THERMALS:

MYTH, CHINESE WHISPER OR GRAIN OF TRUTH?

Tony Cronshaw asks coach Kevin Atkinson how to separate thermal facts from fiction

Multiple thermals under wide cumulus - looking NE towards Snitterfield and Stratford upon Avon (Tony Cronshaw)

TONY Cronshaw talks to leading coach Kevin Atkinson about commonly held beliefs about thermals, often passed down from one generation to the next – beliefs that are sometimes myths with a tantalising "grain of truth" – to disentangle the truth about thermals.

TONY: ***The simple diagram (left of figure 1) of a thermal structure seems easy to understand, but why is it not quite right?***
KEVIN: Diagrams such as this, perhaps quickly sketched as a teaching aid, can unfortunately baffle people trying to understand how thermals really work. The diagram suggests that the rising air/bubbles form a slanted structure surrounded by sink, which is also leaning. But rising bubbles are controlled by convection, and sinking air by gravity, both of which act vertically, not at an angle.

The grain of truth here is that the wind will carry the entire system sideways. However, it's better to think of the air mass as a block of air in which the thermal sits as a vertical structure: A better diagram (right of figure 1) makes it clear there will be a cylinder of sink acting vertically around the cloud, and bubbles will be found rising vertically under the cloud.

A further common misunderstanding is that a bubble is uniform inside, something like a helium balloon. However, the truth is that the air surges upwards in the middle of the bubble, then goes sideways and returns down the sides of the bubble. This toroidal re-circulating pattern of warm air is similar to the dynamics in a smoke ring.

TONY: ***They say "bull baffles brains" or something less polite! But is it true that thermals get bigger with height?***
KEVIN: The simple diagram also suggests that the thermal grows bigger in diameter with height. We can get this perception when thermalling, but physics does not support this. It's true that the pressure reduces with height, but then the temperature also reduces. Putting these considerations into the gas laws show the thermal core diameter of 200 metres expands by 20 metres (10 per cent) when the bubble has risen by 5,000ft. However, as our turn radius is governed by True Air Speed and we fly according to Indicated Air Speed, our radius of turn will increase by more than 15 per cent. As these two factors more or less cancel out, the core diameter should feel consistent in size.

TONY: ***So why is it that we sometimes find ourselves using a gentle angle of bank when approaching cloudbase?***
KEVIN: If we fly a wide circle under a big cloud, we may be visiting multiple cores as witnessed by intermittent bursts of climb. When we look at large cumulus clouds we can see multiple domes (figure 2) from the individual cells that it's made up of. Hence we sometimes see gliders using different cores under the same cloud, each glider using plenty of bank to turn tightly.

We can also extract energy passing under a wide cloud without circling. But again the energy is actually coming from a series of thermals probably marshalled along the wind line.

Remember that the "hydraulic effect" of the surrounding cylinder of sink pushing down hundreds (or thousands) of feet will cause air to recirculate under the cloud, capturing further bubbles, and adding generally ascending air underneath the cloud (see also [1] and [2]).

Another possibility, caused by considerable instability above cloudbase, is "cloud suck", which can reinforce lift just below cloudbase.

As a result of these various effects, it sometimes makes sense to climb under the cloud with a large radius turn, but sometimes it will be more efficient to pick the best core and turn tightly in it. Anyone starting a cloud climb will do exactly that.

By the way, wide clouds merely indicate that there are a greater number of adjacent

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thermal bubbles feeding the cloud, not that thermals are stronger than a smaller cloud. Taller clouds, however, DO indicate stronger thermals.

TONY: ***The experience of thermalling at low heights, eg after a winch launch, gives the impression that thermals are narrower here and we need to turn tightly to stay in the lift. What's happening to the bubble's toroidal vortex at low heights?***

KEVIN: Below 1,000ft, the bubble centre may still be accelerating upwards before the toroidal vortex that will maintain the bubble as a stable structure has fully developed during its ascent. The cylinder of sink surrounding the thermal will also be starting to establish itself, but the sink will be less strong until the bubble starts to rise more quickly and form into the classic toroidal vortex. The smoke ring like vortex will give the bubble stability – and a structure that we can understand and recognise at greater heights.

All of these factors add up to give us a "half-baked" thermal at low heights. This formation process is invisible for natural thermals, although can be seen where warm air, vapour or smoke exits from an industrial chimney or cooling tower – or seen in the flames/smoke just above a bonfire or stubble fire. In those cases, we can see how the first puff of energy ejects vertically in the embryonic phase, then develops into a series of rotating toroidal smoke rings.

So, like a lot of myths, there is a grain of truth in the need to turn tightly when exploiting thermals at low height; it enables us to stay in contact with the embryonic thermal and avoid losing it.

TONY: ***At low height after a winch launch, I agree we should treat the thermal as if it's "the best one in town" and nurse it despite a slow rate of climb. The lift usually strengthens above 1,500ft. Too many times I've jumped off in search of a better thermal only to be forced to land home.***

KEVIN: When you're low, you should remember the old song: *Love the one you're with*!

TONY: ***Moving on to another aspect of thermalling and centring: It's often said that we need to keep the speed constant because changing speed will distort the circle's shape and diameter and we risk nudging the circle sideways, most likely away from the core. Is constant speed the correct strategy?***

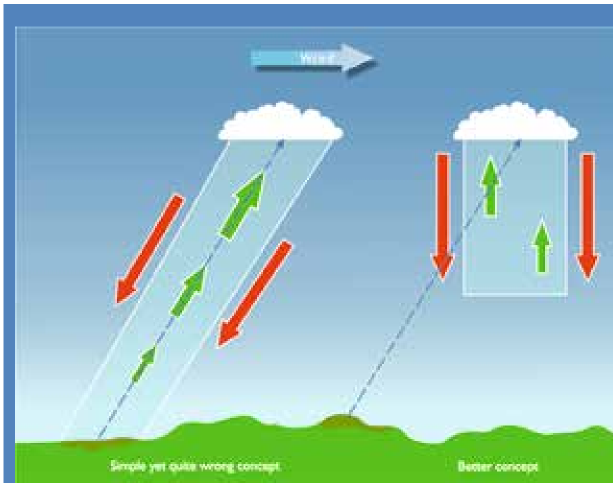

Figure 1

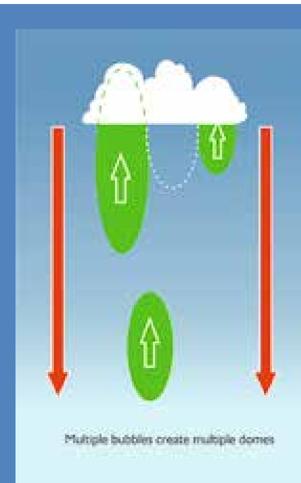

Figure 2

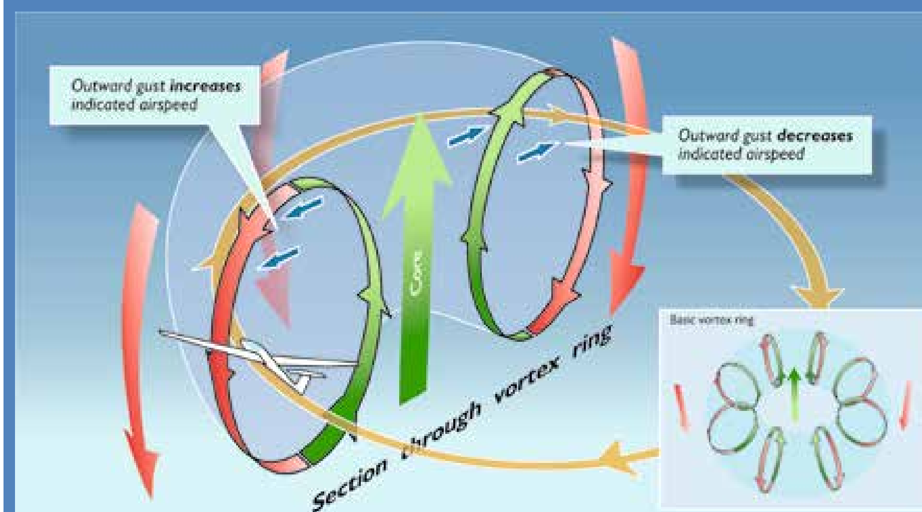

Figure 3

Illustrations by Steve Longland

KEVIN: Keeping the speed constant when thermalling is actually very difficult and at times simply impossible. Our glider is carving a path through the thermal's toroidal vortex. If we are not centred perfectly then this will often present a gust increase to our airspeed as we get nearer the core and a gust decrease as we move away from it. These gusts are most obvious in the upper part of the bubble (figure 3). Hence we make continual small adjustments to keep centred as best we can, whilst experiencing the airspeed gusting higher and lower. These gusts can be used to map out where the thermal core is located. The yaw string flicking briefly to the side during a gust is another clue: The gust flows out from the core, so the string blows away from where the core is located.

TONY: ***Sebastian Kawa made some suggestions on how to enter and centre***

Tony Cronshaw is an Ass Cat instructor at Cambridge Gliding Centre with over 1,000 hours gliding. His enthusiasm for helping the next generation of pilots includes running courses for visitors and members, and supporting CGC's recruitment and retention sub-committee

Kevin Atkinson is the club coach lead for the BGA Aim Higher initiative (*www.gliding.co.uk/bgainfo/aimhigher.htm*). He started gliding at age 13 at Ouse GC (now York), flying his first solo on his 16th. Kevin has over 3,500 hours gliding, including competing in UK national and regional competitions. He also has more than 7,500 military jet hours (Tiger Moths to Typhoon)

■ Kevin's book *Gliding in Lift and G-SINK* is available at *www.bgashop.co.uk* or direct from *kratkinson@yahoo.com*

a thermal during his recent visit. He talked about using the gust on the ASI as an indication that we are approaching lift, but not taking action just yet. He recommended waiting for the subsequent surge (the seat-of-the-pants upward force) and then reacting promptly by slowing down and turning (eg towards the wing that feels pushed up) progressively tightening the turn as the surge increases.

KEVIN: Bear in mind that the gust on the ASI will also be seen as an increase in total energy by the vario – in the same way that the vario indicates "lift" when we are parked on the ground and a gust comes along. So, used in isolation, the vario could create a premature indication of when to turn in the thermal.

On approaching the core, I think it's important to get a feel for crossing the turbulent boundary between the sink and the core. I call this area the "cobble stones" because we feel a series of vertical bumps in rapid succession. This would be a good moment to carry out a look-out scan – visually and checking the FLARM – just before we anticipate entering the core where we'll feel the upward surge.

TONY: ***When we feel the surge, the glider presumably accelerates vertically, but what do you think about the often quoted issue of "vario lag"?***

KEVIN: First of all, the glider does not change vertical speed instantly or we would also experience it every time we leave severe sink and entered normal air.

Since the vario measures vertical speed, there will be a delay from the application of a vertical force to that force producing a vertical speed (according to Newton's laws of motion). So it's not the vario's fault that there's a delay before it reacts. Our best strategy is to feel the surge indicating the moment that the core is strongly pushing up vertically. This is the moment to nail the core by turning promptly and slowing down.

[1] *How a column thermal forms*, S&G, Oct/Nov 2015 pp10-11
[2] *Learn basics to exploit streets*, S&G, Dec 2015/Jan 2016 pp8-10

■ In the next *Ask the Coach* Tony asks Sebastian Kawa and Mike Fox about a much debated topic, thermal centring techniques

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