All about thermals

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Thermals are free and renewable energy which we modellers rely on to further our flights. But what are they? Let ex-glider pilot and lifelong modeller Chris Bryant give you the benefit of his thirty-year experience actually flying in them. What follows is based on my experience as a glider pilot and as a modeller in the UK. If you want to soar well then you have to visualise what is happening to the air around you if you are to exploit its opportunities successfully. I thought it necessary to deal with the subject as a whole but there should be plenty to glean for those who only fly modelsize.

THE ATMOSPHERE

First, a concept. Wind: think of it as an all-enveloping layer of gas flowing over the surface of our planet from high pressure to low. On the way it bumps over the surface of the earth and the lowest part, the troposphere (the stirred layer), is stirred up by things like land, sea and heat. If the air flowing over one area (like a warm sea) gets heated up more than that flowing over another area (an ice shelf), then the colder, heavier parts of the gas will try to burrow under the warmer, lighter parts. That makes weather fronts. That is part of the bigger picture.

At flying field scale, the same thing may be going on but reduced in size and this imposes a further local dynamic over the bigger picture. If the temperature difference between warm and cooler bits of air is sufficient then cold will push up warm and you have the makings of a thermal. The indispensible force needed to do this is *gravity*. The other component is, of course, *sunshine*. The necessary dynamic is *differential heating*. Where there is change of colour and texture in the surface then the sun will heat each differently. In turn the air passing over these disparate areas receives differing amounts of energy, the densities of the air streams change and the chances of thermal production increase. But it is not a guarantee that you will get thermals. Conditions have to be right. The air mass itself has to possess a certain latent energy – entropy. If that is wanting then nothing happens. More often than not this is called winter!

The defining properties of *entropy* are *temperature, pressure and humidity*. When these are right you can have thermals and, if a thermal goes high enough, it can become a cloud.

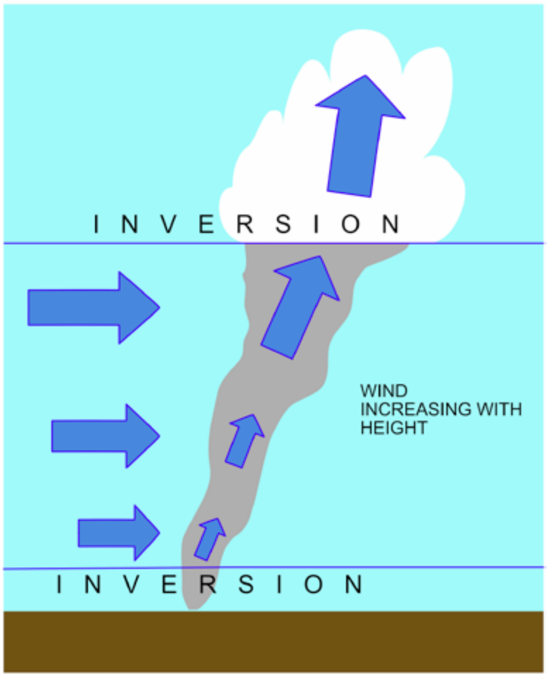
A long time ago I witnessed an experiment to try and define the motion of the troposphere. It consisted of a large loudspeaker lying on its back and an amplifier that fired bursts of sound into the sky. Alongside were microphones and a tape recorder to capture the echo sent back by the atmosphere passing overhead. Every fifteen minutes there was an almighty instantaneous bark from the speaker. The recording went on for several days 24/7; we did not get much sleep! The resulting tape was analysed in such a way that it revealed the size and rough shape of any distinct parcels of air above the speaker up to a height of a few hundred feet. A sort of air sonar. The results were surprising: the sample revealed discrete blobs of air ranging in size from a few inches to many feet across and that the arrangements of these blobs was random. The troposphere above Lasham in Hampshire UK was living up to its name. It was stirred and quite chaotic.

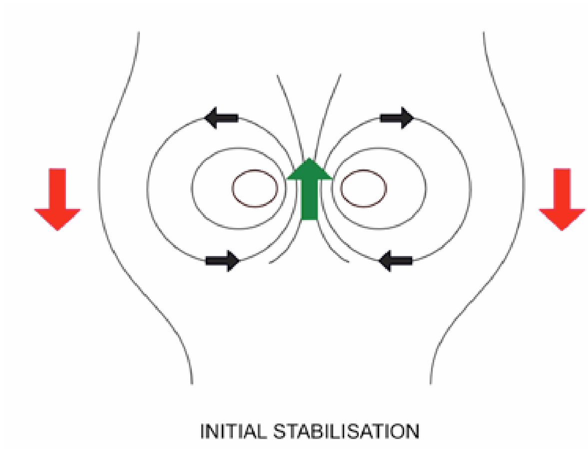
HOW TO MAKE A THERMAL

Now bring on your average soaring day and the sun comes up and starts heating up the landscape. For any given day the conditions will be unique and the air mass will either make thermals or not.

Let us suppose that today is a cracker. It's summer and, if you were up at dawn, there was mist covering the ground and no wind to speak of. The mist tells us that there is an inversion just above ground level. An inversion occurs when the temperature of the air stays constant or starts to rise with height instead of dropping. This can wipe out a thermal's temperature difference compared to the surrounding air. It can stop upward progress. However, as the day progresses the wind picks up and the sun disperses the mist. The sun climbs in the sky and heats up the landscape a lot more.

At a certain point, the conditions will be right and the little parcels of warmer air near the surface will start to coalesce until they form a parcel big enough and warm enough to lift through the inversion (which has risen to a hundred feet or more), detach from the earth and be forced up by the cooler parcels burrowing underneath it.

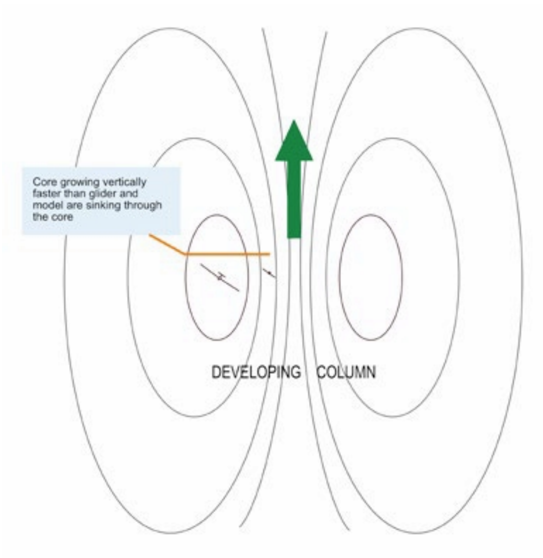




Pictures 1 and 2

Down low, in the first few hundred feet of its journey, the thermal will be weak, ill defined and small in diameter [Pictures 1 and 2]. As it climbs, it will tend to form a rolling torus rather like the ring clouds surrounding nuclear bomb plumes.

As it rises it elongates vertically and may be followed by other puffs of warm air from the same source which may combine to form a column. Think of it as a deep doughnut shape where the bottom is constantly rolling into the centre and up and the top is expanding out and down. Low down the torus is quite small. The turning circle of a full-size glider might be 300 feet in radius and somewhat larger than the torus. The pilot may only find weak lift around the edge of the torus and what there is may be fragmented - strong in one part of the circle and not in another. The pilot must make a tight circle well centred on the torus to stay in any lift. A model, however, has a much smaller turning circle and you are better off when exploiting such a situation.



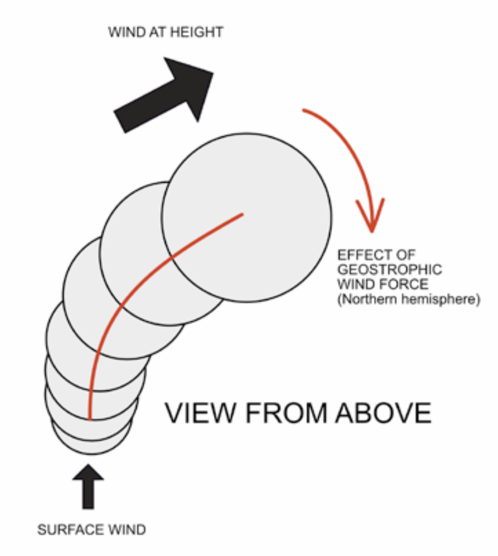
Picture 3

As the thermal rises so the torus becomes a column, gets more vigorous and spreads out until it reaches its condensation height – cloudbase – where the water vapour in it condenses out as cloud [Picture 3]. Often this coincides with another inversion and the cloud spreads out above it, the thermal spills over like the top of a fountain and stops climbing. There may be other, weaker inversions that our thermal encounters on the way to becoming a cloud and these can deflect or even divert the thermal from its upward path. If any of these are strong enough they may prevent it from reaching condensation height and you get a blue day. Thermals but no clouds.

Commonly, the lift on blue days is narrower, rougher and, of course, more difficult to find since there are no aerial clues to its whereabouts (unless you wear orange sunglasses which can make the rising currents just about visible). As the air in the torus rises, so cooler, denser air rushes in underneath it to fill the space it leaves. Thus thermals are often surrounded by sinking air.

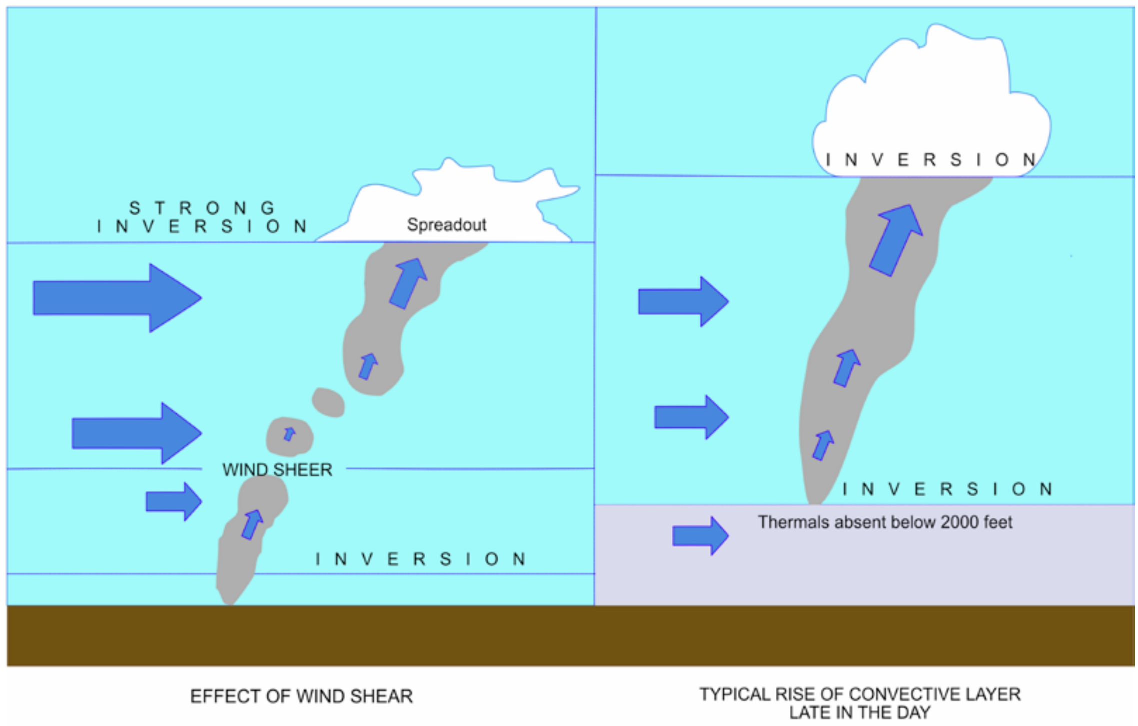
Also, it is inevitable that thermals will mix and blend with their surroundings and become polluted by cooler air. Nevertheless, to an extent they are self perpetuating since the rate at which the slightly wetter air in them cools can be about half that of the drier air surrounding them, maintaining or increasing the differential as they rise.

Despite mingling with its surroundings, a thermal can arrive at cloudbase with sufficient power to carry on above condensation level and form a growing cloud. At this point the latent heat of condensation released by the clouds formation can boost the thermal up to stratospheric levels and a cumulo-nimbus can be created which has the potential to go bang and rain like hell. The lift under thunderheads that I have flown in can be a mile wide and very gentle. Go on up into the cloud and the rate of climb can double or more. Go above the freezing level and all hell breaks loose with hail, icing and extreme turbulence to contend with while you are flying blind!. Even on a hot day it is freezing above your head if you go high enough! [Picture 4]



Picture 4

But this is not the whole picture. Two more factors influence the growth of the thermal: wind direction and strength usually change with height. Whilst our torus (perhaps the idea of a banana shaped parcel of air might be more appropriate in reality) is ascending the airmass it passes through is moving over the ground [Picture 5].



Picture 5

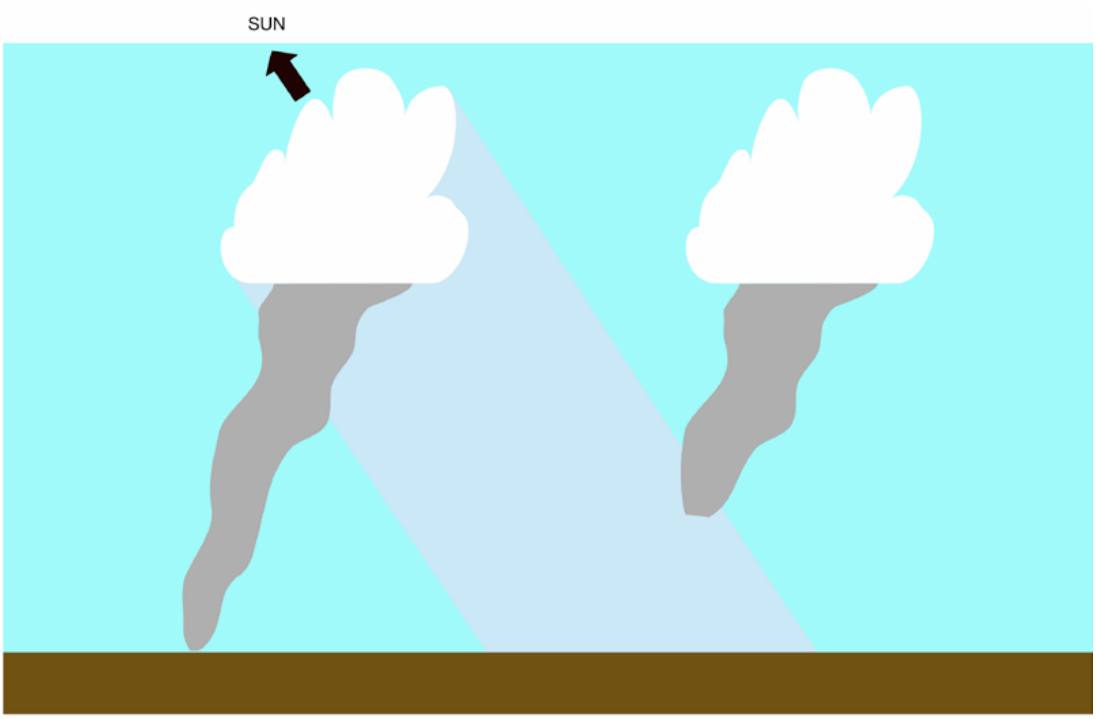
Thus thermals may swerve as they rise according to the strength and direction of the wind at various heights. Indeed, if there is a sharp enough change of direction and strength with height (known as wind shear), the torus may get displaced laterally, may even shear off and reform at some distance from the lower column. The moral of this story is if the lift suddenly stops then make a wider circle and look upwind. It is as if the torus has capsized and you have fallen out the bottom of the last puff. Finally, thermals twist about their centres as they go up. In the Northern hemisphere they twist clockwise; in the Southern hemisphere the twist is anticlockwise. This is due to the geostrophic wind force which affects the movement of the atmospheres of gassy planets throughout the universe. For modelling purposes you can ignore it. If you want to see it, fill a sink with water, pull the plug and watch the way the water goes down the plug hole. It twists - just as it would on Jupiter.

WHAT STOPS THERMALS?

Inversions.

The wet Whilst some water content is necessary to provide entropy, too much is fatal. Keep away from wet areas on your flying field.

Clouds



CLOUD SHADOW CUTTING OFF THERMAL SOURCE

Equally, a lack of sunshine is obviously going to spoil your day. One of the great thermal killers is cloud shadow that falls on the ground source of the thermal you are in, killing it stone dead. Any cloud will do, not just the one you think you are thermalling under.

For the same reason spreadouts at cloudbase may shut down thermal production for an hour or even the rest of the day if the inversion at cloudbase is strong enough and the updrafts are wet enough.

You get spreadout and soon everywhere is in shadow. Every time a hole appears in the upper cloud strata it is filled by cloud from an ascending thermal. Alternatively, this phenomenon may only occur at one time of day when the sun's angle to the earth's surface makes the shadows and the sources of thermals coincide. When the sun or the clouds are either higher or lower it may not happen. So time of day is important

Strong winds kill thermals. It can tear them to pieces, especially if the wind gradient near the ground is steep enough. A few miles per hour at ground level may become 20 or 30 miles an hour at one hundred feet. Such rapid change can be sufficient to roll thermals up and shatter them.

A tip: sometimes it is wise to extend the into-wind leg of your circles to keep up with the lift production on the ground, especially when low. Keep moving the centre forward in the wind so that it remains more or less stationary with reference to the ground.

Sunshine Then there is light. The strength of thermals is directly related, amongst other things, to the amount of heating the sun provides which is inextricably linked to its height in the sky. Is where you fly running under Greenwich Mean Time or is it an hour or two off it for local reasons? The sun's heating peaks at midday GMT. Work it out.

Lastly, a *change of airmass* can kill all lift. If wet sea air comes in in then forget it. Read your weather forecast. Where is the air mass coming from?

WHERE TO FIND LIFT

(Albedo) *Contrast* in the landscape is the generator of thermal lift. Astronomers call it albedo - the ability of a body's surface to reflect back sunlight. Dark buildings next to a grass field can be a source. Dark roads and runways are very effective. Hedgerows and woods can fill with warm air and not be good during the day but, as the sun goes down, they may release their heat when all other sources have died off.

Fire is an obvious winner. Years ago, farmers in the UK used to burn off the stubble left after the wheat harvest had been brought in and I have completed cross country's by flying only in the narrow and violent thermals stubble fires produce. Otherwise, the air was dead. It needed fire to reach the popping temperature. A very exciting ride I can tell you with bits of burning straw floating by, some of it coming in through the cockpit ventilators!

Hills are good sources of thermal lift where there are sun-facing surfaces. The increase in wind speed that a hill may cause can help to strip warm air off the surface, even off the downwind side of a ridge if it is sunsoaked. The air may be sucked up the back surface and stripped off the top by wind shear. Even small clumps of vegetation, a hedge or thicket, may provide shelter from the wind and a suntrap that puffs off lift from time to time.

You are very unlikely to hit a thermal head on. More likely, one wing of your model goes up and the usual rule is turn towards the rising wing. On the other hand, if you get into sinking air without any roll then look upwind. If the sink gets stronger as you go on then that is often a sign you are heading towards your next source of lift. If it isn't, start walking! Look at the clouds above where you are flying. Try to work out which cloud is at the top of the thermals you find. If it has a flat base and looks a firm, crisp, growing shape then it is working all the way to and above cloudbase. If it has no clear base and looks like a bad haircut then it is most likely dead and will be sitting on a pile of sinking air.

Watch the grass and vegetation nearby for signs of movement. If the grass gets blown back the opposite way to the wind direction, you know something is happening. Either it's the cold outflow from a collapsing thermal or the inflow to a new one just being borne. How long is it since the last thermal went off? That's a clue. Chasing nature's miracles is a fascinating sport. You are always learning something new.
Be aware of the air!

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