Official Newsletter of the Southern Ontario Glider Group

TASK

Affiliated to the Model Aeronautics Association of Canada

OFFICIAL NEWSLETTER - SEPTEMBER, 1990

Vol. 6 - #5

PRESIDENT:	Otto BANDMANN R.R. #1 Dundas, Ontario L9H 5E1	519-623-2560
TREASURER:	Gerry FRITZ 19 Pepperwood Crescent Kitchener, Ontario N2A 2R4	519-893-7558
SECRETARY/ NEWSLETTER EDITOR:	F. J. FREEMAN Unit #17 - 11 Colmar Place Dundas, Ontario L9H 4L1	416-627-9090

THE NEWSLETTER IS PUBLISHED BI-MONTHLY.

Any material for inclusion should be sent to:-

The Editor,
F. J. Freeman
Unit #17 - 11 Colmar Place
Dundas, Ontario
L9H 4L1

"— ALL THIS FOR A HOT-DOG AND
A COOKIE ?"

CLUB DAY - JULY 22nd. 1990

"WINGIN' IN THE RAIN"

Only one word is necessary to describe the conditions on this day - WET!

The Gods, who only the week before had accepted (and guaranteed!) my requisition for south-west breezes and 75° temperatures, reneged and, before we had time to realize what was happening, they dumped the lot on us!

Despite the weather, 18 brave souls turned out to venture into the wet blue yonder, and we were able to complete two full rounds of flying before the less-than-inviting conditions became unbearable. So we took the positions that everyone held at the end of the second round and distributed the awards accordingly.

It was, I suppose, an anticlamatic conclusion to the contest, but the fact was that by this time everyone was rather damp (B----y soaked), and more than ready to quit. Results were as follows:

1. AB INITIO-(Beginners)

1. Frank Berenkey	531 poonts
2. Peter Ashton	475 points
3. Paul Riedlinger	379 points

2. INTERMEDIATE -

1. Bill Rodgers	506 points
2. Bill Moar	352 points
3. Fred Freeman	316 points

3. INSTRUCTORS (EXPERTS)-

1. Norm Klebert	569 points
2. Bud Wallace	551 points
3. Werner Klebert	519 points

My thanks to the ladies, Margaret Ashton and my wife Gladys, who between them kept tabs on the scores, made sure that the frequency board was kept as honest as possible, and dished out the food afterwards.

Bill Woodward loaned his barbeque and also made up our new frequency board, to say nothing about the surfeit of ketchup he carried in his shopping bag!

Otto Bandmann took on the chore of obtaining the certificates from S.O.S.A.

Gerald Fritz did his usual masterly job on the plaques in addition to buying the wieners, he also brought along his barbeque.

I also have to thank all who brought winches or hi-starts and took care of them all day in the rain.

And last, but by no means least, thanks to all who showed up - I hope that, apart from the rain, you enjoyed this, our first attempt to do something for the membership. perhaps we should do it again next year.

BUT PLEASE, LORD - DON'T LET IT RAIN!!!

F.J.F.

EDITORIAL:

THE (IN) GLORIOUS TWELFTH (AND BEYOND)

It seems that all our contest activity is concentrated in the latter half of the flying season this year. After the soaking on Club Day 1990, we had hoped for better weather for our planned sortie into C.O.G.G. territory on August 12th. - we had also hoped to have had a little more support. However, Werner, the two Bills (Woodward and Moar) and myself ventured forth, like lambs to the slaughter, in what was really only marginal weather - Algebra-wise, that is - to do battle on the Holland Marsh, only to find that conditions, although excellent for Gentle Lady-like wing loadings, were, at least in the first rounds eminently unsuited to our heavier Algebras - even Werner had only limited success, until just after the lunch break when the wind began to blow a little and each of the Algebras performed with much more promise; unfortunately it was too late - the light lift of the earlier rounds had taken its toll. However, the effort was not wasted and we should all be prepared to put it down as a very meaningful experience and strive to do better next time!

Upcoming in September we have the "Big Bird" (3 metre) contest on SUNDAY, 10.00 a.m. SEPTEMBER 2nd. 1990 - C.D. Werner Klebert (416-578-9431) and on SUNDAY, SEPTEMBER 23rd. 1990 - Fun/Fly & Scale - C.D. Bill Woodward (519-653-4251). 10.00 a.m. In addition , C.O.G.G. announces a 2 metre Contest (2m only) on SUNDAY, SEPTEMBER 30th. 1990 - to be run as a team contest between 2-man teams consisting of 1 expert and 1 sportsman. C.D. Mike Thomas (416-654-8128)

CLUB MEETINGS 1990-91

Following the suggestion put forward by Werner Klebert at the April 29th. meeting we will try to arrange meetings on the second Sunday of each alternate month beginning with October; so the first of our bi-monthly meetings will be held at Beverly Town Hall on Sunday, October 14th. 1990 starting at 1300 hours.

The suggestion made by Kurt Flitz, re the appointment of "callers" for each area will be considered at this time.

I hope to see you all at the contests quite soon - until that time remember to

Drift with the Lift

Fred

ALL ABOUT THERMALS

THERMALS are probably as individual as fingerprints, many share common features but no two are identical. Their scale ranges from columns 50 feet in diameter, usable only by seagulls and buzzards, to mile wide monsters sucking thousands of tons of air a second into giant cu-nim clouds.

(This item by courtesy of Free Flight via Sailplane and Gliding might help our members to better understand thermals.)

Tom Bradbury
from SAILPLANE & GLIDING

Laboratory studies of thermals

Until a cloud forms there is almost nothing to show the shape or size of a thermal. Atmospheric thermals are too big to be studied in a laboratory but one can produce similar motions in a water tank using fluids of different density. Many experiments were done by releasing salt water (made visible by a white precipitate) into a tank of clear water. A series of photographs was taken as the denser saline cloud sank through the clear water. These pictures, when inverted, looked remarkably similar to a real cumulus cloud. The experiments led to the now familiar picture of a thermal bubble rather like a vortex ring but not exactly similar.

Figure 1(a) shows successive two dimensional outlines of a water tank "thermal". The arrows show how protuberances which began near the centre line fanned out sideways. In 3D this showed that the circulation was formed by fluid rising up the middle of the thermal, spreading out in all directions at the top, and then sinking down the outside. The vertical motion in the core of the bubble was about twice that of the cap.

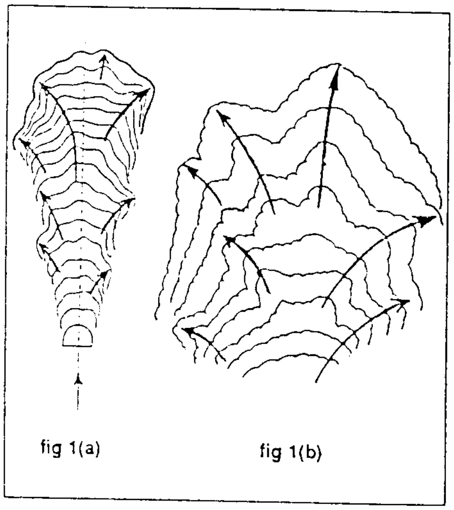


fig 1(a) fig 1(b)

Figure 1(b) shows outlines of a developing cumulus with individual turrets being displaced sideways as new turrets rise up from within the body of the cloud to take over. Real clouds have also been found to have their strongest upcurrents rising about twice the speed of the cloud top.

The vortex ring

Some laboratory models show that the artificial "thermal" forms a vortex ring circulation before it dies out. Part of the surrounding air is pulled into the circulation of this expanding ring, diluting the thermal. Eventually the weakening thermal loses the rest of its energy trying to accelerate this additional air. The ring ceases to rise and soon decays.

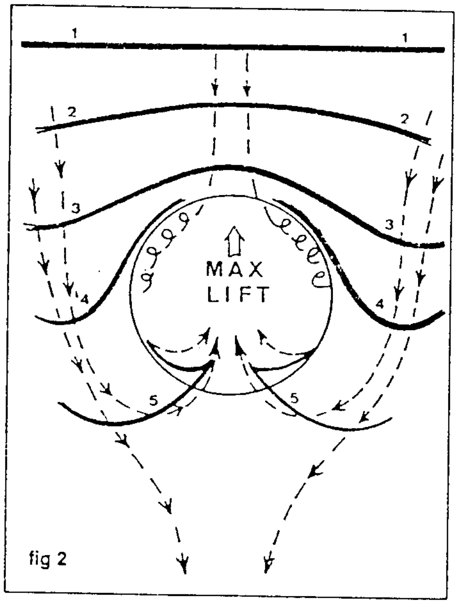


fig 2

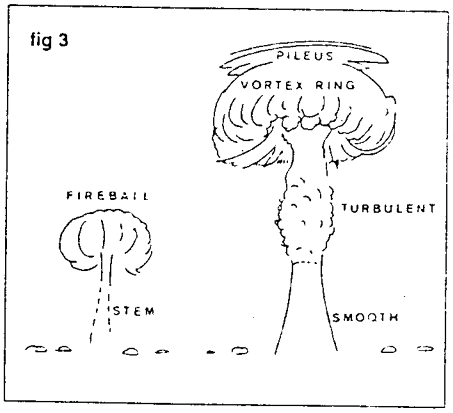
Flow into a thermal bubble

Figure 2 above shows a highly simplified diagram of how a rising thermal bubble can incorporate outside air into its circulation. The circle in the centre represents the bubble. Dashed lines show how air from above flows round the thermal. The numbered black lines above and round the side show how an originally flat layer of air is distorted as the bubble comes up through it: (1) shows the undisturbed line, (2) and (3) show the upward push developing as the bubble approaches. Notice that a small upward push occurs before the bubble actually arrives. If the air is already very moist this may be enough to form a thin lenticular cap called "pileus". At (4) the line is broken by the bubble. Some of the air is mixed into the rising cap while the rest slides round the edge. As it nears the bottom of the thermal bubble (5) the line is distorted by the curving inflow. This inflow takes drier air back up into the bubble. In some cases the arrival of drier air turns the bubble into a sort of doughnut ring with a clear hole in the centre (when viewed from above). The flow in and around a real cloud is not as simple as this. The complete vortex ring pattern seldom appears unless the thermal is forced to rise fast; for example due to some massive burst of heat such as an atomic bomb.

Nuclear explosions and thermals

The most dramatic example of a thermal bubble is formed by a nuclear explosion. Photographs taken after the initial fireball has cooled show a long column extending up from the ground capped by the well-known mushroom cloud surging upwards. Figure 3 is a sketch of two stages in the life of an atomic cloud. On the left the original fireball is still too hot for any moisture to form a cloud. The bubble has a tail of debris swept up from the ground. In the right hand sketch the expanding mushroom has expanded and

fig 3



cooled enough for moisture to condense forming a white cloud. The underside of the mushroom shows how the outside air is being drawn up into the core from below, just like the model thermal. The column below consists of extra moisture sucked up from lower levels and condensed into cloud as it cooled.

Pileus

The speed of ascent has also produced a smooth lenticular cap (called pileus) formed from outside air pushed up ahead of the mushroom cloud. Pileus sometimes appears above ordinary cumulus if the air aloft is very moist. The pre–thermal lift causing it appears in figure 2 as a bend in lines 2 and 3.

Double bubbles

In another water tank experiment a second "thermal" bubble was released after the first had risen some distance. This is illustrated in figure 4. AA is the first thermal. BB is the follower. Timing of BB could be critical. If released at the right time BB would rise through the centre of the expanding vortex ring formed by AA and accelerate upwards. However, if the delay was too long BB tended to break up in the turbulent wake of AA and never got through the sink.

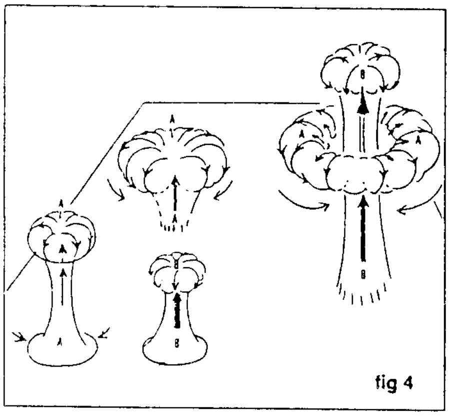


fig 4

The theory of a thermal bubble seems to be supported by the experience of pilots circling in the central core of a thermal who find it possible to close the gap between them and gliders higher up. Those at the upper level only go up at the speed of the bubble but in the core lower down the air rises twice as fast. Eventually everyone is left circling round at the top of the bubble in weak lift. Occasionally a newcomer picks up a fresh bubble lower down and catches up to the gaggle. If this sailplane is in a BB type thermal everyone else will start to climb faster when the new bubble arrives; if not all will stop climbing at about the same height.

The idea of consecutive bubbles can be comforting to a pilot searching round at low level in the decaying dregs of an old thermal. Quite often patience is rewarded and a new and vigorous bubble comes pushing up. However the following bubble does not necessarily rise directly beneath the original one. One may have to shift the search upwind.

Thermals and cloud forms

Once cloud has formed, the latent heat of condensation releases an extra supply of heat which invigorates the thermal. The shape of a cloud provides an excellent marker showing how much air has been affected by the thermal. The rising cloud dome is covered with lots of smaller protuberances like tiny thermals. These mark the region where drier outside air is being mixed into the thermal and diluting it.

Time lapse films suggest that although most clouds show similarities to the laboratory models the larger clouds are usually complicated by the existence of several originally separate thermals. The cloud shape is distorted by collisions with inversions and twisted by the effect of vertical wind shear. Since most clouds persist longer than thermals their shape reveals more about the past history of the thermal than its present condition. Lift under a cumulus is usually confined to a relatively small area where an active plume enters. The rest of the cloud just marks where ascent took place some time ago.

Plumes and bubbles

Figure 5 shows what probably occurs in the atmosphere starting with a large but relatively shallow reservoir of warm air. Level 1 is the initial state; levels 2, 3, 4 and 5 are stages in the ascent of a column of warm air. Such a rising column has been termed a "plume". It represents the stage before the circulation at the top develops into a detached thermal bubble. Notice that as the plume accelerates upward (levels 3 and 4) the diameter of the column narrows for a time before widening out and then developing a mushroom like shape at the top. This narrowing is why one often has to turn much tighter to climb away in thermals low down. Higher up the mass of air comprising the thermal grows wider but the lift is confined to the central core. The airflow at the top of the thermal is continually spreading outward but any vortex ring pattern is only partially developed in the early stages.

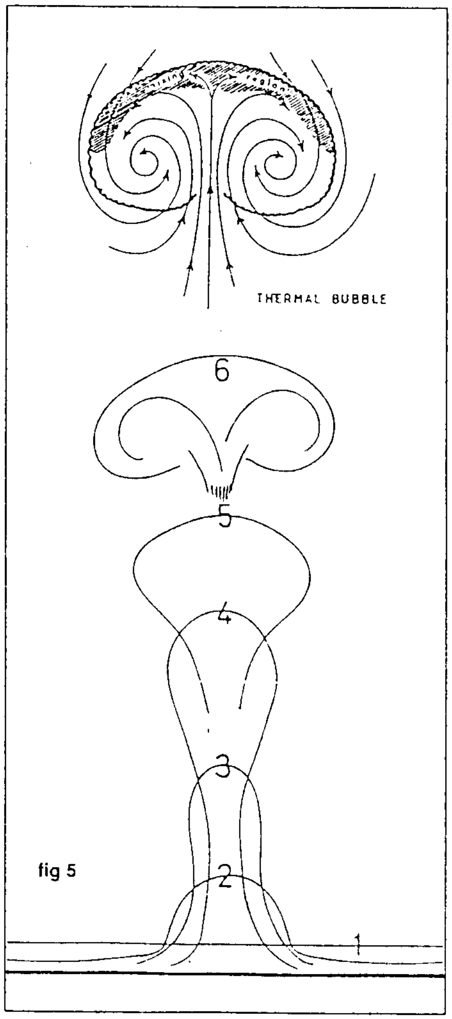


fig 5

By the time the supply of warm air is exhausted, (level 6) the full circulation of the thermal bubble has developed. This is shown in more detail at the top. The shaded area is where most of the mixing takes place. The circulation carries the diluted mixture down the sides of the bubble and eventually some is drawn into the base. The mixing process is called "entrainment". This reduces buoyancy by diluting the thermal and also absorbs some of the spin as slow moving air from outside is pulled into the vortex ring. As a result the initial bubble often slows down and disperses well below the level it could reach if undiluted.

There is sometimes an argument between people who feel that a thermal is better represented by a tall plume of rising air rather than a bubble. It seems likely that both forms occur, with the bubble being the most likely shape after the supply of warm air from the surface has been cut off.

Any ring circulation usually disappears when the cloud top ceases to rise. In many cumuli this circulation seems to be so slow that it never becomes a complete ring. Distortions due to encounters with wind shear and inversions usually prevent a symmetrical ring forming. The tops of many dying cumuli look inert. Not only does any ring circulation vanish but the cloud top may fall back into the main body of the cloud as an evaporation downdraft develops. Figure 6 illustrates the destruction of a central column of cloud in this manner. Such a downdraft tends to reverse the original circulation at the cloud top.

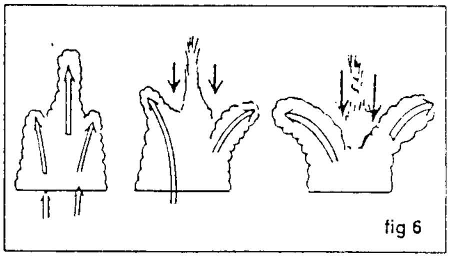


fig 6

Evaporation downdrafts and holes in the clouds

Water tank models are unable to reveal the effect of evaporation in a cumulus cloud. Evaporation occurs when the growing cloud incorporates much drier air from above. When the dry air enters it forms pockets of evaporation which eventually make holes in the cloud. The heat needed for evaporation cools the air so much that regions of sink develop. Researchers have found these holes on a wide range of sizes between 10 and 100 metres growing to 500 metres. Larger holes occur in multi-cell groups of cloud. Generally there are more small holes than large holes. They produce sink going down into the middle of the cloud (not just at the edges as the basic model suggests). This central sink tends to disrupt any strong core of lift in the middle of the thermal bubble. Soon the circulation no longer resembles the basic model. If you watch the cloud shadow you may see the solid black area break up into a ragged "fishnet" pattern as evaporation erodes the cloud and the sink takes over.

Sloping thermals Unless the air is practically calm for several thousand feet, thermals are likely to be tilted over by the wind. However, the amount of tilt depends to a great extent on the strength of the thermal. A soarable thermal contains thousands of tons of air and this mass has considerable inertia. If this mass starts off with a low ground speed it tends to maintain its original speed even when it rises into a stronger wind. The upper winds are then diverted round the side or deflected over the top of the thermal. This is why some cumulus can produce lift in the clear air on the windward side and transient waves over the top of the cloud.

The influence of wind shear is sometimes visible in the shape of clouds. While they are growing strongly they usually remain fairly vertical. When the thermal dies the stronger winds aloft tend to topple the cloud over. It then starts to evaporate in the strong sink on the downwind side. This alters the look of the cloud. The growing side keeps producing clear cut bulges while the sinking side develops a fuzzy outline as evaporation starts to shred the cloud.

Effects of wind shear above shallow cumuli – hook shapes
The distortion produced by wind shear depends on the rate of ascent of the cloud and the amount of shear. On most good soaring days the tops of cumuli are limited by a layer of stable air higher up. If there is a well marked inversion, there may also be a noticeable wind shear above it. The cloud top quickly stops rising when it reaches the inversion and any part which overshoots tends to be twisted over into a hook like shape as shown in figure 7. One may see several little hook shapes appearing briefly on the up-shear side of these clouds. When the end of the hook starts to turn down it begins to evaporate so one cannot see the full effect of the sink which develops on the down-shear side. Sometimes almost all the cloud evaporates leaving just a puzzling narrow hook shape.

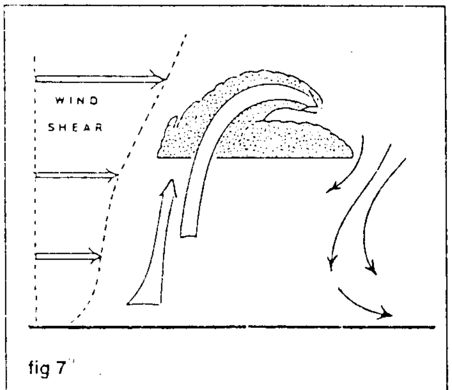


fig 7

Wind shear with deeper instability
There are occasions when, although the air is unstable to 10,000 feet or more, the surface heating is only just enough to set off thermals. With only a small excess of heat these thermals rise slowly at first. When they reach the condensation level so much extra energy is released that the cloud starts to shoot up rapidly producing long thin columns. Cumulus clouds formed over tropical oceans sometimes behave like this. There is very little lift underneath these oceanic clouds except close to cloudbase. Once into cloud the lift often becomes strong. The clouds remain narrow if the surrounding air is fairly dry. However, tall thin cumuli usually have a short life and such clouds are soon tilted over by stronger winds aloft. Figure 8 is a sketch of a series of thermals which produced similar tall cu over the Cotswolds on 24 September. On this day the wind was almost calm at low level. Clouds were chiefly confined to high ground with large blue areas over the Severn valley. The numbers in figure 8 show a succession of plumes breaking off into individual bubbles. Number 1 furthest downwind is in the decaying stage; 2 and 3 show how the tilt increased with time. The originally firm cloudbase degenerated into a ragged skirt marking sink under 3 and beginning under 4. Cloud 5 was still growing well but the lift beneath was shut off. Only cloud 6 was accessible from below.

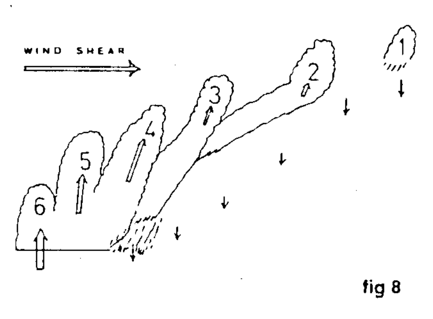


fig 8

Stubble fires and thermals It can be instructive to watch the behaviour of smoke from a stubble fire. Of course the extra heat put out by these fires varies enormously. Much depends on how the fire was lit and whether the flames have to work their way feebly upwind through a sparse cover of stubble or are allowed to sweep downwind through piles of deep straw. It is worth noting that unless the air has neutral stability (a dry adiabatic lapse rate) even the fiercest stubble fire is unlikely to send up a soarable thermal. I have watched a stubble fire lit long after sunset which produced six foot flames but the smoke trail only made a feeble hump in the nocturnal inversion. The fact that most stubble fires do seem to initiate a thermal is because farmers usually wait till the overnight dew has evaporated and the straw is really dry before lighting up. The majority are set off fairly late in the morning and through the afternoon. The air is usually unstable by then.

Feeble fires With the weaker type of fire, the smoke plumes frequently seem to rise in a series of pulses rather than one solid column. This is particularly noticeable with long lasting fires when there is a fresh breeze blowing. After one upward surge has risen the smoke starts to trail along the ground almost horizontally until another surge is set off. This looks as if a series of thermals is moving across the stubble fire and the arrival of each thermal is marked by a fresh hump of smoke. Figure 9 illustrates the idea. Flying upwind towards the source of the smoke one can find the thermals well below the puffs of smoke. This suggests that the lift is not entirely due to the hot air from the fire. Feeble fires like this do not seem to produce mushroom clouds.

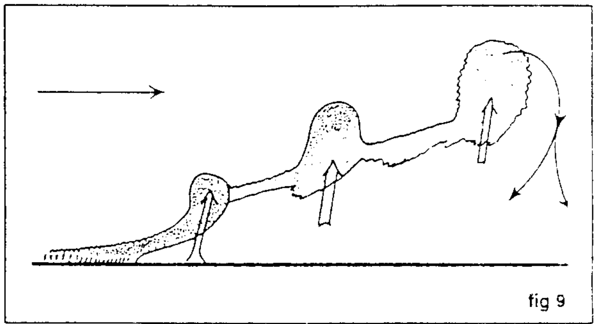


fig 9

Fierce fires
Farmers seem to be more cautious nowadays and one seldom sees the really monster stubble fires with a vertical column of black or grey smoke towering up into a mushroom cloud. Some have minor whirlwinds spinning round at the base. Inside the plume the lift is astonishing but the air is so rough that one has very little control of the aircraft. Large clumps of burning straw appear and go rushing by. Occasionally they become doubled over the leading edge of the wing and are reluctant to slide off. I have sideslipped a thousand feet to get rid of such unwelcome hitch-hikers.

The fiercer the fire, the shorter its life
Astronomers tell us that many of the biggest and brightest stars use up their store of hydrogen quicker than their smaller brethren. After a brief surge of brilliance as a "supernova" they subside into a much dimmer object. This is sometimes true of stubble fires, too, especially those one sees many miles away. I have watched pilots fly past a 5 knot thermal under a nearby cumulus in their urge to sample a distant stubble fire. Sometimes they come back, very much lower down, to the cloud they had spurned fifteen minutes earlier. As moths make for a candle flame so pilots divert to stubble fires. I have diverted to a fire whose flames were high enough to be clearly visible more than ten miles away. When I arrived all that was left was a charred field and an inert pall of smoke much higher up.

More complex patterns

Only the smallest short-lived clouds are the result of a single thermal. Most are the work of a series of thermals. The individual turrets of large cumulus clouds show that there must have been several closely spaced thermals. Cloud streets show that thermals may be organized in a regular fashion which has little to do with hot spots on the surface. There are other influences too such as the interaction between downdrafts or the result of outflows.

Multiple thermals

Thermals are not necessarily isolated columns of lift. Several can exist close together as shown in figure 10. Such a group may be unsuspected when flying alone. One usually discovers these near a busy gliding site where a number of pilots are marking lift in different places. Quite often rates of climb seem to be similar in each column. At level 2 the circles are far enough apart to allow each group to climb safely. By level 3 turns are becoming uncomfortably close and at level 4 the overlap means someone must shift circles. At level 5 the columns have merged to form one of those comfortably wide thermals which occur well after midday and especially late in a summer afternoon.

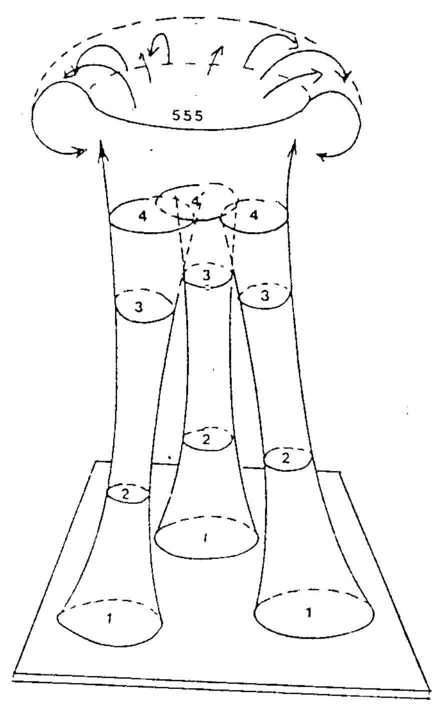


fig 10

Figure 11 shows a plan view of the lift distribution between levels 3 and 4. Beside it is a cross-section of the lift encountered by an aircraft hurrying straight through along a line A–B. Some clusters of thermals have far more cores with less sink in between. When lift is distributed like this it is difficult to know whether one should tighten up the turn in a surge of lift or take off bank. If you are the only one in such a thermal and in no hurry to press on, the pattern of lift can be explored for quite a long time. However, it is hard to build up a mental picture of it. The only certainty is that a cross-section of lift is not circular.

Street of lift – horizontal vortices

The upper part of figure 12 shows a familiar pattern of clouds in long, regularly spaced streets which are aligned parallel to the wind at their altitude. Such streets occur when the tops of cumuli are restricted by an inversion or stable layer so that they all reach approximately the same level. If there is also a moderate to strong wind a convective circulation develops in the form of long lines of parallel contrarotating vortices. These produce lines of lift under the clouds with lines of sink in the clear air in between. By tracking constant pressure balloons, researchers have found that the air is following a helical path. The cross-section in the lower half of the diagram illustrates a two dimensional circulation.

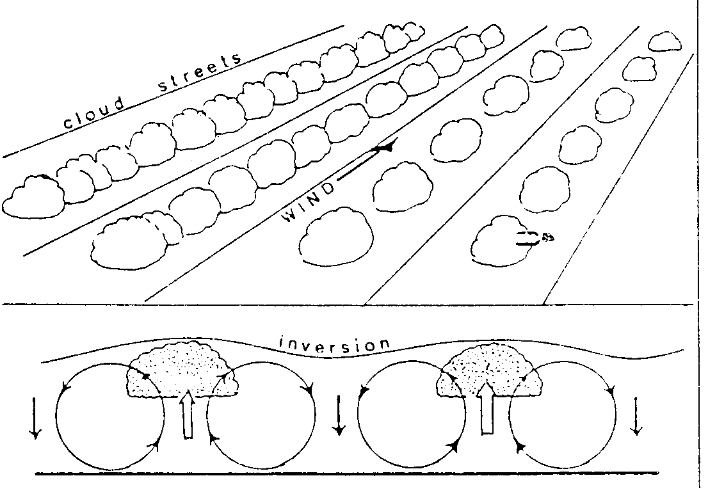


fig 12

Such streets do not depend on any hot spots on the surface; they form spectacularly well over the ocean where strong winds bring cold air spreading out from polar regions. The circulation of these cloud street vortex rolls extends from the surface up to the base of the inversion. The spacing depends very largely on the depth of unstable air, the deeper the layer the wider the gap between streets. If the depth of unstable air increases, the widening of the cloud free lines is achieved by destruction of some of the intermediate streets, not by a fanning out of all streets. Streeting breaks down when the air becomes too unstable, and tops are no longer at a uniform level.

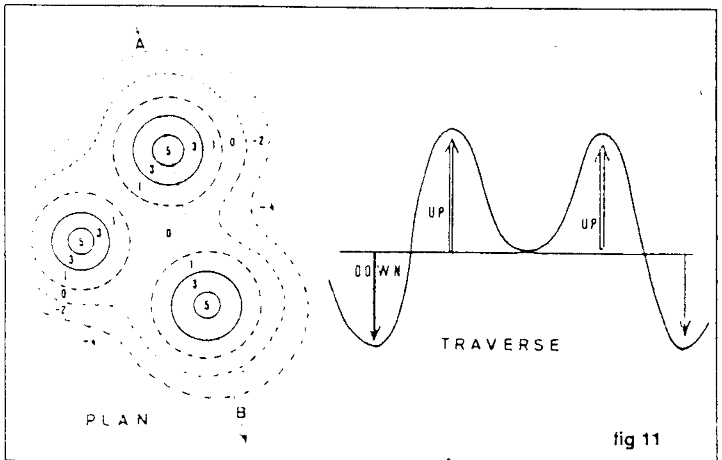


fig 11

Cloudless streets

Streets can also exist under cloudless skies. The circulation pattern will precede the appearance of clouds. When cumuli do appear the clouds may actually extend upwind of a fixed spot on the ground as well as moving downstream.

Lift is not as regular as one might suppose from the diagram; the vortex pattern stimulates ordinary thermals under the streets and inhibits them in between so that the initial gain of height can be made by regular circling in a region of stronger lift. Then one can dolphin along the street at high speed maintaining or even gaining height. On a cloudless day one may remain ignorant of the pattern of streeting for a long time. One should anticipate streeting over fairly uniform ground whenever there is a wind of 15 knot or more, and particularly if the wind becomes much stronger. Unusually frequent encounters with thermals or alternately an alarmingly long period of sink may mean that streeting has occurred.

Chimney vortices

Old fashioned steam locomotives sometimes emit a series of perfect smoke rings if the puffs leave the chimney with just the right force. These are true vortex rings initially but they usually break up after a short time. The gases from a factory chimney never come out with such vigour. They tend to dribble out in a sluggish series of puffs or, if there is a breeze over the top, form a small pair of contrarotating vortices. Looked at from downwind (see the left hand side of figure 13 on the next page) they appear like a two dimensional cross-section of an ideal thermal bubble. Instead of a complete ring rising almost vertically there are two horizontal rolls trailing downwind. These rolls have an updraft in the centre and downdraft at the outside. The rolls occasionally spread apart leaving a clear gap in between where clean air from outside has been pulled into the circulation. This is a two dimensional example of the kind of circulation which produces a doughnut shaped hole in a 3D thermal bubble.

Knife-edge "thermals"

On rare occasions one may encounter an extremely narrow line of lift which gives the impression one is flying along a knife edge of rising air. I believe this is a much larger version of the chimney vortex pattern illustrated in figure 13. The suggested circulation has been drawn on the right hand side of the figure. Its size probably lies between a full sized street and the tiny chimney vortices. These vortex rolls produce a very nar-

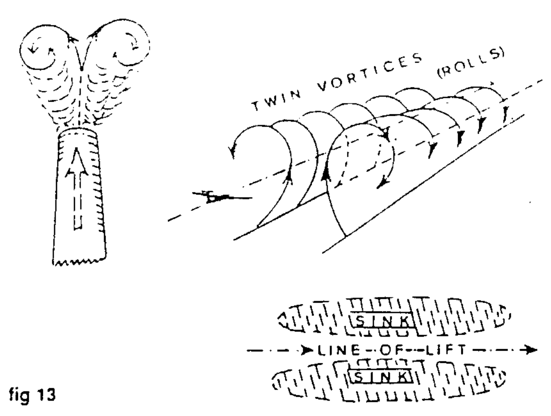


fig 13

row line of lift. One may encounter the effect after leaving a thermal. This lift is usually weak, often barely 1 knot, but it can extend for a mile or more. The line is much too narrow for circling, unlike a cloud street where one can stop and circle for extra height. Circling between these vortex rolls invariably takes one into sink whether the turn is to the left or right. Straighten up on to the original course after turning 360 degrees, and the lift returns.

Misleading indications

It is a common fault for pilots accustomed to the narrow thermals found over the British Isles to turn too soon on finding lift. This is more likely to happen when one has been flying fast between thermals and is now approaching a height where another climb is needed. First one runs through the strong sink so often found on the edge of a good thermal. Then the sink stops quite suddenly, so that it gives the impression one has run into a surge of lift. At the same time the vario gives a frantic burst of squeaks. A turn takes the pilot straight back into sink for a complete circle. Straightening up and continuing on the original course one eventually finds the real thermal is actually quite a long way further on.

Figure 14 is an attempt to show how this deception occurs. The airflow in and around a cumulus cloud is apt to be much more complicated than the model of a thermal bubble suggests. Some of the complexities were discovered by sending up a barrage balloon which supported a chain of anemometers attached to the cable at different levels. When all the readings were combined, streamlines of flow were drawn. These were not at all what one might expect. The flow went up, down and horizontally in a surprising manner.

The little glider on the left (which is not to scale) has a pair of dotted lines from the cockpit to represent the sector being scanned by the pilot. At this position the pilot has the impression of being just under the cloud although really he is still a little way outside. (Pilots seldom look vertically upwards unless they are in a gaggle.) When point "A" is reached, the glider flies through one of the side eddies and the cessation of sink is followed by a sudden increase in airspeed due to the horizontal gust. The total energy system interprets this as lift. Perhaps the sudden increase in "g" enhances the effect.

Three factors: the belief you are already well under the cloud and have reached point "B", the seat of the pants feel of a surge of lift, and the burst of excitement from the vario, all combine to fool simple pilots into starting a turn. It catches me regularly, particularly after rounding a turning point and beginning an into wind leg. I used to keep quiet about such lapses but was cheered recently to hear that competent pilots have been fooled the same way. The problem does not arise when you still have lots of height; then you just pull up and climb straight ahead, increasing speed again if it turns out to be a false indication. It doesn't matter if there really was a little thermal there or not because it was not needed.

Influence of waves aloft

Whenever there is a stable layer above the level of any mountains and the wind speed increases with height (while remaining fairly constant in direction) there is a possibility of waves. In the early morning or late evening one may see some indications in the shape of clouds. Often the air aloft is too dry for any lenticulars and during the heat of a summer day the lower levels are too churned up by convection currents for waves to exist low down.

It is not unusual to complete a flight using thermals and be quite unaware of wave lift above. Far away from the hills any changes in the thermals may be put down to normal variations. As your flight comes nearer the hills it may become apparent that some thermals are remarkably strong, the sink in between has got worse and some of the gaps are much wider than before. This is particularly distressing when heading into wind, for example when flying from the east towards Wales. If nothing odd had been noticed earlier one's first suspicions are likely to be aroused on approaching the line from the Forest of Dean to the Malverns, Kidderminster and Bridgenorth. Further north it is the lee side of the Pennines where thermals are most likely to be affected by wave. Over Scotland one automatically looks for wave.

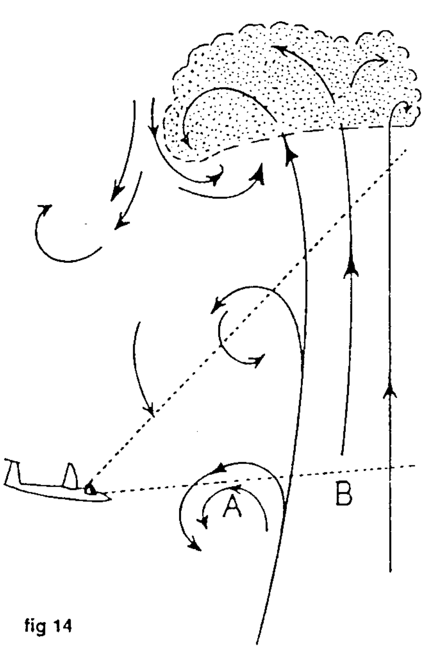


fig 14

Waves aloft tend to boost the thermals which occur under wave lift and suppress those trying to rise into wave sink. Wave troughs coincide with blue holes. Figure 15 illustrates the sequence. Be warned that the gaps between the cumulus are normally larger than shown here. At first conditions seem to be improving as you fly from east to west (right to left on this diagram). Thermals become much stronger and some may be twice the average found further east. Then there is a gap where the post-thermal sink is unpleasantly strong and goes on far too long. Relief at reaching cumuli on the far side turns to frustration when it seems that none of them are working. Going downwind across such a gap is far easier. The tailwind reduces the time spent in the blue and the very first clouds on the far side work well.

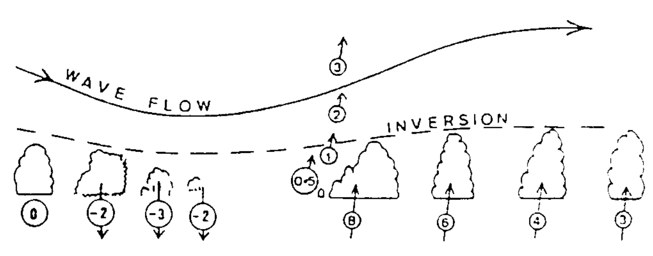


fig 15

It may be possible to get into the wave from the last strong thermal before the gap. It may not be necessary to make a cloud climb first though one should take the climb right up to cloudbase if possible. While climbing in the last thermal it may be necessary to straighten up each time the circle brings you into wind. This is because the normally circular pattern of the lift is distorted into an oval or race track shape by the wave. If one makes perfect circles the lift will apparently decrease as height is gained. By constantly shifting upwind one can keep in the best lift. (The same technique is useful when using thermals coming off a ridge.) In both cases a long lasting thermal "plume" is being triggered off from a particular place. If you are climbing in a single bubble where the central core is ascending more rapidly than the entire bubble the effect of the wind may not matter. In a plume whose base seems to be anchored to a ground feature one tends to be drifted out of the best lift.

One indication of wave is the continuation of lift (usually very weak) upwind of the last cloud. If the lift persists when you make a crosswind tack it probably is due to wave. Patient working of this lift, which is usually very feeble to start with, may eventually get you up to a level where there is a respectable rate of climb. If you are racing round a triangle the time wasted becoming established in wave will seldom be regained, however if the blue gap upwind proves too wide there may be no option but to turn tail and try for the wave.

Triggers for thermals

Cloud streets and upper waves are examples of methods of setting off a series of thermals. If one excludes the very first thermals of the day, it is likely that many new thermals are dislodged from the surface by the sink from air displaced by older thermals coming right down to the ground and then spreading out horizontally.

Over a flat ground a shallow layer of air can be warmed to a temperature well above what is theoretically necessary to set off a thermal. The lapse rate is called "super-adiabatic" because it is much greater than the dry adiabatic lapse rate found between ground and the base of cumuli. Despite the excess of temperature the overheated air seems reluctant to produce a thermal. It waits for some trigger like the downflow from a previous thermal to stimulate activity. The downflow acts like a wedge detaching new plumes from the surface. The arrival of these wedges can often be felt as a gust of wind. Sunbathers on a typical English day may notice that such chilly gusts often coincide with the arrival of the cloud shadow from a passing cumulus. A number of thermals seem to be triggered off when the shadow from an advancing cloud comes across. One can observe this while waiting to escape from ridge soaring. If many minutes of continuous sunshine have failed to set off a thermal the arrival of a cloud shadow may do the trick. Presumably the activity is initiated by the downflow from the approaching cloud.

Lesser convergence lines

There are many days when the air is too stable for cu-nims but some feature of the wind flow produces an almost continuous line of cumulus. These are often called convergence lines and forecasters can seldom tell when or where they will develop. With sufficient observations one may find that the low level winds do really converge along a well defined line. Large scale charts may show a kink in the pattern of isobars but this usually appears after the event.

Sea breeze fronts are one type of convergence line and satellite pictures have shown a line of cloud starting over the Cornish Peninsula where two sea breezes meet and then growing to extend all the way to London. Such convergence often makes cumulus grow far larger than one would expect from looking at the temperature trace of the latest upper air sounding. John Findlater reported an occasion when sea breeze fronts coming from different directions met over East Anglia and thunderstorms developed at the crossing points.

Thunderstorm outflows and convergence lines

The downflow from a moderate sized cumulus is negligible compared to that from a full grown cu-nim. When big cumulus reach the shower stage the mass of falling water, perhaps weighted down by hail too, can combine with evaporational cooling to produce powerful downdrafts that reach down to the ground and spread out horizontally for many miles. In the extreme case the downdraft may be termed a microburst with storm force squalls. (The strongest gusts so far recorded from a microburst in the USA was 130 knots). More often the outflow only forms a vigorous gust front which spreads out to trigger off new shower clouds. American meteorologists have observed that thunderstorms are often initiated at convergence lines, and where two such lines collide the result may be a very severe storm. The collision of two gust fronts can set off a great fountain of rapidly rising air. Sometimes one gust front spreads out to undercut an existing storm, greatly adding to its vigour and possibly setting off tornadoes. At other times the arrival of the gust front at a range of hills is enough to set off new storms.

Developments like this are best watched from the ground or from a powered aircraft which can turn tail and get well away when conditions begin to look dangerous. Even in England, where the majority of thunderstorms are babies compared to the American monsters, the collision of two gust fronts can be followed by extremely rapid extension of the storm area.

Thermal detectors

I have not yet heard of any successful way of detecting thermals instrumentally. Very many years ago it was hoped that sensitive thermistors in each wingtip could be made to show which way to turn on encountering a thermal. In recent years some hangglider pilots have used an instrument to detect temperature gradients in the air they fly through. The device is said to distinguish between the turbulent fluctuations which always exist in thermic condition and true thermals. There seems to be some doubt if the detector really works at high levels, but at the very low levels where hanggliders begin thermalling the instrument may be helpful.

Cold thermals

The problem with any temperature sensing scheme is that thermals are only warmer than their surroundings at low levels. The original temperature difference usually disappears when the thermal rises well above the ground. Towards the top the rising air is usually cooler than its environment. This is illustrated in figure 16. In this figure the actual temperature has been converted to "potential temperature"; this is the temperature which dry air would have if it descended to the surface, (it is usually calculated for the 1000 millibar level). The advantage of the potential temperature is that you can compare the air temperature at different levels to a single standard. If the temperature follows a dry adiabatic lapse rate its appearance on this diagram is a vertical line.

In figure 16 the solid line represents the thermal rising from the ground while the dashed line is the environment temperature. The stippled area at the bottom shows the thermal starting off much warmer than the environment. This part has a super-adiabatic lapse rate. By the time it has reached about 500 feet (sometimes sooner) the thermal will have cooled to about the same temperature as its environment. The two lines overlap with only small wiggles. Near the top where the environment becomes stable its potential temperature rises with height. (The dashed line curves off to the right.) There is then a widening gap between the temperature inside the core of the thermal and the air outside. The shaded section shows this change. Eventually this cooling stops the thermal rising any further, but it may go up quite a long way before stopping.

How moisture helps

Thermals usually carry up moisture from low levels and this acts to reduce the density of the air inside the thermal. Water vapour is lighter than dry air so humid air is *less* dense than dry air at the same temperature. Meteorologists find it simplifies many calculations to use the "virtual temperature" of the air instead of the actual temperature.

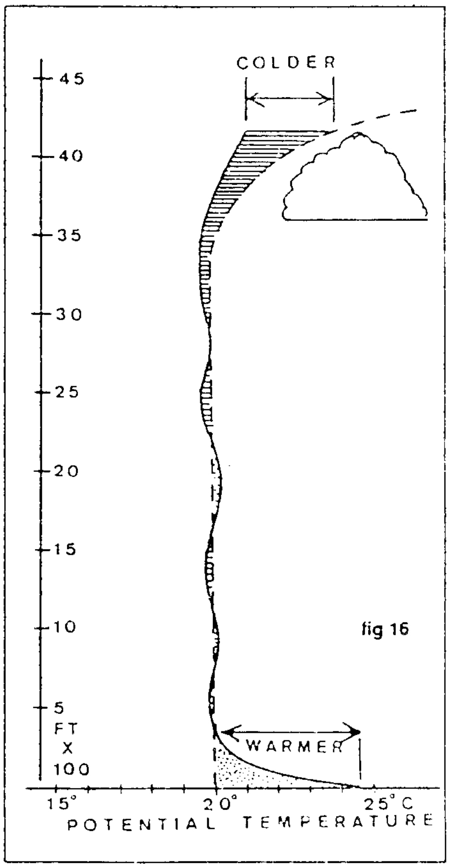


fig 16

Virtual temperature

The virtual temperature is higher than the measured temperature by an amount which exactly balances this change of density. For example if the pressure was 800 millibars (6394 feet on the altimeter) the temperature 14°C and the humidity just over 90%, the virtual temperature would be two degrees higher than the actual temperature of dry air. Put in another way, the air in the thermal could be nearly two degrees colder than the dry surroundings and still have a tiny amount of buoyancy. In real life the surrounding air also contains some moisture so the difference is rarely so great but the effect is still important.

The extra buoyancy due to added moisture and the momentum of the rising air combine to help strong thermals penetrate some distance into a temperature inversion.

FROM THE PAGES OF FREE FLIGHT (OFFICIAL JOURNAL OF SAC) AUTHOR UNKNOWN—(WITH THANKS TEDITOR)

*SUBMITTED BY STAN SHAW

DESIDERATA

Go placidly amid the noise of the towplanes & remember what peace there is in the silence at 5000 feet • As far as possible without surrender, be on good terms with the towpilot • Speak your truth quietly & clearly; and listen to others, even the dull & ignorant — they too have their good flights • Avoid loud & aggressive persons, they are vexations when you are preparing to fly • If you compare yourself to others, you may become vain or bitter, for there always will be novices or diamond pilots about • Enjoy your achievements as well as your plans; keep trying for that next badge leg • Exercise caution in competition for contest pilots are full of guile • But let this not blind you to what virtue there is; many pilots striving for height get help from those already in lift • Be yourself • Especially do not feign affectation • Neither be cynical about lift, for in the face of sink and poor landing areas, it is as perennial as the grass • Take kindly the counsel of the years — gracefully surrendering the things of youth • Let the younger club members push the gliders to the flightline • Nurture strength of spirit to shield you when lift fails • But do not distress yourself over poor forecasts, many fears are born of fatigue & loneliness in the cockpit • Beyond a wholesome discipline, be gentle with the controls • You are a child of the universe, no less than the power pilots & jet jockies; you have a right to some airspace • And whether or not it is clear to you, no doubt the universe is unfolding as it should • Therefore be at peace with the CFI, whatever you conceive him to be; and whatever your labours & aspirations this season, in the noise and confusion on the flight line, keep peace with your fellow pilots • With all its sham, drudgery & broken dreams, it is still a beautiful sport • Be careful • Soar to be happy •

Found in the map pocket of an old 2–22, dated 1954.