

Thermals.

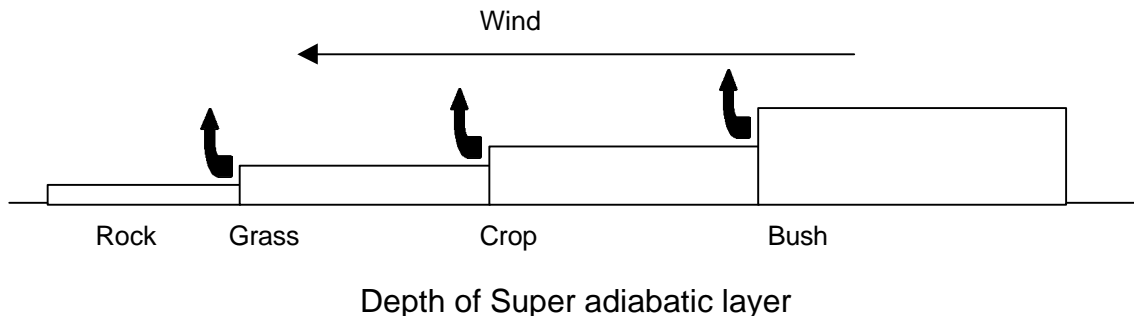
Sources

The first thing we must be aware of is that the hot air that makes up a thermal is created by the air coming in contact with hot ground and heating up by conduction. The sun will not heat the air directly. The only way that air will be heated whilst rising is when there is a high dust content, for example created by a vehicle in a paddock or sheep kicking up dust. Once the air leaves the ground it will rise, loose pressure and so cool at 3° per 1000 ft.

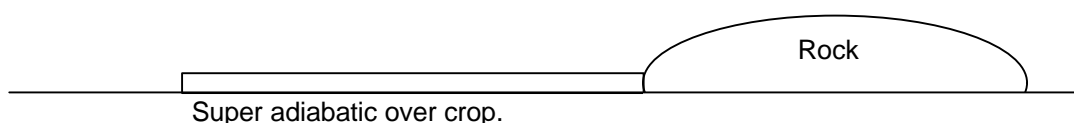
As the air above the ground is warmed up you may think that it would soon become buoyant and rise up, the interesting thing is that is not the case and if it were we would never be able to soar. It is similar to the trick done where you fill a glass full of water, put some paper over the top and turn it upside down. The water will stay in the glass until a corner is lifted and then the lot goes all over the floor. So going back to the air that has been heated and just above the ground, this is called the **super adiabatic layer**. It will remain in contact with the ground until certain conditions encourage it to escape.

It is also worth noting that dark areas will absorb more heat than light areas of ground. This will make them more efficient heaters of the air giving thermals more often or stronger ones.

I have a theory that appears to stand up to observations, that the depth of the super adiabatic layer depends upon its environment. Over a rock it would be very thin, over grass a little thicker, in crop thicker still and in bush quite a bit thicker still.



Now if the wind is blowing the air from say the bush to the crop the super adiabatic layer leaked from the bush will be thicker than that that can be maintained in the crops environment. It will be unable to sustain its self and so will start to rise thus starting the creation of a thermal. This would also indicate why rocks are good sources, not necessarily because of their heat. Roads going through bush always appear to be a good source. Have you noticed in many cases that a willy willy will run down the side of an area of bush, ask Beverly pilots. This also explains why large rocks, Yorkakine, and Caroline are not good sources. Lets look why.



In this case we see that the super adiabatic layer adjacent to the rock is actually sealed in and will only escape by drifting around the side of the rock or in the case of a strong breeze that will push it up over the top.

So when we are flying and looking for thermal sources we will be looking for dark paddocks or bush that is upwind of say a rock that is flush to the ground, a farm house or perhaps a road.

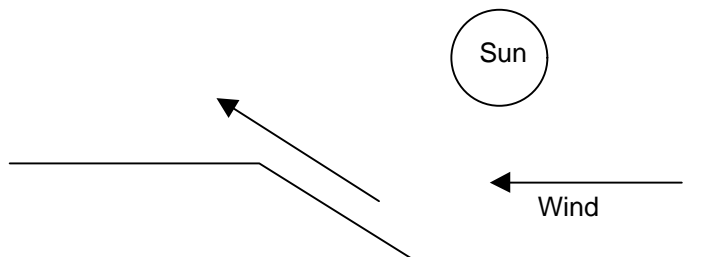
My first thermal

As a child I lived in a large area of woodland, Sherwood Forrest. To the back of our house was an area of cleared land about one hundred meters square. When I was about 8-10 I had a small man with a parachute that I would throw into the air and usually he would drift down to the ground with the parachute generally open. On this particular day rather than the man drifting down. The super adiabatic layer that had stored up in the woodland must have drifted into the grassy area. (I did not understand that at the time,) But I did understand that my little man was not coming down instead lifted up and drifted off over the trees and horizon, never to be seen again. I suppose from that moment I was hooked.

Humid Air

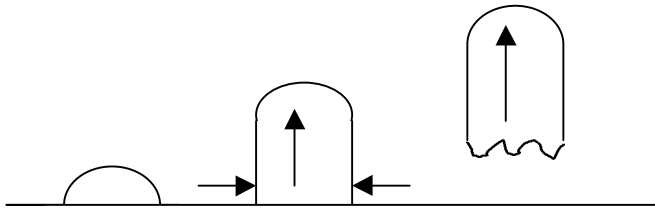
Another interesting point to remember is that water vapor is actually lighter than air. Hydrogen having an atomic weight of about 1, Oxygen of 16, therefore H^2O being 18 whilst nitrogen that is the largest component in air has a weight of 14, N^2 therefore having a weight of 28. It is however also important to remember that water requires a lot of heat to raise its temperature. So areas like salt lakes that reflect the heat and absorb much heat will not be a good source in the early part of the day. With the high water content they may be good in the evening, as they will have stored up a lot of heat energy over the day. In addition being more humid will be inherently more buoyant.

Although we fly in predominantly flat lands it is worth noting how hills will help us. If a hill faces into the sun it will absorb more heat than the surrounding flat land. If the wind is blowing up the slope it will assist the now hot air break away. I can assure you that if the wind is blowing the opposite way to the diagram it could still work, I have experienced this fact,



Breaking away

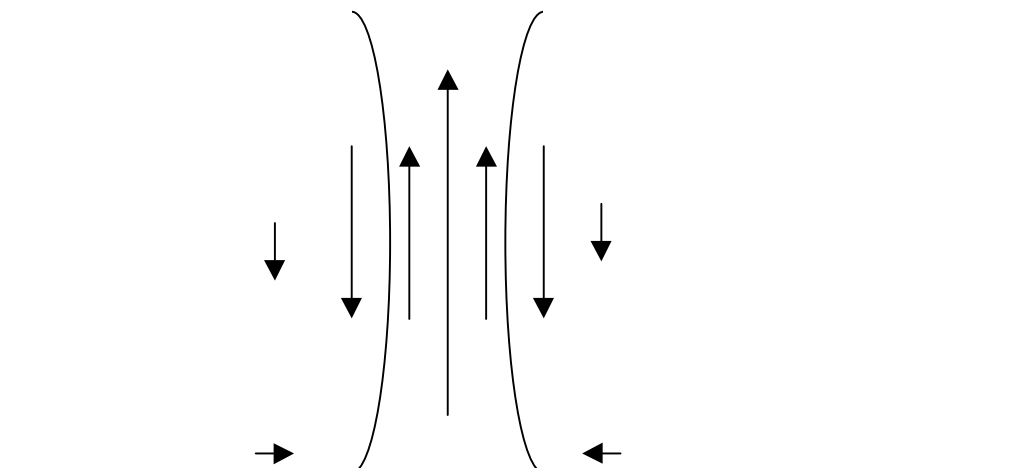
We have looked at how the air is heated up now we should look at what happens as it breaks away from the ground. Let us initially assume no wind.



The thermal rises and in doing so drags in hot air from all sides. It will continue to rise and increase its cylinder length whilst being supplied with more hot air. This will depend upon its local environment. If there is a large area of available hot air in the vicinity the thermal column will be tall, if however there is little available air due to a thin super adiabatic layer, adjacent cloud shadows, other thermals in the vicinity, the height will be less. Once the hot air supply has run out the bubble will be cut off leaving the bubble to rise. One thing to note is that the top of the thermal has a smooth contour, whilst at the bottom of the column it is turbulent. Go to Scitech and have a look at their bubbles rising through a viscose liquid, you will see the effect. It is worth visiting just for this. When you are flying if you find a smooth thermal it may be the top of a new one and worth hanging on to. If alternatively it is rough then you may have arrived too late. We will see later however that it is possible to climb through the bubble, i.e. climb faster than the bubble its self.

Thermal Structure

We should be aware of the basic structure of a thermal, once fully developed. Note that in the case drawn it is a classic thermal with no wind shear and assuming a nice column length. At the bottom the thermal is dragging in surrounding air, remember this when you are low you will get dragged into the core. It rises but due to the friction between the rising column and the surrounding air the core will rise faster than its edge. As the rising air has to be replaced a down draft will develop adjacent to the rising air. The friction between the sinking and rising air will develop turbulence that is noticeable as you enter the thermal from the side. As the thermal reaches the top it is spread out by the inversion and will try to push you out. If you are continually trying to recentre at the top this could be why, may be its time to go. You should be able to see from the diagram why the core is so much stronger and therefore why it is necessary to turn quite tight.

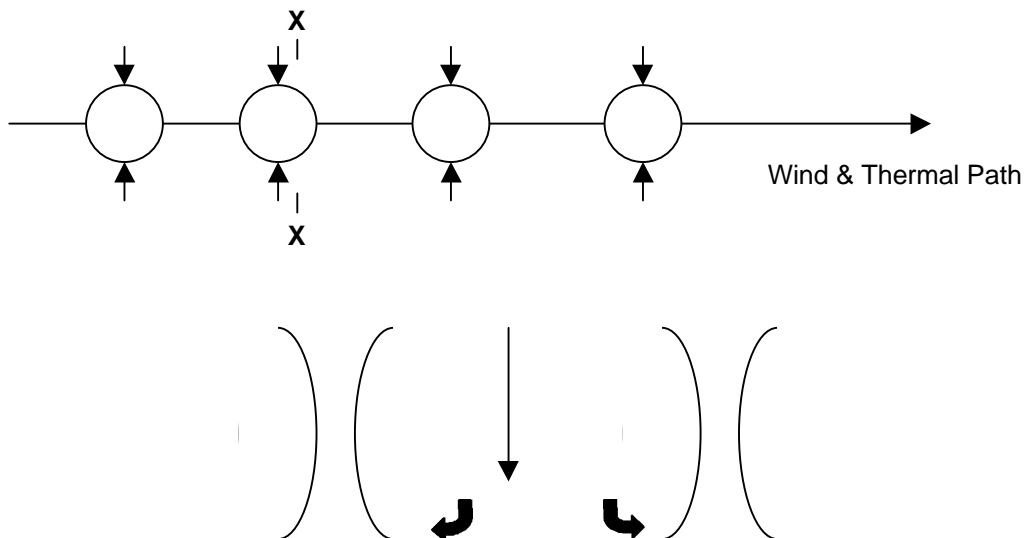


When considering a bubble rising you will be aware that the core of the bubble will be going up at a higher rate than the edge of the bubble. Therefore the rate of ascent of the whole bubble will in fact be lower than the core itself. Bearing this in mind it may in fact be possible to out climb the bubble. This could indicate why some climbs start well, a little rough as you climb through the bubble, the climb rate then drops off but becomes smooth as you have reached the top of the bubble but continue to climb on the top of it.

Streets and Wind.

Now let us find out what happens when the thermal drifts down wind. The problem with the static thermal was that it soon ran out of fuel and in turn was cut short. If there is a little breeze the thermal will drift down wind. As it rises and sucks new hot air from below it is continuously fed with a new supply of hot air as it drifts down wind. The thermal column will remain vertical. This will continue until the thermal passes ground that has either had its heat taken away by a previous thermal or is traveling over unsuitable ground.

When there is a wind the thermals as we have seen will drift down wind taking new hot air from below the thermal column and either side. It drifts down wind sucking up more air. Now having done so the air to the side of the track will be cold and not be able to produce further thermals. In addition the down draft from the initial thermal when hitting the ground will spread out in all directions and will stimulate the growth of thermals cross wind. It may be a few kilometers across wind that further thermals will develop causing similar streets.



Cross section X-X

After the initial bubble has left its source there will be a period of reheating and the process will begin again. Once the day had developed and this action has taken place over the country for a little while a pattern develops. What happens now is that thermals are stimulated as much by the sucking effect of the thermal above, than by the fact that the super adiabatic layer either side of the street is being pushed into the street.

Once the street pattern develops the areas of lift will become quite long but in turn become very narrow. In many occasions 15-30 meters, certainly not wide enough to turn in.

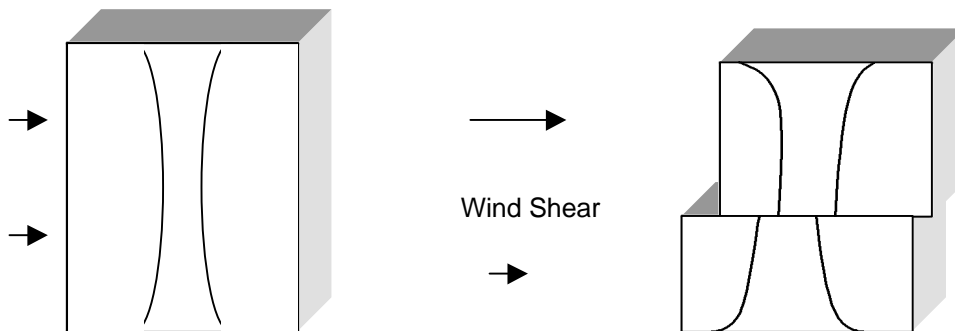
It is noted that in strong winds the thermals are more broken than on relatively calm days. The reason behind this is that at the lower levels, where the super adiabatic layer is built up. Air is turbulated by surrounding ground features. The problem with this is that there is not sufficient time to build a nice deep super adiabatic layer, it will be broken away early by the turbulence on the ground to early to have a good supply of hot air to keep it supplied. Its energy will soon run out so will in effect just become a small bubble with little structure. Don" get low when its windy!

Gliding Myths.

Thermals bend with the wind, or is it against?

As we have seen from all the descriptions above the thermal will form a vertical column. Just look at a willy willy and you will see its vertical tendency. Thermals do not bend into wind or down wind. There are some cases where kinks may occur in a thermal.

When considering what happens to a thermal column you need to think of it in a box of air that is traveling down wind with it. The bubble will be rising vertically in the box and so forming a vertical column but the whole box is drifting down wind. The problem arises when the box is moving at a different speed down wind at the top as the bottom.



We can see on the figure on the right that the wind shear will move the upper column down wind.

Shift into wind or down wind.

When you have lost the core of the thermal you will have to recentre on the assumption that you have not lost it due to inaccurate flying. The general comment is move into wind. This is good when you have reached the top of the thermal, or fallen out of the bottom. Move into wind to find the original thermal source. If however there is a wind shear, usually wind gains strength with height it is necessary to move down wind, i.e. with the shear. You can see from the diagram above that if you are at the top of the bottom half of the thermal, to move back into the core you need to move with the shear to get into the bottom of the top half of the thermal. On this basis it makes sense to examine the weather report in the morning.

Cumulus

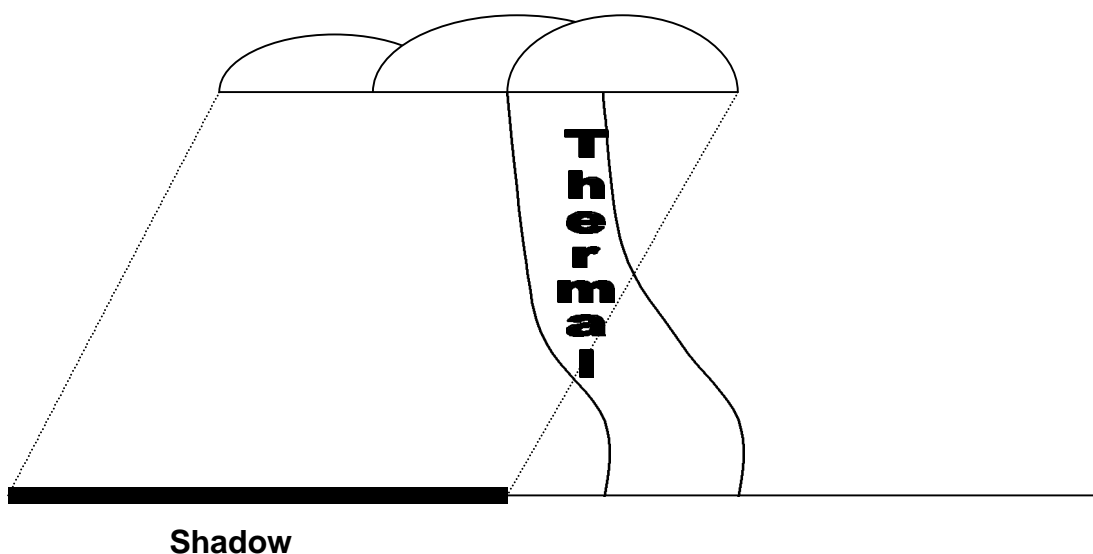
If we are lucky enough for cumulus to be formed cross country speeds will be increased dramatically. You can see the thermals so are able to fly like stepping-stones across the sky from one to the other. With careful observation you can see the core as you approach. In addition the thermal strength is generally stronger under a cu to that in the blue for the same thermal height, normally 1-knot strength per 1000-ft height band, I have also heard 1 Knot per 1000 ft minus 1. This makes a little more sense.

Why does a cumulus increase the lift?

- When you boil a kettle you have to put in energy to convert the water to water vapor. Knowing Newton's law "For every reaction there is an equal and opposite reaction." If you convert water vapor to liquid water, you get energy back.
- Air can only hold so much water vapor, the cooler it is the less it can hold.

So as the thermal rises cooling at 3° per 1000ft. It will eventually reach a point where it has cooled to a point where it can hold no more water vapor. The water condenses, and as we have seen above we will get some heat input into the thermal. There will now be an added boost to the thermal, once the cloud has developed sufficiently it will actually begin to suck air in. If you can keep in contact with the cu's there is a great advantage.

When flying on a cumulus day it is worth noting how it will effect the thermal sources. If the sun is high in the sky, in effect producing shadows directly under the cu. This will cut off the thermal source, so the thermal will not last for long. Well this is what we may think at first. On the basis that the sun is on the ground adjacent to the shadow producing the super adiabatic layer, that will now become thicker than the SAL in the shadow. Another thermal will rise but to the side of the cloud along the shadow line. It will tend to rise vertically and then shear to one side so as to be directly under the sucking Cu. If there is any wind we can assume that the thermal column will not be up wind of the cu as it will already have consumed that air. If the sun is other than directly overhead there will be a tendency for the thermal source to be on the sunny side of the cu as this gives the least path of resistance to the rising thermal.



Wave

Wave is a phenomenon that we get more often than we recognize, although there are sometimes we recognize it when it is not actually there. On the flat lands we fly the wave is generated either by wind shear or by a frontal system to the west. The wave can be visible by producing wave bars in the form of lenticular or cumulus with smooth tops. The effect of the upper level wave will effect the thermal activity right to the ground. The secret is to recognize it and act accordingly.

When the wave is on the up stroke there will be a tendency for the wave to pull thermals from the surface, they will break away smoothly and tend to achieve higher altitudes than the day would normally expect to achieve. That is under the cloud and towards its windward edge, that being the upper wind.

When the wave is on its down stroke it will tend to depress the thermals. If the thermal rises due to the reasons mentioned previously it would in turn be depressed by the upper wave. On that basis you will tend to get large areas of air trying to gain height but in turn being depressed. In other words areas of rough thermals going nowhere. The danger is assuming the thermals are no good and pushing on when all you are going to run into is further subsiding air. The wave length may be many many kilometers.

Remember that it is unwise to go cross wind in the down part of the wave. Better to push into or down wind find the best part of the wave before going across.

Rogue Thermals

We have a term called rogue thermals. These are thermals that are considerably stronger, smoother and go higher than others found on a given day. The problem is recognizing them. And being aware that the day has not actually improved. The tendency of the glider pilot having taken this say 10 knot climb is to push on hard leaving the 6 knots he would had previously taken behind, until he starts calling Kilo Uniform Landing out. I do not know the reason for these forming and would dearly like to know how to track them down. Don't confuse them with the sea breeze front, that can have a similar effect, but has in addition a strong wind and no thermals behind it!