PILOT EXAM NOTES

METEOROLOGY

GT/ Peak Soaring Association Feb 97

Contents:

List of figures:

Lecture 2 : Meteorology

1. Buys Ballots's Law

Very Simple - this states that in the Northern Hemisphere, if you stand with your back to the wind, the area of low pressure is on your left hand side. In the Southern Hemisphere, it is on your right hand side.

2. Fronts

A front is a boundary between 2 different airmasses of different density. Airmasses don't like to mix and the boundary between the two (the front) is where active weather can take place. Fronts are very common in depressions. I recommend Derek Piggots book "Understanding Flying Weather" to see the birth and life of a depression. Although not in the syllabus, a depression starts along the jet stream. The jet stream is an area of very fast moving air circulating West to east (in the Northern Hemisphere). The jet stream is like the traffic on a motorway, it sometimes bunches and sometimes eases off. Where it bunches, the high altitude pressure increases causing a downward flow of air - the start of an anticyclone (high pressure system) where it eases, it speeds up and due to Bernoulli's principle, it causes a reduction in pressure - the start of a low. More details later. As the low pressure "winds up", it twists the airmasses and causes the characteristic low with fronts. The formation of a low with its frontal systems will be explained in the section on Pressure systems.

For this section, the typical low with frontal zones is shown below;

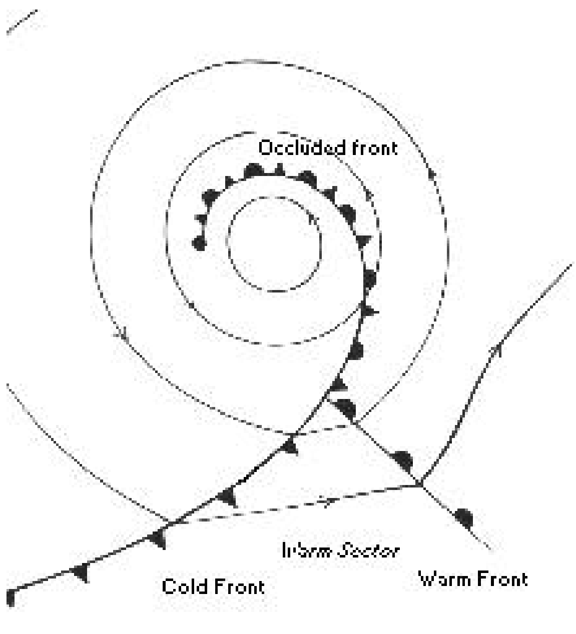

Figure 1 Low pressure system

Since the vast majority of low pressure systems move from West to East, the first frontal system to make its effect on the UK will be the warm front.

2.1 Warm Front

A warm front is where warm air overrides cooler air. Shown on maps as;

Figure 2 Warm front symbol

A warm front is where an area of warm air catches up with an area of cold air and overrides it (due to the less density). The normal warm front has a shallow slope with the air rising gradually over many hundreds of miles. This lifting produces the gradually thickening layer of cloud which eventually results in the steady rain near the frontal zone.

2.1.1 Cross section

The cross section of a warm front is shown below;

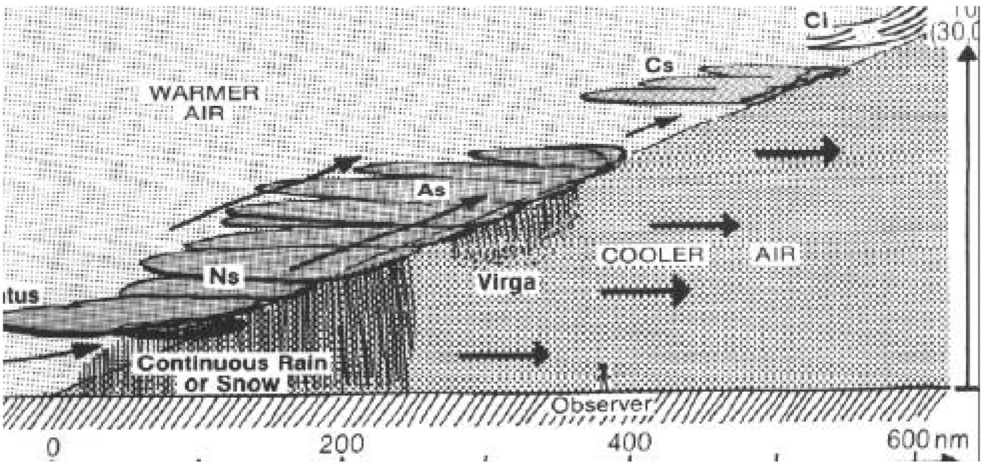

Figure 3 Warm front cross-section

The normal warm front has a shallow slope as the warm airmass overrides the cooler air. The slope is typically 1:50 to 1:400 and the frontal zone effect may extend 500 miles ahead of the frontal transition on the ground. This means that the forthcoming warm front may be seen in advance. High cloud such as Cirrus and cirro stratus will shut off the solar activity usually cutting off thermals. Then the cloudbase will lower with Alto stratus and Nimbo stratus giving drizzle as the front approaches. Rain possibly beginning 5-10 hrs before the passage of the front. The winds may strengthen and [1]back. At the front, the rain eases off, the wind will veer 50 degrees or so and the temperature and humidity will rise. We are now in the warm sector.

[1] back - winds change direction ANTI CLOCKWISE

2.2 Warm Sector

The warm sector is the area between the leading warm front and its following cold front. The air is warm and produces the right conditions for wave flights. Following the warm sector ids the cold front.

2.3 Cold Front

A cold front is where colder denser air undercuts warmer air. It is shown on maps as below;

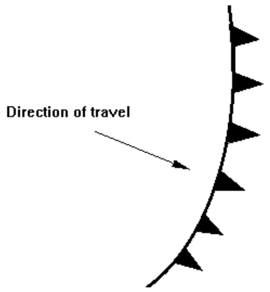

Figure 4 Cold front symbol

When a mass of cold air meets a mass of warm air, it tries to undercut it. The cold air pushes under the warm air acting as a wedge. The slope of the wedge is steep, about 1 in 30 to 1 in 100. They move quickly about 20mph. and strong updraughts can be produced about 100 miles ahead of a front.

2.3.1 Cross section

The cross section is shown below;

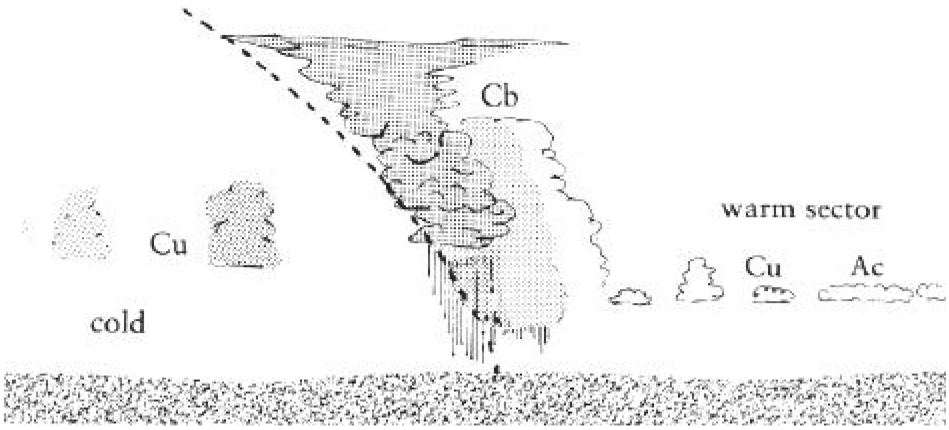

Figure 5 Cold front cross-section

The warm sector gets its name from the fact that the cold front usually follows a warm front. See the section on pressure systems later.

The cold front is often dramatic with heavy showers. At the front, the temperatures drop, the air is drier and the wind [2]veers often to the North West direction. Behind the cold front, there is often a complete clearance of cloud but this very quickly gives way to high Cumulus and

[2] veer - winds change direction CLOCKWISE

shower clouds. Good days for soaring are found after cold fronts have gone through and the pressure starts to rise again. The rising pressure raises cloudbase, and the cooler air means a ready supply of thermals.

For information and probably not likely for the exam. Bradbury indicates the 2 types of cold front **-** the katafront and the anafront. You should know about katabatic winds (flow downslope and are KATASTROPHIC for taking off and Anabatic winds which flow upslope).

The same thing happens at fronts where the frontal zone approaches, the wind upstream of the front can flow down the slope (katafront) or up the front (anafront).

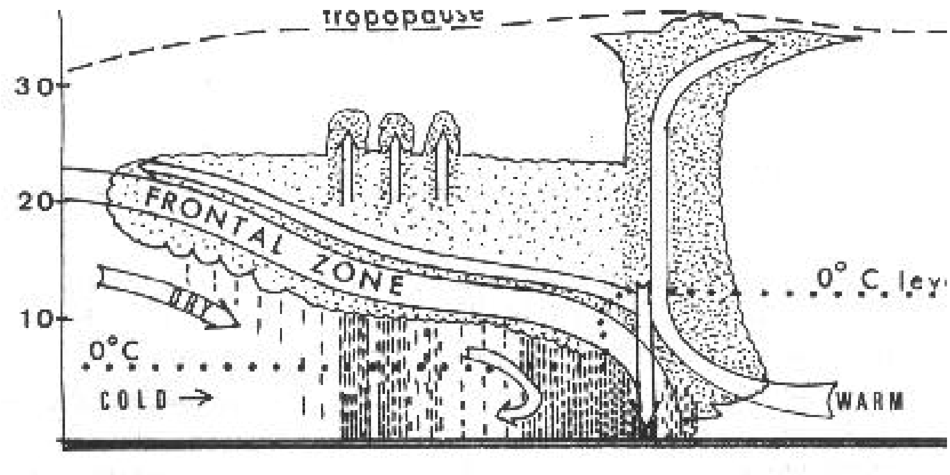

Figure 6 Anafront

Above shows an anafront. The air preceding the cold front is rising above the frontal zone and creating very active clouds such as Cunimb’s. The frontal zone is very steep. The Katafront is shown below;

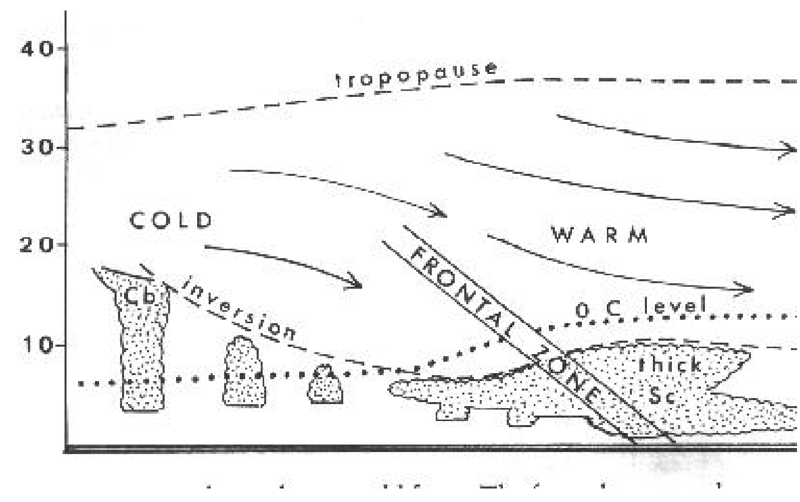

Figure 7 Katafront

The air preceding the frontal zone is flowing down slope and dampens the activity.

2.4 Occluded Front

An occluded front is where a cold front has caught up with a warm front. It is shown on maps as below;

Figure 8 Occluded front symbol

As the depression deepens, the cold front with its weather systems catches up with the warm front and the 2 types of weather become mixed.

2.4.1 Cross section

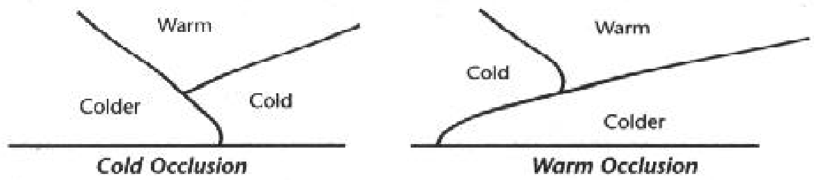

Figure 9 Occluded front cross-section

The occlusions can have some of the characteristics of a warm front or a cold front but on a milder scale. The weather produced by a occlusion can range from that of the 2 frontal types to prolonged periods of rain.

3. Clouds

The amount of moisture that air can hold depends on its temperature, with warmer air holding more air than cold.

Cloud form whenever the air is cooled to a point where the temperature to which a particular mass of air must be cooled for saturation to occur is called the Dew Point.

Sometimes the amount of moisture in the air is measured as relative humidity. The Relative humidity (RH) is;

RH = amount of water vapour in the air / amount of water vapour required to saturate it (at that temperature). This is expressed as a percentage.

i.e. dry air has a RH of 0%. Air about to form cloud has a RH of nearly 100%.

Clouds are classified as high, medium or low according to the height of their base. There are 10 basic types. See the diagram below;

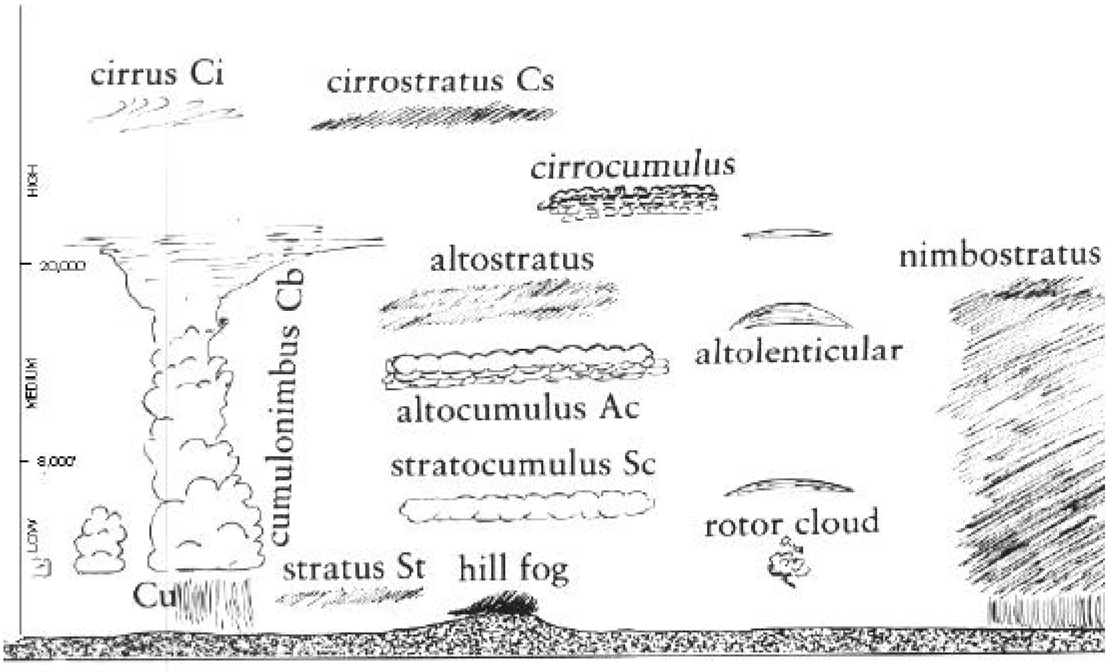

Figure 10 Cloud types

3.1 High

Altitude range is 15 to 40,000ft. These are composed mainly of ice crystals and are known as ***cirro*** types.

1. Cirrus (Ci) is the wispy high cloud
2. Cirrocumulus (Cc) is a high cloud with a cell pattern.
3. Cirro stratus (Cs) is the thin veil type cloud

3.2 Medium

Altitude range is 6,500 to 23,000ft. The are known as ***alto*** clouds.

4. Alto cumulus (Ac) is a medium layer with a cell pattern. In an unstable atmosphere, Ac may produce virga or precipitation which does not reach the ground.
5. Alto stratus (As) is an even layer of cloud at medium height

3.3 Low

Altitude range is 0 to 8,000ft.

6. Nimbostratus (Ns) is a deep layer of rain cloud.
7. Strato cumulus (Sc) is a greyish/whitish cloud consisting of rolls or cells. The weather is light rain, drizzle or snow.
8. Stratus (St) is a low lying layer of cloud. May give drizzle
9. Cumulus (Cu) these are individual heaped clouds with a cauliflower top. Large Cu may give showers.
10. Cumulonimbus (Cb) are heavy shower clouds or thunderstorm clouds. The tops of these can reach past 30,000ft. Weather is rain, hail and heavy showers.

There are other clouds which are not listed above -

Castellanus such as Altocumulus castellanus are excellent indicators (especially in the Alps) or upper atmosphere instability. These in the morning may indicate Cbs later in the day.

Lenticular **-** These lens shaped clouds indicate the presence of wave activity and may be stacked, one above the other in certain cases. They show the top of the wave.

3.4 Formation of clouds

Clouds may be formed in several ways but all rely on the fact that the air is cooled to a point where it cannot hold its moisture.

3.4.1 Convection

The action of the sun will heat the ground. This in turn heats the air layer closest to the ground which will become warmer and thus less dense. It may rise and is it does so, it will cool. Eventually it may reach a point where its temperature reaches the dew point and the water vapour condenses to form cloud. Cumulus cloud is formed in this way.

3.4.2 Orographic uplift.

Air may be flowing along and be forced to rise upwards when it reaches an obstruction such as a mountain chain. As it rises it will cool and it may be cooled past its dewpoint temperature. It will condense and orographic cloud will form on the windward side of hills.

3.4.3 Cloud formed by turbulence and mixing

As air flows over the surface of the earth, frictional effects cause variations in local wind strengths. Eddies are set up which cause the lower level air to mix. The more friction and the stringer the wind, the more mixing. As the air mixes, it may rise and if it cools enough, layer cloud above the friction area may result.

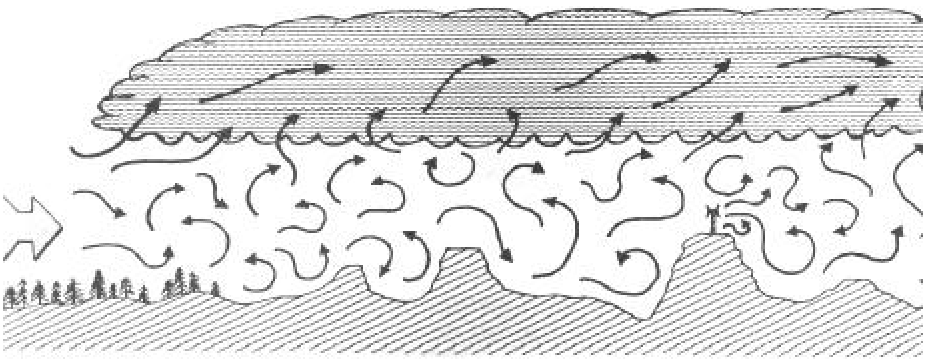

Figure 11 Clouds formed by turbulence

3.4.4 Cloud formed by widespread lifting

When 2 airmasses meet, such as in a warm front, then great areas of air may flow over the cooler air and rise as it does so. High stratus cloud will result. See the section on fronts for more details.

3.5 Cloudbase

Cloudbase is the term given to indicate the height that the base of the cloud is ASL. It can be calculated from the dew point and the ground temperature.

Cloudbase in feet = (Air temp - dew point) x 400.

i.e. Temp of 23 deg with dew point of 12 give a cloudbase of 4,400ft.

4. Convection

One of the main topics in the Met course is to describe thermal growth and activity. By understanding this and the reasons for thermals, we can also understand many other parts of the atmosphere and cover such things as, Inversions, Stability and instability, Cb’s and cloud base.

With increasing altitude, the following decrease -

Temperature
Pressure
Density.

As altitude rises, temperature generally decreases. This change in temperature with height is called the ***Lapse Rate.***

The standard atmospheric rate of change has been defined by Scientists as the standard atmosphere and it has the following conditions;

Environmental Lapse rate (ELR)	=	2’C/1000ft
Pressure change	=	1mb per 30ft

The ELR can be represented on a graph but it is important to know that this is only a “measuring stick”. the real ELR may be a lot different.

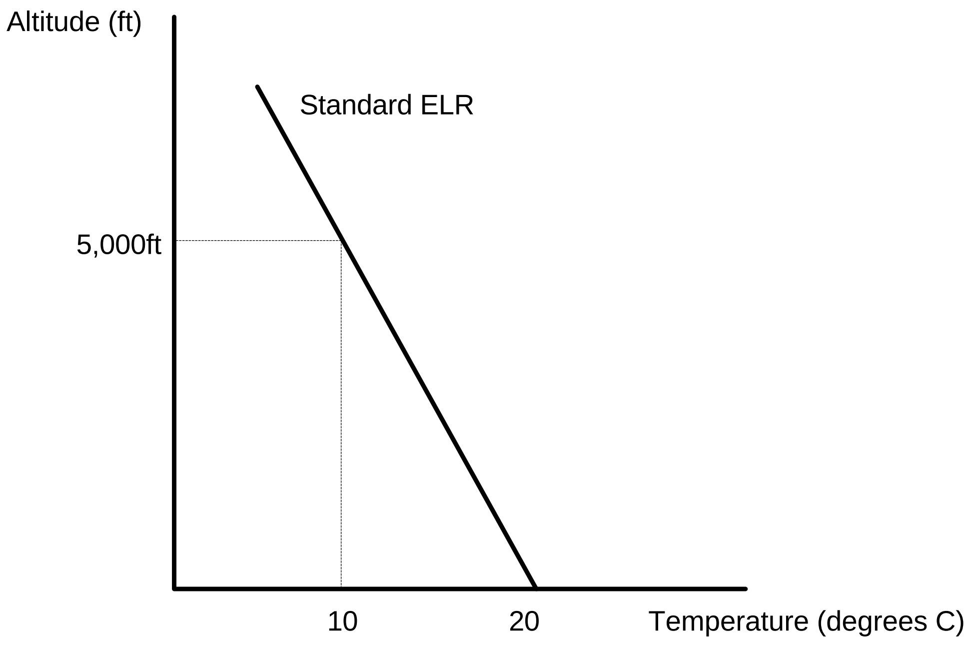

Figure 12 Standard ELR

4.1 Thermal production

As the sun heats the ground, the ground in turn heats up a layer of air close to the ground. A bubble of warm air starts to form and is less dense than the surrounds since it is warmer. It may unstick from the ground and start to rise through the atmosphere. As the density and the pressure of the surrounding air decreases with altitude, the thermal will expand [3]adiabatically and hence it cools. As air expands it cools. The thermal will cool at a known rate and its rate of cooling or lapse rate is the ***Dry Adiabatic Lapse rate or DALR.*** The word dry refers to the moisture in the thermal being retained as vapour and not condensing.

Dry adiabatic lapse rate (DALR) = 3'C / 1000ft

If we plot the course of a thermal leaving the ground with a temperature of 25'C, after 5,000ft the thermal has cooled to 10'C and has reached equilibrium with the surroundings. i.e. it stops rising.

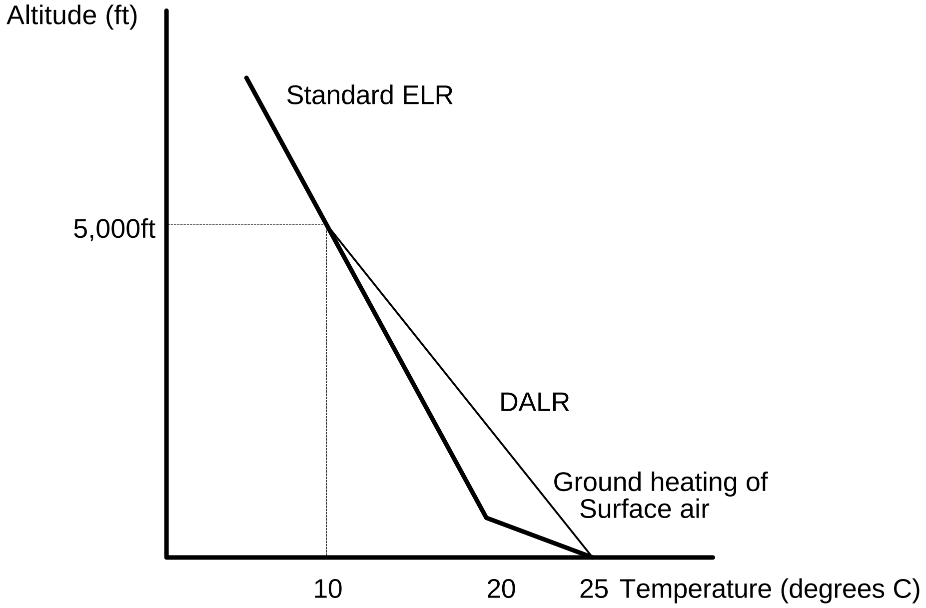

Figure 13 ELR and DALR

4.2 The "Real Atmosphere"

In real life, the atmospheric conditions do not look exactly like the above. Overlaying warm fronts could mean warm air aloft. High pressure systems could warm the upper air due to compression of the upper air. Air close to the ground may be chilled on a clear night. When the air temperature does not fall with height, but rises, then this condition is called an inversion.

4.2.1 Inversion

An inversion is a warming of the air at height increases and can be in 2 types.

- High level - caused by a high pressure system warming the upper air

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[3] An adiabatic process is one where no heat is lost from gained from the surroundings.

- Low level - caused by air chilled in contact with a cold ground which has lost heat by convection

These may be shown on a lapse rate graph as before;

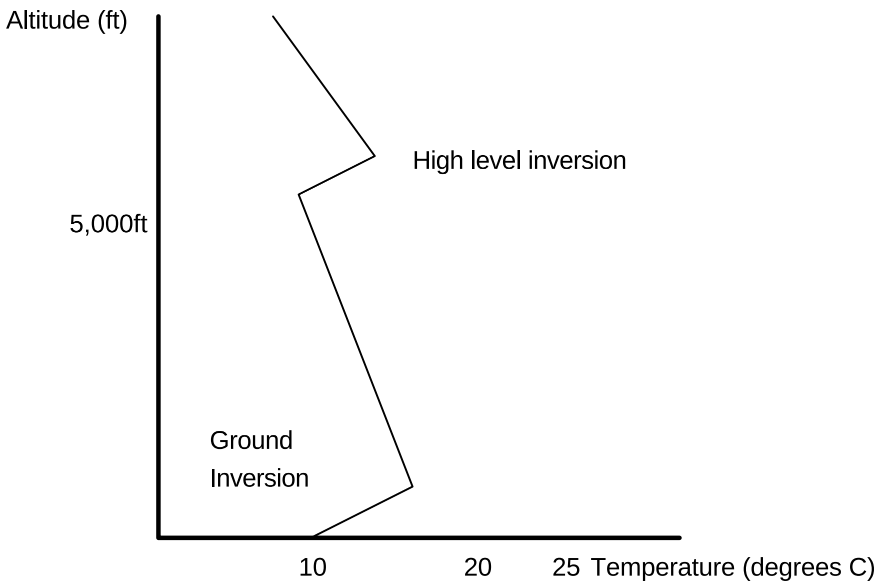


Figure 14 Inversions

Inversions may puts a lid on our max. altitude possible by thermals.

4.3 Stability and instability

We often hear the terms stability and instability with the latter being our preference. Using the lapse rate graphs we can understand the terms. Thermals will rise to a point where they are in equilibrium with the surrounding. If the ELR is such that the equilibrium is never reached, then the thermals will keep rising indefinitely. i.e. the 2 lines diverge. This is unstable.

If the 2 lines converge, then the day will be relatively stable.

Unstable ELR > DALR (3'C/1000ft)

Stable ELR < DALR (3'C/1000ft)

4.4 Cumulus cloud formation

A thermal rising will may contain moisture. As they rise, they cool and may rise to a point where they reach the dew point. At that, the water vapour condenses to form cloud. We have reached cloudbase.

As the water condenses, something else happens. Latent heat will be released. The latent heat is the extra energy required when a substance changes state, i.e. from water to water vapour, extra heat is required to effect the change of state. This extra heat is stored and released when the water vapour condenses back into a liquid. This in effect gives a "boost" to the thermal and acts as a source of heat, hence the lapse rate in clouds will be lower than in a dry thermal. The lapse rate in clouds is known as the ***Saturated (or moist) adiabatic lapse rate) SALR.***

This has a range of values depending on the moisture content but is typically;

Saturated Adiabatic lapse rate (SALR) 1.1 - 2.8'C/1000ft

The thermal in a cloud will keep rising until an inversion is reached or the cloud runs out of moisture. This determines the cloud top height. If the airmass is very unstable and there is a constant supply of warm moist air and powerful thermal development, then the situation may turn be right for the formation of Cunimbs.

The trigger temp is the temperature on the ground at and beyond which thermals will rise past the inversion layer.

Different ground types absorb solar energy better than others as far as thermal production is caused. The thermal is caused by the sun heating the ground (not the air itself), then the ground will warm up the bottom layer of the air to warm a "warm bubble" which wants to rise up. Dark surfaces such as ploughed fields, areas of dark tarmac are better than lakes etc, for the production of a thermal. The exam will expect you to be able to plot the life of a thermal.

Lets look at a typical thermal growth on a lapse rate graph.

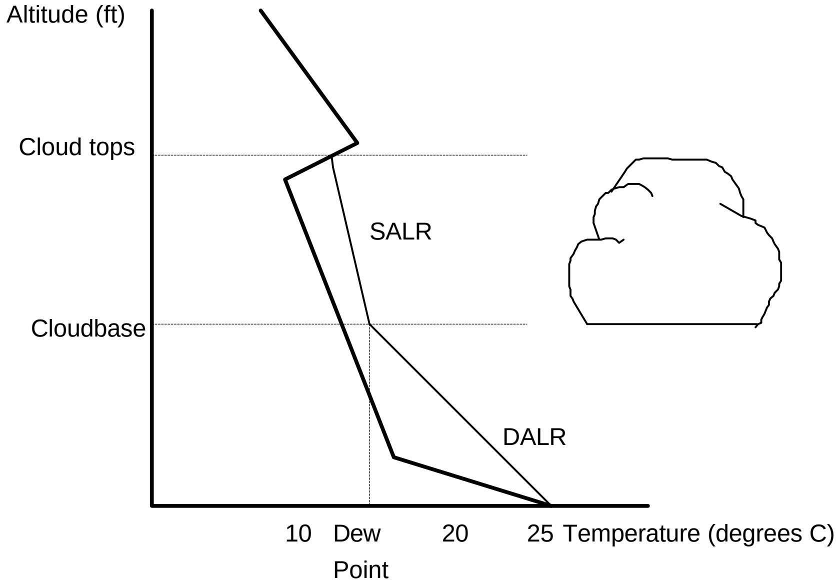


Figure 15 Convective cloud formation

On the day above, clouds have formed with the cloudbase at dew point and the cloud tops limited by a lack of moisture, or if there is an abundant supply of moisture, then the inversion above. Note that if the dew point had been lower, then the thermal would have risen as a blue thermal (no cloud) and could have possible been cut off lower. The SALR has a steeper gradient and thus is very unstable.

Knowledge of ELR, DALR and SALR and the effect on thermals together with dewpoint and the effect on clouds is required for the exam (hint). One other term to know is the ***Isothermal layer.*** This is an area of the atmosphere where the temperature does not change with height.

Lets take an example question.

A table showing air temperature against height is below. Dewpoint at ground is 14'C and decreases by 0.5'C per 1,000ft. SALR is 1.5'C per 1,000ft. Describe what happens.

The ELR is plotted below with the dewpoint shown as a dotted line.

Height	Air temperature
0	24
1000	17
2000	15
3000	13
4000	11
5000	9
6000	7
7000	8
8000	7
9000	6

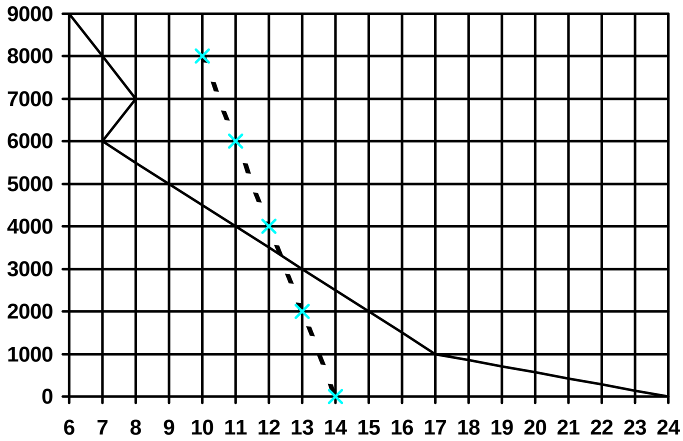
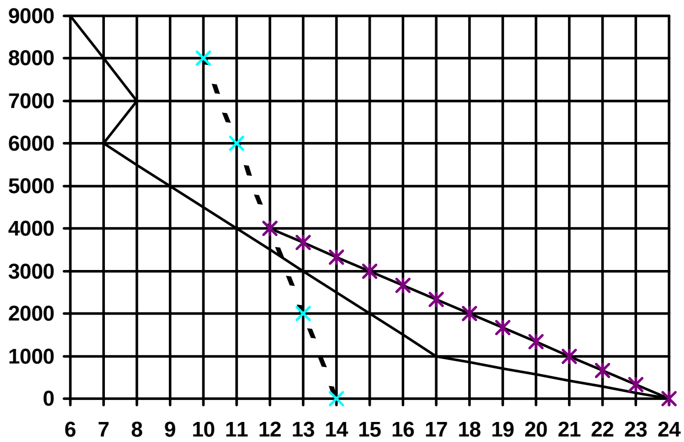


Figure 16 Sample question ELR



The thermal leaves the ground with a temp of 24'C and rises at the DALR.

Figure 17 Sample question ELR and DALR

Then plot the air rising at the SALR of 1.5'C/1000ft after the thermal has hit the dewpoint.

The SALR hits the inversion (in this case) at about 6,600ft, the cloud tops are limited by the inversion to about 6,600ft. Cloud base is 4,000ft which ties in with the equation. Note the reliability of the equation is based on the DALR of 3'C and the dewpoint lapse rate of 0.5'C per 1,000ft.

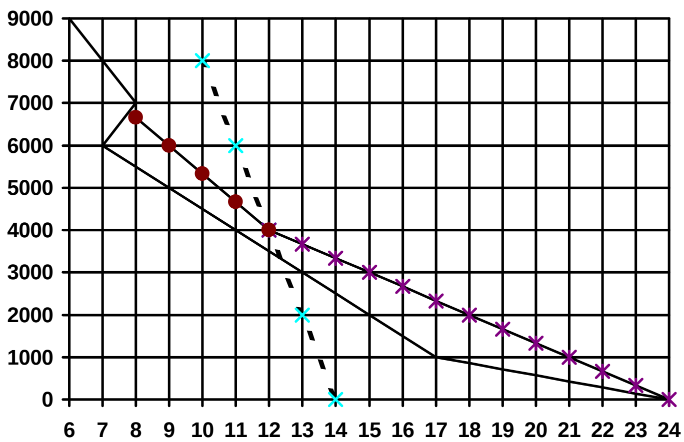


Figure 18 Sample question ELR, DALR and SALR

If the air is very moist and the SALR is less than 1.5, then the possibility exists of the moist air rising at a steeper gradient and therefore escaping the effects of the inversion and high Cu's or Cb's may result.

5. Meteorological terms

Adiabatic - A thermodynamic process where no heat leaves or enters the system

Advection - transfer of air mass properties by motion.

Air mass - huge body of air in which horizontal changes in temp are small.

Anabatic wind. Wind blowing upslope.

Anafront - a front where warm air is ascending over cold air.

Anticyclone - area of high pressure

Backing - winds changes direction anti clockwise

Convection - transfer of heat by motion of a substantial volume of air.

Dew point - temperature at which air must be cooled to become saturated with water vapour.

DALR - Dry Adiabatic lapse rate, about 3'C per 1000ft

ELR - Environmental lapse rate. This is 2'C per 1000ft for the ISA.

Inversion - a layer of air where the temperature increases with height.

Iso - equal

Iso therm - a line of constant temperature

Katabatic wind - wind that flows downslope

Katafront -a front where the warm air sinks down above the frontal surface which will eventually weaken and destroy the front.

SALR - Saturated adiabatic lapse rate, about 1.5'C per 1000ft
Stability - the tendency of the atmosphere to stay as it is. Unstable air, where the ELR is greater than the DALR means that a thermal will diverge from the atmospheric temperature lapse rate.

Standard atmosphere (ISA) has a ELR of 2'C per 1000ft

Super adiabatic lapse rate. A lapse rate greater than 3'C per 1000ft

Tephigram - a aerological diagram with the x.y co-ordinates Temperature and entropy. The diagram is used for plotting the values of temp and humidity at specific pressure levels obtained from upper air soundings.

Veering - wind which changes direction clockwise.

6. Pressure systems

As the earth is covered by atmosphere, this atmosphere exerts a pressure on us all. This pressure is measured in Bars and the pressure is about 1 bar. A bar is too large for any detail so it is divided into millibars and represented as 1000mb. The unit hectopascal may also be used and is the same as a millibar.

6.1 Low pressure

Low pressure systems are the source of a great deal of active weather in the UK. The majority of our weather systems form out in the Atlantic along the frontal boundary between the arctic airmass and the warmer tropical maritime air to the south.

6.1.1 Formation of a low

When 2 masses of air of different density lie side by side they induce a strong current of air to flow along the cold side of the front at very high altitudes. This jet is formed due the extreme pressure differences at altitude causing a close bunching if high altitude isobars. The jet is several miles deep and travels at speeds of about 100 to 200 mph. Disturbances cause the jet to snake around and results in areas of divergence and convergence.

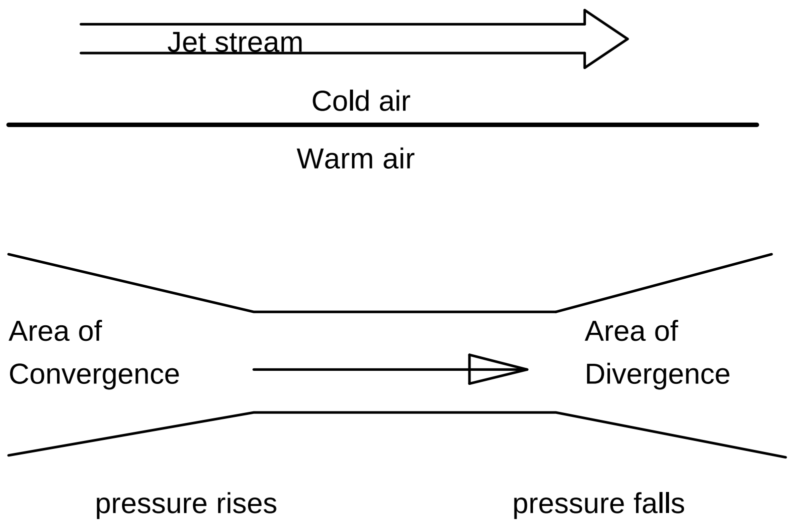
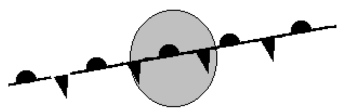


Figure 19 Formation of low pressure

The area of convergence will cause downward flowing air. This results in an increase in pressure at ground level and a downward movement of air. Similarly, at the area of divergence, the surface pressure will fall and an area of low pressure will start to form.

1. The jet stream divergence will cause an area of low pressure to start to form along the frontal zone.



The low pressure will draw the 2 edges of the front together, effectively increasing the temperature and pressure differentials thus aiding the formation of the low.

Figure 20 Formation of low (1)

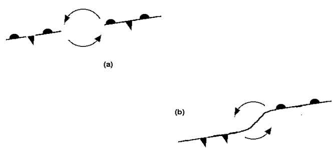
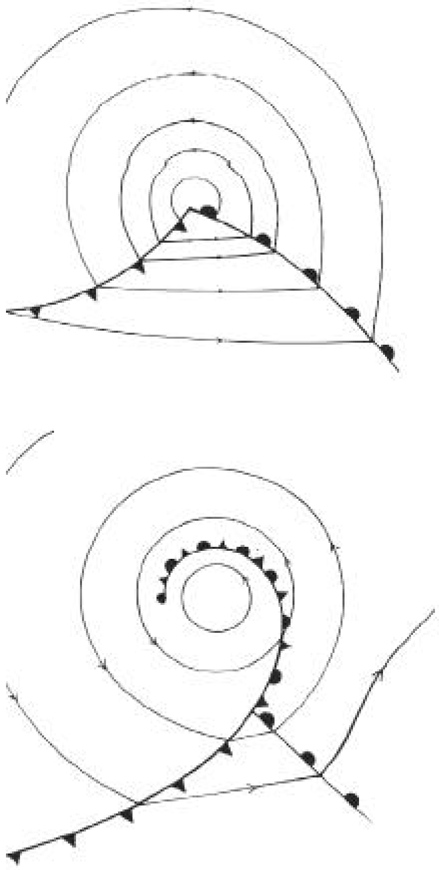


Figure 21 Formation of low (2)

As the air rises it is given a twist by the ***Coriolis force***. This coriolis force is exactly the same as the force which causes the water going down the plughole to spin. The force is zero at the equator and is the reason behind low pressure spinning anti clockwise in the Northern hemisphere and the reverse in the southern hemisphere.



As the air in continually extracted at the top of the system, so the surface pressure drops increasing the circulation and the winds speeds. The anticlockwise circulation is gradually spread up to the upper levels and the upward movement of ward moist air will eventually cause condensation and the release of latent heat to further power the process.

The cold front moves faster than the warm front and catches it up. With an occlusion forming where the cold front has caught the warm front The spiralling air in the depression further twists the fronts round to give the classic “hook” shape of the depression.

Figure 22 Formation of low (3)

6.1.2 Associated weather

The weather associated with a depression is usually poor. Associated frontal systems can bring rain and cloud. A depression may arrive at our shores at any stage of development and it may or may not have frontal systems. It may have a weak warm front and an active cold front or vice versa. A system with an active cold and an active warm front is very rare. It may have a decaying occlusion, but the general outlook is worsening weather.

6.2 High pressure

High pressure systems are formed in a similar way to lows, and areas of high pressure can mean areas where there aren’t any lows. In an anticyclone, the air is descending and being warmed by compression as it descends. Since warmer air can hold more moisture, then clouds are less willing to form.

This results in clear skies at night and little tendency for any overdevelopment.

6.2.1 Associated weather

In summer, a high pressure system always means an improvement with lighter winds and less cloud. In winter a high pressure can mean persistent fog and low cloud or it may lead to clear skies, depending on the source and track of the airmass at low level.

High pressures move slowly and can lead to the production of inversions due to the warmed upper air. The atmosphere becomes stable (cooler air at the bottom) and leads to poor thermal production. Inversions can lead to poor air quality with pollen, dust etc. being trapped in the inversion layer. Highs can persist for days and then they become blocking highs which will often divert the path of a low pressure system around the UK.

7. <u>Winds and things</u>

This section is concerned with the assorted bits and pieces which don’t fit anywhere else.

7.1 Valley winds

Mountains tend to form a barrier to winds at low level. The air tends to flow up and down the valley Imagine a valley with hills on both sides. In the morning, the effect of the sun is to heat up the mountains first since the valley will be cooler and still in shade;

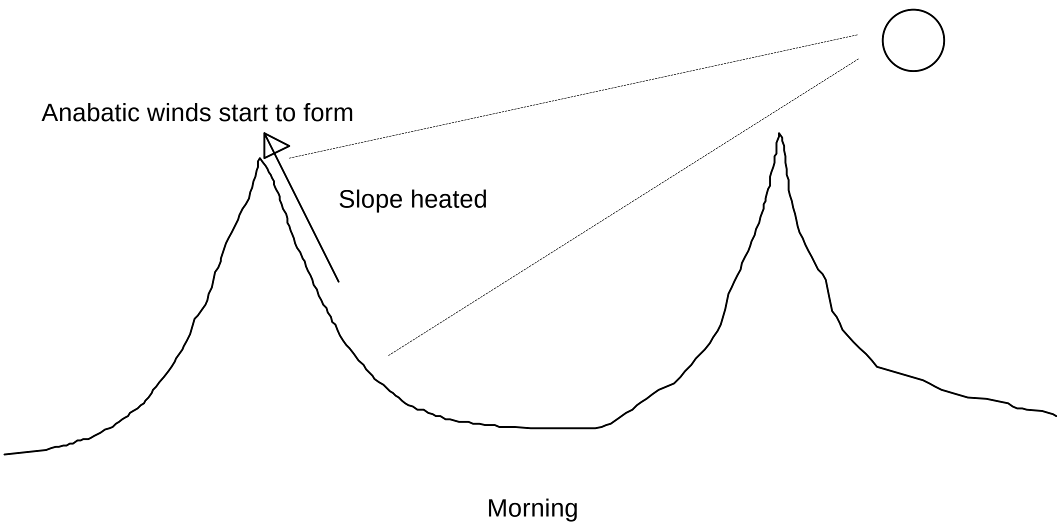


Figure 23 Valley winds (morning)

As time reaches midday, both slopes are in sun and powerful anabatic winds are produced up both slopes

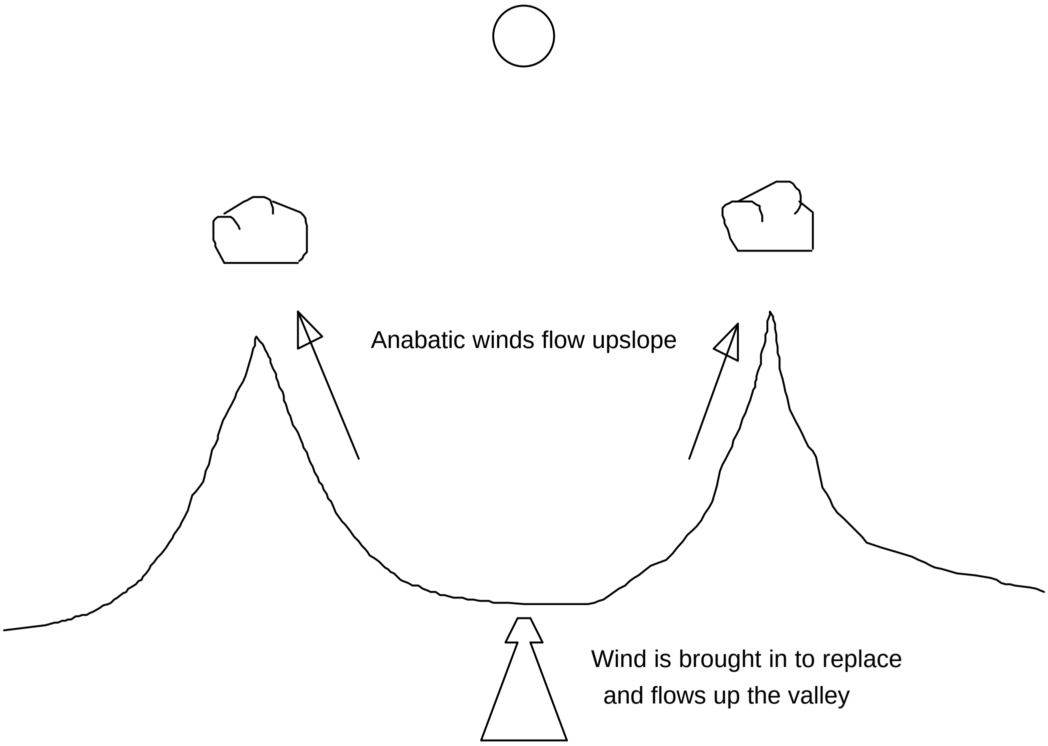


Figure 24 Valley winds (midday)

This causes the winds at low level to rush up the valley to replace the air flowing up the slopes. The valley wind flows into the valley in the afternoon and evening. As the sun goes down and the slopes start to cool off with the altitude, katabatic winds flow downslope

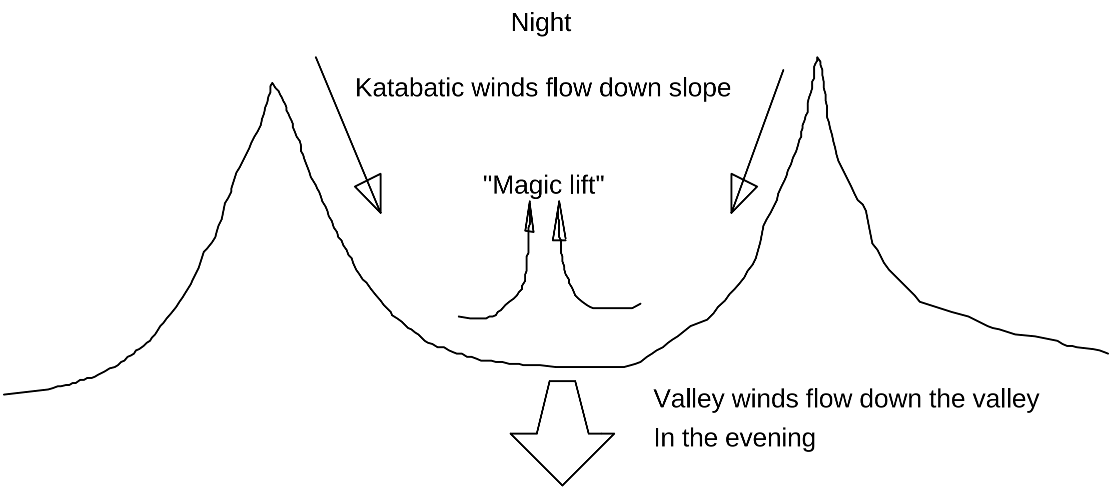


Figure 25 Valley winds (evening)

In the evening, as the wind turns katabatic on the slopes, it can rush down the hill and force upwards, over the valley centre, great areas of lifting air. This is the evening restitution lift or magic lift and can give easy soaring for quite a while in huge areas of lifting air. As time goes on, the valley winds will slow down from travelling up the valley and then turn to the evening and night time valley winds where they flow down the valley.

7.2 Sea breezes

In summer, the land tends to warm up quickly, but the sea remains much at the same temperature. Thermal activity may result in a general lessening of the pressure over the land with the results that air flows in from the sea to replace the lifting air over the land. This is a sea breeze. It can kill convection and shut off any thermals near the coast so avoid sea breezes.

In winter, the sea temperatures are relatively stable and warmer than the cold land. The sea breeze is reversed and sometimes leads to Cumulus formation over the sea as cold land air is blown over the sea, to have its base warmed by the sea to produce unstable conditions over water.

7.3 Sea breeze fronts

When a sea breeze sets up, it could be in opposition to the normal wind. In this case, a sea breeze front may be formed. This front works its way inland and can penetrate as far inland as Sheffield. This is characterised by a hanging curtain of cloud and a stepped cloud base. This is due to the moist sea air having a lower cloudbase. It needs a fairly light wind, warm day and some instability to set up the sea breeze front. The evidence of a front may also be apparent even with no surface [4]geostrophic wind. The cool moist air flowing inland will meet the warm dry land airmass and this is also a cold front of sorts.

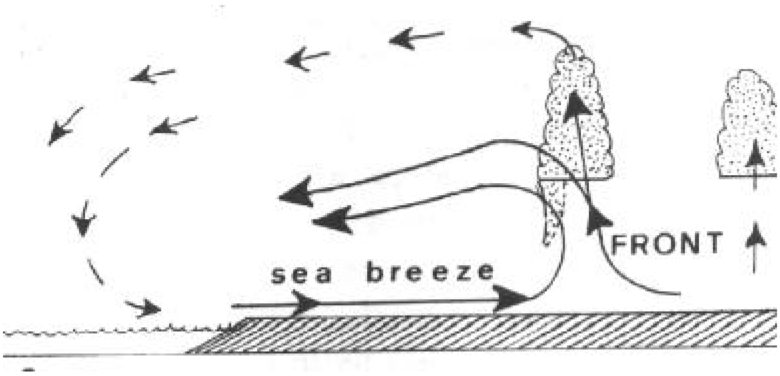


Figure 26 Sea breeze front

Sea breeze fronts rarely occur between October and April.

7.4 Wave lift

Another type of lift is the wave lift. The requirements for wave are;

- Wind to be in a fairly constant direction
- Wind to be increasing with height
- A shallow unstable layer with a stable layer above it works well
- An obstruction upwind such as a range of hills is needed to start the waves off

7.5 Fog

Fog is cloud on ground level and there are several types

7.5.1 Radiation fog

[4] Geostrophic - wind set up parallel to isobars. The "normal" wind

- Conditions suitable for radiation fog are;
- A cloudless night, allowing the earth to cool and thereby causing the air in contact with it to become cool
- Moist air that requires little cooling to reach dew point
- Light winds to reduce mixing

7.5.2 Advection fog

A warm moist air mass flowing across a significant colder surface will be cooled from below. If its temperature is reduced to the dew point, then fog will form. Advection fog can persist in stronger winds than radiation fog.

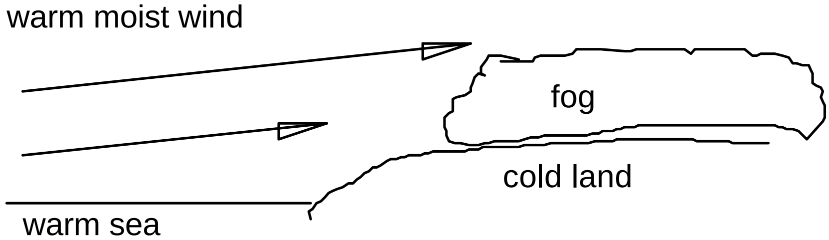


Figure 27 Advection fog

7.5.3 Sea fog

Sea fog is advection fog and may be caused by

- An air flow off a warm land moving over a cold sea.
- warm tropical air moving over a cold ocean or meting a cold air mass

7.5.4 Hill Fog

Hill fog is caused when moist air is uplifted over a hill and cools as it is forced upwards. As it cools it condenses to form hill fog or orographic cloud.

8. Synoptic chart

The exam requires you to understand the symbols, isobars, pressure systems and associated weather that you could expect when checking a synoptic chart.

A typical chart is shown below.

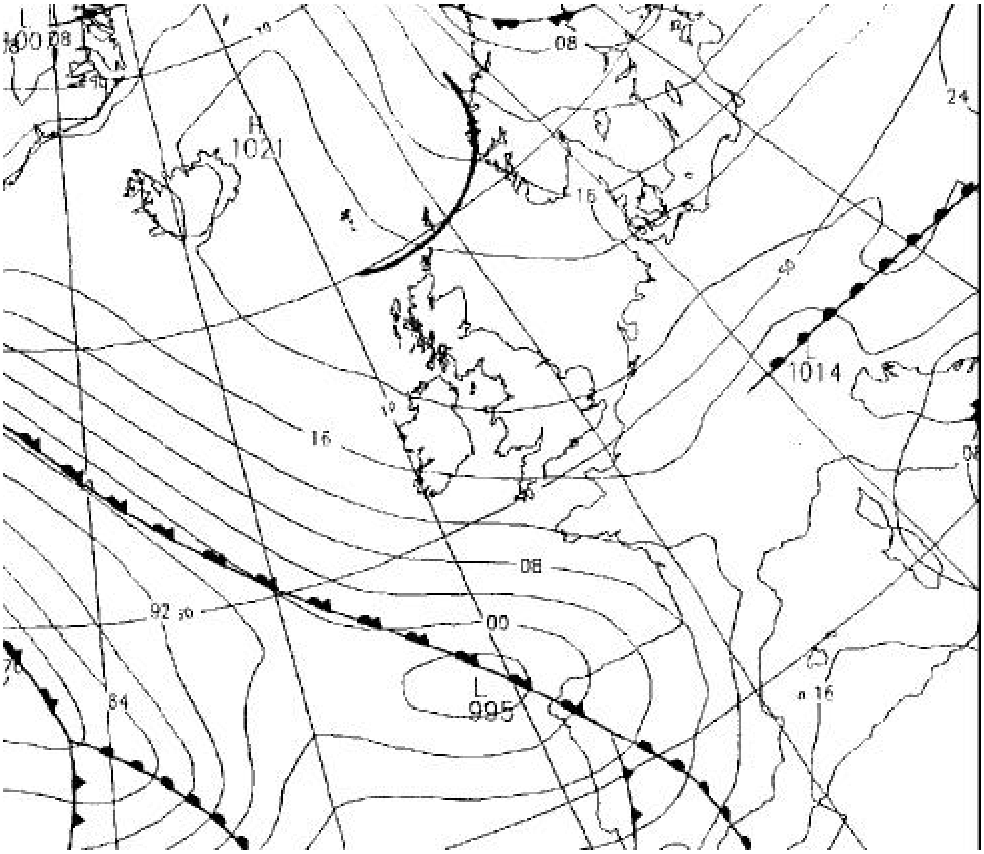


Figure 28 Synoptic chart

Pick out features such as;

- Areas of high pressure and low pressure
- Isobars
- Frontal systems

Remember about the coriolis force and its effect on both high and low pressure systems

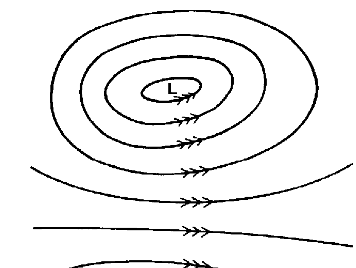
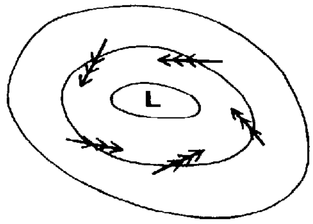


Figure 29 Rotation round pressure systems

The coriolis force means that in the Northern Hemisphere, the geostrophic wind circulates anticlockwise round a low and clockwise round a anticlyclone (high pressure). The winds rotate in the same direction as the isobars, but this is only true for winds at altitude (over about 1,000ft). The effect of the ground causes friction which slows down the surface winds.



The surface wind around a low pressure points to the low pressure by about 30’ over land due to the friction. This effect is less over the sea where the friction is less.

Figure 30 Surface wind round a low

The surface wind around a high pressure points away from the high pressure area by again about 30’ due to the friction. The wind speed also decreases in both cases

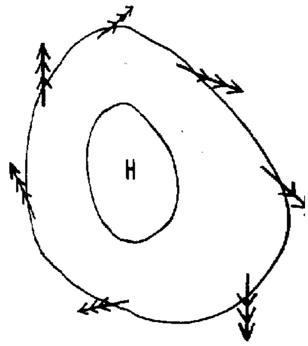


Figure 31 Surface wind round a high

Think of the affects on the atmosphere such as wind speed and direction, temperature, precipitation, cloud cover and visibility.

By the way, the above chart was taken in Jan 96 when we were in the depths of the icy winter. Winds were from the East (Siberia) and as the base of the winds warmed up slightly over the North Sea, this resulted in instability with snow showers over the eastern coast and hills. The high pressure fended off any frontal system and allowed the temperatures to plummet during the evenings. Blocking highs like this can (and did) last for several days. The chart was taken as the cold weather was dying off. The frontal systems in the Atlantic did eventually make their way in and the winds switched direction to the West or South West raising the temperatures and bringing the normal weather of showers, winds etc.

9. Clouds and rain

Rain or precipitation can consist of different types of precipitation. It may be rain, fine drizzle, snow or hail.

Continuous rain or snow is associated with Nimbo stratus and alto stratus clouds and intermittent rain or snow with altostratus or strato cumulus.

Rain and snow showers are associated with cumiliform clouds such as cumulonimbus, cumulus and alto cumulus, with the very heavy showers coming from the cumulonimbus’s

Fine drizzle and snow is associated with stratus and strato cumulus.

10. Acknowledgements

Understanding flying weather - Derek Piggott. Contains everything you need for the pilot exam

Air pilots manual volume 2. Worth getting for the airlaw too

Meteorology and flight **-** Tom Bradbury. Lots of information and detail. Far more then the pilot exam

Instant weather forecasting **-** Alan Watts. Lots of good cloud pictures

Training wings **-** Covers most but not all.

11. Revision History

Date	**Revision**	**Comments**
Feb 97	1	First Issue
23 March, 1997	2	Revised with index and corrections to thermal growth