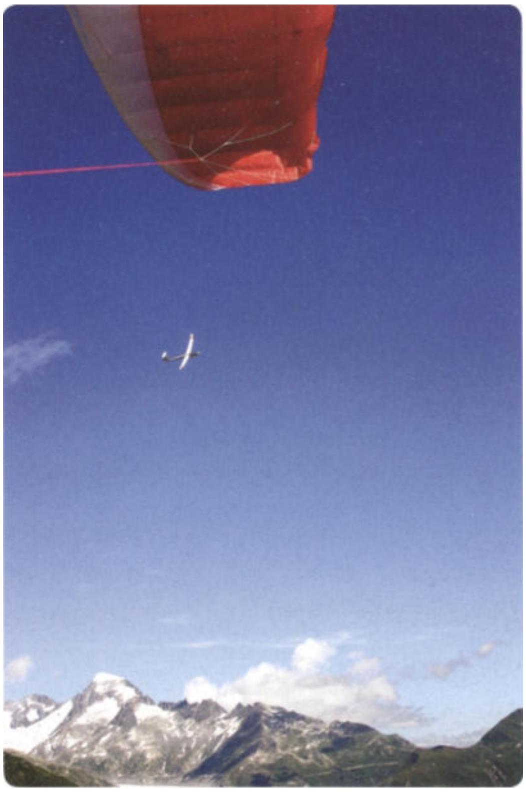
Picture 6.19 When sharing ft thermal with more pilots it pays to adjust the angle between you so that the individual distance is maximised. If 3 pilots are sharing, they should be at 120 degrees to each other, if 4 are sharing they reduce the angle to 90 degrees etc.

Picture 6.21 If two pilots are sharing a strong, narrow core they must look out for each other all the time. The best is to place oneself directly opposite the other pilot, at 180 degrees. See Illustration 6.2, page 162.

Picture 6.22 When paragliders and hang gliders share lift, it is preferable that the hang glider turns somewhat more open than the paraglider - this way they don't change positions among themselves all the time, as would be the case if their radius is the same.

When thermalling together with one of „the others" always keep his visibility limitations in mind. Avoid placing yourself in his blind spot. Paragliders fly somewhat slower than hang gliders, so if the hang glider makes a slightly larger circle you will both need about the same amount of time to do a complete 360. Some say that it is easier for the paraglider pilot to adjust his radius, so it follows that the responsibility to do so is mainly his. The hang glider should remain constant to help the paraglider adapt.

The same can be said for sharing lift with sailplanes



Picture 6.23 In this shot both are thermalling in a way where they are always in each other's line of sight. This is a good way to avoid trouble.

If it gets to crowded for your comfort, simply fly out and let the others climb past you for a bit - it is only a problem when several pilots are at the same altitude.

Picture 6.24 Hang glider and sailplane thermalling in perfect harmony, with the sailplane turning significantly larger circles. Goms, Switzerland.

Picture 6.25 The best way to share lift is always to remain in each other's line of sight. To accomplish this the paraglider turns somewhat tighter circles - then it works out.

Experience:
Once on an XC flight I ran into a big gaggle of competition pilots battling it out. I flew with them for a while as our courses were the same, but whenever I could feel them getting all to aggressive I left them alone for a bit - their stress levels was surely much higher than mine, since I was only out to enjoy myself.

Flying without vario

Good pilots can fly almost as well without vario as with, and many make a point out of turning it off once in a while to hone their intuition instead of always relying 100% on technology. This is excellent training as it forces one to use all the other fantastic senses that nature has given us, and if we never do it we may feel like blind people as soon as the vario is off.

Without the help of the vario, sensing the air must be felt with the bottom instead of heard with the ears. Feeling the changes in vertical air movement is relatively easy, but sensing the lateral pulling and pushing of thermals requires more practise and skills.

Just as when we're riding an elevator it is no problem to feel the accelerations but once the „cruising speed" has been reached we don't feel the motion any more. This makes flying without a vario even harder, as flying from -3m/s into -1m/s can easily feel like entering a good thermal. To avoid ending up ..thermalling" in descent it is necessary to keep taking fixes on recognisable objects on the ground. In the mountains this is no problem as long as we're still below ridge height, but in the flats, and when above the ridges, it gets trickier. In the mountains we use a peak close by, and the view behind it to discern whether we're making any vertical progress, in the flats we need to be even smarter than that.

All the info, from the fix point lines to the sensations in the seat and the way the glider moves, are combined into an overall picture of climb versus sink. Finally, flying together with a group of pilots makes going without the vario much easier.

Experience:
Even your sense of smell may help you locate thermals. I once had a strong smell of fresh wood in my nose as I entered a good thermal - it had brought the smell up from the forest being cleared below.

Picture 6.26 Alpine Daws are some of the most skilled aviators in the sky - this one is catching apple bites in the air. They are also some of the only birds that can be seen to really enjoy aerobatics, doing loops, barrel rolls etc.

Engadin, Switzerland. Picture: Martin Scheel / azoom.ch

Chapter 7: Valley winds, the important wind-sytem in the mountains

Understanding valley winds is a prerequisite for safe flight planning in mountain regions. Anyone who has taken the time to get to the bottom of them, studied the theory and made their own observations is surely a much safer pilot in the air. In the following paragraphs I will outline the most important issues.

Valley winds can occur both summer and winter, but they get much stronger in the summer. Any day in the mountains that is thermally flyable is also a valley wind day.

The formation of valley winds

Illustration 7.1 shows a cross section of two different areas, one flat, the other mountainous. On a sunny day, both these two areas will get the same amount of energy from the sun. In the mountains, certain areas (the slopes facing into the sun) will heat up dramatically whereas the shaded slopes won't, and the warm slopes will in their turn heat the overlying air. And this is where it gets interesting! Because the mountains take up so much space, there is much less air to heat in the mountainous regions! It follows that the temperature rise is far more distinctive in the mountains than in the flatlands. Adding to the imbalance is the fact that the mountain air is also drier, and dry air heats faster than moist.

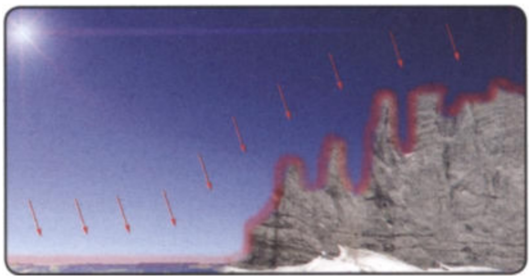


Illustration 7.1 Cross-section of a flatland region meeting a mountain range. The two equally sized regions get the same amount of energy from the sun, but since so much volume in the mountains is taken up by rock, there's much less air to heat - it follows that the heating happens faster and reaches higher temperatures than in the flatlands.

Finally the mountain air is generally also cleaner which adds even further to the better heating profile.

The warmer air is lighter than the colder air in the flats, and the air pressure drops during the day in the mountains. We call it the heat low.

In the Alpine region the heated air spreads out up high and gets cooled down, then sinks back down north and south of the actual mountains creating a circular flow around the entire mountain range. The process sets in on all sunny days, sometimes stronger, sometimes weaker. In the winter it may be really weak but still there.

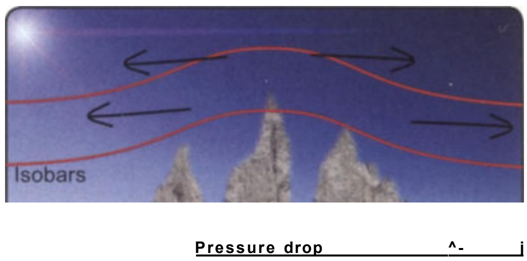


Illustration 7.2 Formation of a heat low in a mountain range. The relatively warmer air in the mountains expands and the pressure in the mountains drops. Up high, the air flows laterally away to sink back down again far away, and at ground level the air flows in from the side to fill the low pressure - and the valley wind sets in.

For simplicity this whole process was previously often described as a case of warm air rising and sucking in air the surrounding flatlands. This is only partially correct since the reverse conclusion would be that there

are only valley winds on days with thermals, which we know isn't the full story. One example here would be an old high-pressure with hardly any temperature gradient, no thermals worth mentioning yet the valley winds can still get surprisingly strong!

Of course the valley winds get even stronger as soon as thermals add their dynamics *to the* equation.

The rising thermals also suck in air from the sides. This influx of air becomes much more pronounced in true mountainous regions as opposed to hilly country. However, the air thus circulated actually sinks again in the near vicinity and can never account for the large-scale heat low as we know it from mountain chains like the European Alps.

The heat low over the Alps is only a few

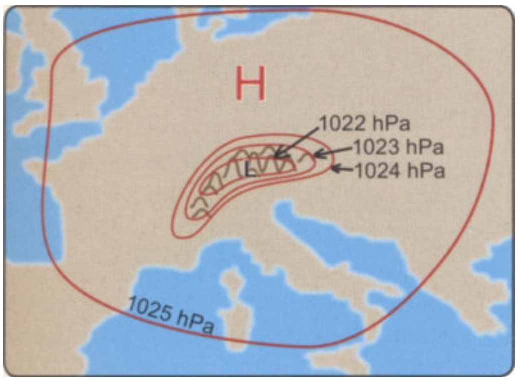


Illustration 7.3 The heat low setting up in the Alps is but a few hPa lower that the surrounding airmass. Since standard meteorological isobar maps don't have such high resolution (they tend to work in 4 or 5 hPa steps) it actually doesn't show up on these.

hPa lower and thus doesn't show up on the isobar maps, as these operate with 4-5 hPa resolution.

Valley winds may reach surprisingly high up into the mountains, sometimes flushing over ridges more than 1000m high. The average speed in wide valleys in the Alps is around 20-30km/h but in extreme cases, like in the Himalayas, they may reach 80km/h.

Conversion table see page 21.

Hint:
ALWAYS hook you speed system up before you fly - even if there's only a breath of wind on launch. The valley winds may be much stronger than you anticipate, even on days with little or no thermal activity.

Valley wind strength during the course of the day

In the low Alps we can expect the valley winds to start blowing around 9AM, slightly later in spring and autumn, and slightly earlier on very good days in midsummer.

At this time it is still weak and battles the catabatic mountain winds. The further we move into the high Alps the later the valley wind arrives.

Around 12AM the wind is strong enough to overflow minor ridges, at 2PM it is nearing its peak, and at 4PM we can expect it to begin abating again - all times based on midsummer conditions.

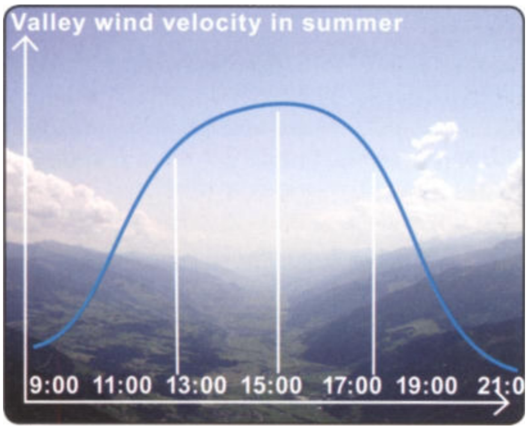


Illustration 7.4 Valley wind velocity during the course of the day.

Around 6PM it should be noticeably weaker again, but it will often continue to blow, albeit weak, right until sunset, when the catabatic flow takes over again. The mountain wind begins slowly and builds up during the night, only to be replaced by the valley winds again the following day.

Hint:
Knowing your local area helps you predict when it pays to start heading for launch. I know my home mountain rather well, for example the important times to know in the summer are as follows:
Catabatic flow/mountain wind on the landing till app. 9:30AM, same on launch till 10:30AM. Beginner-friendly winds on the landing till 1PM.

The Bavarian Wind

The so-called Bavarian Wind influences the entire northern section of the Alps. This wind is caused by the heat low and may get very strong, often overflowing mountains up to 2000m and reaching all the way to the main dividing range. Such local phenomena may be observed at many places around the planet and are important to know both for safety reasons and for planning XC flights efficiently.

The valley wind strength depends on the following factors:

- Valley length - long valleys faster stronger winds
- Venturi effects - narrow sections accelerate the wind
- Macro-meteorological wind direction and strength - if it is blowing the same way as the valley wind they tend to strengthen each other, whereas opposite directions have the opposite effect. Some places are known for Jnversed" valley winds caused by other winds overruling the logical flow.
- Temperature gradient - a good temperature gradient accentuates the valley wind formation
- Thermal strength - see above
- Inversion altitude - if there's an inversion at ridge height the valley winds may get accelerated by the venturi effect beneath it. See Illustration 3.63, page 108.

Picture 7.5 Even when there's no wind on launch the wind beneath the inversion may be very strong. If the inversion lifts the valley winds becomes weaker. Always hook up your speed system!

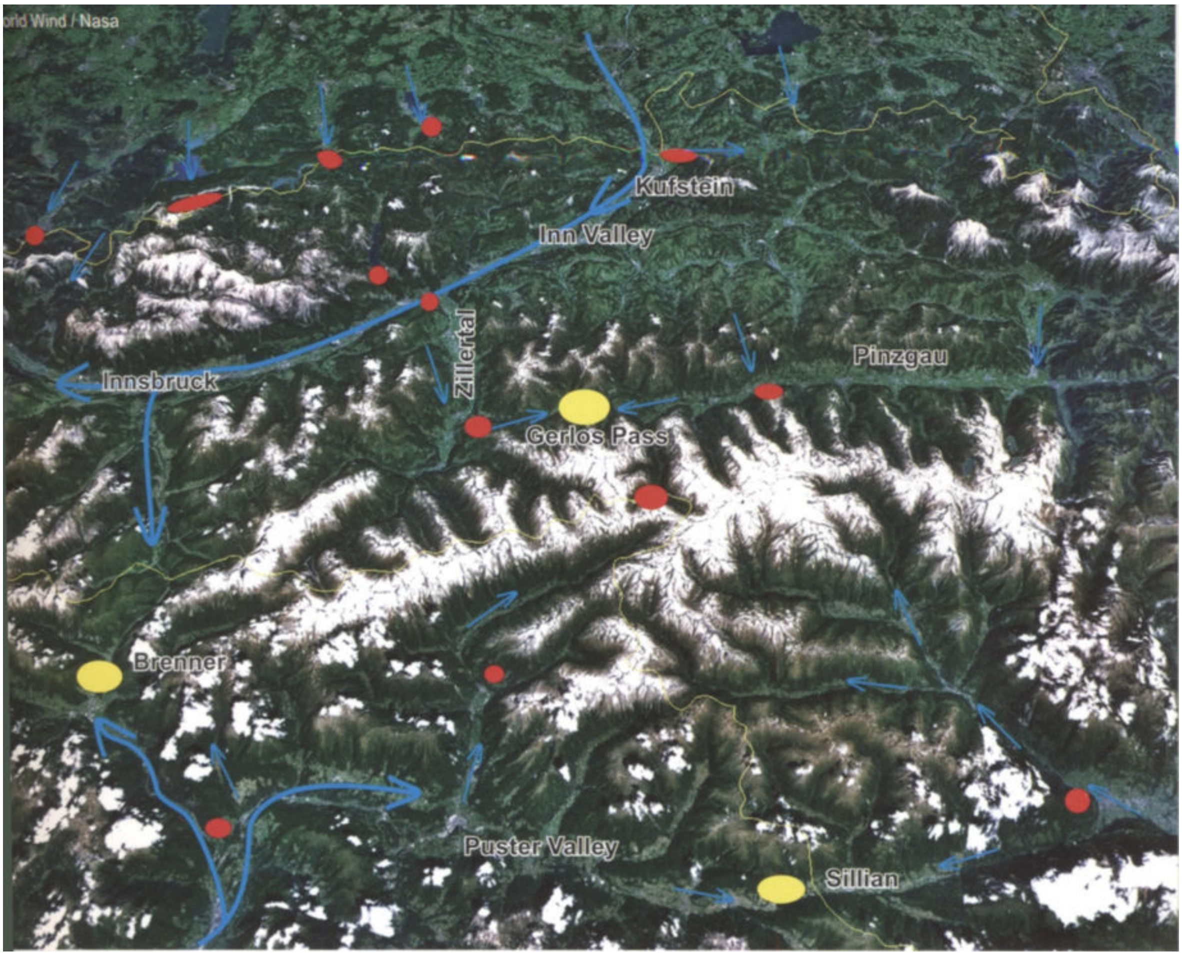
Valley wind strengths during the course of the year

Spring: Medium strong - up to 10-20km/h
Summer: Strong - up to 40km/h
Autumn: Medium strong - up to 10-20km/h
Winter: Weak - 0-1 Okm/h

Glacier wind

The air overlying a glacier will get cooled by the ice, gets heavier and flows down. Once this downdraught reaches the valley floor it meets with the valley wind and causes turbulence. If it meets a ridge oriented

Picture 7.6 The glacier cools the air, and the colder, heavier air flows down into the valley where it meets the valley wind and causes turbulence and unpredictable direction changes



ation 7.7 Aerial view of the Austrian Alps with valley wind directions drawn in blue, convergences in yellow and • wind soaring ridges marked in red. Notice how the winds split when valleys split.

erpendicular to the flow it may make the idge soarable, or it may converge with ther winds to cause a convergence to set p, see Illustration 3.35.

alley wind courses

To understand valley wind systems it akes sense to take a look at an image like e one in 7.7. In this case (the Alps) the neral orientation of the chain is E-W, and e main influx of air due to the heat low thus mes from N and S. But once within the lpine region, the winds do not remain north south - rather, they follow the valleys up wards the centre of the heat low, located ound the main dividing range (the glaciers the image). Notice that the north wind ound Kufstein turns and becomes east at st until the mouth of the Zillertal, where the main body continues west towards Innsbruck but a significant part blows up the Zillertal as north wind again. Further up the Zillertal the wind branches again, with one part blowing up towards the Gerlos Pass, now a west wind!

If the valley wind is strong it is important to avoid ridges that are being flushed by it (like the previously mentioned low one at the mouth of the Zillertal, the Steinerhof ridge, above the „tal" in the word ..Zillertal"). Such lees are turbulent and produce no useable lift, see illustration 7.9, next page.

Another good example is the Pass Thurn (blue arrow east of the Gerlos Pass) where the north wind (Bavarian wind) breaks into the Pinzgau valley and overrules the local valley wind coming from the east. The XC pilot wishing to get past here in the afternoon does so by switching from the north side of the Pinzgau to the south side. At Hollersbach, opposite the Pass Thurn, it is possible to soar back up from surprisingly low in the Bavarian wind overflowing the pass (see Illustration 7.8).

Illustration 7.8 The Bavarian wind overflows the Pass Thurn and hits the Hollersbach ridge across the valley. Here, the wind is diverted straight up, which makes the ridge soarable from very low.

I have already mentioned the low „Steinerhof" ridge at the mouth of the Zillertal, where the valley wind blowing from the east will often overflow in the afternoon. There's even a launch on the lee side of this little ridge - no points for guessing where the wind is coming from there in the afternoon. Also check Illustration 6.17

Illustration 7.9 The Steinerhof launch at the mouth of the Zillertal (red arrow). In the afternoon the valley wind blows over the ridge and causes tailwind on launch. Opposite the Steinerhof ridge there is a soarable section where one can soar the valley wind till sunset.

Hint:
A good rule of thumb says that the valley wind will flow against the flow of any rivers following the valley bottom. However, as with most rules of thumb there are local exceptions and it always pays to get local advice before launching into an unknown flying arena.

Hint:
If the main valley has little side valleys branching off (like the Pass Thurn in Pinzgau mentioned above) the prevailing wind direction in the main valley may be overruled by winds coming from the side valleys. On the opposite side of such a side valley junction the winds may blow in both directions. At Hollersbach in Pinzgau there is east wind east of the valley wind influx (against the main valley wind direction) and west of the influx the extra wind from the Pass Thurn serves to strengthen the normal valley wind.

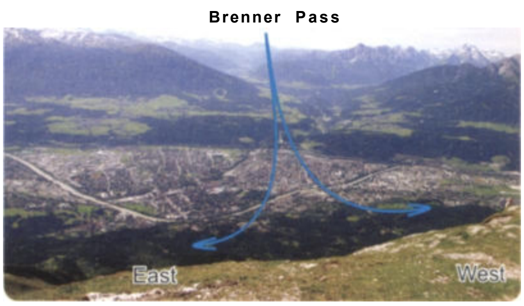
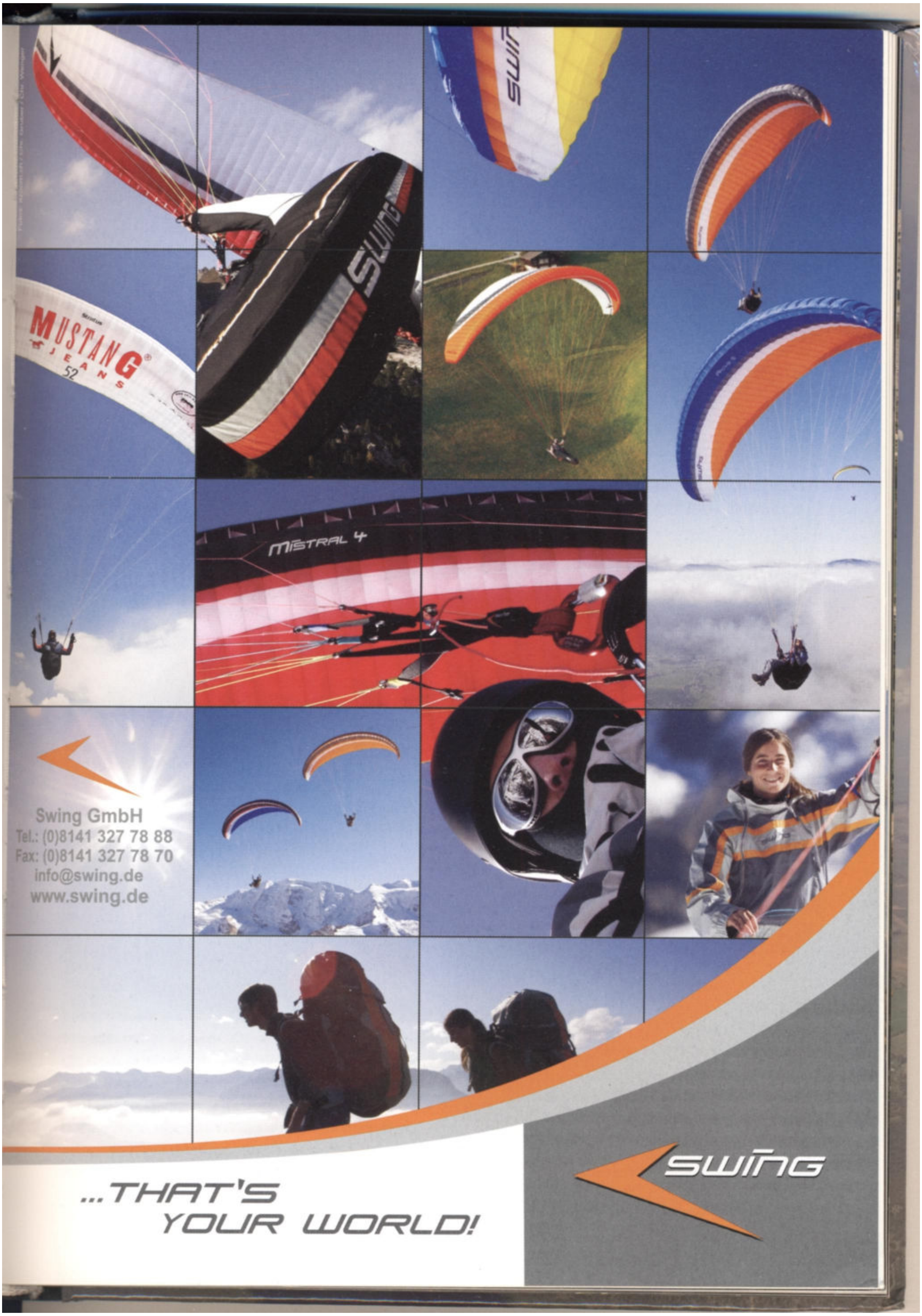


Illustration 7.10 Another local exception to the general rules takes place above Innsbruck in Austria. If the macro-meteorological wind is from the south if flows over the Brenner Pass south of Innsbruck and hits the Karwendel chain north of town. Right on the Hafelekar launch above Innsbruck this wind splits so that one part flows east, the other west, along the Karwendel. This photo was taken from the Hafelekar launch viewing south.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Soarable ridges and valley wind lee sides

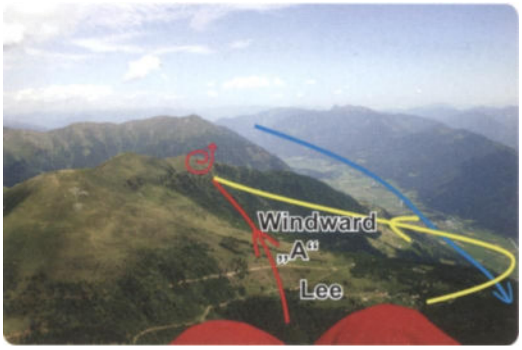
Before launching we should always consider the following:
- From where can we expect the valley wind to blow?
- Where is a chance of soaring the valley wind in case the thermals are pausing?
- And where will leeside conditions appear?

all
this

Picture 7.11 Soaring a relatively wide ridge oriented perpendicular to the valley wind. If the ridge is low, hooking a thermal from it may be tricky.

Sometimes during a cross country flight we may encounter weakening conditions for a while, often caused by thin layers of high cloud. When this happens, a ridge facing into the valley wind flow may save us from

Hint:
If you find yourself descending down into the valley wind long before the day is over, you must check your options carefully. Often more than one soarable place presents itself and it is important to choose the right one. Look for a ridge with a good connection to a mountain behind it, as these will be much easier to get away again.
It is not uncommon to find a small ridge where one can soar until sundown yet never climb out from, and finding oneself there early in the day is almost worse than landing prematurely. The best possibilities are found on ridges tall enough to rise above the valley wind, as a strong valley wind effectively disrupts any thermal development.



Picture 7.12 Route planning when taking valley winds into account. The direct route to the bowl (red arrow) is good if we have plenty of altitude. However, if our altitude is low enough that we're likely to pass over the flatter „A" section at minimum altitude it is better to take a detour (yellow arrow).

an early landing. Some times we may even make distance good using only soaring. We explore such things further in the next chapter.

Picture 7.13 This is the illustration to the previous hint. The small hill in the foreground is perfectly oriented into the valley wind flow, and can have us soaring there until sunset. But climbing out from it will be hard, so we opt for the less-than-perfect soaring face in the background, where the going will be harder but the climb-out possibilities are better.

The venturi effect

In chapter 3 we briefly touched upon the usefulness of water to visualise the flow around obstacles. But water can be used for more than visualising turbulence; in fact it is an excellent means for learning about all the attributes of flowing liquids/gases, in this case the venturi effect.

Whenever a flow is forced through a constriction we can observe venturi effects. The flow speed in the constriction increases, and the pressure drops.

Picture 7.14 A classical venturi, albeit with water. The „valley" narrows and the flow speed increases dramatically. If the wind was already strong before the constriction we can safely assume that we'll be going backwards in the constriction.

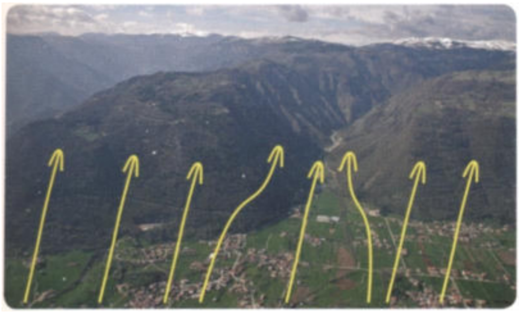
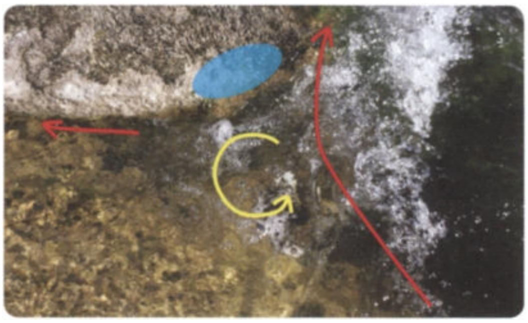


Illustration 7.15 The narrow gorge just W of launch in Bassano, Italy. Time and again this gorge eats pilots who underestimate the venturi effect and blunder too far in, only to find that they cannot get back out against the wind. There are some small landing options in there but it is far from ideal.

Picture 7.18 Fields of fog are good at making air movements visible, and obstacles make the picture more interesting. Here, the Diedamskopf in the Bregenzer Wald/Austria.

Picture 7.16 A gap in an otherwise closed chain - all wind coming from either side must pass through here. No wonder the winds must increase a lot here. Note that side rotors will also form, see Illustration 3.12.



Picture 7.17 An interesting look at the flow around a rounded knoll. Here, the knoll is a rock in a creek and again the water acts as our visualisation guide. It flows fast against the knoll and even forms a rotor left (yellow). Further downstream (downwind) the flow is laminar once again, on the right it hits the knoll and a soarable liftband forms where the flow is upward (blue). Further right the flow is parallel to the knoll, and soaring is not possible.

Hint:
In order to jump from one soarable ridge sticking out into the valley wind flow from the ridge, to the next against the valley wind, it pays to fly a large arch around the descent and the lee right in between the two ridges. This is especially the case when the thermal lift doesn't reach high enough to break out of the valley wind flow.

Competitions are excellent occasions to observe which of the route choices are the most efficient, as there will generally be several pilots trying out all the different options. The longer, arched route avoids the worst of the sink and pilots choosing that one over the direct route generally arrive slightly later but considerably higher than their more impatient adversaries, see picture 7.12

Knowing the wind direction and velocity at ground level

Working out exactly what the wind is doing at different altitudes isn't always straightforward, but at least at ground level we have several good indicators to help us out. If the day is thermally active there should be valley wind, and if we need to land we'll generally be facing down the valley.

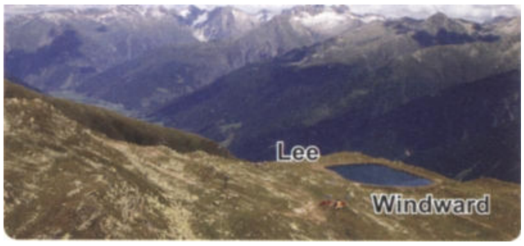
Hint:
In a valley bend the wind strength is greater on the outside of the curve than on the inside!

When appraising the winds on the valley floor the following factors should be taken into account:

- Macro-meteorological wind direction.
- Is the valley wind in the opposite direction of the above? If so, the valley wind may be inverted.
- Are there any other valleys near by that could influence the wind direction?
- Are there any glaciers reaching all the way down near the valley floor? The cold glacial air may influence winds locally.

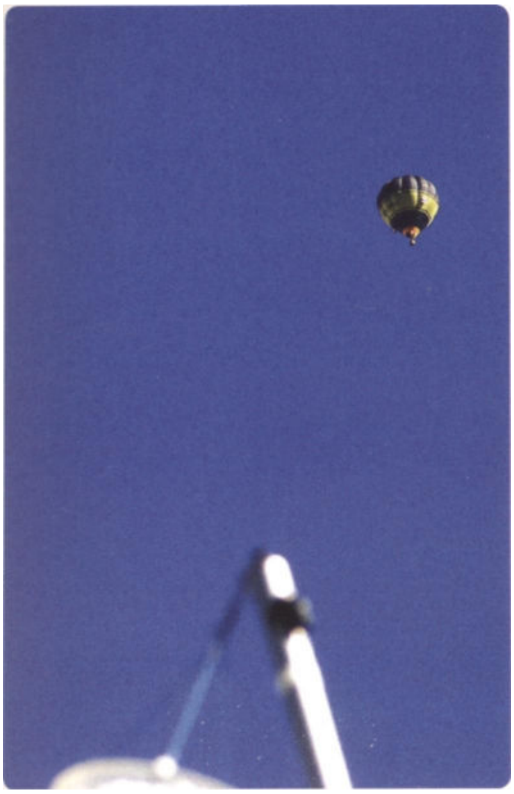
Hints for appraising the wind direction at ground level:

Picture 7.19 The large house and the little island cause small, local lees where the water is smooth - the wind is coming from the right.



Picture 7.20 The upwind end of the pond has a smoother surface, something that is visible from quite high. Lakes situated high in the mountains are good for judging wind directions out of the valleys - the wind is coming from the right.

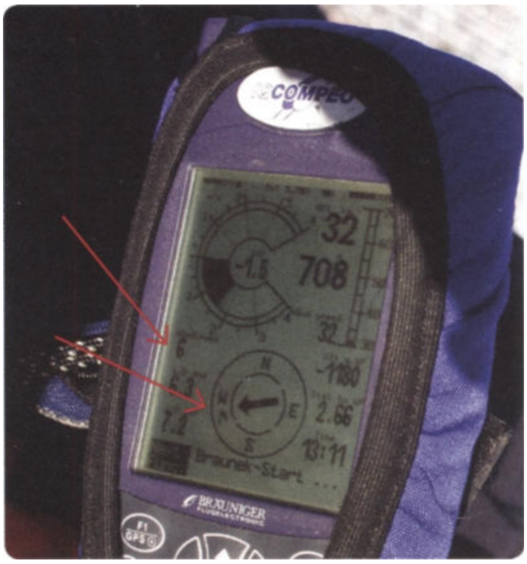
Picture 7.21 The anchor is always fastened at the bow, and the mast is closer to the bow than to the stern. Since the boat will always align itself with the wind, boats at sway are excellent wind direction markers. In this photo the wind is quite weak, or the water would be more disturbed.



Picture 7.22 Hot-air balloons are great for showing the winds up higher. When they land the ground level winds are also easily visible.

Picture 7.23 Windsocks are easy to see even from up high, but they only do their job when placed correctly. They should be out in the open flow, on peaks or shoulders, with no obstacles around. If not they only serve to confuse us.

Picture 7.24 Most deciduous trees have leaves with lighter-coloured bottom surfaces. When a stronger wind hits these trees the bottom surfaces of the leaves becomes visible, and tells us where the wind is coming from. These „white trees" are also excellent thermal markers up wooded slopes!



Picture 7.25 With a GPS, finding the wind direction and strength is easy. Just fly a big circle and note your ground speed changing - when your ground speed is highest you are flying with a tailwind. If you know the trim speed of your wing you can subtract it from the ground speed and get the wind strength.
Some vario's have integrated GPS and a wind speed/direction indicator. In this case the little windsock inside the compass rose indicates WSW winds, and the display (top arrow) gives a wind speed of 6km/h.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Picture 7.26 Dedicated anemometers are even more sensitive than wind socks. Furthermore they are generally placed on higher stakes and thus give a more correct reading - but they are small and can only be seen from close by.
Wind streamers also need less wind than true windsocks.

Picture 7.27 Landing gliders are good for wind direction appraisement. Beware though; if the pilot doesn't flare and brake, the wing may overshoot and land on its leading edge, causing us to believe he landed with a tailwind.

Picture left: You can judge the wind direction by watching kites, sailboots or wave movement.
Lake Achensee, Austria.

Picture 7.28 Smoke, dust or even pollen can be great for marking the air movement.

Picture 7.29 Irrigation systems are visible from far away and are good wind markers.

Illustration 7.30 Attention! If the dust plume is caused by a moving vehicle the wind direction is not entirely aligned with the plume. In this case the wind direction is indicated with an arrow, and the deviation between the plume and the actual wind direction depends on the vehicle speed.

Picture 7.31 Light southerlies in the Valais, Switzerland. The south side of the Alps was completely covered in clouds, whereas Valais had good thermal development. The N-S oriented valleys had north wind.

Another reason for inverted valley winds

On days where the entire mountain chain is experiencing uniformly sunny weather the centre of the heat low will be located around the main dividing range. But if parts of the mountain chain have very different weather, like in the picture above where the southern Alps are covered in clouds, the centre of the heat low moves correspondingly. If for example France and Switzerland are covered in clouds, the heat low will move east, causing confusing valley wind patterns in certain areas.

One such area is the westernmost part of Austria, close to the Swiss border. The normal valley wind blows from the east, up towards the border. On days where the centre of the heat low is displaced towards the east due to cloud cover in Switzerland, this valley wind may invert and blow from the west.

Pilots flying in the region may not be able to see the cloud cover on the other side of the border, and can be surprised by the confusing valley wind direction upon landing.

Picture 7.32 The big bend in the Inn River identifies this valley as the flying arena around Landeck/Austria. If the western Alps are covered in clouds, the centre of the heat low will be displaced towards the east and the valley winds here may be inverted.

Hint:
Pilots should always acquire updated weather forecasts before going to launch. These will tell if adjacent regions have substantially different weather patterns that may influence valley winds locally. Thus, unusual situations are less surprising.

Sea breeze

The sea breeze is very similar to a valley wind, the land heats better than the sea, and causes a regional heat low to form. The heat low sucks in air from the surroundings, in this case the sea.

Sea breezes may travel far inland and mix with valley wind systems, influencing both strength and direction far from the sea. The sea breeze is also both stable and humid so thermal development is generally adversely affected if an area is under the influence of a sea breeze.

Sea breezes are great for soaring dunes or cliffs on the coast. The French Dune de Pyla is such a sea breeze dune soaring spot. The time of year should be taken into account when considering a trip to a soaring spot - late autumn is rarely a good time for sea breezes to form.

Experience:
Volker Schwaniz has noted that the macro-meteorological wind may overrule sea breezes if it is strong enough.

Picture 7.34 Panoramic flight over Eze (near Monaco) in France. Once the sea breeze sets in such flights become possible for most, making the amazing scenery available for everybody to see.

Picture 7.33 Soaring at Map of Africa in South Africa, This is a sea breeze soaring site, working mostly in afternoon during the summer.

Hint:
Large islands also experience sea breezes. Often these will blow Onshore everywhere so that any cliff or dune all the way around the island is soarable.
On the Canary Islands the trade winds rule the show, blowing from the northeast. The mountains on Lanzarote are low and flying is only done on the northeast side of the island, where the coast line faces into the trade winds.

But on Tenerife the Teide, the highest mountain in Spain, effectively blocks the trade winds so that a microsystem may set up on the south side of the island. The south side is flyable, with good thermal development, even on days when the trade winds hammer the north side of the island.
Flying in a big lee like that is not for everybody, and newcomers are advised to join local pilots for their first exploits.

Picture 7.36 The Teide, Tenerife, Spain, blocks the trade winds and allows pilots to fly on the south side, in the lee of the mountain.

When the sea breeze begins to blow it pushes cold air inland. This cold air often triggers a line of thermals topped by large cumulus clouds, often somewhat lower than the cloud base further inland. We call this line of big clouds the sea breeze front. Seaward of this line no thermal development should be expected. As the day progresses the sea breeze front pushes progressively further inland, and any pilot lucky enough to reach the line can fly good distances parallel to the coast.

Picture 7.35 The sea breeze front, clearly visible through the large and heavy cumulus clouds. Further inland the cloud development was more modest. The photo is from Monaco, taken from above the launch looking north.

Picture 7.37 The Lijak in Slovenia is a great soaring slope once the sea breeze sets in. Until that happens the pilots play with their wings on the landing site.

Chapter 8: Soaring

Soaring means flying in a lift band caused by the wind meeting an obstacle. As Alpine pilots we're used to the obstacle being a mountain, but in reality it can be anything, and people have soared buildings, forest edges, stacks of baled straw and probably many more things that I haven't heard of.

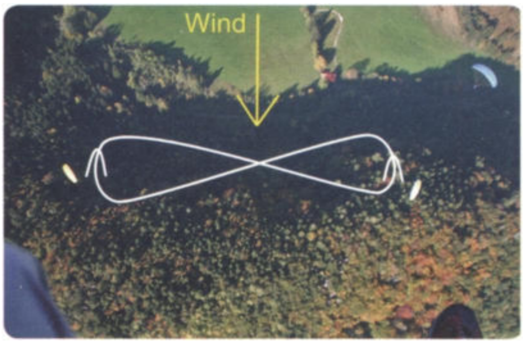
Soaring is more predictable than thermalling as long as the wind hits the obstacle at a reasonably perpendicular angle there will be lift in front of the obstacle.

Most XC flights involve at least some soaring along the way, and good soaring ridges are a fast means of travel when we're heading far away.

How to soar

When soaring in dynamic lift we simply fly back and forth in front of the hill, taking care not to let the drift push us too far back and always turning away from the hill when we reverse direction. The track viewed from above should look like an elongated „8".

On big, lifty slopes the lift band may get wide enough to allow 360's but great care should be taken as the downwind drift is great and especially unexperienced pilots will often be surprised by the sudden increase in ground speed when we go from headwind to tailwind. Hitting a slope downwind ALWAYS hurts, regardless of the geology.



Picture 8.1 The soaring pilot flies figure 8's in front of the slope, taking care to fly every turn away from the hill. If several pilots share the same lift band they must keep all other pilots at their own level in sight.

The pilot should try to remain in the best lift. This is depending on slope inclination and wind strength, but a rule of thumb in mountains could be between 20 and 80 metres from the slope. If the soaring slope in fact is a vertical wall and the wind is weak, the lift will be considerably closer to the ridge than that. The stronger the wind becomes, the further away from the slope we fly.

The pilot must always keep a safe distance to the soaring slope. There are no hard and fast rules, but if you can look yourself in the eyes and honestly say that you can cope with a collapse at the current distance then you are probably OK.

Hang gliders need to keep a greater safety distance than paragliders, as they take longer to correct if the outer wing gets lifted. They must first build up some speed flying along the new heading before they can steer back out, whereas paragliders are quicker to get onto a new heading even following disturbances. It goes for both aircraft that if the soaring is rough and turbulent you better find somewhere else to soar.

If the wind hitting the soaring slope is laminar the flying generally becomes stressfree and extremely pleasant. Dune soaring is great fun and probably the least stressful form of flying.

Influence of the topography on the lift band

The ideal soaring mountain is broad, free of obstacles and high, just like the one in the photo on the previous double spread. The best lift occurs when the wind is perpendicular to the mountain orientation. If the wind is angled from either side the pilot flies faster on the slightly downwind legs of the figure 8, slower on the upwind legs. This may lead to the false notion that the upwind

Picture 8.2 When soaring ridges with furrows like the one above it is noticeable that some areas will offer better lift than others. In the picture above the wind is coming from the right, and the left side of the furrow is more into wind than the right side, resulting in better lift on the left.

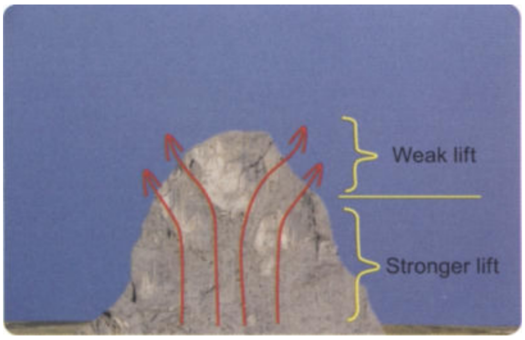


Illustration 8.3 When soaring rounded knolls it quickly becomes apparent that the top section isn't a very good lift generator as all the wind flows around the knoll instead of over it. In this example the wind is coming from the direction of the observer.

leg lifts better, but I suspect the real reason is that one flies through the good bits faster on the downwind leg.

Rounded knolls are only soarable low down, up high the wind flows around them rather than over, see the water flow in Illustration 3.13.

Mountain slopes are almost always criss-crossed by secondary spurs, landslides and gullies etc. that are oriented differently to the wind compared to the main ridge. Along these the lift will be different, something that the good pilot notices and takes advantage of.

Most pilots aim to soar to the greatest possible altitude. But many mountains are irregularly formed and have flat sections interspersed with the more vertical parts. It is often possible to soar up past such plateaus but care must be taken to avoid landing up there. The vertical motion of the air around the edge of the plateau will often suck in air from the plateau as well, leading to turbulence and tailwind behind the edge.

Hint:
Anyone wishing to top land on a rounded knoll should be aware that on the top there is hardly any lift but plenty of wind. We may find ourselves descending faster than we expected.

The best way to climb past such plateaus is to use a thermal embedded in the dynamic lift to get high, then allow oneself to drift back to the main ridge again. Another option is to look further along the ridge; maybe there's a place where the plateau is narrow enough to allow the switch back to the main ridge without risking a high landing.

Picture 8.4 Tricky plateau (drawn in red) west of the south launch in Bassano, Italy. In front of the plateau edge the ridge is often soarable in the afternoon, but when thermals flow up the face they suck in air from the plateau and cause increased descent. Many pilots have had to top land there.

Collision avoidance when soaring

The pilot flying with the ridge to his right has the right of way. But practically all soaring pilots should always keep an eye out for anyone soaring at the same altitude. Before turning, pilots should look over their shoulder to make sure no one is endangered by the turn, and furthermore we should always avoid trapping anyone between ourselves and the ridge, or another pilot.

If several pilots are soaring together it makes sense that everybody maintains the same distance to the ridge. When meeting someone head on, the pilot with the ridge on the left flies a curve out from the ridge and lets the oncoming pilot pass between him and the ridge. The reason for this rule is that we always evade by flying right, however the pilot having the ridge to his right cannot do this without crashing into the mountain!

There's a further advantage if everybody maintains a similar distance to the slope; everyone can turn when it suits him without risking a collision with someone flying slightly behind yet further out from the ridge.

***Picture right:** Remember to look over your shoulder befan reversing direction on a soaring slope; there could be» meone there. The picture shows Wilderness, South Africa.*

Hint:
Wingtip vortex causes our wing to shudder when we fly through the wake behind another glider. The closer we get the more dramatic the shuddering becomes. Tandem gliders are carrying more weight and trail stronger vortexes.

***Picture 8.5b** Soaring the famous V-shaped hotel in Monaco. This pilot would have the right of way if another pilot was meeting him head on, as evading to the right would lead to a collision with the hotel!*
Well-known building soaring sites include Neta nya in Israel and Lima, the capital of Peru.

Picture 8.5a
When soaring, the pilot flying with the slope on his right has right of way. For convenience all pilots should maintain the same distance to the slope; in this picture the orange glider is blocking the other one, who cannot turn when he wants to but has to wait until the other pilot has gone. That is bad airmanship.
Bassano, Italy.


Wilderness, South Africa. Picture: Nina Brummer

Picture 8.7 Overtaking is done to the right, and if that isn't possible we don't do it! This hang glider must remain behind the paraglider as he cannot overtake to the right without getting too close to the rocks, and he isn't allowed to do so on the left.

Picture 8.8a The ridge in the picture is soarable in the yellow zone, and thermals may come through in the red zone. Compare to the situation in Illustration 8.15, page 207. If there are no thermals we soar the yellow area, but once thermals add to the equation we may attempt to connect with one in the red zone.

Experience:
If the situation described beneath picture 8.8 takes place on a shallow hill in the flatlands it is necessary to crab around in the weak lift generated by steeper sections of the hill, moving from one to the next up along the slope. Once higher the chances of connecting with a proper thermal are much better.

Picture 8.8b Soaring near Mount Olympos in Greece.

Vector analysis of soaring winds

Lift as a function of wind strength and slope inclination may be analysed using vectors, as wind is a force with a direction just like anything else we analyse with vectors. The lifting component is what keeps us airborne, and the horizontal component is our headwind when soaring.

Let us take an example: In the illustration below (8.10) we have a wind speed of 25km/h down near the foot of the ridge, increasing to 40km/h at crest level. Through vector analysis we may deduct that we get a headwind component of 20km/h and a lifting component of 15km/h down low, whereas at crest level there'll be 30km/h headwind and 26km/h lifting component. The 30km/h headwind component at ridge height, but in front of the ridge, are still just flyable if we assume that the paraglider has a trim speed of app. 35-36km/h. But right behind the crest line (point „A" in the illustration), where there is no vertical component to the wind, the headwind is suddenly 40km/h - too much for comfortable flying.

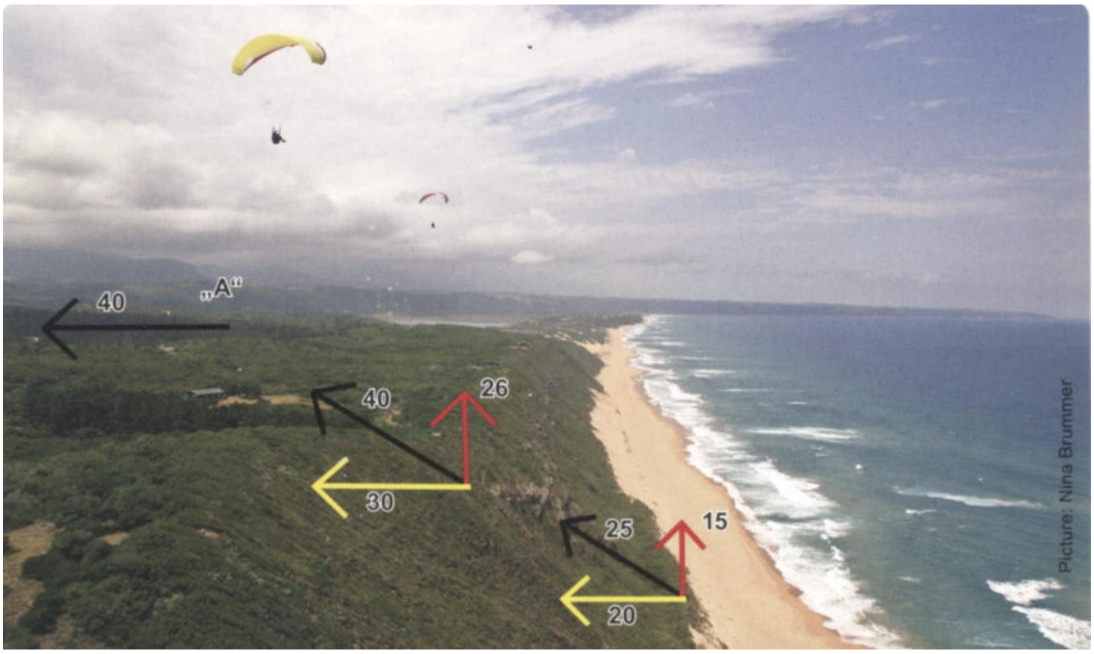
This is the actual wind strength when there's no splitting it up into vertical and horizontal components. It follows that launching on top would be all but impossible while the flying in front of the ridge is still entirely possible.

Experience:
I once flew the site shown in picture 7.33, the Rainbow Beach in Australia. It was an amazing experience to soar along this forested dune stretching for several kilometres. I climbed to the top following the topography, then edged forward a bit to continue climbing. As I got higher the wind increased gradually so that I had to keep pushing out over the sea to remain safe. Eventually I reached a maximum altitude of 600m ASL, 400m out over the sea.

Conversion table see page 21.

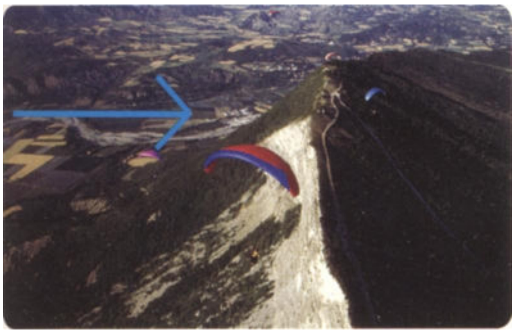
The vector analysis makes it abundantly clear that soaring should take place in front of the ridge, not over it. If you find yourself getting pushed back over the ridge, and even worse behind it you'll find only wind and no more lift, and if this headwind exceeds your own airspeed you could quickly find yourself going down through the rotor

Picture 8.10 Vector analysis of the headwind and lift components when soaring in dynamic lift (in km/h). The black arrow is the wind speed, yellow is the perceived headwind and red is the lift. Right above the ridge the wind speed equals the perceived headwind, whereas there is no more lift to be found. Just to spice things up further the ridge even acts as a venturi, accelerating the wind additionally. The picture shows Paradise Ridge in South Africa.



behind the ridge.

Hang gliders have a considerably larger safety margin in terms of speed, and cannot be blown back under normal, flyable conditions, but paragliders are always at risk when soaring near their maximum speed limit. Going down through a rotor close to the deck in strong winds is a serious matter and should not be taken lightly.



***Picture 8.11** The closer pilot is doing it right by staying well out in front of the ridge. The pilot behind is pushing the limit and in this case actually struggled to get back out on the upwind side of the ridge. Laragne, France.*

Hint:
If there's a cloud layer above the ridge the venturi effect mentioned in the previous page may be accentuated further. The clouds act like a lid, funnelling the wind through the narrow gap between ridge and cloud layer. If you find yourself waiting for a lull on an overcast ridge launch, chances are it will come together with a clearing of the skies.

Experience:
I had a close call while soaring back in the very early days of my flying career. I was climbing up the upwind side of a rock face in southern France and choose to do full circles as soon as I cleared the peak. However the lift I had wasn't thermal but purely dynamic, and as soon as I had done the first full circle I was hopelessly pinned behind the crest, going backwards even on speed bar. So I choose to try to run away with a tailwind and overfly the rotor, except my altitude was insufficient for such a manoeuvre. It turned into a full-blown SIV course going down through the rotor, and if the mountain hadn't been as steep on the downwind side as it was upwind I would surely have crashed. As it turned out I found normal air again down near the valley floor and could even continue my flight, albeit with a big adrenaline overload. Since then I have approached soaring with increased diligence, and I hope my experience will also help you to avoid similar situations. I know that humans learn best the hard way, but this was a learning experience you could live without - trust me.

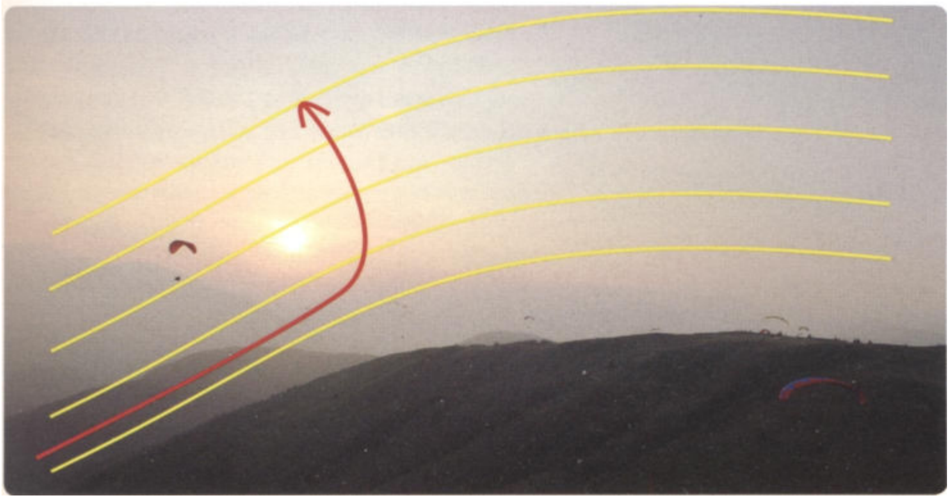


***Illustration 8.12** This illustration shows the path of the best lift. As you can see (red arrow) the best lift moves upwind from around the crest level. The picture shows the top landing site in Meduno, Italy.*

Safety distance when soaring

There are a number of factors influencing the recommendable safety distance both laterally and vertically when soaring. None of these are hard and fast rules, and nothing beats sound judgement, but having a few simple hints in mind will help you remain safe.

The stronger the wind becomes, the greater the safety distance should be. There are two reasons for this, namely turbulence and drift.

Turbulence first: Turbulence is exponentially related to wind strength. If the wind increases from 15 to 30km/h, the turbulent area behind an obstacle grows to 4 times of its previous expanse. It follows that a ridge that is pleasant and smooth to soar in 15km/h wind may be all but unflyable at 30km/h - and our safety distance must reflect this.

Picture 8.13 If the wind is weak, and the drift and the turbulence thus equally negligible, it is possible to soar very close to vertical rocks. This pilot however seems to be overdo it a bit. Almerima, Spain.

The next thing to consider is the drift, also increasing with wind strength. If we encounter bad air, and our aircraft takes a hit, we need to make sure that we have sufficient open air to operate in whilst we correct the situation. Soaring a paraglider close to a vertical cliff in strong wind and suffering a collapse could have us hanging from a rocky outcrop in no time, counting our broken bones.

Finding and using embedded thermals when soaring

We generally don't get much higher than the highest peak along the ridge using solely dynamic lift. To get higher than that we need to find an embedded thermal rising well clear of the topography - but how do we locate it?

We start by soaring as high as we can get. Then we start to explore the horizontal expanse of the lift band - how far out in front does the lift go? Once we know this our chances of identifying a passing thermal are far greater, since the thermals will usually expand the width of the lift band considerably.

The first sign of the embedded thermal remains the increased climb rate. Once we have located such an area, we turn away from the hill and head out perpendicular to

Picture 8.14 A good ridge for soaring. The clouds indicate that there are thermals embedded in the dynamic lift. To find it the pilot searches for areas where the lift band is wider, and the lift thus expands out further from the slope.

Illustration 8.15 When soaring we always watch out for areas of better lift. If we meet such an area we do a turn away from the hill in order to verify if it is a thermal or not - if the lift remains strong even further out from the slope it is probably a thermal. If the wind is not too strong we may decide to centre it right away, and circle next to the slope. This however doesn't work in a strong wind, where we'll surely be pushed against the slope on the downwind leg - in such cases the figure-8 is the way to go. Once above ridge height the first circle should always be away from the ridge, so that if we fall out we're not in danger of dropping behind the ridge. A few turns later we can relax and concentrate on the thermal without paying so much attention to the terrain anymore. The picture shows the Monte Grappa in Bassano, Italy.

it. If the lift doesn't decrease at the distance we discovered above, we have got ourselves a thermal.

The safest procedure now will be to fly in small figure-8's in the thermal until ridge level. Circling down close to the slope is risky because the drift on the downwind leg may push us against the mountain.

To centre the thermal we continue in figure-8's until well clear of the top, then push out upwind until almost at the edge of the thermal. Now we may initiate our first full 360. We continue like this, with somewhat longer upwind legs than downwind, until well clear of the top - then we can allow ourselves to drift a bit with the thermal.

The advantage of this method is that we always remain inside the upwind part of the thermal, and will almost surely fall out the upwind side if we get a circle wrong. This is far better than dropping out the back, where we have both strong descent and a headwind to battle in order to join the thermal again.

If the wind is close to the limit I advise against doing 360's even above the ridge. The risk of getting blown back into the rotor is simply too high.

Hint:
Sensitive pilots can often feel the temperature difference when encountering an embedded thermal in dynamic lift.

Hint:
Once above the hill the thermals should be centred in the usual manner. Note that strong thermals drift less with the wind than their weaker counterparts! In strong wind it makes sense to wait for a strong thermal before leaving the comfort of the dynamic lift, as the chances of not making it and simply getting blown back are greater in moderate winds.

Experience:
In weak soaring conditions I may opt to do full circles in the embedded thermals even low down. If the thermal is just 70m across or more I find that I can climb better by doing 360's than by flying figure-8's. Hang gliders will need somewhat more than that.
If the wind is strong I soar normally - strong wind and steep slopes mean good climb rates anyway.

Dune soaring. Photo.: Felix Wölk / blue-project.de

How much wind do we need to soar?

There's a launch in the Valle de Abdalajis in southern Spain where the cliff in front is about 250m high and virtually vertical all the way. Newcomers often don't even bother to launch in light winds, thinking they'll just glide down to land, but the pro's know better: With just 5km/h wind and a vertical face it is actually possible to soar!

The shallower the slope the more wind we need to soar.

Conversion table see page 21.

Experience:
My home mountain, the Brauneck in Germany, has launches facing south and north. The south launch is rather shallow and requires about 25km/h wind to be soarable, whereas the north launch is steep and works with only 15km/h. Taking off is easier in 15km/h than in 25, so I prefer soaring the north side..

Picture 8.16 It takes just 5km/h wind to soar a vertical cliff of a certain height - the shallower the slope, the more wind we need. The photo shows a slope in the Gourdon, France, with what feels like enough wind to fly using only a jacket...

Another example of a steep slope producing soarable conations with very light winds. Here in Karakoram, Pakistan.

XC soaring

Soaring can help us make distance good on our XC flights. There are two possible scenarios:

The first method takes advantage of secondary ridges pointing into a main valley. We may use the valley wind to soar these and fly XC. We soar up each ridge to the maximum altitude, then fly a large curve out into the main valley to avoid the lee behind the little ridges. On the next ridge we repeat this process, see illustration 8.20.

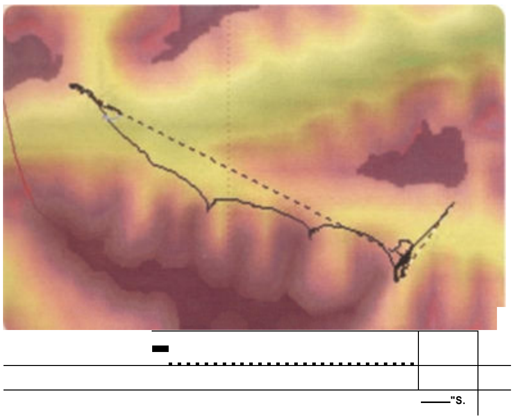
The track in illustration 8.18 shows it clearly. Note that this only works in strong wind, where the rotor behind the ridges is best avoided.

The second method is more straight forward and involves blasting down long uninterrupted ridges facing into wind - in this manner the XC pilot may really get some kilometres under his belt. This is also the reason why the FAI does not accept flights done solely in dynamic lift for badges or records.

Picture 8.17 The dune behind the Plage Blanche in Morocco is 30m high, but it allows pilots to soar the full 5km length as soon as the wind blows with more than 25km/h.
Such soaring is pure bliss - no turbulence and the whole beach is one big landing field.

Cloud base is often very high in the Pustertal, Austria. Should the thermals become unreliable we often prolong our flight with dynamic soaring - this has saved many XC pilot from landing during brief overcast periods. As soon as the clouds are gone, the thermals start kicking off again.

Conversion table see page 21.



Picture 8.19 Alghero, Sardinia. The sea breeze allows forXC soaring all along the coastline.

Illustration 8.18 XC-soaring in Sillian, Austria.The wind is from the east and blows with app. 25km/h. Note the big curves out into the main valley each time the pilot leaves his soaring ridge to fly to the next one to avoid the turbulence behind the ridges.

Picture 8.20 When soaring the secondary ridges in a large primary valley, make sure you avoid the lee behind the ridges by flying a large curve out into the main valley every time you leave a ridge. Begin by building height at „A", fly a curve to „B", then to „C" etc.
The picture was taken in Sillian/Austria.

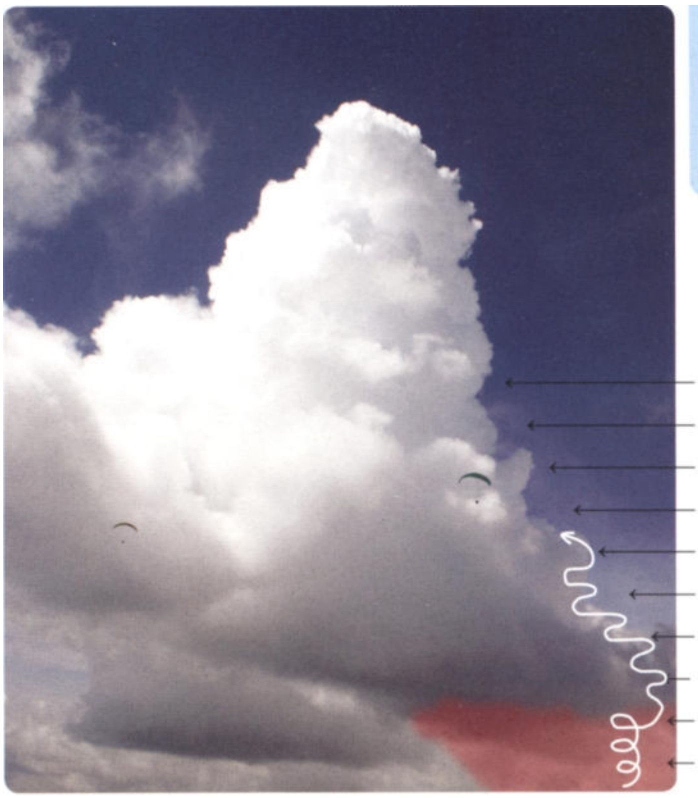
Cloud soaring

Big cumulus clouds actually also work as obstacles obstructing the wind. By climbing up in the upwind side of the thermal, where the lift is usually best anyway, the pilot may manage to connect with the dynamic lift on the side of the cloud and thus climb to well above the cloud base without ever loosing visual reference. Once you have tried this you won't forget it again - very spectacular.

In controlled air space there are rules about how far from clouds one must stay, but in free air space the rule is simple - we must remain free of cloud.

Picture 8.22 In order to soar a cumulus cloud we first climb as high as possible in the upwind side of the thermal, then move to the side of the cloud.

Experience:
Once in a comp in Alsace in France we encountered a big, 1000m high cu en route to the next turnpoint. Some pilots managed to soar up the side of it and fly around it whereas others had to pull big ears to glide under. The former group arrived at the turnpoint 1000m higher than the latter! Aside from the joy of having made such a coup, just having flown alongside such a cloud made the whole trip extra worthwhile.



Picture 8.21 Prerequisites for cloud soaring are as follows: The wind must increase around cloud base level and the airmass must be unstable, compare with Illustration 1.39. This cloud was really very big and would surely have worked, however since the cloud base was already high nobody attempted it.

Picture 8.23 In Teba, Spain, a castle ruin adorns the soaring ridge. The best altitude is always reached right in front of the old tower.

Picture 8.25 Alpine Daws are the soaring experts par excellence. Watching them play in the air is almost as good as flying.

Picture 8.24 Soaring in Ghana. This is sometimes almost as joyful as a long XC flight.

Chapter 9: The temperature gradient

The temperature gradient (called temp hereafter) tells us how much colder the air gets as we travel vertically up through the atmosphere. It is normally drawn as a graph in a coordinate system, where Y is the altitude (or pressure) and X is the temperature. Vertical resolution is often set to100m.

The faster the temperature decreases with altitude, the higher the instability of the atmosphere - and that is what makes the temp so interesting to us, as we generally want to have an unstable atmosphere so that thermals may form.

If the temperature decreases slowly with altitude, or even briefly increases, the atmosphere is stable. The more stable it becomes, the unlikelier it is to have good thermal development.

The temp is a great tool for predicting a number of things about the flying conditions of any given day.

If we have the temp, the humidity at ground level and the predicted maximum temperature of the day we may already deduct the following values:

- Cloud base altitude,
- Trigger temperature (the temperature that air pockets must reach in order to be released as thermals),
- The likelihood of thunderstorms, the amount of cloud coverage and the expected day quality in terms of thermal strength.

Admitted, this all sounds rather complex. However by using a number of easily understood examples in the following pages I will slowly guide you through until you have a far greater understanding of this magnificent tool for pilots.

The temperature as function of altitude is physically acquired by releasing balloons (called radiosondes) sending their measurements (soundings) back to earth via radio.

Picture 9.1
This radiosonde was found in the Isartal. The instruments are attached to the lower end and transmit the soundings back down to earth via radio.

The actual coordinate system, with its complex combination of isotherms, saturated and dry adiabats and the mixing ratio, will not be described in detail - my aim is to point to the general usefulness of the temperature gradient for pilots.

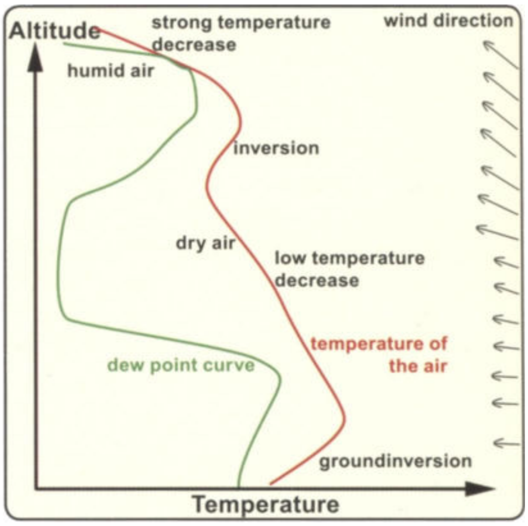


Illustration 9.2 By reading the temp we may learn a lot about the prevailing flying conditions. The red graph shows the temperature as function of altitude/pressure, the green graph is the dew point. If they are far apart the atmospheric situation is dry, where the two graphs meet the relative humidity is 100% (which means the radiosonde has gone through a cloud). The harder the red curve leans left, the greater the instability. If the red graph takes a turn to the right it means that the temperature is increasing at that level, so there's an inversion there.

Radiosonde / Weather balloon

A radiosonde is just a balloon with a bunch of instruments attached. It helps the meteorologist by collecting data that would otherwise be out of reach. The soundings contain information about temperature, humidity, pressure and in recent years also position and wind speed etc. The soundings are transmitted by radio to the ground crew.

There are plenty of temperature gradients to look at in the Internet, try searching for „emagram", „tephigram", „Stuve diagram" or „Skew-T log-P diagram", all different ways of depicting the same thing. Illustration 9.2 shows a real life temp.

The radiosondes all over the world are all deployed at the same time, namely at midnight and 1200UTC. They rise to about 30.000m before the balloons burst, and transmit data all the way up. By releasing them all at the same time, meteorologists acquire something akin to an atmospherical snapshot of the global weather twice every day.

As pilots we must know which soundings to base our observations on. In the central Alps there are 3 different launch sites, Innsbruck, Munich or Stuttgart. If the general flow is from the south I go with the Innsbruck one, if the flow is north the Munich one is more suitable. By westerlies the Stuttgart soundings are also interesting.

The temperature gradient in illustration 9.2 is an example only. As there are at least four different standards for making these diagrams (see above), they will look somewhat different almost every time you cross a border. The important thing to work out with each new diagram is which of the lines indicates the dry-adiabatic temperature decrease in the ideal atmosphere, and compare that to the actual curve. In some, the dry adiabat is shown as a vertical line in the diagram, but most have them tilted somewhat to the left. Where the day curve follows the dry adiabats the atmosphere is indifferent, where it is leaning more to the left the atmosphere is unstable, and less means a stable atmosphere.

On the right hand side of the temp diagram we usually get the wind direction and strength, shown with arrows. In Ill. 9.2 the wind increases somewhat with altitude, and turns from east to southeast.

In the so-called ideal (but non-existing) atmosphere the temperature decreases 0.65 degrees centigrade/100m upwards through the atmosphere on average.

The dry adiabatic temperature **decrease with altitude is -1°C/100m.** Once the rising air mass condenses as a cumulus cloud the temperature continues to decrease, but along a saturated adiabatic line. This line isn't constant but is normally given as -0.6°C/100m.

The saturated adiabatic cooling is slower because the condensation process releases energy stored since the evaporation. The energy is released as heat and slows the cooling down. The colder the airmass is, the faster the saturated adiabatic cooling happens. This is due to the fact that cold air can hold less moisture, and the influence of the condensation process on the airmass temperature is thus lower. In very cold air the saturated adiabat and the dry adiabat are almost identical.

Roughly estimating the temperature gradient through available data

If no real temp diagram is available we may almost make one ourselves with the help of a detailed weather forecast, like the glider forecasts issued by many national weather services.

Altitude	Tempera-ture	Wind direction	Wind speed
meters	Degr. C	Degrees	km/h
1000	25	210	5
2000	18	220	10
3000	10	240	10
5000	2	230	20

There's a temperature gradient between 1000 and 2000m of 7°C (25°C minus 18°C) which gives us -0.7°C/100m. For the other levels we get the following table:

	Alti. 1000 to 2000 m	Alti. 2000 to 3000 m	Alti. 3000 to 5000 m
Temp, (°C/100m)	-0,7	-0,8	-0,4

Table 9.3 This is a remarkably good day, with an unstable atmosphere low down and a strong inversion between 3 and 5 thousand metres to stop the clouds from going ballistic.

If we can get hold of the values mentioned in the table above it is actually possible to build a rough impression of the day in our minds. The example shows a particularly good XC day, where the atmosphere up to around 3000m is very unstable. We see this from the fact that the temperature drops fast with altitude, and the thermal quality is accordingly good. Of almost greater importance is the fact that somewhere between 3000 and 5000m the temperature decrease with altitude becomes far less conspicuous, indicating the presence of a strong inversion somewhere in this layer - very convenient, as this puts an effective lid on the cloud development and stops the cumuli from growing into CB's or filling the skies with flat, inactive clouds stopping the sun from reaching the ground. On this day the shower probability is very low!

Had the opposite been the case, with a temperature at 5000m of, say, -8°C, the temperature gradient in this layer would have been -0.9 and we would have known for sure that no inversion was stopping the cloud development. On such a day the likelihood of overdevelopment is high, and we would most likely have to terminate our XC attempts some time into the early afternoon.

„Rules of thumb" for applied use of the temperature gradient

- If the temperature gradient is positive it means we have an inversion. This stops thermal development at the affected altitude.

- From 0 to -0.2 the air is stable and the thermal development extremely poor.

- If we find values between -0.2 and 0.4 we can assume weak inversions and poor thermal development in the layer. If these values are found up high (at cloud base or above) it is good, lower down they adversely affect our climb rates.

- Between -0.5 and -0.6 the thermals are still weak but perfect for learning thermal flying. The air isn't too turbulent, but at the same time there aren't any big distances in this sort of airmass.At these temperatures it takes a long time before a thermal bubble releases from the ground, and once it does it climbs slowly. Such thermals are easy to centre and pleasant to fly, but they only release with long intervals.

- Once the temperature gradient shows values of-0.6 to -0.8 the thermal quality becomes good. The thermals are strong, and so is the associated turbulence. Such values indicate excellent XC weather.

- Values above -0.8 indicate extreme thermal development and very high descent rates between them. On such days thermal bubbles release from the ground as soon as there is the slightest temperature difference, and rise as small fast bullets causing rough air with difficult thermalling. These days aren't particularly well suited for XC flying.
If there is no inversion to stop the cloud development, chances are that the day will either overdevelop or the clouds will soon shut out all sunshine so that no more thermals may develop.

Ideal temp for strong, enjoyable climbs without too much turbulence.

The perfect day has a gradient of somewhere around -0.5 to -0.6 at lower levels, increasing to -0.8 to -0.9 up higher. Around cloud base the gradient should decrease again, to around -0.4. This will slow the thermals down gradually and decrease the boundary turbulence.

Still higher we would prefer a weakish inversion and some dry air, to stop overdevelopment and excessive cloud development.

Such a day is a pilots dream - plenty of strong, smooth thermals, moderate turbulence and a high cloud base virtually guarantee successful flying endeavours.

For beginners a slightly less pronounced temperature gradient is better, ideally around -0.5 to -0.6 at all levels up to cloud base. This causes the thermals to be wide and inviting, and the turbulence to remain controllable even by inexperienced pilots. The better we become the more aggressive a temp we can tolerate.

Picture 9.5 Large, well-defined thermals and a distinct vertical limit to the cloud development. On this day there was an inversion between 2000 and 3000m and temperature gradient at this level was -0.3°C/100m.

Picture 9.6 A good day for beginners learning to thermal. Large and gentle thermals with an inversion just above cloud base to stop the clouds from growing too big. The gradient at lower altitudes was around-0.55 and the inversion lay at 3000m.

There's a neat way to acquire the data needed without having access to full-blown diagrams, namely by finding the temperatures at the top of skilifts. The altitudes of these is always known and the temperatures often published either through radio or Internet. Once we have these we may calculate our own gradients for the relevant altitudes.

Example:
The Santis (CH) is located at 2500m and the temperature is 12°C. The Jungfraujoch (CH) is at 3573m and the temperature there is 4°C. The gradient is calculated to -0.47100m.

The glider pilots have used this trick for years and found that the difference between these two top stations should be around 6°C to 9°C, giving a gradient of -0.58 to -0.847100m for the day to be good.

If the gradient is lower than this the thermals will be weak, a higher gradient may cause the day to overdevelop either vertically or horizontally, both to the detriment of the day quality.

Determining the cloud base and the cloud height through the temp diagram

The gradient diagram is useful for more than just learning about thermal quality. It may also be used to determine cloud base altitude and how high the clouds will grow.

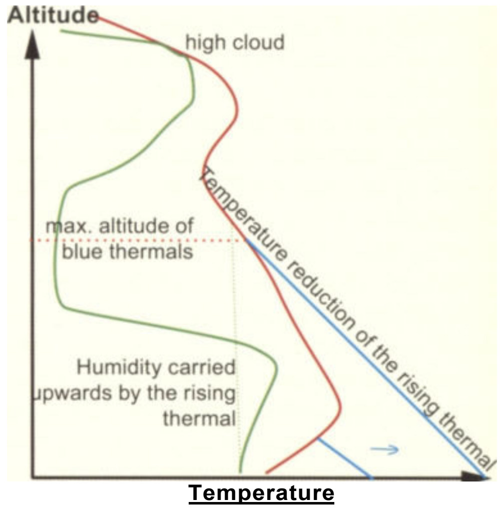


Illustration 9.7 In the day's temperature gradient diagram, draw a line from the expected day temperature on the X-axis and corresponding to a dry-adiabatic temperature decrease of -1.0°C/100m (drawn blue in the illustration above). Where the blue line meets the graph we may read the altitude where the thermals stop on the Y-axis (provided they remain blue, and the air cooling thus remains dry-adiabatic).

But will the thermals remain blue? Well in the above example the answer is „yes" for the following reason: The dotted green line goes from the dew point at ground level (the bottom of the left curve) to the temperature graph for the day, and indicates where the cloud base will be in case there are clouds. If this altitude is above the maximum thermal altitude, the day will remain blue. Note that to be able to determine the altitudes accurately we need a Stiive-diagram paper.

Picture 9.8 The Rosengarten, Dolomites, Italy, towards evening. The temperature gradient shows a modera-

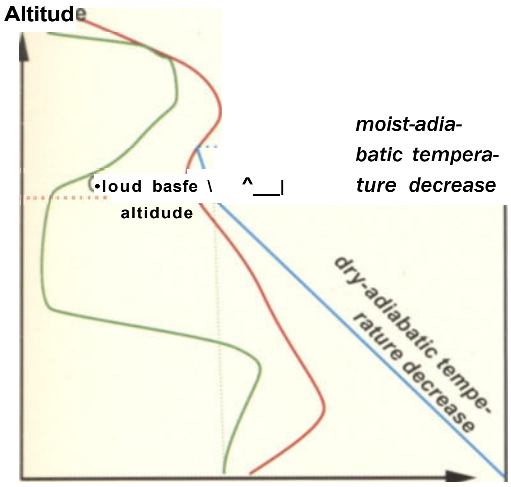


Illustration 9.9 The same airmass as in illustration 9.7, however the day temperature continues to rise. The blue line now begins further right and consequently meets the dotted green line indicating the humidity in the airmass BEFORE meeting the temperature curve. From this point the temperature decrease is moist-adiabatic due to the condensation taking place (-0.65 °C/100m), and the difference between the altitude where the thermal begins to condensate and the altitude where the blue line meets the temperature curve indicates how high the clouds may grow.

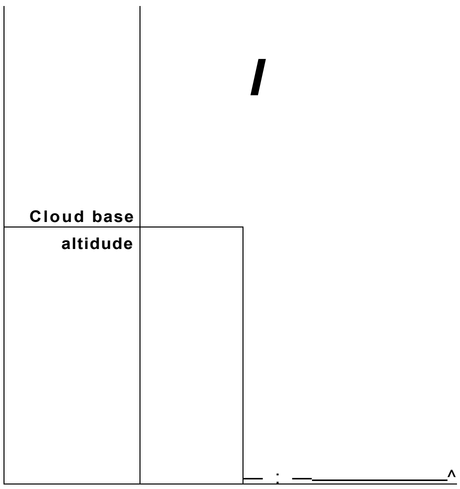


Illustration 9.10 This diagram shows a weather significant airmass (the two curves are closer to each other), and furthermore the red curve has no inversion built in anywhere. Finally the blue line never meets the red curve so there's no lid on the thermal development - the thunderstorm is brewing.

Identifying the subsidence inversion from the temperature gradient diagram

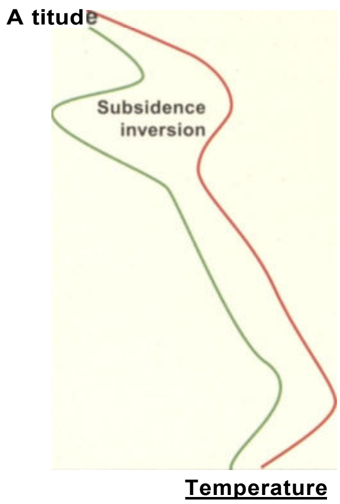
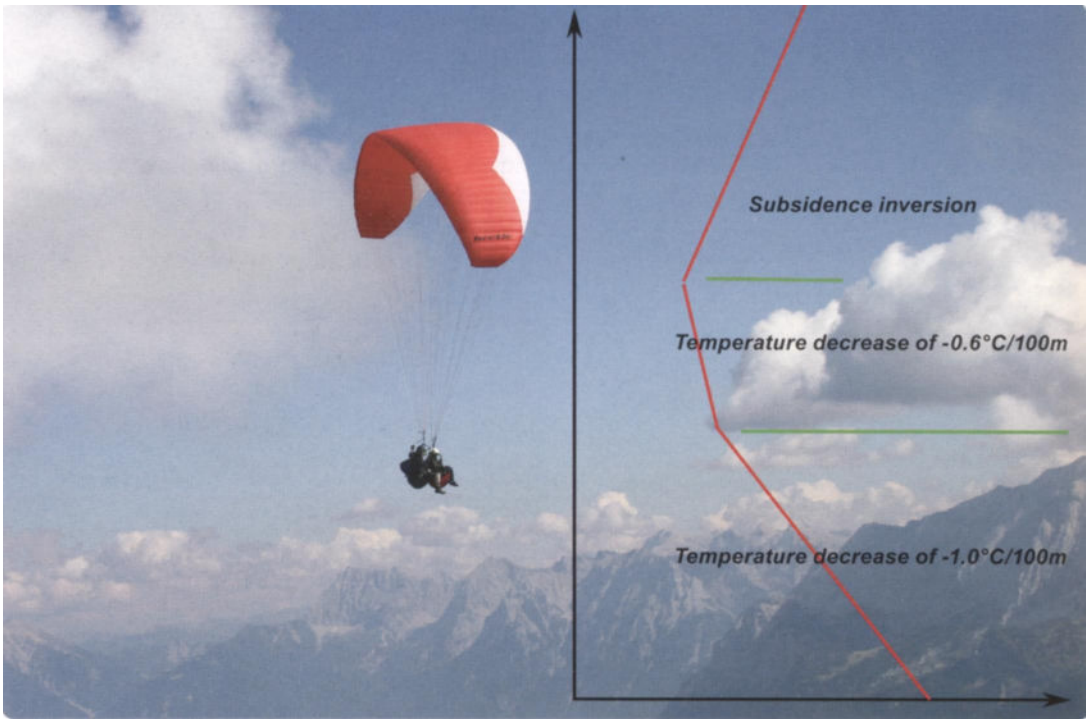


Illustration 9.11 This diagram shows a typical subsidence inversion as briefly described in Chapter 3. The subsidence inversion determines if the day is good for flying or not; if it is high we have plenty of spread available for thermal development, if it is low the thermals cannot rise and the day becomes poor.
Notice that around the level of the subsidence inversion the temperature increases with altitude, and simultaneously the dewpoint line takes a sharp turn to the left, indicating drier air. This is the exact image indicating a subsidence inversion.



Illustrion 9.12 In this photograph I added the adiabatic temperature gradient, dry lower down then moist from cloud base up. Notice how the cloud has a distinct upper ceiling caused by the subsidence inversion. Picture shows the Garmisch-Partenkirchen (D) flight arena.

Picture 9.13 The stuff of dreams... High cloud base, high subsidence inversion stopping any overdevelopment. Perfect. The picture shows the Pustertal (I/A), with the Grossvenediger (left) and the Grossglockner (right).

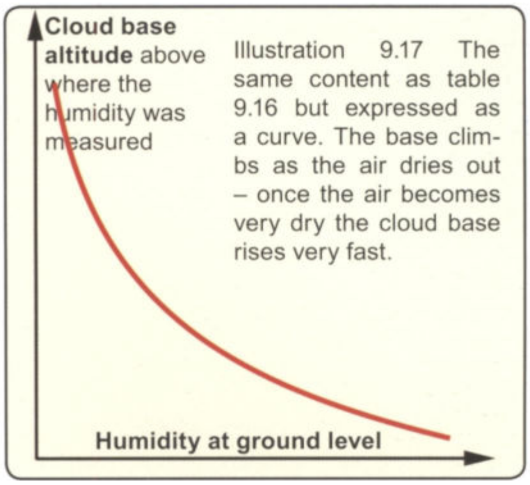
Determining the cloud base altitude through humidity

There's another way to roughly determine the cloud base, namely by using the air humidity at ground level. That is the moisture which will be carried upwards by the thermal and which will eventually condensate and form the clouds. It is actually rather self-evident; the drier the airmass, the higher the cloud base. In the following table the approximate values are given - the humidity is measured with a simple hygrometer:

Table 9.16

Relative humidity (in %)	Cloud base in meters over the point where the humidity was measured
20	3400
30	2600
40	2000
50	1500
60	1100
70	800
80	500

Picture 9.14 When the air is very dry the cloud base becomes correspondingly high. On this day near Lienz (A) we had a cloud base around and slightly above 4000m, but in the Otztal the air was even drier and pilots were getting to 5000m (approx. 16500 ft)!



Picture 9.15 It is actually far easier to determine the cloud base using the relative humidity than using the Stiive diagram or the Emmagram, as we did in Ill. 9.9.

Cloud base development during the day

It is common knowledge that the cloud base rises during the day. Here is the explanation:
- As the day wears on, the humidity at ground level decreases as humidity is continuously transported up by the rising thermals.
- The higher the temperature at ground level, the further the two curves in the thermodynamic diagram are apart - we say that the „spread" is high (the term „spread" refers to the distance between the temperature curve and the dewpoint curve in a thermodynamic diagram). When the ground level temperature increases by 1°C the cloud base climbs approx. 125m!

On a normal thermally active day the cloud base may climb 500-1000m during the day. In extreme cases the cloud base may climb far more.

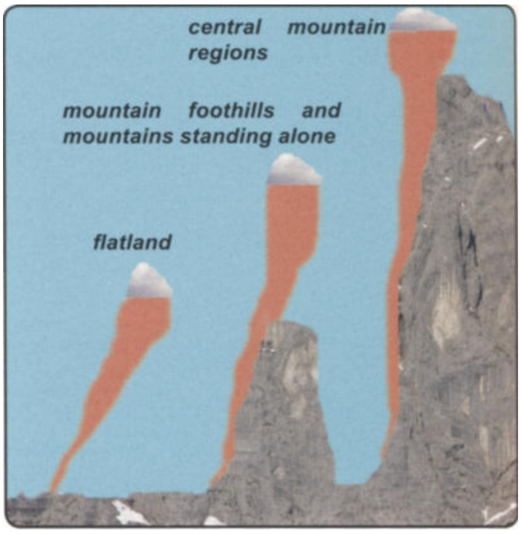
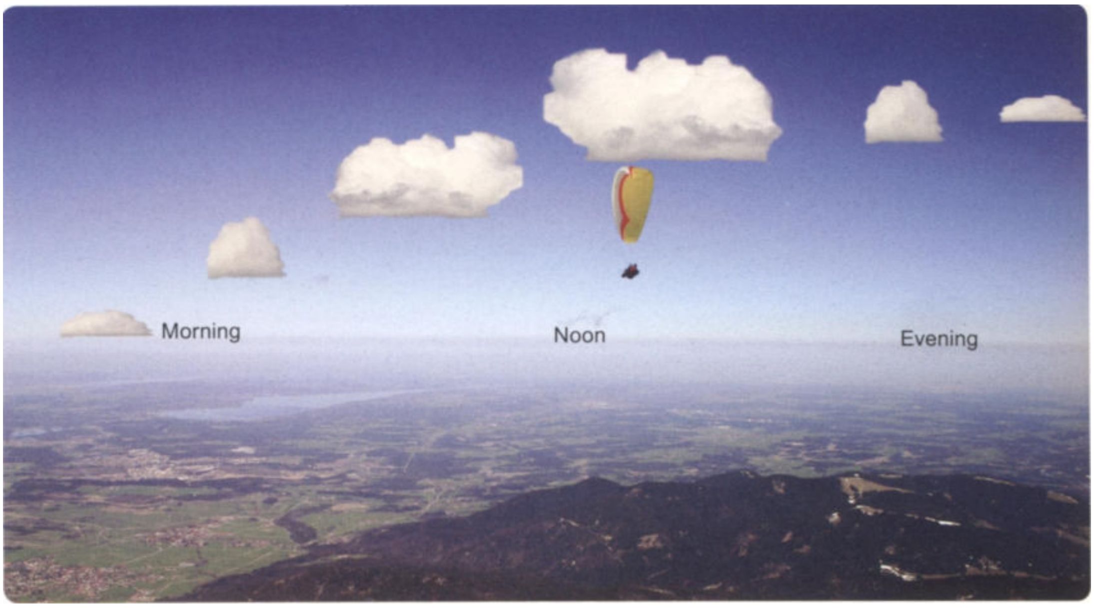


Illustration 9.18 The condensation level and thus cloud base level depends on a number of factors, with the most important one being the available humidity in the air and the temperature gradient. As a general rule, cloud base will be lower in flatland regions than in adjacent mountain foothills, and the difference to central mountain regions is still greater. On days where the flats have 1500msl, the foot hills may often get 2300msl and the Alpine dividing range even 4000msl! Sailplanes can go far under a 1500msl ceiling but paragliders and hang gliders prefer a little more working space.

Illustration 9.17 Cloud base rises during the day, sometimes with more than 1000m. During this process we may observe the clouds going from small in the morning over large around the best thermal time, and back to small again towards evening. That is the way a good day should look! The picture shows the Bavarian foot hills (D).



Glider forecast

Many national meteorological services issue glider forecasts during the gliding season. As thermal flyers these forecasts are of great value for our flight planning.

A glider forecast usually contains the following informations:

- Wind speed and direction at various altitudes. If the wind speed increases dramatically at a certain height we know that we should expect turbulence at this level. Once we know the wind directions we can also determine which mountain ranges are in the lee and which may be soarable.
- Condensation level/cloud base, or it may simply state that the day will remain blue.
- Thermal trigger temperature, the temperature that an airmass must reach in order to rise all the way to condensation level. Anyone flying before this temperature has been reached will find only calm air.
- Thermal life cycle and duration
- Particular dangers. If it says „No particular dangers" then the day is perfect as there are no storms expected, no strong winds at ridge level with associated turbulence, no Fohn and no new frontal systems expected. Note that such a statement pertains to the general meteorology, not the involved pilot skills!! Avoiding lee is still the pilot's responsibility.

Picture 9.19 Perfect flying weather, just as forecasted. Brauneck, Germany.

World weather forecasting

Most countries have special flying weather forecasts, and many even have dedicated meteorologists working only with aviation weather forecasts. In other places pilots are stuck with the general forecasts. Provided it is available, the glider forecast is always the most relevant of them all. If we can't get a glider forecast we can use the Bracknell charts showing isobars and frontal systems. Supplement these with good wind forecasts and maybe some current data from ski stations in the region where we plan to go and we have probably got a pretty good picture of what to expect.

There are two websites with worldwide weather info made easy:

www.weatheronline.co.uk

This page uses easy-to-understand pictograms to depict forecasts for every country in the world. The following illustrations show how it works.

Grafik: www.weatheronline.co.uk

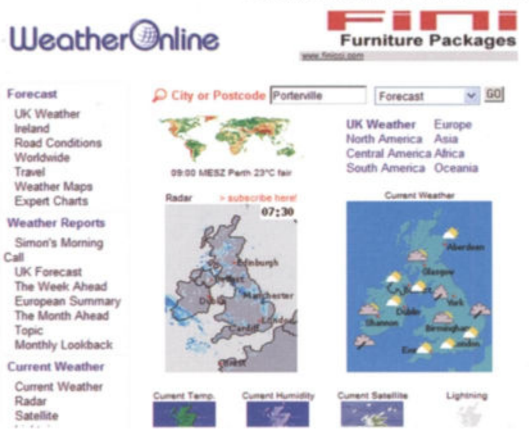


Illustration 9.25 The *__weatheronline.co.uk__* *homepage. Also available in German, Dutch and Chinese (I). Click near the bottom of the page for the different languages. The buttons in the upper right hand corner lets us select locations either directly (here we have choosen Porterville, South Africa) or via continent>country>province>town.*

Grafik: www.weatheronline.co.uk

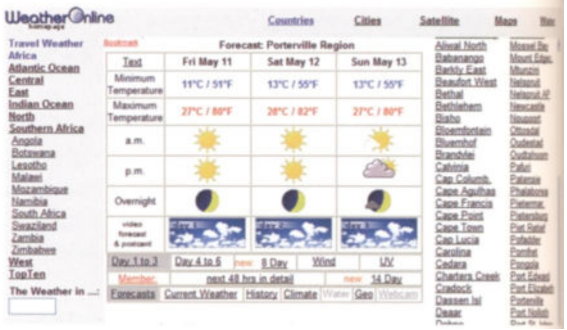


Illustration 9.26 Once we have selected a destination (here Porterville) we get this screen. On the left we may click on other countries in southern Africa, on the right there is a list of all the locations for which we can get forecasts. We get the current situation and the forecast at a glance, and this is what makes this site so useful. The current situation has wind strengths right now, and we may even look at the recent weather history for the place we have choosen. Aside from this I consider the page self-explanatory, and please note the option to go straight to another location via the links at the bottom of the page.

Grafik: www.weatheronline.co.uk

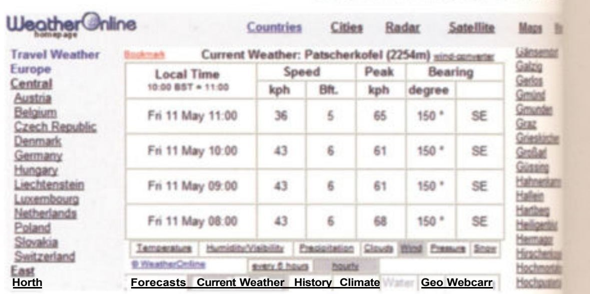


Illustration 9.27 If you select the Patscherkofel as your point of interest in the *__weatheronline.co.uk__* *system you get direct access to a key weather station in the central Alps. If there is a Foehn blowing the anemometers at the Patscherkogel will know. Click "Current", then "Wind". On the day this screenshot was taken the SE wind was gusting to 65knots!*

Every pilot should find such useful key locations around his home, to help him judge and evaluate the day quality.

Remember that any wind speed indicator is only as good as its location - to be of any use it must be placed in an exposed position where winds from all corners of the globe can hit it unobstructed.

www.wetterzentrale.de

This website, sadly only available in German, allows its users access to excellent forecasts from all over the world. The data comes from the very useful American system called GFS (Global Forecast System).

Frettag, 11.05.2007

Grafik: www.wetterzentrale.de

iWetterzentral^

H»u, Wenerkarten DVD CB I GFS-EI.S 12Z I Wetterwerte ab 18761 Bodendruckkarteti 1880-1950 I Stdl Kan Kartenauchtv ab 1948 | Wassertemperaturen I Sonnenau/unlergang |

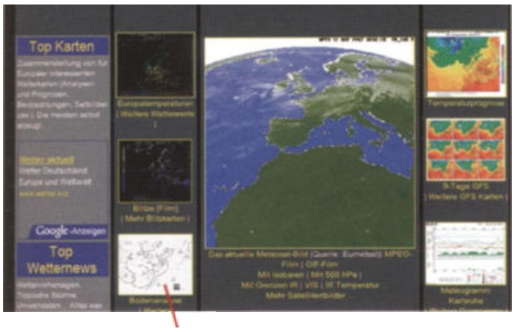


Illustration9.28 Bracknell map, Mick here. The wtterzentrale.de homepage. The list of links under "Top Karten" at the upper right hand corner lead to the weather maps we're interested in.

Illustration 9.29 We're primarily interested in the "GFS" link - try clicking it:

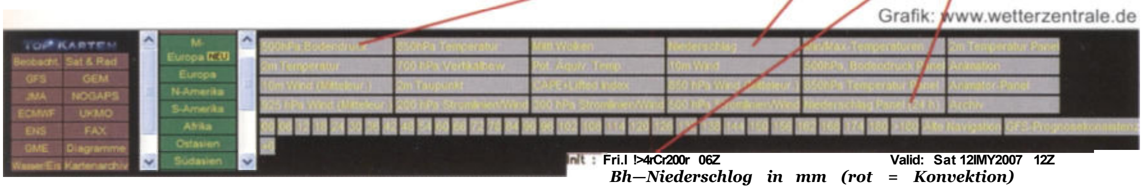
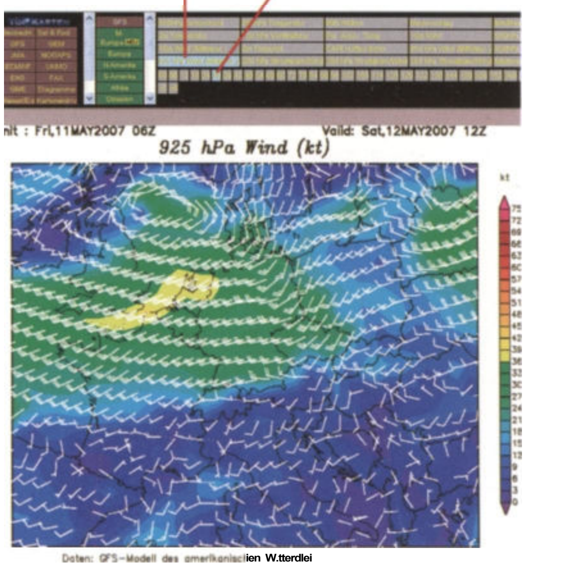


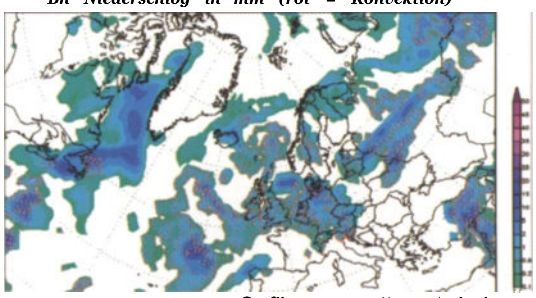
Illustration 9.30 And we get the following screen. The green list on the left selects the geographical area, the yellow links in the grey table on the right take us to the different parameters, like wind speed, precipitation or isobar charts. Clicking on a number in the list at the bottom of the grey table takes us to the selected chart, with the numbers indicating hours from now.



Grafik: www.wetterzentrale.de

Illustration 9.31 As an example lets take a look at the 925hPa wind chart for central Europe. This screenshot depicts the 30h forecast. In flatlands the 925hPa altitude is the preferred reference for wind speeds, whereas in the Alps the 850hPa altitude is more interesting. The ground level wind charts are uninteresting for pilots, both because they are less accurate and because we generally are above these levels.

We can find the publishing date and time above the chart on the left, and the "Valid for" time above it on the right: "Valid 12. may 200712 Z. The Z is for Zulu time, which in central Europe means daylight saving time +2(1). In the precipitation charts the forecasted precipitation amounts within the next 6 hours from the selected timevis shown.



Grafik: www.wetterzentrale.de

Chapter 10: Need-to-know

This chapter contains miscellaneous nuggets of insight that didn't fit in any of the other chapters but couldn't be left out due to their importance.

The polar curve

The polar curve of a gliding aircraft is simply a graph showing the relationship between speed and descent in a coordinate system.

To construct a usable polar curve for a paraglider, or a hang glider, is not necessarily an easy task. The first prerequisite is absolutely calm air - not a common occurrence anywhere. Second is a good memory, or simply a Dictaphone, a vario and a speed probe. Early mornings offer the best chances of recording an accurate polar curve. I won't even begin to list all the possible errors that may adversely influence the final result. It is important to know how the polar curve looks in principle. That is useful for optimising our gliding in different situations - it doesn't matter so much if the actual polar is dead accurate or not.

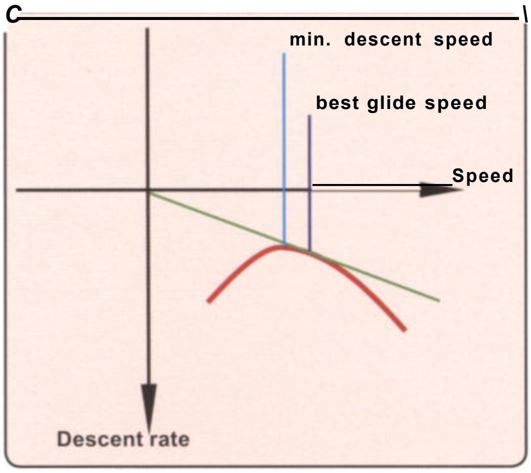


Illustration 10.1 The polar curve for a paraglider. Notice the green tangent line through the coordinate system origin; where the line touches the curve we may read the speed for best glide on the X-axis. The highest point on the curve indicates the min. descent of the wing, to be seen on the Y-axis.

This is how a polar curve is acquired:

In order to get a sufficient number of coordinates in our coordinate system to draw the polar we simply fly at all the speeds our wing is capable of (for example in 2km/h increments), all the time recording the descent rate corresponding to the different speeds.

Once we have all the values (speed/descent) we plot them into the coordinate system. Illustration 10.2 shows a table where the values for a modern sports-class wing have been entered. Notice that both axis' are in m/s, so we'll have to convert our speed measurements into m/s before entering them into the table. With these numbers we can also calculate our L/D ratio, often referred to as our glide ratio, by dividing A (speed) with B (descent rate).

Conversion table see page 21.

Polar data (very good paraglider), Harness SupAir Altix, flying altitude 2000 meter, temperature 4°C, humidity 65%)

measured	calculated	measured	calculated
Speed km/h	Speed (A) m/s	Sink(B) m/s	L/D ratio = A/B
25	6,9	1,6	4,31
30	8,3	1,3	6,41
34	9,4	1,15	8,21
38	10,6	1,1	9,60
41	11,4	1,2	9,49
45	12,5	1,5	8,33
50	13,9	2,0	6,94
55	15,3	2,3	6,64

Table 10.2 The measured airspeed is converted into m/s then divided by the descent rate and we already have the glide ratio (L/D).

How to glide the furthest?

This question is of elementary importance to the XC pilot, particularly when crossing difficult areas. If we're crossing a wide valley we normally want to arrive at the other side as high as possible so that we increase our chances of locating lift and continuing the flight. The wing in the example above has an approx. trim speed of 40km/h, at least with the wing loading used for the polar measurements. The best glide angle is calculated to 9.6 in the table. If there's absolutely no wind this is then the best speed to glide for long transitions. Note that most paragliders are designed to have their best glide in calm air with the brakes untouched and no speed bar applied.

Hint:
If in doubt it is always better to glide a little too fast than a little too slow.

Hint:
The infamous www.para2000.org website has the most complete collection of glider performance data available anywhere. It also contains polar curves for pretty much every paraglider on the planet, however the accuracy of these is something I don't want to comment upon.

Picture 10.3 Minimum descent rates, aerodynamic body position as well as sgnificant wheight shifting are vital parts of thermal flying.

Optimising the climb using the polar curve

It doesn't take a degree in maths to work out that the best speed for thermalling is as close to the min. descent speed as possible. If we return to the example from the previous page it is easy to see that for this particular wing the min. descent is around the 38km/h mark, in fact not very far from the speed for best glide. It always surprises me when I meet or overhear people saying something along the lines of „there I was with the brakes buried almost to my hips and the others were still climbing better!" One glance at the table is enough to tell us that we get absolutely nothing out of flying too slow.

How to glide with a headwind

If we look at a headwind situation from a polar curve view, we simply change the origin of the tangent line on the X-axis corresponding to the wind speed. The tangent touches the curve further down the slope, indicating that the optimal speed for gliding against the wind is higher than when we wish to go far in calm air.

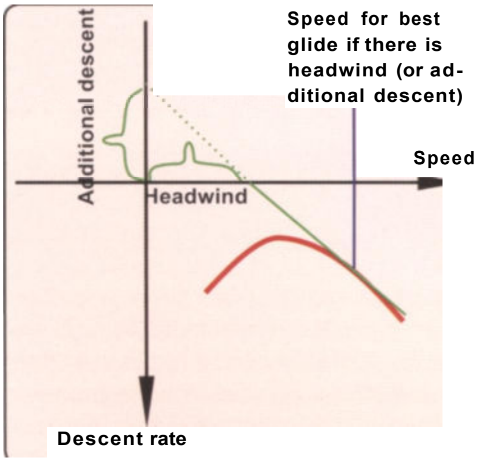


Illustration 10.4 When flying with a headwind the speed for best glide is shifted right, or further down the slope of the polar curve. In order to go the furthest with a headwind we must thus increase our speed to beyond the trim speed.

Practical hints - headwind:
If there is up to 10km/h headwind we use only a little speed to 1/3 bar. Around 20km/h it pays to speed around 2/3 of the full range of the speed system, and only when the headwind reaches 30km/h it is worth it to go at fullspeed.

NOTE:
It is good to be aware of the fact that the glide ratio is severely affected by a headwind. If the wing in the example above flies into a 20km/h headwind the glide ratio is only half of what it would get in calm air, and at 30km/h it is down to an L/D of 2.6. This translates into the understanding that even small valley crossings are all but out of the question if there's a strong head wind.
In real-life flying it is rare to be going at full speed on a paraglider. It is only necessary if there's a venturi effect stopping us from getting over or around a spur or similar - or on final glides in competitions.

Hint:
When flying with a lateral wind we must go slightly sideways (..crabbing") in order to counter the drift. Note that the headwind rules apply - we must speed up to reach best glide. The more lateral wind, the faster we must fly to optimise our glide angle.

How to fly in a descending air mass

We can also use the polar curve coordinate system to work out how to fly through sinking air. To do this we must move the origin of the tangent up the Y-axis corresponding to the descent rate we meet. Again it is clear to see that the tangent touches the graph further right, indicative of the need to speed up in sinking air. See illustartion 10.4.

Practical hints - sinking air:
If the surrounding air is sinking 1m/s (the vario is showing app. -2.1 m/s and the glide-ratio reduced nearly to the half!!!) we should accelerate 1/2 to 2/3. Once the needle hits 3m/s, corresponding to a surrounding air-mass sinking with 2m/s, we must go very fast to escape.

NOTE:
When flying through an airmass sinking 2m/s our glide angle is reduced to something like 3.4 almost regardless of whether we're going 40 or 50km/h! This means that getting out of the sinking airmass is top priority, either by speeding up or by changing heading. Aside from that we can only hope that we can get through it before we run out of air to fly through.

Hint:
If we find ourselves low and desperate it pays to search downwind, i.e. with a tailwind even if it means flying back the way we came from for a while, as this allows us to explore a far greater area than if we keep insisting on going against the wind, it is better to fly a long detour than to be sitting on the ground!

How to deal with a tailwind

Gliding with a tailwind is great; it gives the impression that one can go on forever. If we look at the coordinate system again we can see that the origin of the tangent line is shifted left, which means that the tangent touches the speed polar curve further left as well. Further left is closer to the speed for min. descent so it follows that it pays to slow down a little in a tailwind. Notice that the gap between speed for best glide and speed for min. descent is narrow on modern wings so don't overdo the braking part - on the wing used in the examples above we should never slow down to an airspeed of less than 38km/h as this just makes the descent rate increase again!

Active piloting

This enchanted concept keeps turning up wherever two or more paraglider pilots are gathered. I'm going to put it as straight as I can: If you fly a lot you learn a lot! This also translates into the important insight that if you're a novice you do yourself a favour by not flying during the most thermally active times of the day. The more turbulence you encounter, the greater the chances that you'll hit that bit of air just beyond your own capabilities. Far better to approach turbulence in a gradual manner and learn active piloting step by step.

Many paragliding schools offer safty and performance training courses. If you haven't yet attended such a clinic I would recommend that you do so, as this is really the best way to prepare oneself for learning active piloting. In the following I will however explain the concept in more detail - note that all this doesn't in any way replace good safty training but it could make your learning curve steeper.

Active piloting is the name we have choosen for the art of always keeping the glider vertically above the pilot and travelling at the same heading as the pilot. It sounds simple, but it takes a lot of practise to get it right.

In order to pilot actively the pilot needs to know the brake pressure of his wing - sensing the changes in the brake pressure is the first prerequisite for getting the timing right.

Picture 10.6 The glider suffered an asymmetrical collapse, immediately followed by a counter-collapse on the opposite side. Both collapses would have been avoidable for the skilled pilot, but the glider is a forgiving model and has hardly changed its heading.

Novices generally react too late to the changes in brake pressure - and please don't interpret this as some sort of reproach, all comes to him who practises!

How to react when the glider pitches back

When we meet a lifting airmass, like a strong thermal, the glider pitches back to a greater or lesser extent. Sitting in the harness it feels not unlike the sensation when we tilt a chair backwards. Note that the brake pressure increases whilst the wing is getting pitched back.

Picture 10.7 Strong thermals may pitch the wing back quite violently.

To counter the movement the pilot releases the brakes precisely enough to maintain the brake pressure at the level where it was before the wing started to fall behind. If he gets the timing right the pitching will be greatly reduced. As soon as the wing has stopped pitching back the pilot should begin to dampen the surge by reapplying brakes, taking care to only brake enough to stop the wing right above his head.

The whole sequence happens very fast, and the pilot should instinctively do the following:

- Release the brakes as the wing begins to pitch back. Failing to do so will make it falling even further behind
- Begin to catch the surge **as soon** as the wing reaches the most extreme point in the back-pitching movement
- Be back to the normal brake position once the wing is back over your head - braking more will just replay the sequence

How to react when the glider shoots forward

If we drop out the side of a strong thermal, or otherwise hit sinking air, the glider shoots forward. If it surges too far the leading edge will collapse, so we always aim to control all the surges to avoid collapses. A surge is easy to identify through the brakes because the brake pressure decreases, and extreme surges may have us almost facing the ground, feeling like we have been tipped out of a chair.

As long as the surge is happening we must apply more brake. In extreme cases it may be necessary to brake up to 100%.

As soon as the forward pitching moment ceases we must begin to release the brakes again - once the wing is above our head again the brakes should be back to the initial position.

Picture 10.8 When the glider surges we must try to stop it by applying brake. The most common mistake here is to brake too little and too late - and this is what allows the wing to collapse. Very skilled pilots can prevent practically all collapses, especially on wings with good feedback through the brakes and risers.

If we get the timing wrong and release the brakes too late the glider will pitch back and we'll find ourselves in a pilot induced oscillation. If our timing remains off it is possible to increase the oscillations until the wing either stalls or collapses over the leading edge.

Hint:
Practise active piloting whenever you fly by always attempting to keep the wing right above your head. Consciously note the relations between brake pressure, harness movement and glider position in relation to yourself. Good exercises for increasing spatial awareness in the sky are deliberate pitching movements (dolphin flying) and wingovers. Be sure to approach all of these gradually and with caution, and only with sufficient altitude.
Once you get it right the movements are very rhythmic, but note that wingovers going higher than 45° are best learnt over water and with competent guidance.
Pilots who are consistently able to fly long series of high, rhythmic wingovers are almost guaranteed to be skilled at active piloting as well!

Asymmetric collapses

Before the wing collapses above you it talks to you, warning you of what is about to happen. The brake pressure decreases on the affected side, and the lines all go slightly slack. We notice the latter because we tip to the affected side in the harness. If we're quick we may respond by applying more brake on the affected side, enough to keep it from surging forward but not so much that we risk spinning or even pitching the affected side back. Once we get this right collapses will be a thing of the past.

Getting the amount of brake input right when one side of the wing wants to collapse is not always easy. Note that it may be necessary to briefly apply up to 100%, to avoid the wing collapsing.

If we get the timing wrong and the collapse gets us anyway we should stabilise our heading by applying opposite brake. To do this, brake the open side and weight-shift to the open side, but only so much you need to maintain the heading. In order to know our heading it is better to look forward than up! Beware, it is easy to accidentally apply too much brake on the open side and inadvertently stall it - if this happens we call it a cascade incident, and such things are beyond the scope of this book.

One of the things you learn when you do a safty course is how surprisingly little steering input is normally needed to stabilise the heading with one side collapsed. Inexperienced pilots generally pull too much and get into trouble for it - see the words about cascade incidents above.

Once we have stabilised our heading the collapse will most likely be sorted out all by itself. If there is still some canopy folded under, pump it out with one or two deep, powerful but short pumps on the collapsed side - little dabs on the brake have no effect, but take care not to stall the collapsed side!

Picture 10.9 Small collapse caused by a wing-over gone wrong. Docile wings forgive most of our mistakes while Open Class wings may show hefty reactions to such mishaps.

Do yourself the favour of practising all these things under qualified supervision and preferably over water - they are your life insurance, but can get you into a lot of trouble if you get some of it wrong.

Training programme

Anyone wishing to excel in any given activity must train to improve. This is pretty clear, but we can add that a person training in a goal-oriented manner, all the time focussing on learning from mistakes and applying theoretical knowledge to the practical situations, will improve much faster than someone who just goes flying and doesn't think much about it neither before nor after. Flying a lot is good, but not the whole story.

I came up with a training programme for you to refine your basic skills, integrating theoretical knowledge and practical skills. Start by practising the exercises at home, and then take them with you to new flying sites so that you may build up your experience bank fast.

Exercise 1

Picture 10.11

Climb to cloud base, then leave the thermal and loose 300m of altitude fast. Rejoin the thermal and climb back up as fast s you can. Repeat, but loose 500, then 750m etc.

The goal is to practise the centring technique and learn about the structure of thermals.

Exercise 2

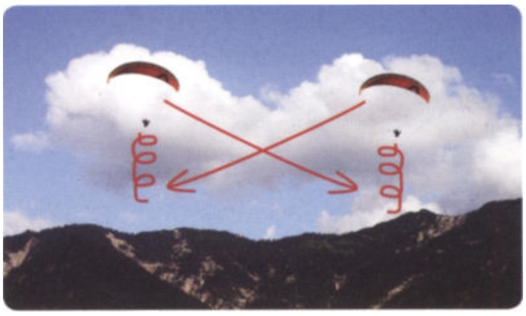


Illustration 10.12
Switch back and forth between two reliable thermals. Climb up to cloud base in one, glide over to the other, repeat there but leave 200m beneath cloud base to return to the first thermal. Once there, climb again but only till 400m beneath the cloud, then switch to thermal 2 again. Continue until you are almost on the deck.
The Goal is to learn how to find the thermals at any altitude and to improve our low-scratching skills.

Exercise 3

Illustration 10.13
Learn about the expansion of the thermal. Once you have located a thermal try to widen your circles for every full 360°. Sooner or later you will have found the boundaries of the thermal. Then re-centre and note which turn radius gives you the best climb rate.
Goal(s): Learning about the ideal turn radius for a given thermal. Learning about the size and shape of thermals.

Exercise 4

Picture 10.14 Sospel, France, near Monaco.
When soaring on thermally active slopes practise exploring the expanse of the lift band particularly away from the slope. Fly away from the slope until there's no more lift, then return and do the same further down the ridge. If you happen upon an embedded thermal try to bite into it and take it as high as you dare without risking to get blown back over the top.
Goal: To learn to discern between dynamic and thermal lift and to exploit thermal lift in combination with dynamic.

Exercise 5

Picture: Ozone / Olivier Laugero

Practise thermalling to the opposite side of what you normally prefer.
Goal: To become proficient at thermalling both ways. Having this skill sorted makes quick centring much easier as we rarely hit thermals right in the middle and it is almost always best to turn one way or the other right from the start.

Exercise 6

Picture 10.16

Try to change directions in the thermal. Try it both on the upwind and on the downwind side.
Goal: You may need to be able to do this soon enough, and having practised it beforehand is always good. It also builds your awareness of upwind and downwind in the thermals.

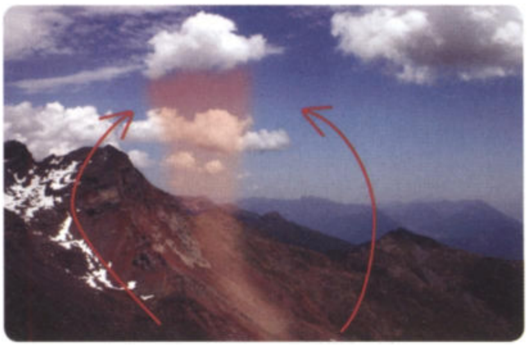
Exercise 7

Picture 10.17 Boxi (Stefan Bocks) climbing out from the Wilde Kaiser (A) with no vario!

Switch off your vario for a while and practise flying, and thermalling, with no external aid.
Goal: To hone your sensitivity towards the subtle messages the air is transmitting through your eyes, ears, buttocks and hands. Beware of subtle changes in speed when you fly in and out of thermals. Also note the changes in brake line pressure - it increases when you fly into a thermal and decreases when you hit turbulence or fall out of the thermals. Try to notice if the air is being sucked in towards the thermal or pushed away.

Use fixpoints to register climbing and sinking. This is easy beneath ridge height but gets more complicated above the terrain. Use two peaks that are aligned and notice if the one further away is becoming more or less visible with time. If you see more of it you are either gliding towards it or climbing!

Exercise 8



///. 10.18 The Drautal near Greifenburg in Austria

Fly between two known thermals, once in a wide left arc, once right. Notice which of the routes was best. Repeat to see if the result is also repeatable.
Goal: To learn that the best route isn't always a straight line. Detours may often be better in the long run.

You don't need a vario to fly the socks off any paraglider pilot out there. Griffon Vulture photographed by Paul Klima.

Exercise 9

Picture 10.19

Attempt to fly to a thermal marked by circling gliders. Climb to cloud base in the new thermal.

Goal: To improve your distance-judging. Other gliders are generally much closer than we think, mostly a lot closer!

Exercise 10

Picture 10.20

On a day with abundant cumulus development, practise discerning the ones that are forming from the ones that are decaying. Always attempt to approach only forming clouds and avoid the decaying ones. Try to judge the life cycle of the clouds around you in minutes.

Goal: To learn about cloud life cycles.

Exercise 11

Picture 10.21

Practise your ground handling skills and your reverse launches. All you need is an open field and a bit of wind.

Ground handling is the best thing aside from flying that you can do for your glider handling skills. You may even practise collapses by pulling in an A-riser while the wing is inflated above you - try to keep it flying without letting it touch the ground. If you're there with a friend, make a small battle where you attempt to get in the way of your buddy - whoever has his wing touch the ground first has lost! Such games are great fun and will make you a better pilot too. Remember to wear your helmet and gloves!

Picture 10.22 Playing in the valley wind. Whoever has his wing touching the ground first has lost! In this case we had to declare a draw after 15 very sweaty minutes.

Pictures 10.23 *Playing with our favourite toy. If you're not wearing your harness, steering with the A's and D's is the easiest way. With the harness the D-risers are still useful for steering but remember to wear gloves when you grab paraglider lines - they make painful burns. If the wind gets stronger you should ALWAYS wear a helmet.*

Picture 10.25 Hay bales, benches, rocks, logs or garbage containers; anything goes if the objective is to climb obstacles while balancing your wing above your head.

Picture 10.26 If the launch is shrouded in fog but the wind is blowing just get your wing out anyway and start playing. The photo shows the Krippenstein launch in Austria.

Top landing

Top landing hasn't really got anything to do with thermal flying, it is however an important skill to have and can save car retrieve hassles, give you an opportunity to warm up before a second flight, enjoy the solitude of the mountains in tranquillity, AND it can save you from having to land in a valley bottom where the valley winds have become too strong or too turbulent for comfort. Here follows a few hints for safe top landings:

Top landing is generally both more demanding and more dangerous than just floating down to the official landing site at the valley bottom. However there are exceptions, like when the main landing field has come under the influence of a sudden strong valley wind, a valley wind convergence or something similar. As an example, in Fiesch in Switzerland the local pilots tend to avoid the main landing when the Grimsel-wind breaks into the valley as this causes the conditions to become turbulent there.

Some of the things that need to be considered when setting up for a top landing are wind strength and direction, likelihood of rotor formation over the choosen landing spot, likelihood of sudden thermal activity that may change the wind direction completely etc. Never force it, always keep your calm and rather make 10 or 20 failed approaches than stalling in from too high, or going

***Picture 10.28** At the Monte Avena the pilots conies in from behind, just like a normal valley bottom landing. The landing field slopes gently towards the edge, leaving no space for rotors to form.*

***Picture 10.27** One of the greatest top landing areas I know, Monte Avena above Feltre in Italy. The best way here is to fly back over the top of the mountain where there is no lift, loose the height there and come in towards „A" against the wind from behind. On thermally active days there is usually enough wind to almost park above „A", and wait until low enough to glide forward to right next to the parking. Remember to keep pointing into wind! This method only works in places where there is no lee behind the edge.*

in with a tailwind. If the wind is too strong and/or the lift too abundant simply abort the attempt and leave it for another day.

Note that most top slopes are far less suited for the purpose than the one in these photos - in Europe, other well-known easy top landings include the Castelluccio in Italy, Aspres sur Btiech in France or even the Dune de Pyla, also in France. All of these are great places for practising your toplanding skills before graduating to more demanding sites.

A good top landing site has a gentle transition from steep slope to level top with no sharp edges, see pictures 3.9 and 3.10. It is also comforting if there is no steep opposite slope behind the top where you could get blown to in case the wind is stronger than expected, and grassy fields are much preferable to rocky expanses - the latter tends to be dotted with prickly brush anyway...

If the wind is not straight onto the slope you must beware of this and always point your wing into the wind anyway - failing to do so will almost surely give you an involuntary dragging experience.

If the lift in front of the slope is strong, as in the picture 10.27, it pays to move to the point „A" and simply „park" there until you are low enough to glide forward to the landing. This works because there is no lift at „A", only wind, compare also to picture 8.10 page 204.

If we have choosen an dome-shaped knoll for our top landing attempt it is important to know that any dynamic lift from further down the slopes is simply blown around the top at peak level, so there may be less lift and more wind than expected close to the top. It may suddenly sink quite fast!

If there is a healthy breeze blowing it is important to not flare hard upon landing, as this will just see you getting dragged backwards off you feet. Brake gently to make the touchdown soft, then balance the glider above you until you have turned to face it - only then should you kill it either via the brakes or, in very strong winds, via the C-risers. The reason for turning around first is that you may then run with it instead of being pulled backwards. Practise this manoeuvre at the landing field before you need it in earnest.

Slope landing

Paragliders land across the slope whereas hang gliders land against it, „fly on the wall" style. Don't try this on a paraglider, it will hurt. When slope landing on a paraglider, first you need to work out if there's any headwind component to help you make your landing soft. The wind is rarely straight onto a slope so there will often be one way where you fly slower than the other.

Picture 10.29
Paragliders land across the slope, hang gliders against it.

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Chapter 11: Bruce Goldsmith: Hints and Tricks

The Mental Model

When you fly XC in any type of terrain you are searching for areas of lift to climb in and other zones to glide through with the objective of covering distance over the ground. In order to achieve this, you should try to build up a mental model in your mind of how the air is moving in the sky in 3D. What forms this mental model and how to update it and the ability to change this model as fast as possible are what makes a really successful XC pilot.

Things that influence the mental model can be weather systems, fronts, sea breezes etc or valley winds or local effects, topography sun and shadow patterns. I am always trying to link ground sources with the thermals I can see as well as the clouds. The timing of cycles is also an effect that is difficult to predict and looking for visible indicators is the only true clue to this.

You should constantly be updating your mental model all the time and be aware of other possible models also. A good pilot is one that is able to change his mental model quickly using only a small amount of information. This information can come from any of your senses. Sometimes when I am gliding, attempting to find information, I try to make myself as sensitive as possible. I try to go in a kind of super receptive state, when I make myself extra sensitive to anything around. I feel for movements in the wing, I try to open my eyes extra wide and adjust the focus in and out to scan for objects in the air. Objects in the air can very often tell you a lot about what the air is doing. You could see another glider or bird. Sometimes I have seen some grass flying up thought the air caught in a rising thermal, or even a plastic bag. Smell can even tell you some information, you can often smell where a thermal stated from the scent in a thermal, though I must say that smell has not really helped me to find lift.


Picture: Bruce Goldsmith

Flatland Flying

Flat land flying has many similarities to mountain flying. In mountain flying the biggest cliff or mountain throws off the biggest thermals. In flat land flying the most important features also produce the biggest thermals, but the trick is to identify the most important features. In the mountains the most important features are completely obvious, it is the biggest mountains and especially the ones that face the wind and the sun. In the flat lands there are no mountains so you need to be aware of more subtle features. However there are very often just as many thermals as in the mountainis so you need to understand which features are most important in the prediction of thermals.

It is best to separate your decision making into 3 different categories.
1) Clouds.
When you are flying high, clouds are the most important signal of what is going on in the air.
2) At any hight, other flying objects.
At all levels other flying things can give you a sure image of where to find thermals. There is no guessing needed if you see a glider or a bird thermalling and climbing you know for sure that there is lift there.
3) Ground sources. This is maybe the most difficult item to identify but particularly when linked with the first 2 items, it gives the location for the birth of thermals.

When you are high you should use the clouds as the main source of influence on your decision making. When you are low you should use ground sources. At all levels other climbing objects can be used and takes preference over both ground sources and clouds. There are of course all the shades of grey inbetween.
Sometimes it is good enough so that you can link ground sources to clouds. I remember one particular occation that I experienced on an XC when I was getting very low in the flatlands and I could clearly see the source of a cloud street was a small rise in a field with a tiny building in it. The field was dark earth and had recently been ploughed and so was absorbing more heat than the surrounding grass lands. The small house was acting as a thermal trigger breaking the thermal away from the ground. Then directly downwind from the field I could see an active cloud and it was the first cloud in a cloud street heading directly down wind.
I arrived above the house with just 20-30m and found the climb I had been hoping for 3m/sec all the way to cloud base. It was remarkable to see such a clear thermal source even though the feature was very small.

Manilla, Australia during the Worlds, March 2007.


Picture: Bruce Goldsmith

Thermal Rumours and Legends

When flying in flatlands the smallest things can set off thermals or become thermal triggers:

1) A pilot landing.

There can be no thermals around and a pilot goes down to land. The tip vortex of the pilot landing can be enough to brake the bubble is super heated air close to the ground and can start the release of a thermal.

2) Sheep running.

I have heard of cases in Australia where hang glider pilots get low and line up their approach to a landing paddock full of sheep. The act of the glider flying low over the field causes the sheep to run about and this can be enough to trigger the thermal. Some hang glider pilots actually search out the sheep and shout at them when low to get the sheep to run around! Those Aussies are crazy!

3) Power lines.

I have found many times that power lines are good thermal triggers. The reason for this is not clear. Some say that the power lines themselves do not cause the thermals but it is the area cleared of forest and bushes below the line that causes the thermal. Onother explanation is that it is the surface of high tension power lines that is hot and maybe this causes a constant flow of hot air over the wires that causes the thermals to trigger. Whatever the reason power lines can make a good thermal trigger, and have helped me several times when low.

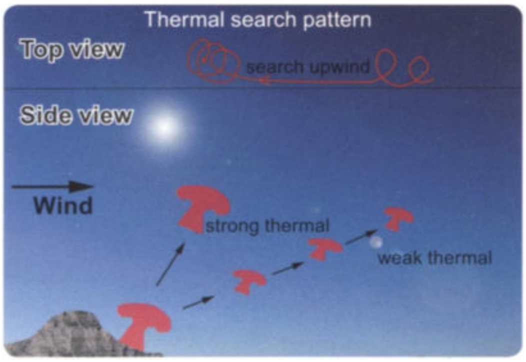
The Horse Race thermalling concept

On any XC flight it is important to climb as quickly and efficiently in each thermal. In competition approximately half the time is spent climbing in thermals and so and often you can get more of a lead from out climbing pilots than you can by gliding fast or better than them. So to climb fast in a thermal you need to be in the best lift and climbing in the most efficient way. Observation is extremely important and you should be carefully looking at any other gliders or birds around you and if anyone is climbing better than you, you need to change your thermalling pattern to take the same lift as them. You should never be outclimbed by someone. So climbing in a thermal is a vertical race to climb the fastest. Never be content to simply circle in the same lift, you should always be modifying your circle to climb better and centre on the best area of lift during each turn.

You can compare climbing in a thermal to a horse race. However it is more sophisticated than a horse race because it is not just about chosing the best thermal and climbing the fastest. You should be constantly looking for stronger lift and better cores and changing from one area of lift to another. So if you compare this to our horse race, it is means that you have to choose the horse which takes an early lead in the race, then when another horse starts to race though the pack you should jump onto that new horse, then as he tires out you should jump on another. You should be constantly choosing the best horse to win the thermal race.

Thermalling hints

Finding the core is very important. The core of a thermal is the place where the the thermal is lifting the strongest, If there is wind then most often the core is to be found upwind. This is because weaker thermals are more offset by the wind than stronger ones. So if you are already in a weak thermal then as part of your 360 you should straighten out as you turn into wind and start to search upwind to try to check if there is stronger lift upwind. Try to conitinue to check upwind until you find that the lift strength decreases, then just go back to the strongest lift you found and use that.



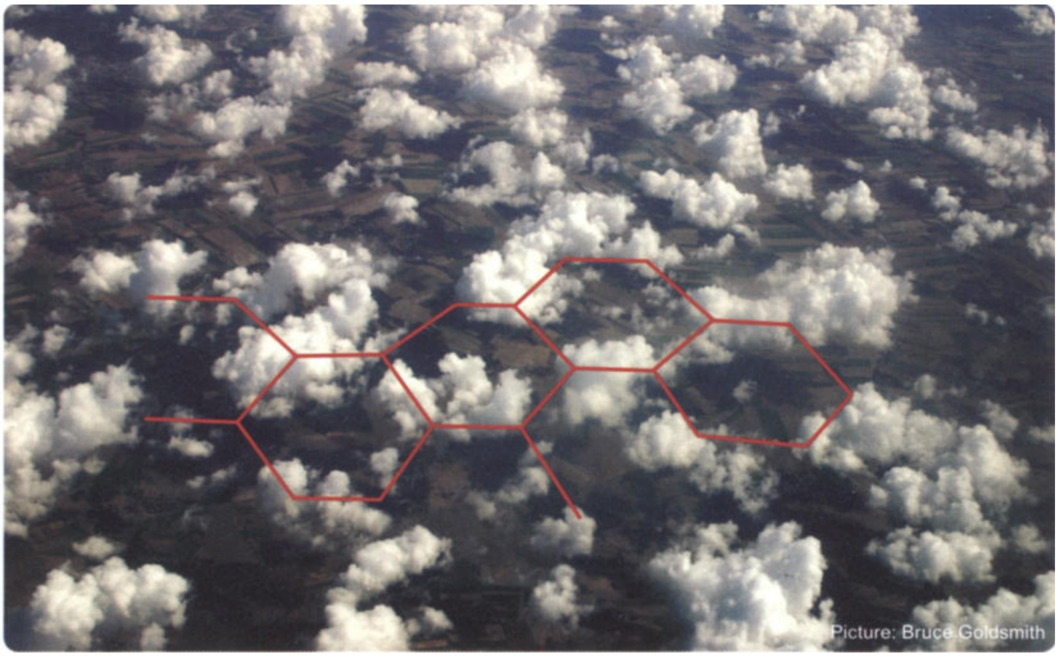
You can see from this example that you may have to fly though weaker lift or even descent before you find the stronger core, though this is often not the case. The lift often just gets stronger and stronger as you search upwind and fly into the stronger core.
You can also see that the stronger thermals cut better through the wind. To start with, a thermal is a mass of air attched to the ground. This mass of air can weigh hundreds of tons. It is attached to the ground like a bubble and is not drifting with the wind. As it breaks away from the ground the thermal then starts to get accelerated by the wind. Smaller thermals will get accelerated faster by the wind than bigger ones. This is both because of their size as well as the fact that the stronger thermal is moving faster vertically.
This explains why stronger thermals are to be found upwind, but it also gives another very important characteristic that the paraglider can use to his advantage. If you want to fly upwind then it is even more important to find the strong cores.

Sob *Drury on Magic 4 in Mai 2007 in Cusco, Peru. Picture: Bruce Goldsmith*

The Hexagon Theory

In the 1960's a group of university meteologists visited the Sahara desert to study cloud formations over a perfectly uniform desert. The sand stretched for hundreds of kilometres in every direction and the idea was that the clouds would form in a way that was not influenced by the thermal sources but simply by the natural circulation of the air.

The result of this study was the amazing 'Hexagon Theory'.

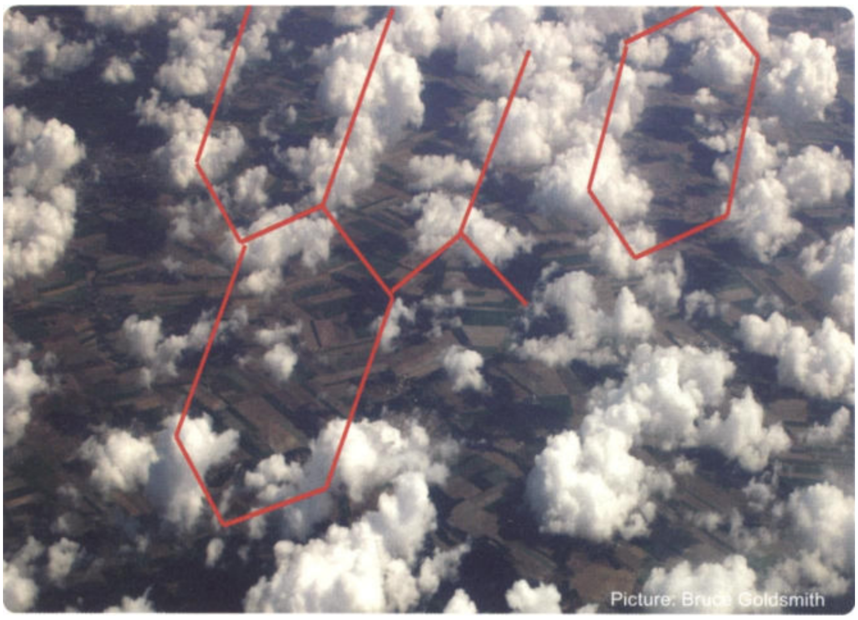


Hexagon clouds 1:
The Hexagon Theory states that over flat and uniform terrain clouds will form in a hexagonal pattern with the sides of the hexagon each being 6km. In no wind conditions the sides of the hexagons will be all of the same length, but as the wind picks up, one side of the hexagon will be aligned with the wind direction and will become longer. The stronger the wind the longer that side will become.

i

Hexagon clouds with wind:

With wind one side of the hexagon gets longer and becomes a cloud street. This has some important conclusions to the XC pilot. Firstly it means that cloud streets do not go on for ever, but they will have a limited length, which in light winds will be 6km, and will be longer as the wind speed increases. It also gives an important clue as to what to do when you come to the end of a cloud street. The end of a cloud street is simply the end of one side of a hexagon, so you should look to fly at 60 degrees to the line of the cloudstreet to the left or right. After 6km on this course you should expect the beginning of the next cloud street.



Picture: Bruce Goldsmith

I took these photos from 10 000m one day when takinig a scheduled airline. They explain better than words how the hexagon theory works in practice. The hexagon theory is not so much a rule but a way of interpreting the clouds in the sky. As soon as there are strong thermal sources on the ground the hexagon pattern breaks down, but if there are only weak thermal sources then the pattern can hold quite well. The pattern can also explain why some thermal sources work and others do not. It is the thermal sources that coincide with the hexagon pattern that are going to work the best.

Manilla, Australia, Bruce Goldsmith on the way to World Champion. Picture: Martin Scheel / azoom.ch

When is a lee side not really a lee side?

When you fly in the flat lands you should never fly over the back of a ridge with a 20km/h wind blowing. You will get rotored immediately. However in the Alps every valley is in the lee side of some mountain and yet people fly when the wind is much stronger than 20km/h. Why? When is it safe to fly in the lee side and when is it unsafe? These are very difficult questions and there is no simple answer. I can offer some advice from my own experience of flying different mountain sites all over the world.

In paragliding school every pilot learns that he should not fly in the lee. Flying in the lee is obviously dangerous because of lee side turbulence and rotors. This rotors can be violent leading to collapses and accidents. On the lee side even a reserve parachute may not work if the air is too turbulent.

However a meteorologist once told me that all thermals start on the lee side! If you fly in major competitions you will see top pilots flying on the lee side on a regular basis! What about protected flying sites, such as Greolieres where you often fly on the lee side? How can it be safe to fly in the lee sometimes and unsafe at other times? How can you tell when it is safe or not? What is Conical hill convergence?

None of these are easy questions to answer, but I hope these words of advise will help to give pilots some of these answers to these questions.

Every thermal starts as a rotor

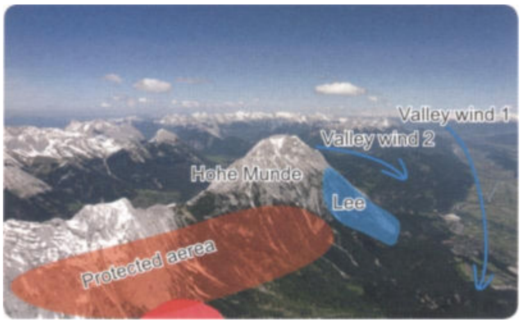
Thermals start when the sun heats the air unevenly. If the wind is contantly blowing in a smooth fashion over the ground, then the ground will therefore heat the air in a similarly smooth and constant fashion which is not ideal for thermal formation. However for thermals to form what we need is differences in air temperature. As soon as you introduce an obstruction into the airflow such as a house, a fence or a hill, you get an area of turbulence behind the obstruction. Sometimes the obstruction will cause the air to remain calm for a time, protected from the wind, which gives the air a chance to warm up. Then the turbulence may separate the bubble of warm air from the ground releasing it into the wind above as a thermal. The same thing can happen on a small or large scale, so you may get thermals being kicked off behind a fence, a house or a hill as shown in the diagram. You can even get wind shadows or a rotor behind thermal which can act as an obstruction itself.
So the lesson to be learnt is that a rotor is just as much a friend to the thermal pilot as a hazard.

Lee rotor made visible.

Size matters

It is difficult to say when it is safe to fly in the lee of an obstruction. The simple rule is if in doubt, don't! That is of course to cover your butt / limited liability answer that you can get from any paragliding school or text book. However this does not really solve your problem, it's just the safe answer. My own personal experience says that the single most important factor is the size of the hill. The bigger the hill or mountain the more protection it will offer.

In my experience you can almost never fly in the lee in the UK where the hills rarely reach more than 500m. On the other hand in Tenerife nearly all the flying is done on the lee side of Mount Tiede which towers to 3000m (eg the site of Taucho). You can even fly in the lee in Tenerife even when the prevailing wind is as much as 50km/h, however you can expect strong lee side thermals and strong winds if you stray outside the protected area.



Behind the Hohe Munde the Bavarian wind (valley wind 2) blows into the Inn valley (valley wind 1). The blue area is a known turbulent lee region. The red zone is protected from the Bavarian wind, as the ridge above is high enough to block it.

Wind strength

The lighter the wind, the less dangerous it is likely to be flying in the lee. Wind strength is extremely important to the safety of flying in the lee. Flying in the lee when the wind is only 5km/h should pose very little problem but if the wind is greater than 20km/h leeside flying is likely to be extremely hazardous and dangerous.

Solar heating

Thermal heating of the lee side helps a lot. This means that even if the air is turbulent on the lee side it is being heated by the sun and so the air will generally have an upward

Flying on the protected lee side of the Teide, Canary Islands.

motion. This is also the case in Tenerife where the site of Taucho faces SW into the afternoon sun. Other sites such as Greolieres and Monaco use a similar thermal powered protection.

Sea Breeze

If the heating is combined with a sea breeze or a valley wind system the protection from the prevailing wind is even greater. The presence of the sea tends to lead to a larger scale air movement than simple rotor, helping to make the air less turbulent.

Conical Hill Convergence

When air flows around an isolated hill or mountain, the air devides on the upwind side of the hill and then flows together again on the downwind side of the hill. The area in front of the hill is therefore an area of divergence and the area behind the hill is an area of convergence. Therefore where the air is converging it can produce lift especially if there is some thermial activity as well that helps to produce some upward movement in the air when the air converges. If the air is not going up due to thermal activity it may be falling just as strongly as it could be lifting.

Diagram 1 shows how classical Conical Hill convergence works. The diagrams show how you can get an area of lift downwind from a hill rather than an area of rotor which is normally what you would expect, as is shown in diagram 2. There are many different factors that can mean that you will get lift behind a hill rather than a rotor.

Factors that will help you get lifet are:

1) The size of the hill, the bigger the better.

2) Heating from the sun on the downwind side of the hill.

3) The stability of the air. If the air is unstable it may flow over the top of the hill instead of around the side, meaning that the air will come crashing down in an area of descent behind the hill. So a layer of stable air to stop the air displacing vertically in front of the hill can help.

4) The exact shape of the hill.

Behind the conical hill could be lift or a rotor!

Summary:

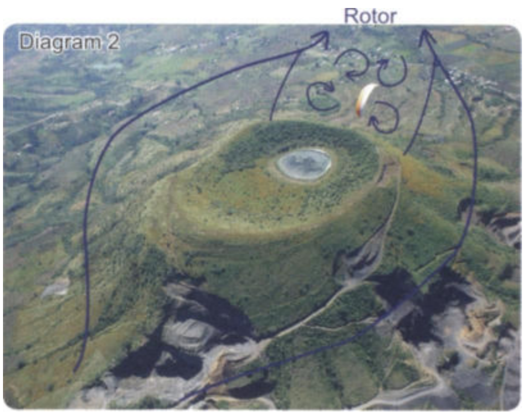
The main factors to consider in flying in a lee are:

1) Wind strength
2) Size of the obstruction
3) Solar heating on the lee side
4) Air stability
5) Shape of the hill
6) See breeze or valley wind considerations

There can be no hard and fast rules as to whether if it is safe for flying in the lee, everyone must make it's own decision based on it's own skill level and their ability to be able to cope with any turbulence likely to be encountered.

One last consideration is that it is often the edge of the lee side that is the most dangerous area. If you are completely in the lee, you may be fully protected, but if you are at the edge of the protected area, then you may well encounter the maximum amount of turbulence. If you intend to fly in a protected area you need to go all the way into the lee, it is often more dangerous to test out the waters by feeling around the edge of the protected area than flying all the way into it.

One final word...Lee side flying is only for the very experienced pilot, or for pilots under the instruction of a very experienced pilot flying in controlled conditions. Please take all possible precautions when considering flying in the lee.



Valle de Bravo, Mexico. Picture: Mads Syndergaard.

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The importance of observation

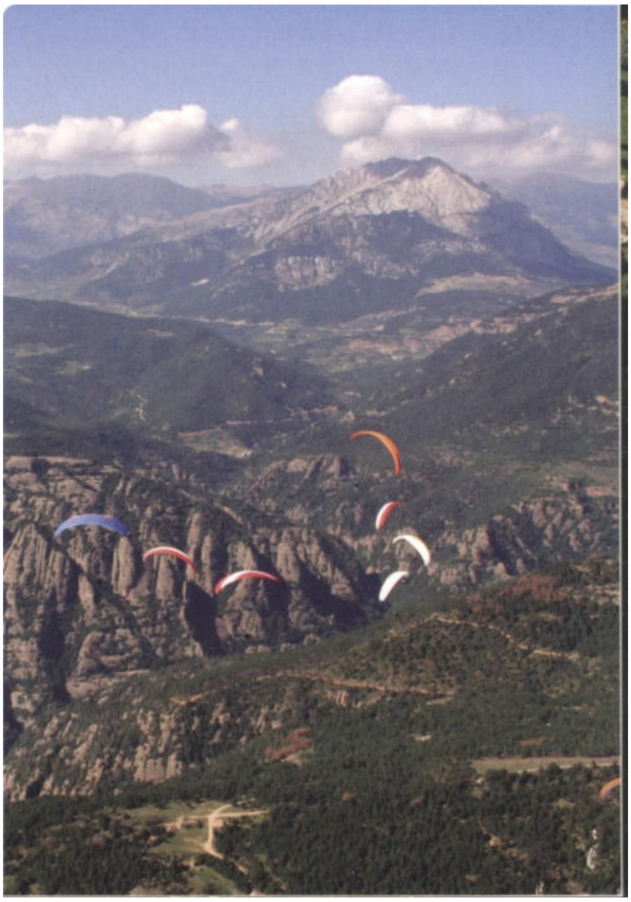
The importance of Observation.
To a large extent flying is a guessing game. In order to fly safely or to simply fly down from launch to landing pilots need to know all kinds of information about the air and the way it is moving.
What is the wind direction?
Where is that thermal?
What size and shape is it?
Where is the core?
What is the turbulence like behind that hill?
But what makes flying so fascinating is that the air is invisible so you cannot see it directly so pilots can only deduce what the air is doing by its effect on visible objects. These things include most obviously the clouds, the ground and of course other flying objects, both other pilots and birds. So it is not surprising that observation is the key to understanding what the air is doing, and hence the key to becoming a good pilot.

This sounds simple and logical enough but in reality it is not so easy. Pilots who do not fly so often need most of their concentration to control the glider. They simply don't have the spare capacity to be concentrating too hard on looking around and observing the world. However as the act of flying becomes more of automatic pilots can free up their mind to pay more attention to their surroundings, and to a large extent this is what makes more experienced pilots so much better at flying. It is precisely because the act of flying their wing has become automatic that they have more time to be able to look around and observe more details in the surroundings. There are literally hundreds of useful things to observe, so the more you observe the better you understanding of the way the air is moving, and therefore the better decisions you can make. This applies to nearly every situation a pilot can find himself in from launch, to landing, thermalling, ridge soaring gliding, and of course competition flying.

Thermalling

When thermalling you should pay great attention to any other pilots in your thermal or within easy gliding distance. If any pilot starts climbing faster than you, you should leave the lift you are in to join the stronger lift. There is no excuse for being out climbed by someone close to you. You should always join him before he goes past you. The same goes for birds or even a floating plastic bag getting sucked up in a thermal. Thermalling should always be a quest to climb the fastest. When thermalling watching the relative climb rates of all the pilots around you. If you think someone is climbing faster than you, try to estimate his height relative to you, each time you go round a 360. For instance one pilot may be 50m lower than you, and theh next time he comes into sight this height difference could have dropped to 30m, so gently readjust your center of turn to join into his circuit in the thermal.

Castejon de Sos, Spain. Picture: Bruce Goldsmith



On glide

The same goes when on glide. I always look closely at all the pilots close to me to see if they are entering lift. If they start to climb I normally start gliding towards them before they have even started to turn. In competition seconds count and the earlier you can react the better. I find that it is quite easy to see when someone you are gliding with starts to enter lift, you can see their glider start pitching around as they begin to enter the turbulence around the thermal, you can also see their height relative to your own also relative to the pilots gliding around them. If you are behind a group of pilots you will actually be able to judge better where the best lift is, easier than the pilots themselves because you can see how all of them move relative to each other. This type of observation is exceedingly important in competition. Placing yourself in a group so that you can see more easily where the best lift is, is another tactic worth considering.

Manilla, Australia during the Worlds, March 2007. Picture: Bruce Goldsmith

Ridge soaring

Such strategies are not only limited to competition flying. It is equally important for pilots ridge soaring on a hill. If you are trying to catch thermals, you should not only be thinking about what you are doing but you should be carefully looking at every pilot on the hill. If someone gets up, you should know where he got that lift from. You should be looking at every move each pilot makes and see if his strategy worked or not. This can save you making the same mistake, or if the option was a good one, it will tell you the way out.

Competition

In competition flying this is even more important. You should know exactly what everyone in your field of view is up to, why they are doing it, and weather it works. Sometimes I see a pilot turn 90degrees to the course and fly off for no apparent reason in that direction. I immediately look for the reason of this decision. Has he seen a bird that I have not seen or another pilot climbing in the distance, so then I start to try to see the same thing, is there a bird, is there another glider climbing over there. Sometimes I might decide to follow the pilot even before I have spotted what he is after, this just depends on the reason he was flying in the other direction in the first place.

When you see someone making a decision you should keep watching him to see if that decision worked.
Do not let someone out of your sight for more than a few seconds, especially if you are on glide with him and you are hunting for thermals. I often have to really stretch my neck and try to look above and behind me to be able to see everyone I am gliding with.

When flying on a hill with a load of gliders and you are trying to get high to go XC, you should be trying different ideas to get up. Also you watch every one else's ideas of how they are trying to get up. If someone succeeds you should exactly know how he did it. Where he found that lift or how he flew to get up. You should also link your observations with the weather, i.e: the last time the sun came out over there the guys in that little bowl on the end of the ridge got high.

Ridge soaring example

Today I had an interesting example of this same kind of thing. I was watching a group of pilots who were struggling about 300m below me a little further down the ridge. We were also not doing very well, but had been only just maintaining our height for about 15 minutes. Because these pilots were not doing very well the pilots with me were ignoring them. But I always try to keep an eye on everyone, so I was looking just glancing over at them every 30 seconds or so. They had been climbing a 100m or so from time to time, but all the lift had been weak. They were still low but then a couple of them hooked into a thermal that looked a bit better than any of the previous little bumps of lift they had been climbing in. I made my move over to them immediately arriving well above them, and before they had climbed up to my altitude, and I was very happy to find some good lift. The rest of my group then came over to join us just 30 seconds later as the lower group had just climbed up to our level, but none of them could catch me as I quickly climbed away from both groups. Making my decision earlier basing it on their relative climb rate rather than waiting for the group to get high enabled me to make the decision earlier and get in on top of the thermal, rather than in the back end of it.

Landing

Judging the wind speed and direction on landing is important for all pilots. There are the obvious things to look at like the wind sock in the landing field and we should all know to watch the way the trees and bushes are moving. I have a few other things that I like to keep an eye on before landing. I look at any pilots who landed before me and watch carefully to see if they made a good landing. If they pile in tailwind you can normally see it from way up. Another one of my favourite hints is to look at the direction in which birds land or even the way they stand. Yes, the way they stand. Birds always like to stand facing into the wind. This is very obvious when brids are standing on wires. Birds get the feathers ruffled the wrong way if they stand facing down wind, and they just don't like that, so a bird standing in as good as a windsock.

Mai 2007 in Cusco, Peru, Picture: Bruce Goldsmith

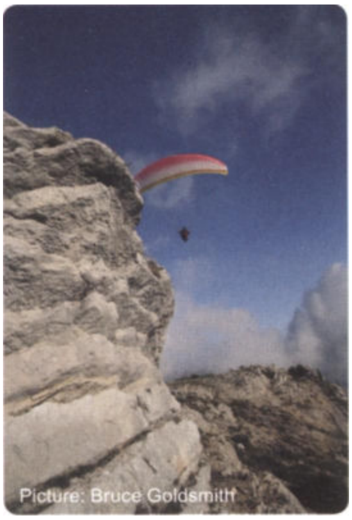
Hints:

- look around all the time.
- don't let people out of your sight, if you lose site of someone it is very likely that they are doing something that you had not considered.
- peripheral vision is important, do not wear a helmet of glasses that restrict it.
- get used to your glider and equipment so that you can spend more time observing your surroundings.
- do not spend much time looking at your instruments, looking around is much more important.

ten you can stay up where the ride is vertical but you go down where the ridge is just very steep. I think part of this is that you can get your canopy close to the area of best lift without the pilot being too close to the ridge. Personally I recon that little cliffs are so important because they produce a kind of mini venturi as well in front of the top of the cliff accelerating the lift in this area much more tan you would expect from the small size of the cliff.

4) The level of turbulence

Safety is always the prime consideration when flying and how close you dare go to the ridge must be primarily a safety decision. If the air is turbulent then you cannot fly as close to the ridge as if the air is smooth. This decision is also different depending on your pilot skill and the kind of glider you have. You may feel happier to fly closer to the ground on a glider you feel more confident with.



Exfra ***strong lift at top of cliff.***

When I fly in England in smooth ridge lift I feel quite safe and confident to fly close to the ridge. As the thermals start popping in, I tend to start to fly further from the ridge and start hunting for thermals further out.

The pictures demonstrate nicely 2 of these points. On the left side of the picture you can see a lower ridge which is minor compared to the higher ridge to the right, but on several days during the competition the thermals were better on the lower ridge than the upper one, and the best way to climb on the upper ridge was to fly 500m in font of the main ridge.

The second point is the mini cliff half way up the main ridge on the right hand side of the photo. This is a typical example of a small vertical part of the slope that will produce much better lift than the slope below or above it. This small cliff may also act as a thermal trigger with the thermals then being found directly above this cliff and not close to the slope.

The conditions in Ager are strong turbulent desert like conditions and in any case during the day it is just not safe to fly close to the ridge due to the high level of turbulence and the rocky nature of the terrain.

Lower ridge may produce better lift than thehigher ridge. \

Vertical cliff produces much better lift than the slopes below or above.

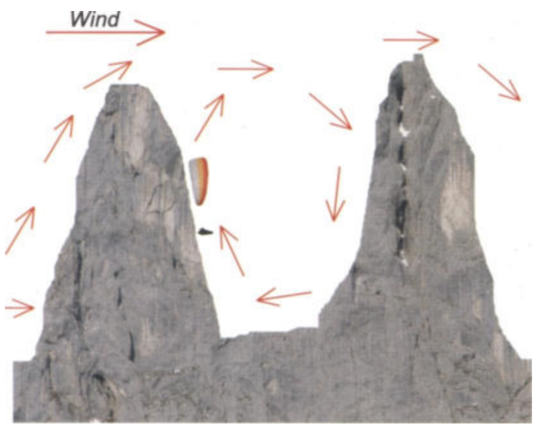
A final word from Bruce

The objective of my chapter is to try to give an idea to the pilot how flying does not follow strict rules. It is useful to know the rules but often there are two or more different concepts that can apply to any situation, and so understanding which rules to apply when, can only be decided upon by the clues in the sky. Being open to interpret these clues quickly with the ability to change the mental model is what makes a great pilot.
'If it's not working what your doing then do something else' and the opposite also applies 'If you are winning by what you are doing, then don't change'.
This saying was going though my head constantly during the last task of the World Championships and decided my strategy on that all important last day of the Championship.

One of my favorite stories is an example of how this saying was applied to soaring what appeared to be simple slope soaring on the side of a valley. Our pilot was one day flying down a windward facing ridge, and even though he was on the windward side of the valley he was in bad descent. He could not understand why he was having such a bad time and was going down fast.

If you have a very good level of flying and you feel that you can get yourself out of most problems then I often find that you can try the 'suck it and see' method of flying. You can test out your mental models by trying different things by going to fly somewhere to see what happens. If you get bad turbulence or descent then turn around and go and try something else. It is however suprising how many of our mental models of flighing are wrong and do not follow conventional lines of thought. This is the beauty of flighing. I always say that my best flights are when I manage to do a flight that I thought was physically impossible.
Unfortunately because of modern task setting in competition this event happens increasingly rarely.

Our pilots thought to himself 'If it's not working doing what your doing then do something else' so he crossed the valley and flew into the lee side of the mountain. To his amazement he found nice smooth lift and the day was saved. The explanation is that the airflow in his valley was basically a huge vortex that caused the flow to reverse on the valley floor. He needed to change his mental model to understand what was going on. Conventional thinking was wrong. Clues that may have helped him to change his mental model were the descent he was in and signs of the wind direction at the bottom of the valley.



I hope my chapter helps pilots to 'expect the unexpected' in flight as well as in your earthbound lives.

Bruce Goldsmith


Picture: Bruce Goldsmith, Gourdon, France.

Chill Out

Renegades at Stubaicup 2006

Felix Wölk at fullstall

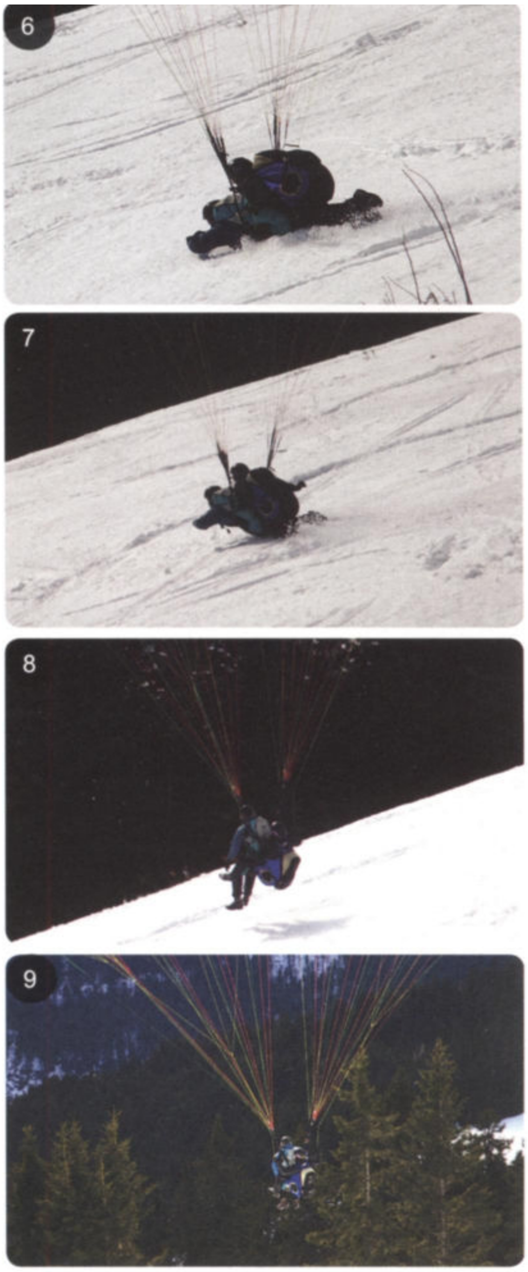
Thermal flying isn't as hard as it is made out to be. At times it even seems that getting airborne is the trickiest bit... The person in the following pictures wasn't hurt, but could probably have benefited from a bit more ground-handling practise, see from Picture 10.21, page 238.

Keeping the balance on such short little skiers is tricky. Once the pilot had lost his balance he should have at least let go of the risers (picture number 4). This would have kept the wing from overshooting (picture number 5).

Practising your ground-handling skills should be done in places where there are no obstacles around. Failing to adhere to this basic rule may quickly put you in dire straits. This pilot had gusts of 35km/h coming through; notice the elegant negotiating of the obstacle (antenna) in the first photo. As long as one can still smile all is (almost) ok.

Pictures: Christian Feil and Burkhard Martens

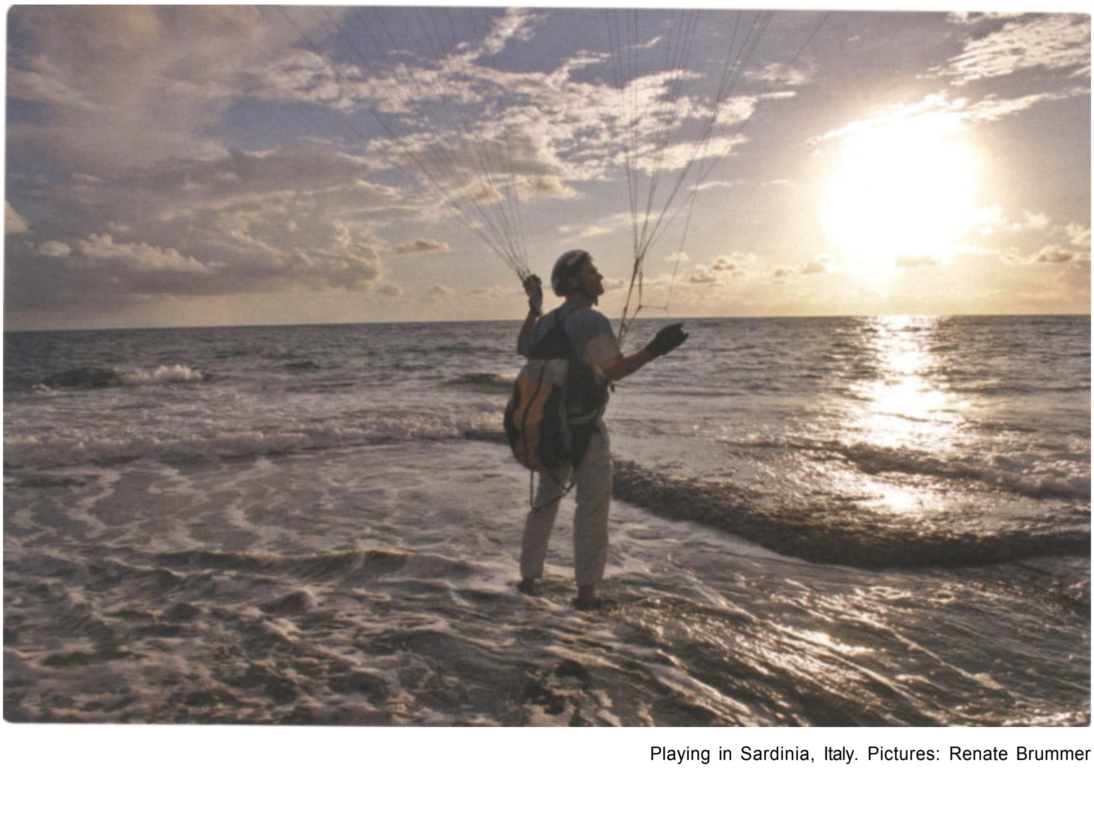
ft



Launching on snow in light winds is just harder. Notice however the unperturbed pilot, simply letting the glider build up speed in spite of the skidding passenger. The passenger looses foothold in picture 4, but the pilot keeps going and eventually the couple lifts off. It would have cost more sweat and hassle to have stopped the launch attempt.

Playing in Sillian, Pustertal, Austria. Pictures: Renate Brummer





Playing in Sardinia, Italy. Pictures: Renate Brummer

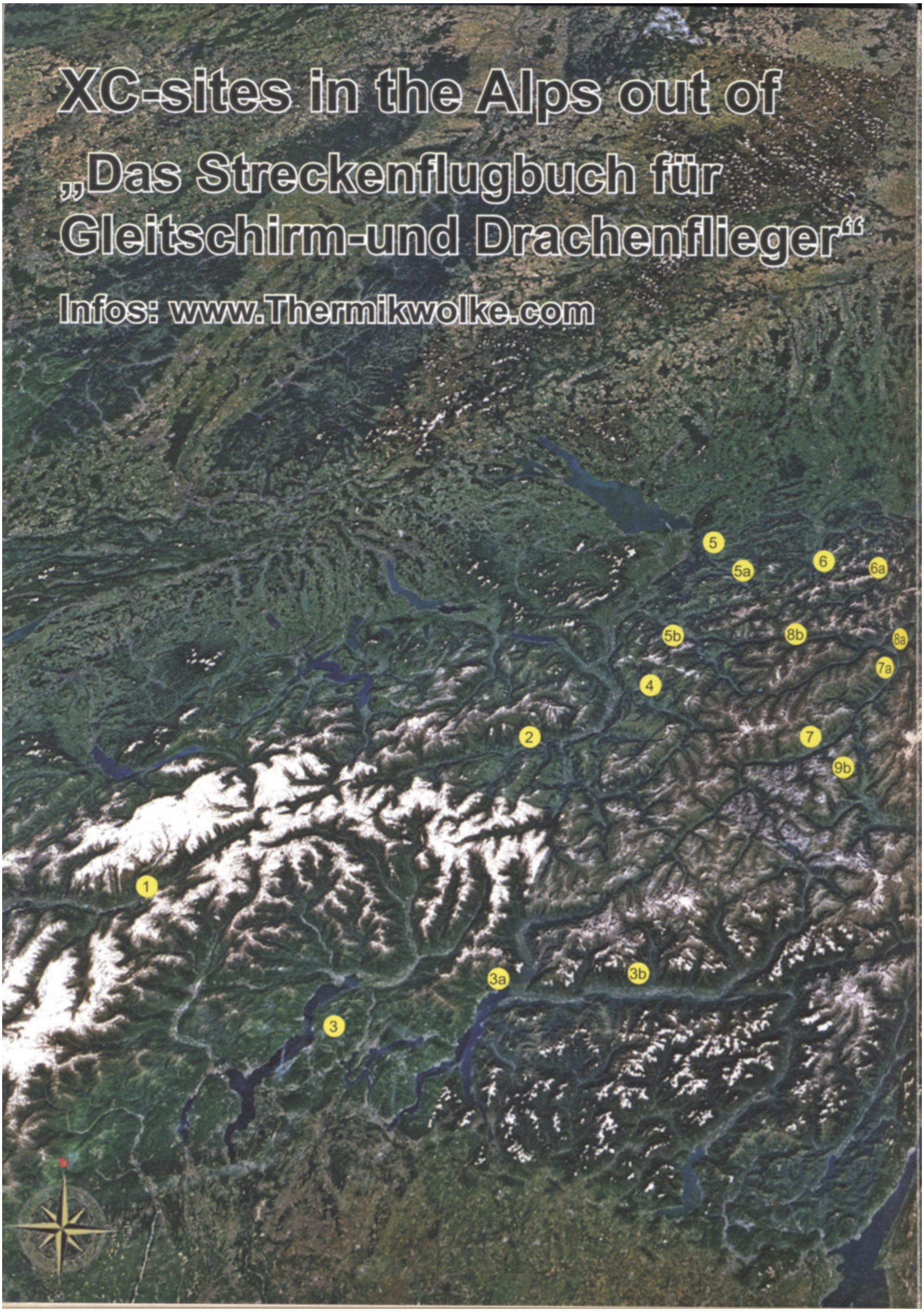
The Author in front of his local site, the Brauneck, Lenggries, Germany.

But we won't end a book on less than a perfect note so here's a pilot who has it sorted out . First a perfect reverse launch, turning around and looking up to check at the same time, then the final sprint in fine style. Perfect.

Many happy landings!

Burki, Bruce and Mads

The famous „Drei Zinnen“ (Three Peaks) in the Italian Dolomites.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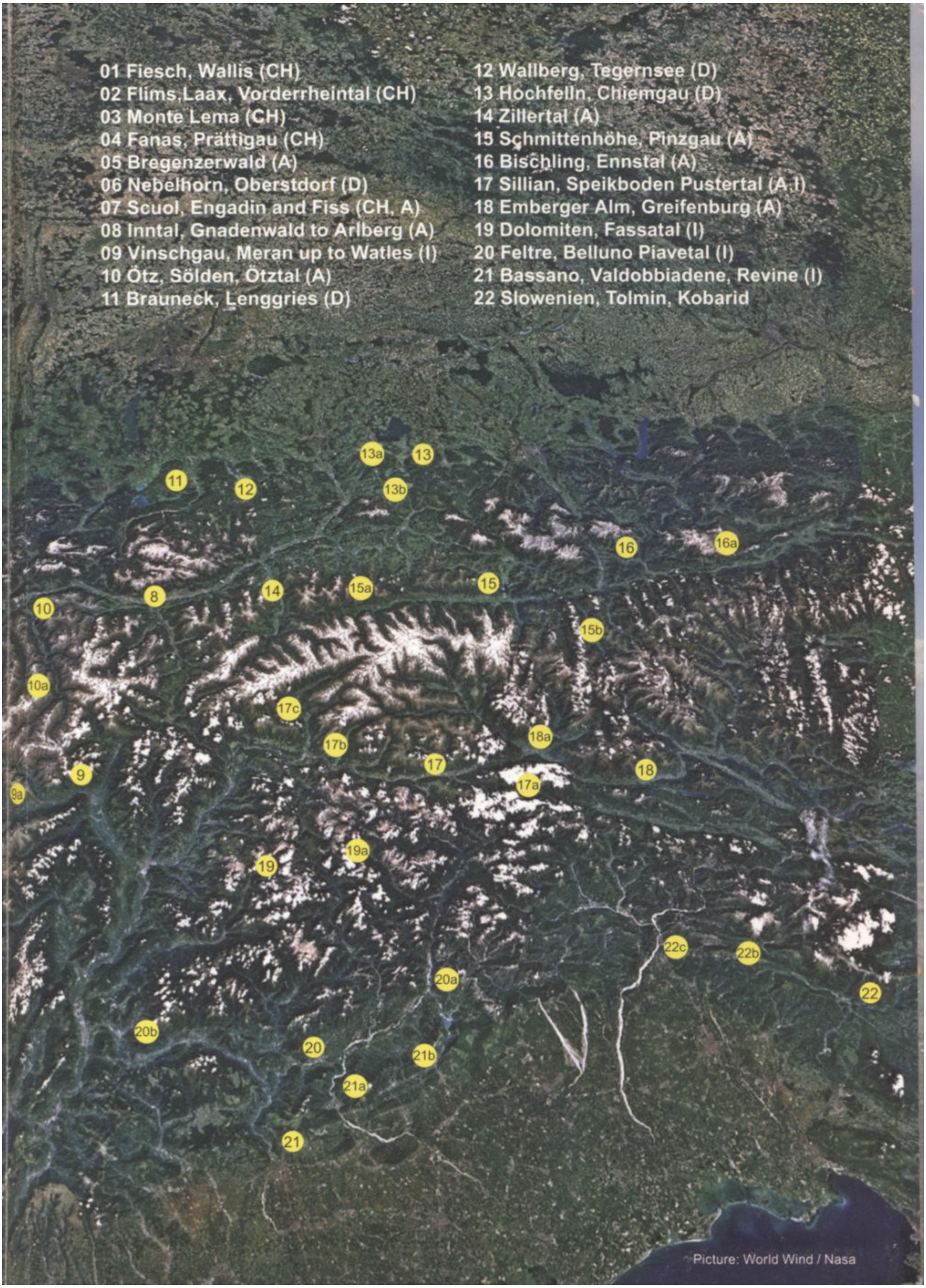
01 Fiesch, Wallis (CH)
02 Flims,Laax, Vorderrheintal (CH)
03 Monte Lema (CH)
04 Fanas, Prättigau (CH)
05 Bregenzerwald (A)
06 Nebelhorn, Oberstdorf (D)
07 Scuol, Engadin and Fiss (CH, A)
08 Inntal, Gnadenwald to Arlberg (A)
09 Vinschgau, Meran up to Watles (I)
10 Ötz, Sölden, Ötztal (A)
11 Brauneck, Lenggries (D)
12 Wallberg, Tegernsee (D)
13 Hochfelln, Chiemgau (D)
14 Zillertal (A)
15 Schmittenhöhe, Pinzgau (A)
16 Bischling, Ennstal (A)
17 Sillian, Speikboden Pustertal (A,I)
18 Emberger Alm, Greifenburg (A)
19 Dolomiten, Fassatal (I)
20 Feltre, Belluno Piavetal (I)
21 Bassano, Valdobbiadene, Revine (I)
22 Slowenien, Tolmin, Kobarid
13a
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13b
16
16a
8
14
15a
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17c
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22c
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20b
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21b
21a
21
Picture: World Wind / Nasa

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Burkard Martens was born in 1962 in Lower Saxony, Germany. After completing his studies in 1989 he moved to the south of Germany and took up paragliding. For several years he managed to work as an environmental engineer AND be a very passionate pilot, but from ,94 his life has been inseparable from flying. From ,94 to ,97 he worked for paraglider manufacturers, and from ,97 to 2003 he owned and ran a paragliding school.

Since ,03 he has worked freelance as a instructor pilot, journalist and author. He took up hang gliding in 1998.

For 7 years Burkhard did the comp thing, flew in the German League, the Nationals and in the World Cup. He bagged several national and international records during this time, and some of them still stand.

Burkhards passion is the cross country flight, and after flying in the German XC League for ten years he finally managed to win the Sports Class in 2004.

This success was followed by the publication of the book „Das Thermikbuch für Gleitschirm- und Drachenflieger" in 2005. This book has already been translated to several languages.

In April 2007 the next book in the series, „Das Streckenflugbuch für Gleitschirm- und Drachenflieger" (The XC-Flying guide for paraglider and hang gliders) was published. Although it has only been on the market for a very short time the sales figures are already impressive."

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