27 - METEOROLOGY & INSTRUCTING

This chapter assumes you already know something about meteorology, and looks instead at its direct and indirect effects on instructional flying. Much of the information in this chapter is stuff that ought to be passed on to trainees, and as a result it is largely a list of things that can 'hit the fan' and so doesn't follow the same pattern as the others.

Weather forecasts may seem comfortably reassuring in their own far sightedness, but the weather frequently takes no notice. Besides, as an instructor concerned with general airfield safety, your most pressing problem is not tomorrow's weather, but *what will the weather do today, in the next few hours*? You need to be able to assess conditions throughout the flying day; an ability which you can't buy, or soak up from television or the internet. You need to be there, and observant. An unfortunate truth about the weather is that even when you know what's going on, you can still get taken by surprise, if not quite as often as someone with little weather experience. Most of these surprises are benign, some can startle. You should always be open to the possibility that a rare few may turn out to be quite dangerous, and that it may not be you who has to deal with them.

Sources of weather information

- ☐ BBC web site and TV forecasts
- ☐ MET office aviation and general website (Forms 214/215)
- ☐ Ballooning forecasts are also useful and contain much information relevant to glider pilots - eg thermal strengths etc

The best way to minimise meteorological surprises is to look at the forecast charts for every day, and then compare them with the reality. In this respect forecasts based on synoptic charts are infinitely preferable to media presentations with clouds, which often say little more than *fine and dry* or *wet and windy*. Ascents are also useful. Synoptic charts and ascents are available on the web, on sites tailored to the needs of aviators (see box) rather than people going shopping. Local TV forecasts can be quite good, with the advantage of being area specific; which is often sufficient for most 'up, round and down' instructional flying. The inaccuracy of many forecasts reinforces the message that when it comes to the vital 'what's going to happen next', your own judgement, like it or not, can count for quite a lot.

TEMPERATURE

The major influence driving the weather is differences in temperature. Despite that, most of the effects discussed in this chapter come under other headings because, even though temperature will have probably triggered them off in the first place, it may not be the most obvious, nor necessarily the most problematic thing about them.

High temperatures & dehydration

During a long instructional turn on a nice Summer's day it is far too easy to keep bashing on, and forget to stop every so often to take a drink of water. This is a mistake because, even when you have become badly dehydrated and start to suffer some of the symptoms below, an exceedingly unhelpful quirk of human biology means that you may not feel thirsty until you actually drink something and begin to rehydrate. Dehydration is cumulative and its effects take a long time to reverse.

Some of the symptoms are:

- (1) air-sickness, a severe headache or just a general feeling of being unwell
- (2) torpor, extreme tiredness and/or irritation
- (3) irrationality
- (4) poor or non-existent judgement.

If severe dehydration isn't dealt with the victim becomes unconsciousness and eventually dies. If you're solo and become unconscious in the air you'll be beyond help. If you're flying dual, and expect either a member of the public or a trainee of who knows what ability to save you, rehydration may be academic.

Dehydration is not confined to trainees and instructors. Everyone on the airfield - winch driver, tug pilot, log keeper (the lot) - can be affected. If there is a wind everyone will dehydrate at a faster rate which will be greater the stronger the wind.

How much liquid you need to take in to remain adequately hydrated depends on what you're losing. If cockpit temperatures are very high (85°F/28°C+), you can sweat out a litre an hour. A sensible intake rate which doesn't cause unnecessary overflow, or merely delay dehydration until slightly later in the day, is difficult to gauge, but what you take in probably ought to balance what you've lost. Though you're not likely to know exactly what's required, there is some leeway. In any case, it is best to drink small to moderate amounts frequently rather than huge amounts infrequently. Water is preferable to canned drinks, which can make you more thirsty. Tea and coffee are diuretics, and while they will rehydrate you, you'll also have to top up far more frequently.

High cockpit temperatures can be extremely tiring, particularly in blue conditions. During hot weather instructors should make sure that pilots doing badge flights, particularly Silver C duration, are suitably equipped with sufficient amounts of water, sun hats, dark glasses etc - and high factor sun cream.

Also worth pointing out is that though the need to relieve oneself when airborne is usually confined to long flights, or shorter ones if the temperatures are very low, pilots who desperately need to pee - and for one reason or another either don't or can't - can become totally obsessed with their discomfort and lose interest in more critical issues, such as lookout or an imminent out-landing. More life-threatening is the possibility of a full bladder bursting if you do a heavy landing or the ground run is very rough.

Low temperatures

The effects of low temperatures are more immediately obvious than those of heat, but it can be so shudderingly cold that we can't think about anything else, or even anything at all. Trainees can spend a lot of time standing around waiting to fly - even the launch point bus or caravan may be like a fridge - and by the time their turn comes the cold can have rendered them less receptive than normal to briefings, demonstrations, and more critically, to prompts. Extreme cold can lead to:

- drowsiness and mental apathy
- hypothermia
- frostbite.

One wouldn't knowingly fly in conditions likely to result in frostbite or hypothermia. Frostbite is bad enough, but hypothermia is particularly nasty because once the body's core temperature has dropped below a certain minimum, it is extremely difficult to raise it again. Potentially, extreme cold and low levels of physical activity during long flights (in wave, for example) can create significant problems.

A ‘cure’ for cold is to dress for the temperature at your likely operating altitude, regardless of how warm it is at ground level. You can also spend a long time standing on very cold ground, so good footwear is essential. Good headgear also, because without it a fair percentage of your body heat will be lost through your head.

Add a wind or draught to an environment and there's the chill factor to consider. Many older gliders are draughty, and even in gliders which aren't, the pilot's feet are usually hidden away in the dark under the instrument panel and can get particularly cold. A suitable flap over the aerotow hook hole is a useful modification for two seaters like the AS-K13, but in any glider thick socks, decent shoes and thermal underwear are a great help.

Make allowance for the fact that adequate clothing in the coldest parts of the year will almost certainly restrict your freedom of movement in some way.

Other cold related items

Exhaled breath is loaded with moisture, normally invisible, which evaporates quickly. During colder parts of the year breath condenses out as a small cloud in the cockpit, and mists over the inside of the canopy. While this is often little more than a temporary nuisance, cockpit ventilation when the glider's on the ground is pathetic. Condensation often doesn’t clear until the launch is well under way. It may not clear at all. A low cable break when one can't see ahead, or anywhere else, doesn't bear thinking about, so pilots tend not to think about it. They should.

Long flights or repeated launches above the freezing level can gradually cool the entire airframe to below 0 C. Any condensation that then forms anywhere on the glider as it descends below the freezing level will instantly turn into ice. Clearing the canopy may be impossible, and ice forming on the flying surfaces will seriously affect the glider's performance.

In addition, many large clouds contain a layer of supercooled water thousands of feet deep, straddling the freezing level. Supercooled water can remain liquid at -40°C. Any aircraft passing through this layer will act as the nucleus for rapid ice formation, and end up completely encased by it. In the UK these supercooled layers are rarely low enough to affect 'circuit bashing' instructional flying, but if freezing rain starts to fall out of them, don't even think about taking off. If you're airborne, get the ventilator and the clear vision panel open before they freeze shut. There's no direct forward view through a clear vision panel - it would be draughty if there was - but what there is beats having none, and it is possible to land a glider using it.

The controls can sometimes stiffen up if ball bearings and similar components have been lubricated with high rather than low temperature grease. Another cause can be temperature induced changes in the lengths of push rods or cables. Adjusting the cable operated controls of older gliders to the correct tension in the Spring, almost invariably meant they were too slack during the Summer, and too tight during the Winter.

If you don't cloud fly its not very likely (freezing rain excepted) that you'll have the controls start freezing up, but there can be circumstances where you need to have the brakes out - emergency descent from wave, say - and there is a real possibility they might freeze open. This can make things exciting, but is better than overspeeding.

Coping with icing

The easiest way to cope with icing is to try and avoid conditions where its likely to form in the first place.

Pausing during a lengthy descent from on high allows the airframe time to warm up, relatively speaking, and can help get rid of ice. It also helps lessen the temperature gradient through a GRP structure which leads to the gel coat cracking and crazing. The effectiveness of such a pause, assuming you are able to make it, will depend on the height of the freezing level and the lapse rate below it. In Winter the 0°C isotherm can be several hundred feet underground.

Moving the controls may help break any ice that forms on them, but it could be argued that this might also give ice an opportunity to get to places it wouldn't otherwise have reached.

Temperature inversions

In the lowest level of the atmosphere - the troposphere - temperature normally falls with height. If it does anything else a 'lid', or inversion, is created which can be anything from a few feet to several thousand feet thick. As well as limiting the height of convection, inversions have other effects:

- on clear nights the ground radiates away heat gained during the day. If high pressure dominates for several days, the inversion layer gradually deepens and lowers. Convection starts later and later each succeeding day and goes less and less high. Visibility deteriorates as increasing amounts of murk are squeezed into a smaller and smaller volume. The effects continue to worsen until the arrival of a new air mass
- during the coldest parts of the year inversions help and speed the formation of fog, particularly late in the day and/or when the wind is very light. In such conditions fog can be very slow to clear
- radio reception can be affected [chapter 26].

At any time of year the height of an inversion can drop very suddenly as sea breeze fronts, or occasionally just sea air, roll in from the nearest coast. A number of things can then happen:

- conditions become ‘blue’, or
- there is a sudden increase in cloud cover, usually stratus
- the visibility changes for better or worse. In cases where sea air comes in it can bring sea fog with it.

Inversions have nuisance value in that they affect soaring and visibility. But, occasionally, they can have odd results. For example, given the right conditions, large estuaries like the Wash or the Severn can produce tongues of ‘blue’ air that stretch downwind for anything between 10 and 60 miles, in which the inversion level is several thousand feet lower than the base of any cumulus on either side.

WIND

Admiral Beaufort (1774 - 1857) classified wind speeds according to their effect on a 'well conditioned man of war'. The scale named after him (table below) compares the descriptive terms for wind speed against the actual speeds and his original scale.

The wind is an invisible constant in gliding (sometimes positive, sometimes not), and a contributory factor in many accidents, from blowing over to spinning in.

There are four wind related problems in instructing:

- **too little wind.** A problem only in so far as it may help create another, such as fog, or limit the height of launches
- **too much wind**. An obvious problem, but it can creep up on one (see smaller box, bottom right)
- **abrupt changes in wind direction**. Sea breezes and squalls can cause these, as well as thermal gusts
- **abrupt changes in wind speed.** Causes can be vortex shedding from obstructions such as buildings, steep wind gradients, and/or gusts. Also gust fronts related to cumulonimbus, and steep wind gradients.

The Beaufort Scale

Description	**Wind speed (kt)**	**Mean speed (kts)**	**Beaufort scale**	**Terms used in public forecasts**
Calm	<1	0	0	Calm
Light air	01-03	2	1	Light
Light breeze	04-06	5	2	
Gentle breeze	07-10	9	3	
Moderate breeze	11-16	13	4	Moderate
Fresh breeze	17-21	19	5	Fresh
Strong breeze	22-27	24	6	Strong
Moderate gale	28-33	30	7	
Fresh gale	34-40	37	8	Gale
Strong gale	41-47	44	9	Severe gale
Whole gale	48-55	52	10	
Storm	55-63	60	11	
Hurricane	64-71	68	12	

The windsock

Windsocks are there to show pilots the direction and strength of the surface wind, but they can also tell you how turbulent the air is likely to be. If the windsock flaps up and down and constantly shifts from side to side, it is very likely to be rough.

A windsock rated at 20kt will stand out straight when the wind is at or greater than 20kt (figure 1). A 10kt windsock will do the same at 10kt. 20kt is more useful for gliding clubs. Regardless of their speed rating, windsocks come in a variety of sizes. The bigger ones are preferable if only because they are more visible.

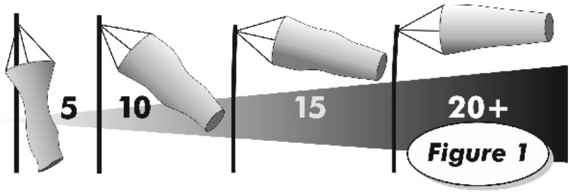


Figure 1

Though reliable, windsocks only tell you what's happening at their level. At wave sites a windsock can hang lifeless from its supporting pole, but at 300' on aerotow, say, all hell breaks loose. In some conditions the indicated wind direction at ground level can be 180° out from its direction at, say, 100'. This presents no problem for the landing itself, but can lead to pilots overshooting badly on the approach if they haven't realised what's happening.

If you fly from a site where such conditions occur, you will know what to do about them when they're there. Those most at risk are visiting pilots of almost any level of experience, from less difficult sites. Their proper briefing and supervision is vital.

Strong winds

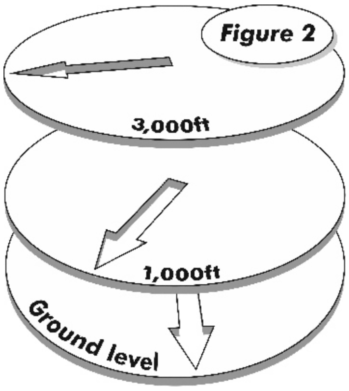
Given a suitable glider we might be flying at a ridge site if the wind was a moderate gale, force 7 (28-33kt), but probably not at a flat site. Even so, any site can find itself operating in 'out of limits' conditions, if not by accident, then certainly by unintentional design. The developing scenario described in the box below is not uncommon, even if the results aren't always the same. The weather may have been awful for days, even months, giving an added incentive to flying on as long as it's possible to do so, particularly if lots of frustrated pilots are practising being peeved at the launch point. Given the pressures for you, the instructor, to do the 'right thing' (frustrated pilots generally interpret 'right' to mean letting them do exactly what they want, safe or not), it can be difficult to pack up. Nonetheless, that is exactly what you should do if there is any doubt at all about the safety of the operation. As importantly, you do need to be aware that the situation IS deteriorating. It's not always obvious.

> Early in the day the wind was brisk but steady. The gliders were taken out to the launch point at about 0900hr and flying started almost immediately. At about 1100hr convection began to stir the atmosphere, bringing down stronger upper level winds ahead of an active front and its associated depression. Thermal gusts were much in evidence, masking the fact that the overall wind speed was slowly increasing.
>
> The process was so gradual that flying continued on into the kind of conditions where, if everyone had just arrived, they wouldn't even have bothered to open the hangar doors. At about 1330hrs .... (accident report follows).

Gusts and the Mean Wind Speed

Turbulence, felt as gusts and lulls in the wind, is often the result of the wind hitting obstructions such as buildings and trees. It can also be the result of thermal activity, and the rotor associated with wave (see later note). The wind speeds mentioned in 'for the public' forecasts are mean speeds and gust strength won't be mentioned unless the wind is very strong, unlike aviation based forecasts.

If the mean wind speed is low, thermal gusts in the UK aren't usually brisk or long-lived enough to cause serious problems, but there are exceptions (see Squalls, Cumulonimbus and dust devils). It's worth saying that while some GRP gliders are treated as if they were almost impossible to blow over, all gliders will go over eventually if the wind, steady or not, is strong enough. Lighter GRP (Junior eg) will blow over very readily if given the chance.



What does cause problems is a mean wind speed within acceptable limits, but gusts which are either way outside them or heading that way. Gust strength can be the deciding factor in whether to fly or not. Be particularly careful in respect of inexperienced or nervous solo pilots. Their confidence can be severely dented even when, in your view, they have coped. If flying does take place, suitable margins in terms of approach speeds should be decided before take-off.

Wind gradients

Wind gradients still figure in landing and take-off accidents, often because no allowance has been made for them. The rate of change in wind speed with height (occasionally in direction) is usually very marked below 500', and at its greatest below 150'. The changes are greater the stronger the general wind. Any approach needs to take these things into account and be started at an appropriate speed. If it isn't, then there may not be enough height available to accelerate to a safe speed, and in really bad cases it can be impossible to round out [See chapter 14-1 (Approach speed selection) and figure 14-5 for more detail].

Strong cross winds

In the same way that gradual increases in wind speed can cause problems, so too can gradually changing wind directions, especially if the wind is increasing at the same time. Such conditions often occur ahead of frontal systems.

What was initially easy if you can land and take off into wind can become the opposite as the crosswind component increases. Gliders which have a tail skid and sit tail-down when the pilot's aboard can behave badly in cross winds, and a few types will ground loop with ease. If you aren't able to relocate the launch point, for whatever reason, there will be crosswind conditions in which you cannot operate safely, or, more trickily, some aircraft/pilots can't.

The decision as to who, if anyone, shall fly in crosswind conditions must be based on the individual pilot's experience and competence, but if every landing glider veers off uncontrollably into wind during the ground run, you should probably have changed runs or packed up ages ago. Flying in extreme cross wind conditions can lead to ground looping on take-off or landing, and contribute to the ground level wing-over described in chapter 16.

Bungying may not be common these days, but if the wind isn't more or less straight onto the hill, then the glider will be launching cross wind. Dropping a wing is just as likely as during any other form of launch, but on a bungy launch releasing may not alter the outcome.

Yet more windy conditions

The wind can create other interesting problems when:

- a very active cold front and a deep, associated low are approaching
- the same front has just gone through. Conditions immediately behind can be highly unstable, and remain so until the pressure starts to rise
- Cumulonimbus cloud is nearby or directly overhead
- tornadoes and dust devils are in evidence (see later note)
- a sea breeze front crosses the site
- squalls or line squalls approach (see later note)
- there is wave activity and/or strong thermal activity.

Blow, blow, thou ....

In strong and/or gusty winds gliders need to be parked properly. Even if a badly parked one doesn't blow over it can still swing round or change wings and damage itself, people, other gliders and other equipment.

Moving gliders around on the airfield requires far more care and more crew. To ensure that crew numbers are always adequate it may be necessary to limit the number of gliders at the launch point.

Canopies can blow shut or open with equal ease and are very easy to damage and hideously expensive to repair. Wherever possible or practical, lock canopies shut during ground handling.

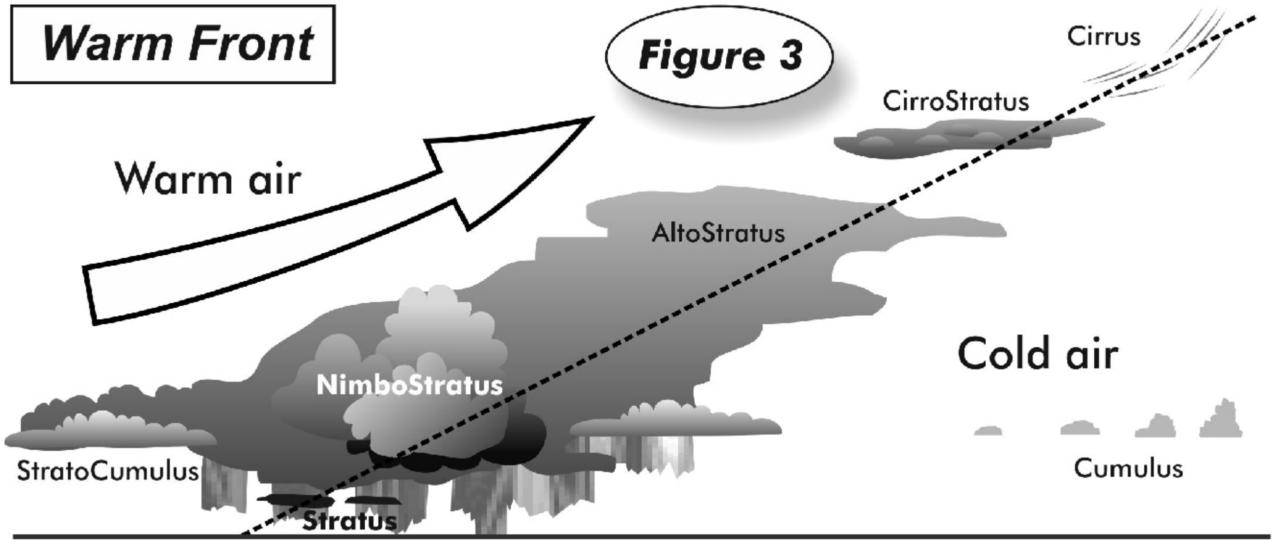
In strong winds pilots should stay in the cockpit after landing until help arrives. Staying in gives the pilot some control of the glider and allows him to keep it 'flying' onto the ground. Since pilot weight can be a significant percentage of the glider's flying weight, getting out reduces the wing loading and the stalling speed. Suddenly, the glider's on its back in the car park - or somewhere.

While waiting for crew, don't undo your straps. If the glider blows over it's not a great idea to fall through the canopy onto your head from 30' up or more, and then maybe have the glider land on top of you seconds later.

Curlover

Curlover is an effect which most pilots associate with the lee side of hills, even though the lee side of anything can create it - lines of trees, hangars etc. Pilots based at ridge sites know all about the 'clutching hand', either by direct experience of heavy sink on the downwind side of the hill, or merely being warned about it. When hill site pilots go to flat sites they tend to do higher and closer circuits than the local pilots. The opposite applies to flat site pilots at ridge sites, and they are more at risk from curlover than hill site pilots are from overshooting. The differences need bearing in mind when checking a pilot from a site markedly different to your own.

While a line of trees might be an obvious source of curlover, ground with a surprisingly shallow slope can also divert air downwards sufficiently fast - it doesn't have to be more than a knot or two - to turn an OK approach into an 'Am I going to get there?' If there is a wind gradient and/or gusts at the same time,



Warm Front

Figure 3

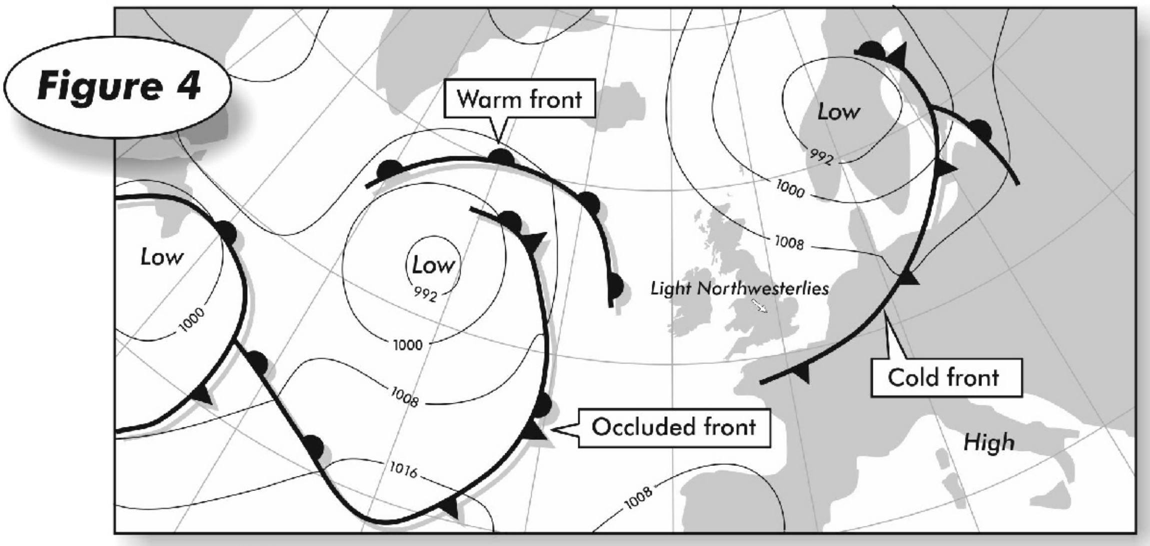


Figure 4

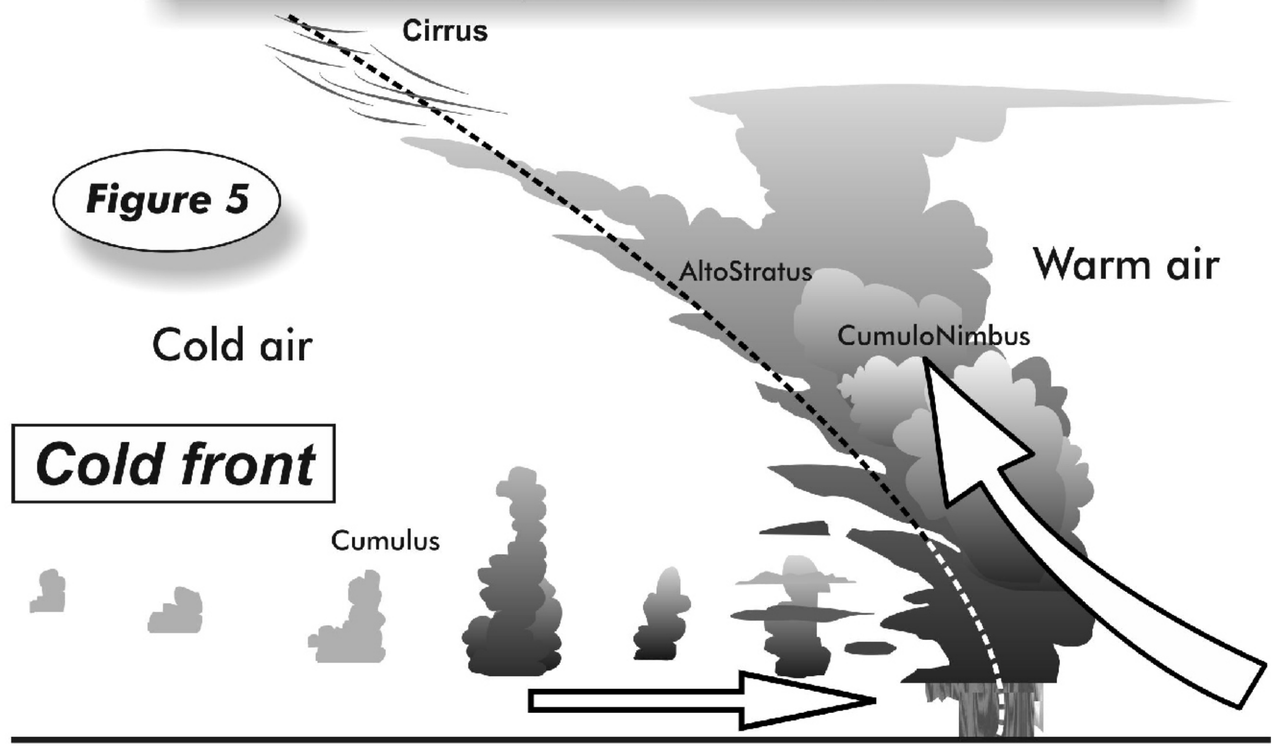


Figure 5

Cold front

an undershoot is likely. It's another good reason why minimal airbrake/shallow approaches should be discouraged.

Some 'curlovers' are quite dramatic, and entirely horizontal. At least one club in the UK has to stop flying in certain wind directions because their ridge produces a huge rolling vortex of turbulent air across the airfield.

Vortex shedding

When the wind blows, stationary vortices can form on the lee side of any object and stay there until a random change in wind direction or speed causes them to break away and tumble off downwind. They are then replaced by another vortex which, in its turn, will also tumble off downwind. These vortices can be powerful and travel a long way before dissipating. Sudden gusts at the launch point may alert you to their presence, but the frequency and timing of their arrival is impossible to predict and in practice they're indistinguishable from thermal gusts. Make the same kind of allowances for them as you would for any other causes of gusty and turbulent conditions.

ACTIVE FRONTS

Every front is active in the sense that any difference between the two airmasses involved will always create 'weather' along the interface. The results can be dramatic when the two air masses are markedly different, and almost impossible to detect when they're not. It's not unusual, for example, for an approaching cold front to be slowed to a snail's pace by a well established and stationary high pressure area, and just quietly fizzle out along the way. Conditions don't get worse, but neither do they improve. This isn't an instructing problem in the usual meaning of the words, but never underestimate the negative psychological effects on the judgement of frustrated pilots who have waited days for better weather and then not got it.

A major problem with any frontal system is predicting exactly when it will arrive. Your experience and reading of the clouds will be invaluable in helping you make an intelligent guess. In general, cold fronts move faster than warm ones.

Warm fronts

The cloud types that precede a front are related to the slope angle and direction of the interface between the two air masses. With a warm front (figures 3 & 4) the less dense warm air slides up over the back of the cold air along a shallow, forward leaning slope of about 1:100, though it can be 1:200 or greater. The width of the interface can be anything between 300 and 600 miles. This thin ended wedge (figure 3) gives the clouds that precede the main rain bearing body of the front their particular characteristics. High thin cirrus cloud, entirely composed of ice crystals, arrives first. This is followed by the cloud gradually thickening downwards to form cirrostratus, then altostratus, and finally low level stratus and rain bearing nimbostratus.

It can remain soarable under the increasing cloud until the drizzle preceding the heavier rain arrives. The wind usually backs and increases in strength as the front approaches, and then veers as it passes through.

Partly because the frontal zone is so wide and shallow, nothing tends to happen at any great speed or even with any sharp definition. Under the main part of the front rain can be heavy and prolonged, but the post frontal clearance may also be slow, with Stratocumulus cloud reluctant to disperse.

Apart from the increasing and backing wind, the most likely instructing problem will be launching into the lowering cloud, or being caught in the rain. The visibility can occasionally become really bad just before the arrival of the main front, and cloudbase can start to drop very rapidly.

Warm sector weather

Soaring is often poor in the warm sector between a leading warm front and a trailing cold one, and the sector is also prone to convection-killing spreadout. Visibility may not be very good either. While warm sector weather doesn't present major instructing problems, it can lessen pilots' chances of completing cross country flights, and is not the ideal time to send anyone off on the lengthier badge flights.

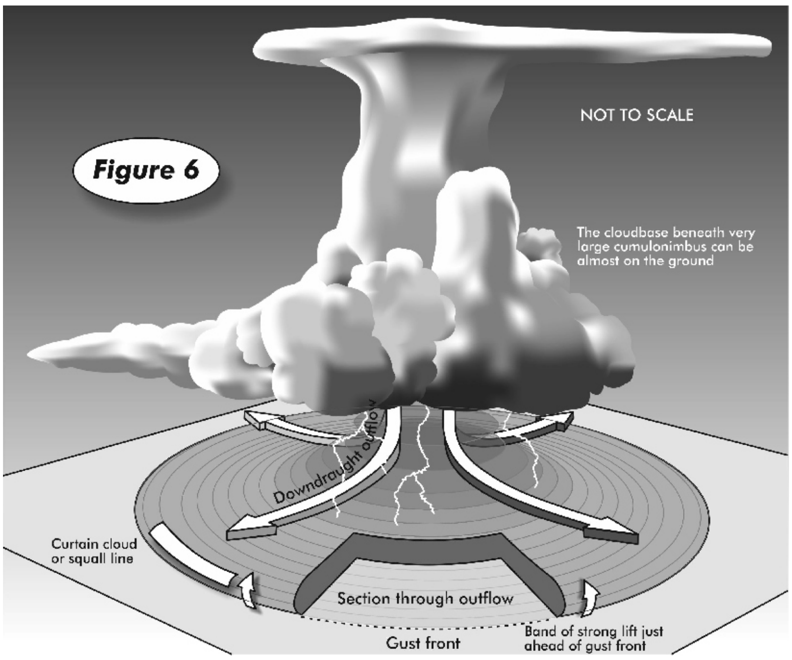
Cold fronts

Cold fronts (figure 5) are usually far more aggressive than warm fronts, and move faster and catch them up. It is the catching up that causes most of the trouble. The denser cold air drives like a blunt wedge under the warm sector, pushing it upwards and increasing its overall instability. Even in the absence of thunder and lightning, it is normal for very gusty and turbulent conditions to herald the imminent arrival of a cold front.

The slope of the interface is far steeper than that of a warm front, and leans backwards over the intruding cold air. Unlike the warm front cloud builds up rather than down, usually starting with mid level Altocumulus.

If the temperature and humidity of the two air masses differ markedly - a matter dependent on their respective origins - the front can be extremely active, and the increased instability often results in Cumulonimbus and thunderstorms. Cumulonimbus aren't always electrically charged thunderclouds, but thunderclouds are always cumulonimbus.

Cold fronts can often develop shallow but intrusive 'noses' at ground level, usually as a result of the downdraughts from associated cumulonimbus, or the speed and weight of the cold air as it drives under the warm air; particularly likely to happen



with very active fronts. The two effects sometimes combine, resulting in a belt of very strong winds and turbulence just ahead of the front, and spectacular lines of lift.

CUMULONIMBUS & LIGHTNING

The formation of cumulonimbus (Cb) (figure 6), or cunim, requires an unstable atmosphere, particularly at high level, and a weak or non-existent inversion at altitude. Cumulonimbus are usually associated with high humidity and temperature - sultry or 'close' conditions - but are just as likely during the passage of a very active cold front. Winter cumulonimbus are less frequent and don't extend as high as Summer ones. Both can temporarily bring extreme conditions, not always confined to their immediate locality.

Something that flashed and banged as much as a thundercloud ought to be obvious even from miles away, but not always. You can get taken by surprise (see box below).

In addition to wind and rain related problems, there is lightning. The majority of strikes occur within the cloud and never reach the ground, and many of them are never seen. The voltages involved are huge - ranging from one hundred million to one billion volts - and the amperage (which is the 'punch' most likely to kill you) ranges from one hundred to one hundred thousand amps.

It was once fairly common to 'go for' Gold or Diamond Height in Cb, but not any more. Cb aren't inevitably electrically charged, but when they are the chances of being struck by lightning whilst in, under, or even near one are about 1 in 10 - as they always were. If you're bold, or merely lack imagination, that level of risk might sound acceptable, but it is important to realise that 1 in 10 does not mean nine misses before you are hit, nor if you are, that the next discharge won't zap you again - and again after that. The same odds apply every time. If this doesn't make much sense, remember that you're the only one doing any counting. Nature doesn't keep a score.

Closing the circuit

A glider's metal parts are, or should be electrically bonded together. This makes no difference to whether the glider will be struck by lightning or not, but it helps stop the pilot becoming the unwitting 'live wire' through which individual metal parts equalise their electrical potential. Despite that, pilots can still get unpleasant and distracting shocks.

Lightning damage can be serious, even structurally catastrophic, not to mention putting the pilot(s) in some jeopardy. In one fairly recent incident the GRP glider involved effectively exploded. Despite this, and rather surprisingly, the chief problem with lightning strikes is when almost nothing seems to have been damaged. The only clue that a glider's been struck, apart from the pilot's say so, can be a few tiny pinholes and burn marks on the structure. These marks bear no relation to what may have happened inside. There are cases where most of the main spar has been vapourised, control cables fused - and a lot more, none of it obvious from outside. If a glider is struck and lands in one piece, it must not be flown again until it has been thoroughly inspected, even opened up.

> **Symptoms of an imminent strike**
>
> - ☐ Buzzing sound. Anything even slightly pointy (eg., instrument retaining bolts) will try to discharge the static build-up. As the electric potential builds and a strike becomes more likely, the pitch of the buzz rises
> - ☐ Smell of ozone ('electrical' smell)
> - ☐ Hair standing out on end, including the hair on your arms
> - ☐ Unusual prickling sensations over the whole body, particularly in hands and feet
> - ☐ There may be fascinating lighting effects (St Elmo's fire)
> - ☐ **NOTE:** Reports suggest that there may be none of these symptoms before a strike!

> The sky was rather dark, cloudbase was 8/8, high and flat. The light wind was straight down the run. The two seater glider took a winch launch. At about two hundred feet the occupants smelt ozone, heard a buzzing noise, and their hair stood on end (see symptoms box, above).
>
> The P1 decided to continue the launch, reasoning that despite the ozone (and the hair) there was no rain and no prior lightning activity, so they were probably OK. He handed over to the P2.
>
> The glider released at 1,000' and turned right, almost immediately running into off the clock sink. P1 took over, turned back through 180°, and just managed to reach and land across the strip. Moments later the wind at the launch point gusted to gale force.
>
> Not once during the entire day was there any obvious sign of rain, thunder, or lightning.

Caught on the ground

People are far too nonchalant about lightning, and are apt to take refuge from the rain, which isn't dangerous, in places which are - under trees, in bus shelters, playing golf, or gossiping at the launch point. You're not safe sat in a glider, metal or not, nor in launch point caravans. Take cover in a car if you can.

If you notice any of the symptoms of an imminent strike (see box) and can't get to safety, go into a crouching position, feet as close together as possible, and don't touch the ground with your hands. Put your hands on your knees; don't cross them. Keep clear of other people, metal objects, masts, fences, and well away from winch cables on the ground. If the winch is struck you don't want to be waiting for the call at the other end of the line! If you are carrying metal objects, throw them away as far as possible.

Approximately 70% of those struck by lightning are NOT killed immediately. The heart stops and breathing is paralysed. Most victims become unconscious. After a few minutes the heart usually starts up again. The snag is that it takes much longer for breathing to restart itself, and unless mouth-to-mouth resuscitation or other form of artificial respiration is applied, the victim usually dies of suffocation.

When to stop launching

Winching when there's an active thundercloud in the immediate vicinity is like throwing a gigantic 1,000' plus lightning conductor into the sky and saying 'strike me', but what is the minimum safe distance between an active cumulonimbus and a winch launching glider? The longest recorded inter-cloud strike is 105 miles; about the distance between Parham near the South Downs and Saltby, near Grantham. 105 miles would be a margin of absurdity rather than safety (difficult to tell the difference sometimes). It has been discovered that some discharges are much stronger than others. Conditions may also make sideways strikes more likely than downward ones. In any event, the 'safe' figure needs to strike an intelligent balance between suicidal and submissive. Nobody knows what the safe distance is exactly, but you should probably stop winching if the cloud is less than ten miles away. Be aware that even if a really large Cb isn't tracking towards you, it can still expand outwards in your direction at great speed.

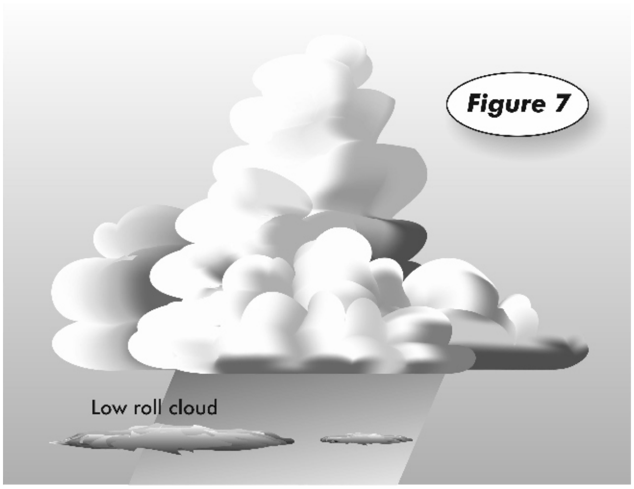
Big as these clouds can get, in hazy conditions they can be a lot nearer than you think. They can also be hidden from the ground behind layers of stratus - see box on previous page.

If you're flying and look as if you're about to be drawn into a Cb, open the airbrakes. If the lift is very strong (>10kt isn't unusual), increase the speed. If you're still going to be sucked in, turn on the T/S, and maintain a heading which won't take you towards the middle of the cloud. Keep the wings level and concentrate on what you're doing. Don't panic. It doesn't help.

SQUALLS & LINE SQUALLS

Squalls are usually accompanied by abrupt changes in wind speed and direction. They can be associated with approaching cold fronts, or accompany isolated cumulonimbus clouds.

Line squalls are also associated with active cold fronts, but they can also be part of a gust front (see later note). One sign of an approaching line squall is a belt of cloud or rain preceded by a layer of ragged low level cloud (figure 7). If you can see this cloud climbing and/or changing its shape rapidly you're in for an interesting time when it arrives. Gusts will be strong and the rain torrential.



If you can't get the gliders away before a squall or line squall arrives then make sure they are well parked and held down. Allowing for the likely wind shift requires a bit of guesswork, but if you do have to re-park a glider during a squall you'll need lots of people to do it. Be very careful!

Strong lift exists in a band the entire length of a line squall's leading edge, and will persist for as long as the associated front. Whilst exciting to soar, you'll be quickly carried away from the airfield, and the often appalling weather conditions that lie just behind the line are likely to block your return. It's also very easy to be sucked into the overhanging clouds, even with full airbrake and full sideslip. Long fast cross countries with uncertain destinations are possible, but even if you land well ahead of the line it will catch you up eventually.

Squalls and line squalls are not for early or inexperienced solo pilots; they're better off on the ground, at the site, long before such conditions arrive. Briefings should reflect this concern.

Gust fronts & microbursts

Down-draughts from active Cumulonimbus clouds can hit the ground and spew out across the countryside at 50kt or more (figure 6). How far they spread out from the originating cloud is hard to say, but with a really big and active cloud it can be tens of miles, though unlike the figure, not necessarily to the same distance all around. You can sometimes hear gust fronts coming, but they're usually very close by then. When they do arrive the surface wind will increase by tens of knots, and can swing abruptly through 180°.

Normally air warms as it descends, but when rain from a cumulonimbus falls through dry air and evaporates, it cools the air around it, increasing its density. This causes it to accelerate downwards, often reaching very high speeds in the process. When it hits the ground it cascades out from a central point on the ground. This is a microburst, distinguished from normal downdraughts by its cause and the fact that, unlike gusts fronts, it doesn't usually last very long.

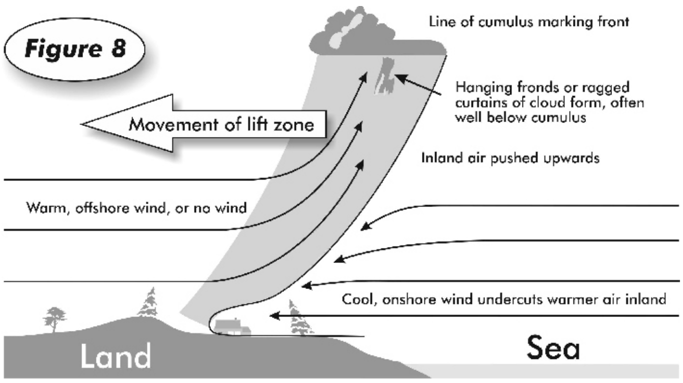
Tornadoes & dust devils

Tornadoes aren't that rare in the UK. They are associated with active cold fronts and isolated cumulonimbus clouds.

Tornadoes descend from cloud, unlike dust devils. Be very wary about flying near dark grey spouts, or snake-like protuberances forming beneath cloud, particularly if you can see them rotating. The vortex will extend high into the cloud above, so don't make this the moment to have a crack at cloud-flying. Tornadoes are dangerous whether you're airborne or not, and especially so if they've contacted the ground and are chucking things around.

Dust devils are smaller and far less aggressive relatives of tornadoes, occur only during hot weather, and come up off the ground. They can be triggered almost anywhere where the surface is relatively smooth (cut cornfields, say, but not woods), the ground heating intense and the local wind light and variable. They're not usually visible until, as their name suggests, they hoover up dust or straw from the ground. In the UK they rarely extend very high or last very long, but you can still get a bumpy ride if you fly through them. The larger ones are quite capable of overturning badly parked gliders. Don't launch or land through one.

Field fires are rare these days, but the lift within them was often extremely turbulent. To maintain any semblance of control and avoid gust induced stalls, it was usually necessary to fly quite a lot faster than normal. The same applies to entering any thermal low down which appears to be associated with a dust devil. Make sure your straps are tight, and fly against the direction of the dust devil's rotation - you'll get a much tighter circle.



SEA BREEZE FRONTS

These fronts occur when the landmass warms more than the sea, and the inland wind is light or non-existent. This causes the entire airmass over the land to rise gently and flow out over the colder sea air. In turn, the sea air is drawn inland and being denser, to undercut the warmer air. The result is a kind of mini cold front (figure 8).

Few places in the UK are more than 60 miles from a coast or large estuary, and sea breeze fronts can be thirty or forty miles long and travel fifty miles or more inland. Most sites will have their operations affected by them at some time or another, with those nearest the coast being affected more often. Good soaring goes with the majority of sea breeze fronts, but the lift zone is usually quite narrow, in some cases only a few hundred yards wide, and the air on the seaward side of the front is usually dead over a wide area.

In terms of instructing, the most likely result of a passing sea breeze front is a short lull in the prevailing wind, followed by an abrupt change in its direction and strength, possibly through 180°, and rising by 10kt to 20kt. While cumulus and curtain-like cloud commonly mark the front, it can also be blue - sometimes visible from the air as a subtle reduction in visibility on the front's seaward side. On the ground you won't know a 'blue' front is coming until it arrives.

If sea breezes are likely, brief pilots on what to expect, with particular emphasis on watching out for changes in wind direction. Look at the windsock!

Pseudo sea breeze fronts

These can occur just about anywhere where there is a marked difference in temperature between two adjacent areas. In some forms they can be potentially very dangerous. For example, there may be fog over one part of the country, and bright sunshine over an adjacent clear area. During the day the sunlit area warms up and the air mass rises and flows out over the colder, foggy air. Like a sea breeze front, this draws the cooler, moister air into the sunlit area, quickly flooding it with fog.

Convergence zones

A sea breeze front is a convergence zone, but the phrase usually refers to something a bit more static. For example, a sea breeze front from the west coast of Devon and Cornwall can meet one from the south coast, giving rise to a long line of lift and associated cumulus down the spine, so to speak, of the two counties. Convergence zones don't have to be sea-breeze related. They can form along the crest of a range of hills. Once again the most likely instructing problem is sudden changes in the wind direction and speed.

PRECIPITATION (RAIN ETC)

Precipitation forms when the air cools below its dew point and the water vapour within it condenses out as visible water droplets - mist, fog, cloud etc. If cooling continues and there is some turbulence or mixing in the air, the water droplets coalesce, forming larger droplets which eventually become heavy enough to fall out of the cloud as rain. If the temperature is below freezing then snow or hail may fall.

Fog

Fog is defined as a visibility of less than 1km (1,100yds), and is effectively ground level cloud. Given the right conditions it can form with astonishing speed, flooding across an airfield in a matter of minutes. Fog is more common during Autumn and Winter, but its frequency is site dependent.

If you get caught above fog, either make for a clear area or, if that isn't possible and you know roughly where you are in relation to the airfield, do a timed circuit to get you down - you're going to come down anyway, so it might as well be under some sort of control. If you have a working turn and slip, switch it on. You may need to use it.

Advection Fog

Fog is fog, of course, but many different conditions can create it. Advection fog forms when a warm moist airstream passes over an already cool surface. For example, a warm moist airstream in the warm sector of a depression passing over the UK in Winter. Another example of advection fog would be mist, fret or fog, forming over the sea and then blowing inland.

Radiation Fog

When the night skies are clear the Earth's heat radiates away into space. As the ground cools, so, by convection, does the air just above it. If a light wind gently stirs the air, it may reach the dew point and then radiation fog will form. If there is no wind, dew or frost may form. Ideal conditions for radiation fog tend to be during anticyclones, or when ridges and cols form and there is little or no wind.

Low cloud

You won't usually know exactly how high cloudbase is until you've been up there to find out. This can result in you losing sight of the ground while in a climbing attitude at low altitude or, if the cloud appeared thin and somewhat broken, popping out on top. The former is a problem because you'll have to release the cable and get the nose down when you're effectively flying blind. You really don't want to lose control and/or spin out of cloud at low altitude, so the moment cloud base looks close, don't wait until you've touched it. Release! It can be very pretty if you come out on top, but its illegal, and, more to the point, it can be very dangerous if 'the cloud' happens to be fog which has suddenly formed beneath you (see *pseudo sea breeze fronts*). When trying to assess cloudbase, its probably a good idea to have the T/S on - if you know how to use it.

Hill or up-slope fog

As the wind blows up the side of a hill the lifted air will cool. If it reaches the dew point before reaching the top of the hill, orographic cloud will form. During heavy showers it can form temporarily on ridges. If your site happens to be on the same hill and you're airborne, try and wait until it clears before landing.

Rain

Rain spreads over the wings of an airborne glider, either as small beads, or as a thin film. It has two main effects, neither of which are useful:

- worse performance, and
- poorer visibility from the cockpit.

Some gliders' performance is hardly affected, but others can do excellent imitations of expensive planks. Older non GRP gliders are usually less affected by rain, but some types, both new and old, can be a bit of a handful and not ideal for inexperienced pilots. In any case, it is not a good idea to launch in rain or drizzle. The stalling speed is likely to have increased, and the general handling may be poor. Symptoms of deteriorating performance (apart from ambiguous ones like an increased rate of sink) are:

- unusual and continuous vibration (often transmitted through the stick)
- marked and generally adverse changes in control effectiveness
- the force needed to alter flap settings may be reversed or changed in some way.

Apart from the above, rain's biggest problem is what it does to visibility through the canopy. Cold rain can cause the canopy to mist over. Heavy rain can distort your view so much that you can't be sure that what you see is what it appears to be, or even where it appears to be. This is an annoying problem with modern gliders because, unlike some older types which had more bulbous canopies and upright seating, the pilot of today's glider is more reclined and has to look at a shallow angle through the rain streaked perspex. If the view forward is really bad, open the clear vision panel and use it.

Advise early solo pilots that they should land back if they're local soaring and a shower approaches - unless they are quite sure they can avoid it or can stay up long enough to land after it has cleared away. They should avoid landing through a shower if possible, or taking-off just as one is about to arrive.

All is not excellent when the rain stops. Airborne or not, the pitot and its tubes may now be partially or completely blocked with unknown quantities of water, rendering the ASI unreliable, or uselessly stuck. In free flight, attitude gives the appropriate information as to speed, but on the launch or approach it won't, which is where you need the ASI. The variometer can also stick.

Snow

Flying in falling snow can be a slightly unpleasant and vaguely hypnotic visual experience, but the chief problem is snow collecting on the leading edges of all the flying surfaces. It will usually stick there and gradually build up. On an already cold airframe it will freeze into rough surfaced chunks. The effect on the glider's performance and handling will be similar to that of rain, but worse.

Cloudbase during snow showers can be very low. Small snow showers can provide good lift just ahead of the snow, but if you penetrate into clear air on the far side you may run into exceptionally strong sink.

Apart from the aerodynamic effects, when fallen snow is new it is completely featureless, making it almost impossible for a pilot to judge the height of the round-out and hold-off.

Whether you aerotow or not when snow is on the ground will depend on its consistency, depth, the available length of the airfield, and the direction of the wind in relation to the direction of take-off. It will also depend, ultimately, on whether the tug pilot thinks it's safe or not. But be careful, it may be safe for him but not for you! Remember that if you're taking off directly into wind you aren't just behind the tug, you're also behind the propeller. Seconds after the throttle is opened you won't be able to see a thing - and it will stay that way until you've taken off and are above the tug's wake. If the option is available, taking off with a cross wind component can lessen this problem.

Apart from the problems mentioned above, there is the cold, the miserable wetness of everything, and a general lack of alertness. Increased risk of falling over doesn't help either, so it probably isn't the time to be swinging the tug's prop.

Hail

Hail forms when minute particles of ice are swept up and down in clouds, gradually accumulating more and more layers of ice until, at some point, the up-draughts simply aren't strong enough to support them, or they fall into the downdraughts and aren't re-circulated. Their size when they finally hit the ground is a crude measure of the strength of the up-draughts, and gives a clue, both to the strength of the related downdraughts and to the likely strength of any microbursts or gust fronts. Very large hailstones are associated with very large and active Cumulonimbus. One case in recent years involved golf ball sized hailstones, a 70kt wind on the ground, leaves ripped off trees, dented cars, perforated gliders, and injuries to several people as they tried, luckily with success, to stop the Club's entire two seater fleet being blown away and wrecked.

WAVE

Wave can be triggered above an inversion by thermal streeting and/or wind shear, but the most common generators are mountains or hills. It isn't always obvious when wave is present, but it should be suspected when thermals produce cumiliform clouds in bars across the wind direction, and parallel to the lie of upwind hills.

Some wave effects have already been mentioned in relation to windsocks. Wave can also produce the following:

- periodic disruption or enhancement of thermal activity. This can take many forms:
  - during a cross country areas of good and bad thermal lift form distinct and regularly spaced bands
  - thermals may be smooth in some areas and rough and broken in others
  - the banding, or regularity, may also apply to the wind speed at ground level; strong in some areas, light or zero in others. This can make outlanding tricky
  - on a day with a good on-slope wind a ridge fails to work properly. This is often caused by wave being out of phase with the hill. If the wave is in phase ridge lift can be enhanced and the transition from ridge to wave be seamlessly smooth.

Equally, the wave may be shifting around, which can make the location of the above effects unpredictable. Signs of this are:

- the wave collapsing and then reforming in a different place, so that what was an area of good thermals may become a bad one, and vice versa
- an area where the wind was comparatively light may now have none, or much more
- if rotor forms (see later note), the ground wind may suddenly reverse direction
- wave gaps closing suddenly and others opening elsewhere.

Wave influenced days can be very poor for cross country flights in thermals, but they can herald the approach of bad weather.

A rather sly wave associated effect occurs if the air's humidity increases during the day, and the airmass is gradually cooling. The wave clouds start to deepen and then the wave gaps start to close at a speed related to the amplitude of the wave. The gaps close slowly initially, but more and more rapidly as the cloudbase lowers (figure 9).

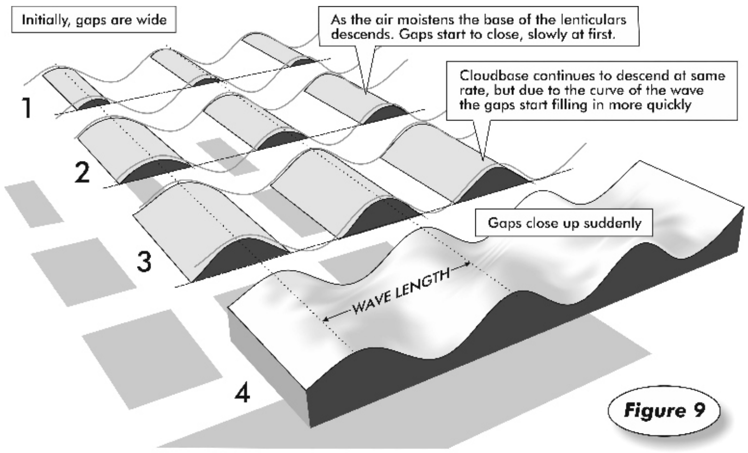


Figure 9

One big surprise about wave flying if you've never done it before, is how long it takes to descend from altitude, even with the brakes fully out. Gaps can close incredibly quickly, with the one you were heading for snapping shut before you get to it. If the cloud base is low in relation to any hills, there's a problem! Large numbers of gliders may all be trying to squeeze down the same vanished hole. Remember that in the evening it can still be light at altitude but dark on the ground. Before launch, make a note of the day's sunset time.

When you're descending fast remember that there is a difference between Indicated and True airspeeds which becomes greater the higher you are. The nominal value of V_{NE} is a **true** airspeed, and the greater your altitude the lower the (IAS) indicated airspeed required to exceed it. See your glider's flight manual.

Rotor

When wave amplitude is large, some of the air in the crests or troughs can begin rotating (figure 10) and form what is, in effect, a stationary, horizontal tornado. This is sometimes signposted by a swiftly rotating roll cloud. In the UK rotor is rarely strong enough to damage airborne gliders, but the potential for damage does depend on how fast the glider flies into the rotor. Whatever else, it can certainly throw you around, has been known to upset aerotow combinations, and can effectively fling landing gliders onto the ground. Treat conditions where rotor is likely, with considerable caution.

VISIBILITY

Visibility - Legal requirements

Whatever the practical problems of poor visibility, one of the legal requirements for flight in VFR (Visual Flight Reference) conditions is that you have one, three, or five Nautical Mile in-flight visibility - depending on the type of airspace you are in and the height at which you are flying.

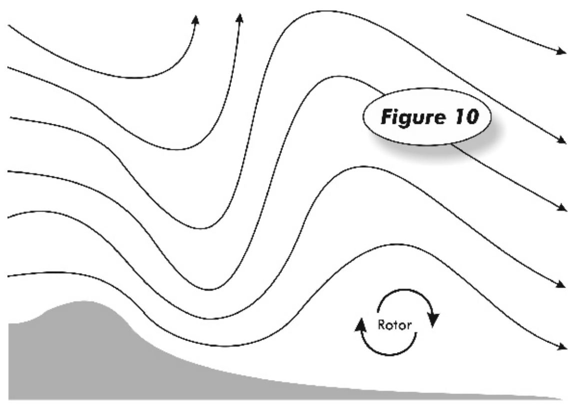


Figure 10

Other points

Visibility on the ground is measured by the distance of the farthest visible fixed object from the observer. A highly visible distant mast tells you that visibility is good, but not the height of cloudbase unless the mast doesn't seem quite as tall as you remembered. From the ground, in-flight visibility is inevitably something of a guess, particularly if it is marginal. You may need to do a local weather check (take a map!) to see what it is. In hazy conditions you can often see directly downwards without too much trouble, but not along - rather like looking into a well.

Visibility is affected by the number of small particles of dust, pollution or water floating in the air, and whether they are opaque, or partially transparent and scatter the light. Water particles form fog or cloud, depending on the temperature. Solid particles, like dust, create haze. Both diffuse the light and produce glare. Visibility into-sun is usually much worse than down-sun. Haze reduces contrast and makes everything look flat. Some haze particles are hygroscopic, and grow in size as they absorb moisture, which is why, as humidity increases, visibility can get worse.

A low sun can make the above problems much worse, particularly so if you are having to land and take-off into it.

Ab-initio problems

Poor in-flight visibility can make controlling the glider difficult. Useful attitude references will be few (no horizon), and pre-solo trainees may find it impossible to keep the wings level. Poor visibility can interfere with judgement of height in the circuit, and make spotting other aircraft a matter of chance. People taking trial instructional flights are also far more likely to be sick when the visibility is poor; virtually guaranteed if the temperature is high and the air rough.

Navigating by map is more difficult. GPS notionally solves that problem, but it can't find thermals, has probably worsened pilots' lookout, and can tempt them to fly cross-country on days when they'd be a lot safer staying on the ground. Instructors may have a supervisory problem here with inexperienced pilots who have whizzy gliders. Silver distance and early cross country flights are best postponed till better days.

NOTE: If visibility is very poor it may be prudent to limit the number of gliders flying at any one time.

Other points; Ultra violet (UV) radiation

If you wear sunglasses they must be able to filter out all the UV. Without dark glasses your pupils close and you narrow your eyes, thus cutting down the amount of light (and UV) that can enter. Put on dark glasses and your pupils open up to let in more light. If the glasses don't filter out all the UV it can now enter your eyes in damaging amounts, which won't be obvious to you at the time. Any damage done is cumulative.

Thin clothing and lots of bare skin may be comfy, but in summer weather and even under 8/8 cloud, UV radiation can be strong. Avoid being barbecued by wearing cloths with a close weave that cover you well. Wear a hat.