2.47 On some occasions the aircraft type is also included in the transmitted information, for example:

2.48 "*Warrior,* [pause] *ROW-meoh TANG-go ZOO-loo*",
or "*WISS-key OSS-kah ZOO-loo,* [pause] *a Pitts*", as appropriate.

2.49 The phonetic alphabet may also be used whenever it is thought necessary to spell a word to ensure correct understanding of a message (such as the names of towns in position reports), if radio reception is poor, or if any confusion arises. An easy way to learn the phonetic alphabet is, as you drive your car, to practise aloud saying the registration numbers of passing cars or street signs.

Pronunciation of Numbers

2.50 If you are transmitting single digits then you should use the following words, stressing the syllables in capitals.

Number or Numeral Element	Pronunciation
0	ZE-RO
1	WUN
2	TOO
3	TREE (or THREE)
4	FOW-er
5	FIFE
6	SIX
7	SEV-en
8	AIT
9	NIN-er
decimal	DAY-SEE-MAL
hundred	HUN-dred
thousand	TOU-SAND (or THOUSAND)

Table 2-5 Pronunciation of numbers.

2.51 It is especially important to differentiate between 5 (pronounced FIFE) and 9 (pronounced NIN-er) because, when spoken normally, they are often confused. If there is a decimal point in the number then it is indicated by the word *DAY-SEE-MAL*. For example, an instruction to VH-AKB to change frequency to 118.3 MHz would be transmitted as:

*"AL-fa KEY-loh BRAH-voh, [pause]
contact Alice Tower on WUN WUN AIT, DAY-SEE-MAL, THREE."*

2.52 You can now extend your practice using car registration numbers to include the numerals. ETV 309 would be pronounced:

"ECK-OH TANG-go VICK-ta, TREE ZE-RO NIN-er."

7. A student pilot is not permitted to carry passengers unless:
   a. he/she has completed 2 hours as pilot in command.
   b. he/she has passed the Recreational Pilots Licence and flies within the student pilot area limits.
   c. he/she has completed 5 hours of cross-country flying.
   d. he/she has had a dual flight within the last 30 days. *(1 mark)*

8. With local QNH set on the subscale, an altimeter will always read:
   a. pressure height.
   b. density height.
   c. height above mean sea level.
   d. height above ground level. *(1 mark)*

9. At a non-towered aerodrome, you should not continue an approach beyond the threshold until a preceding light aeroplane, using the same runway, has:
   a. landed, and has vacated the runway, irrespective of the runway length, and is taxiing away.
   b. landed, and is at least 1,800 metres from the landing threshold.
   c. taken off and is at least 200 AGL.
   d. taken off and is at least 600 metres ahead of the landing threshold. *(1 mark)*

10. You are to operate from a non-towered aerodrome where there is no ATIS and no other way of knowing the latest QNH. Before take-off, you should:
    a. set the altimeter to read the aerodrome elevation.
    b. set the altimeter to read zero feet.
    c. set an approximate aerodrome pressure in the subscale.
    d. set 1013 hPa on the subscale. *(1 mark)*

11. One item which must be included in a passenger briefing prior to take-off is:
    a. a demonstration of the correct crash landing position.
    b. the use and location of fire extinguishers.
    c. the use and adjustment of seat belts.
    d. the demonstration of evacuation procedures. *(1 mark)*

12. With regard to the rules of the air in the CAR, which statement is correct?
    a. An aircraft that is overtaking another aeroplane, has the right of way.
    b. If an aeroplane and a glider are approaching head-on at approximately the same height the aeroplane must give way to the glider.
    c. An aircraft that is approaching from within 70° of the astern position of an aircraft ahead is considered an overtaking aircraft, if its speed is greater.
    d. An aircraft that is overtaking another aircraft must do so by altering its heading to the left. *(1 mark)*

13. On which of the following types of flying is a passenger not permitted to be carried?
    a. An aircraft engaged in aerobatic flying.
    b. Flying training given to a person who has not passed the General Flying Progress Test (GPFT).
    c. An aircraft carrying out formation flying.
    d. An aircraft engaged in search and rescue (SAR) operations. *(1 mark)*

Review 8

1. Circulatory and Nervous.
2. To inhale air and extract the oxygen and to exhale waste carbon dioxide.
3. Reduced processing, disorientation, dizziness, euphoria, loss of consciousness.
4. By the Valsalva manoeuvre, by chewing or swallowing.
5. Hyperventilation. Consciously slow down the rate of breathing.
6. Dehydration.
7. Eight hours.
8. Carbon monoxide.
9. The part of the retina where the optic nerve passes through.
10. Saccade/rest cycle.
11. It rests at about 1–2 metres.
12. Decision-making.
13. To sense acceleration or tilt.
14. Acceleration and tilt.
15. A reduction in oxygen to the blood stream.
16. 24 hours.
17. Trapped gases in the blood, intestines, joints or cavities (sinuses).
18. Lack of sleep, noise.
19. Sedatives, antibiotics.
20. Decompression sickness – nitrogen coming out of solution especially around the joints.
21. 48 hours.
22. Aviates, navigates, communicates – but most of all decision-makes.
23. The rear coating of the eyeball containing light sensitive rods and cones.
24. Rods and cones.
25. The cones in the central foveal region.
26. Slightly to one side of the anticipated direction.
27. Autokinesis.
28. Shallower.
29. Eustachian Tube.
30. Valsalva manoeuvre.
31. Noise, heat.
32. Hearing and balance.
33. The point of the runway where the pilot's eyes would ideally impact – with no flare.
34. It remains a constant distance below the horizon and a constant position in the windscreen if the aircraft's on a constant approach path at a constant speed in a set configuration.

Review 9

1. Troposphere, stratosphere, ionosphere.
2. 36,000 ft.
3. Direction (330°T) and speed (20 kt).
4. Okta is the number of "eights" of cloud cover. 4 oktas = 4⁄8 cover.
5. Ten nautical miles, preferably upwind.
6. Condensation occurs thereby forming cloud.
7. Air that is heated by the earth's surface rises causing a thermal.
8. V_B is the turbulence penetration speed. If this is not known, use V_A.
9. Lights, moderate and severe.
10. Mechanical lift.
11. Frost, rain, hail.
12. A forecast is a prediction of likely weather over some period in the future. A report is a statement of observed weather at a particular time past.
13. Stratiform is layered cloud.
14. AVFAX is a self-help system for meteorological and NOTAM information via Fax.
15. DECTALK is a self-help system which delivers meteorological information via telephone using a computer generated voice.
16. BKN cloud → 5 to 7 oktas.
17. CAVOK – ceiling and visibility OK. To use this abbreviation, visibility must be more than 1 km; no Cb visible; no cloud below 5,000 AAL; and no precipitation, TS, fog, snow or dust devils.
18. TEMPO 60 minutes; INTER 30 minutes.
19. GAF is an graphical area forecast TAF is a terminal area forecast.
20. A forecast is declared provisional (PROV) when it is compiled from incomplete information – it may have errors.

Review 10

1. Weight concerns the amount of mass or load we can put on an aircraft, while balance is the position within the aircraft that weight can be located.
2. BEW is the empty weight plus full oil.
3. ZFW includes BEW and the weight of the:
   - pilot;
   - passengers;
   - payload; and
   - ballast.
4. Specific gravity.
5. To convert AVGAS from volume to weight multiply by 0.71.
6. To convert Litres to USG divide by 3.8.
7. Weight (force) and arm (lever).
8. Centre of Gravity (Fulcrum).
9. To ensure adequate stability, and at the same time provide a sufficient degree of control.
10. Allowable CG range.

Introduction to Meteorology

9

The Atmosphere

9.1 The atmosphere is full of wonderful life-sustaining features. Oxygen to breathe, water vapour to condense as clouds and precipitation to water our plants and animals, ozone to protect us from the sun's ultraviolet and infrared rays, wind to carry seeds and insects, to fill the sails of our boats and to lift our kites, and miraculously this fluid we call air is thick enough to carry us but not too thick to prevent travel through it.

9.2 The atmosphere is layered from ground level up as follows:

- the troposphere;
- the tropopause;
- the stratosphere; and
- the ionosphere.

9.3 The *troposphere* is the layer nearest the surface of the earth. Most of our weather occurs here. Also it contains high winds and pronounced vertical currents. It consists of air of varying density and temperature – because the little particles, called molecules, are stacked on top. Ninety percent of the mass of air is squashed below about 50,000 ft. And almost all of it below 150,000 ft. The temperature reduction with altitude is called the lapse rate. Because the earth rotates, there is a centrifugal reaction which tends to push the air away at the equator so the troposphere is thickest in depth here. Also, it is lower in winter and higher in summer.

9.4 The *tropopause* is the upper layer of the troposphere. It occurs at around 36,000 ft in temperate latitudes and up to more than 50,000 ft in the tropics. The atmospheric temperature decreases as we climb; consequently, the tropopause represents the lowest temperature, and above this, the temperature remains fairly constant throughout the stratosphere. The tropopause is a very important level for pilots because optimum performance for a jet aircraft occurs here. Weather phenomena such as thunderstorms, jetstreams and clear air turbulence all occur in the tropopause. The tropopause also separates the troposphere and the relatively stable and uniform stratosphere.

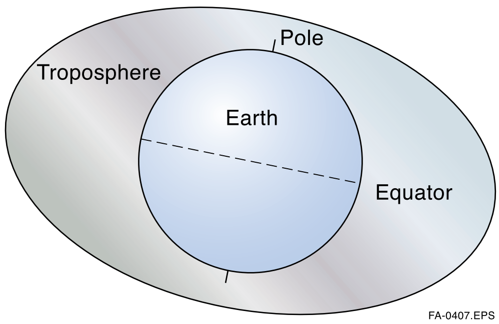


Figure 9-1 The troposphere.

9.5 The tropopause also "caps" the vertical development of thunderstorms, and when you see the classic anvil-shaped cloud, it is the top of the cloud having reached the tropopause being blown along by upper level winds.

9.6 The *stratosphere* is a cold, thin but uniform layer of air where there is virtually no cloud or weather. Flight at these altitudes has to be at very high speeds – several times the speed of sound or ballistic like the trajectory of a projectile. Jet engines cannot breathe here and thrust must be provided by a rocket motor. The ozone layer is contained in the lower stratosphere.

9.7 The *ionosphere* is above the stratosphere and is the layer of charged particles which reflects or "skips" radio waves. It is affected by sun-spot activity as any ham radio enthusiast will tell you.

International Standard Atmosphere

9.8 So that we can compare notes around the world, scientists have agreed on average atmospheric conditions called the International Standard Atmosphere. Like the average person, it never exists but it is a useful yardstick for comparisons. For those who dabble in numbers, the International Standard Atmosphere is as follows:

- Surface temperature: +15°C.
- Lapse rate: 2° per 1,000 ft (up to the tropopause, then constant).
- Freezing level (0°): 7,500 ft.
- Pressure: 1,013.2 hPa.
- Tropopause: 36,000 ft.
- Temperature at and above the troposphere: –56°C

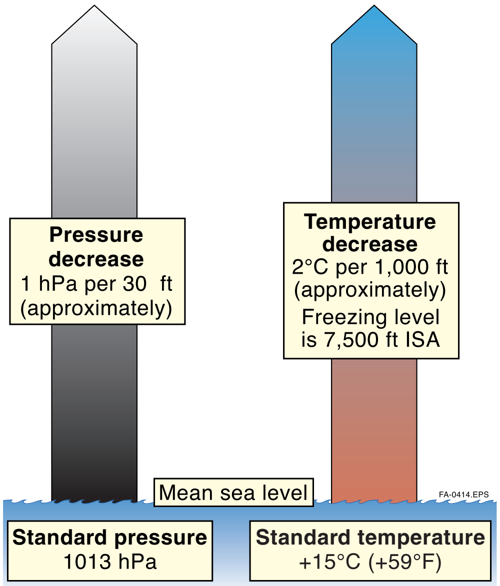


Figure 9-2 The International Standard Atmosphere.

9.9 As you can see, our space capsule is keeping us alive in what is an alien atmosphere for humans, –56°C, almost as cold as Siberia (or North Dakota) in winter! It can be as low as –80°C in the atmosphere above the tropics. Also, there is a pressure drop as altitude increases, and the air at the tropopause is about half the density of sea level air. Thus there is not enough oxygen to sustain life. Fighter pilots breathe oxygen through the masks. We have a pressurised cabin which replicates a near sea level pressure and so there is sufficient oxygen crammed into the cabin for us to breathe normally. Also, because the air at this altitude is so thin, we have to fly twice as fast to generate the same amount of lift.

Weather & Climate

9.10 In the troposphere, the horizontal and vertical currents and the presence of water vapour causes all of our weather – from fogs to clouds, to thunderstorms, to high level mare's tails, to rain, hail, ice and snow.

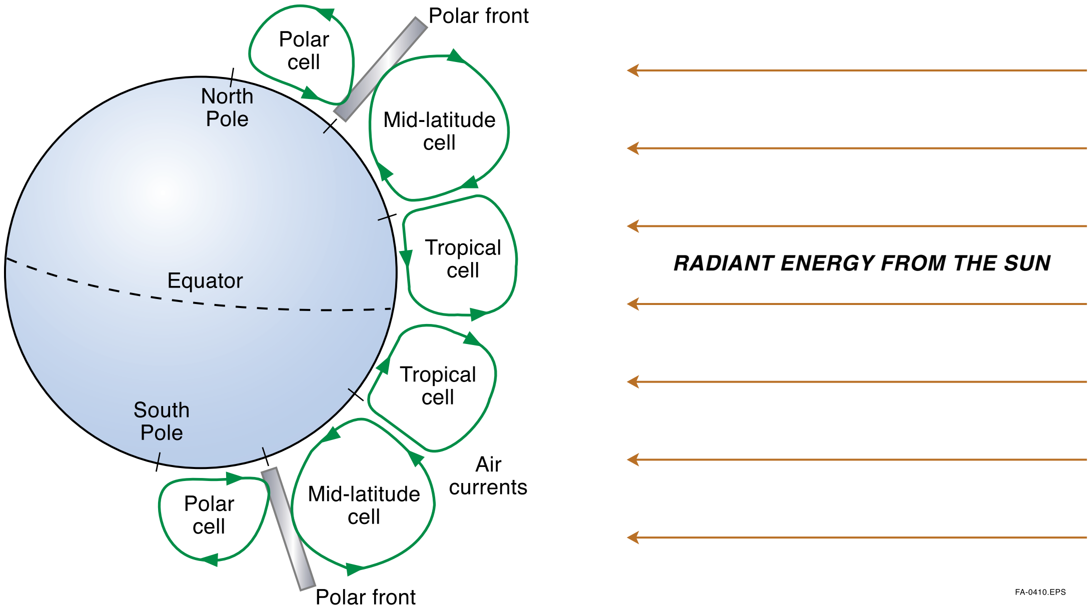


Figure 9-3 A cross-section of the circulation pattern.

9.11 The currents are nominally in the direction shown, but of course there is interaction between the horizontal and vertical currents and there are areas of *shear* where the adjacent layers are moving at different direction and speeds. It is these areas where turbulence is felt and where *jetstreams* predominate.

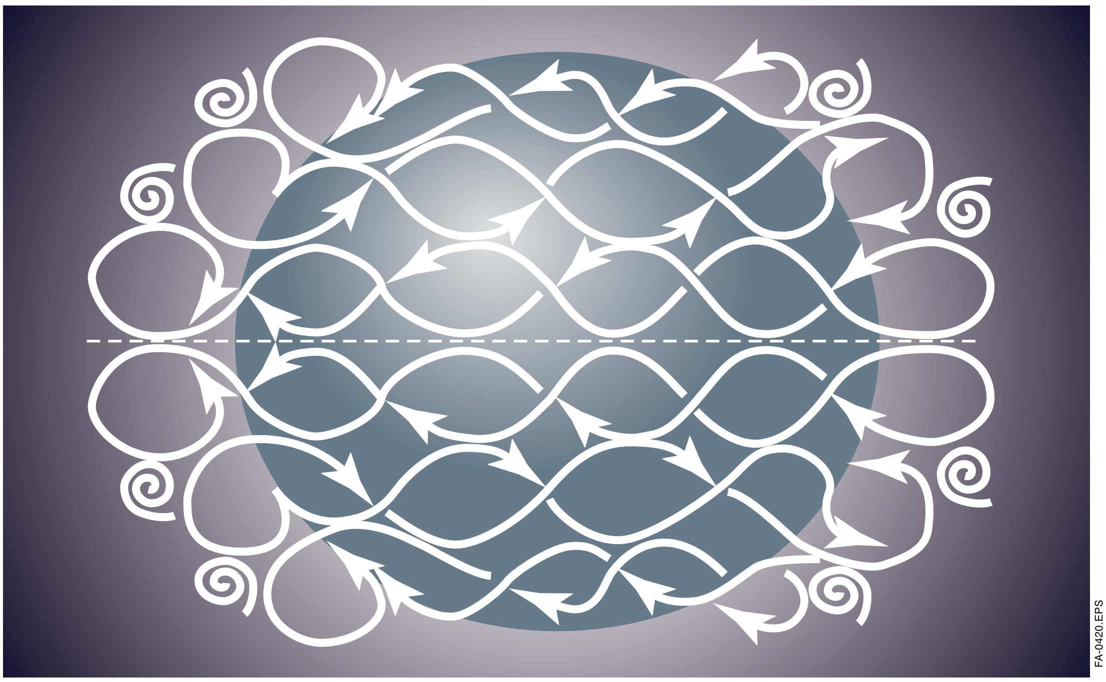
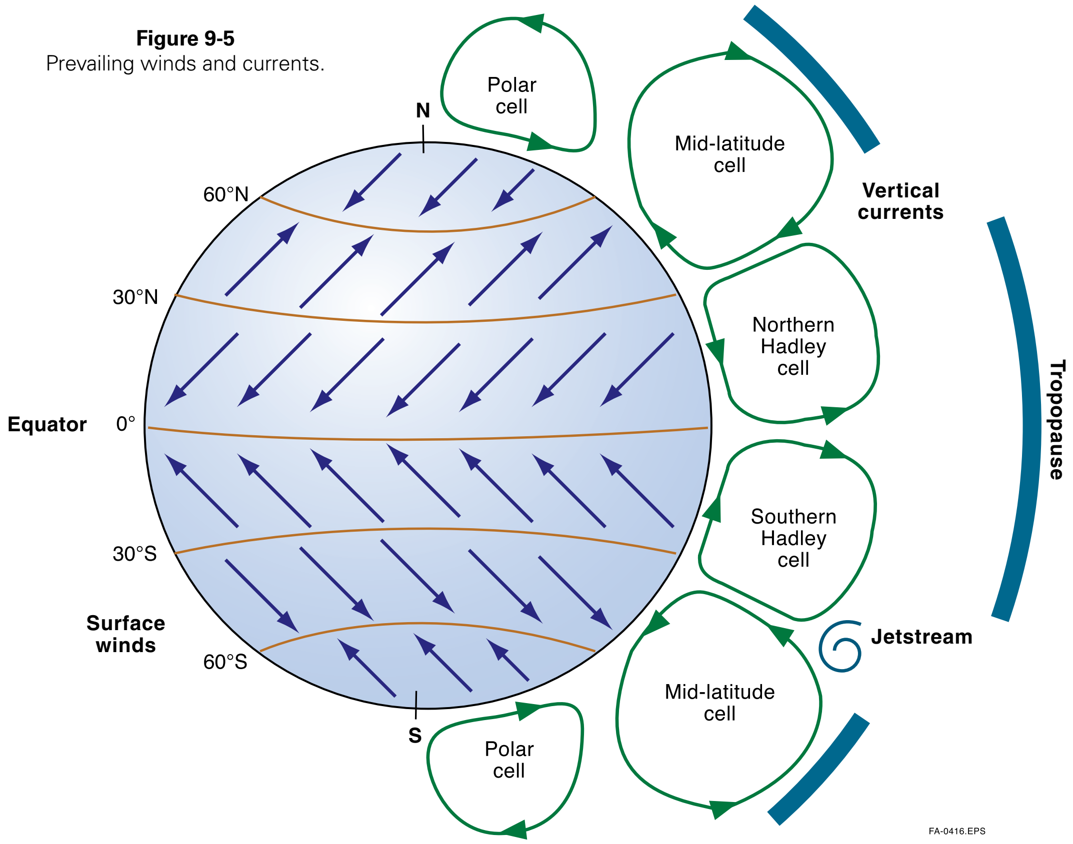


Figure 9-4 General circulation in the troposphere.

9.12 As well as these major flows, there are considerable local influences by physical features such as mountain ranges and coastlines.

Figure 9-5
Prevailing winds and currents.



9.13 These interactions together with daily heating and cooling, the effect of local terrain and the differences in atmospheric pressure, cause the cyclones and anti-cyclones (low and high pressure cells respectively) we see on the weather forecasts.

Figure 9-6
Cyclonic patterns.

Local Weather

9.14 Weather plays a very important role in the life of a pilot, since it determines the conditions in which he or she will be flying, or, indeed, if we will be flying at all on a particular day. The main features of weather for a pilot are wind direction and speed, visibility, and clouds, in particular cloud base and sky coverage as well as the possibility of cumulonimbus thunderclouds. The temperature of the atmosphere is also important. High temperatures reduce air density and, consequently, reduce aeroplane performance, while low temperatures below freezing may lead to ice forming on the aeroplane, which will reduce its performance and controllability significantly.

Wind

9.15 Wind direction and strength generally determine our choice of runway, since taking off and landing into wind has many advantages, such as a shorter take-off ground run. A steady wind over flat ground, or no wind at all, may provide us with smooth flying conditions, whereas a gusty wind might cause more turbulent flying conditions.

9.16 Strong winds underneath and near thunderstorms can also cause turbulence and windshear (windshear being large changes in wind speed and/or direction), as can obstructions such as hangars, hills or trees by breaking up the flow of the wind.

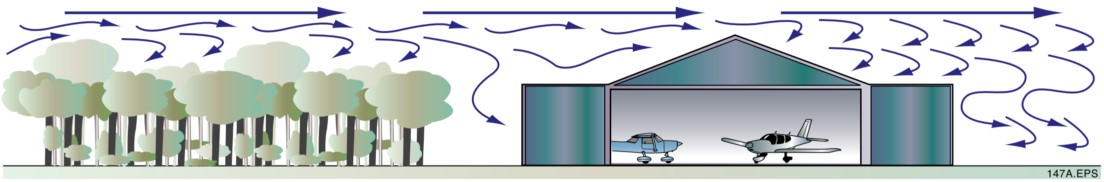


Figure 9-7 Friction and obstacles affect the surface wind.

Visibility

9.17 Visibility is very important to a pilot because it determines how far you can see. Unlimited visibility on a clear day makes flying and navigating much easier than on a day with poor visibility when you cannot see the horizon (making it more difficult to hold the aeroplane's attitude) or distant landmarks (making visual navigation more difficult). Poor visibility can be caused by small particles in the atmosphere, such as water droplets (mist or fog), dust, pollen, smoke, sand, sea spray, and so on. Rain may reduce visibility somewhat, but visual flight may still be possible. Be careful of ice forming on the aeroplane in sub-zero conditions.

Clouds

9.18 Clouds are a very important aspect of weather since they restrict visibility and cause precipitation. Visual pilots are not permitted to fly in cloud, including fog. Cloud base above the ground determines if visual flight operations are possible. Cloud coverage of the sky is usually expressed in oktas (i.e. eighths), with 8 oktas being complete coverage of the sky, 5 oktas being more than half, and 1 okta being not very much cloud at all.

Thunderstorms

9.19 Thunderstorms are a hazard to all aeroplanes, and should be avoided by all pilots, including instrument-rated pilots. Thunderstorms, so-called because of the clap of thunder that accompanies the electrical discharge we call lightning, originate in large cumulonimbus clouds.

Figure 9-8 A developing storm.

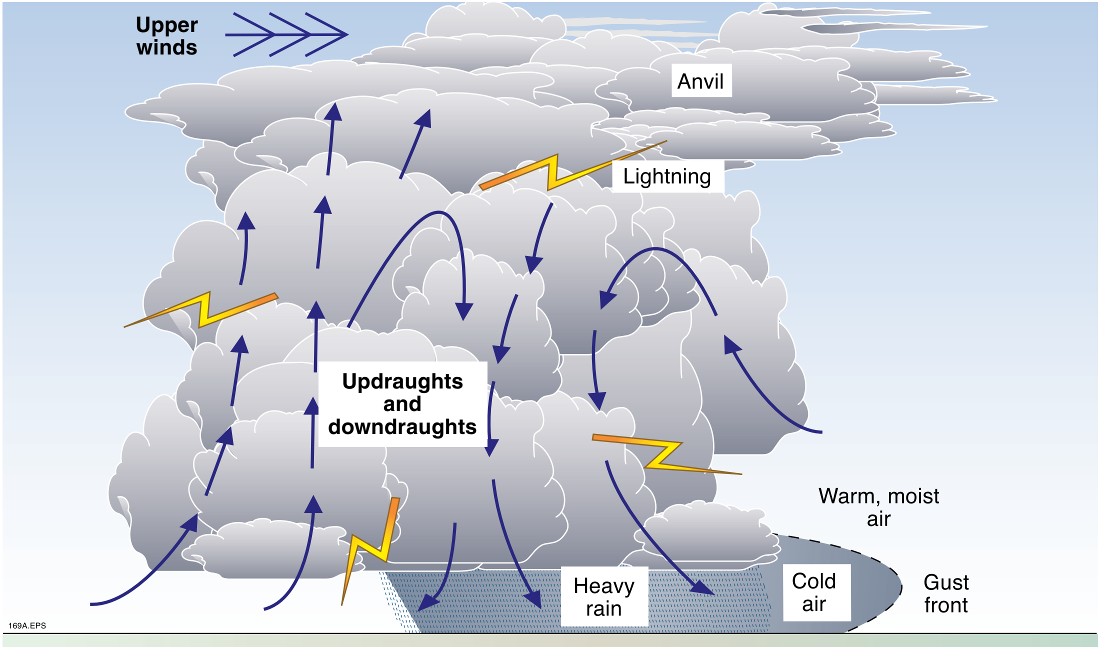


Figure 9-9 The mature stage of a thunderstorm.

9.20 They can cause severe turbulence, severe windshear, reduced visibility, severe icing, damage from hail or lightning strikes, as well as interference with radio communications and navigation aids. You should avoid thunderstorms by at least 10 nm. The good news is that, generally, they are easy to see and avoid.

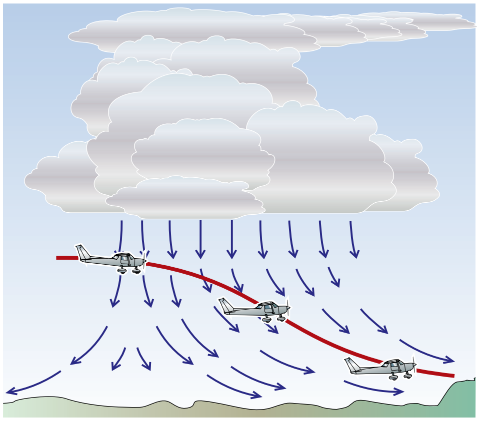


Figure 9-10 Downdraughts beneath storm cloud.

Fog

9.21 Fog is especially dangerous since it restricts visibility near the ground. You can sometimes be flying in a beautiful, clear sky and have a good, if somewhat misty, view of ground features beneath you (such as the runway below), but on approach to land, lose sight of the runway due to the greater slant distance through the fog or mist.

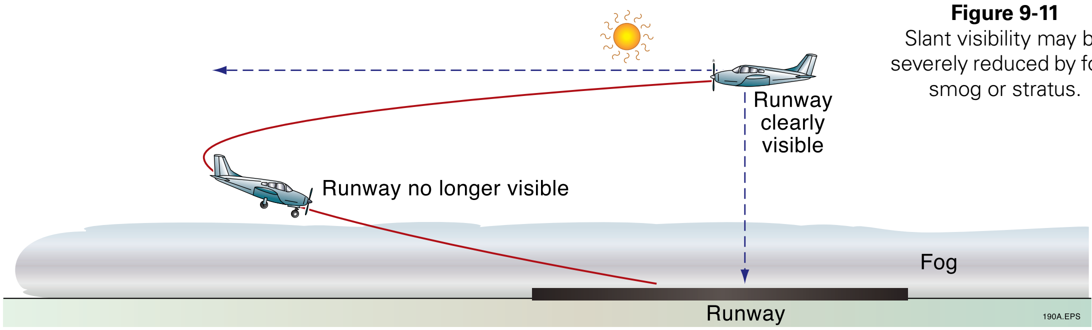


Figure 9-11
Slant visibility may be severely reduced by fog, smog or stratus.

Heating Effects in the Atmosphere

9.22 All weather is caused by heating, the initial source of the heat energy being the sun. The sun's rays are of such wavelengths that they penetrate the atmosphere and heat the earth's surface. The amount of heating depends upon the season (summer or winter), the time of day (day or night), and local conditions (cloud coverage, mountain shadows, etc.).

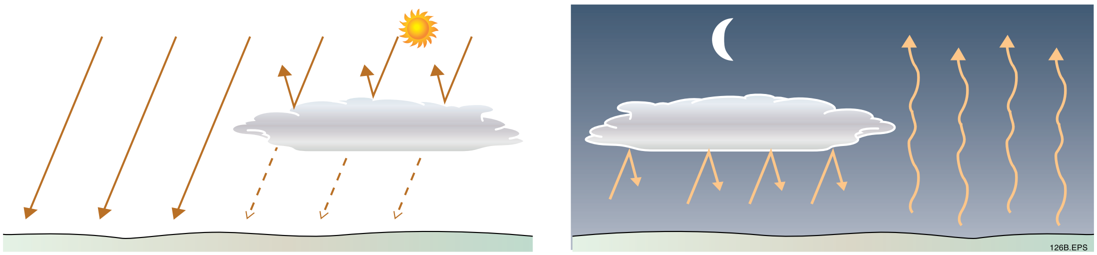


Figure 9-12 Cloud reduces surface heating by day and cooling by night.

9.23 The earth's surface, having been heated by the sun's rays, then gives off heat energy of a different wavelength that can be absorbed by the air, and so, surprisingly, the earth's atmosphere is heated from below. Land tends to absorb and emit heat energy more readily than the oceans or green-forested areas, so greater temperature variations, such as hot days and cold nights, are more likely over open land (for example, in inland desert areas). A parcel of hot air will rise through cooler air surrounding it and, as it rises, it will become cooler. Providing it contains sufficient vapour, it will reach a temperature (known as its *dewpoint temperature*), at which the water vapour will condense out as droplets and so a cloud will form.

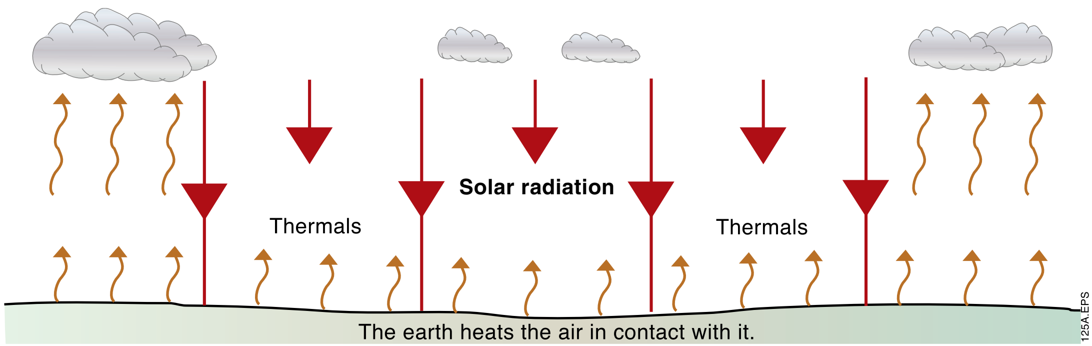


Figure 9-13 Indirect heating of the accomplisher by the sun.

9.24 The rising hot air is known as a *thermal*, and can be detected by cumulus clouds forming above it, and sometimes by birds hovering in it. Thermals are good news for glider pilots since they allow a glider, which doesn't have the advantage of an engine, to gain altitude.

Figure 9-14
Thermals forming for weather cumulus clouds.

9.25 If the air is dry, no cloud will form in the rising air due to the lack of moisture. The nature of any cloud that does form will depend upon the stability of the atmosphere – unstable air will continue to rise, forming lumpy, cauliflower-shaped *cumulus* clouds (also known as *cumuliform* clouds); stable air, however, will tend not to rise further, causing any cloud that forms to be of a layer type, known as *stratus* or *stratiform* cloud.

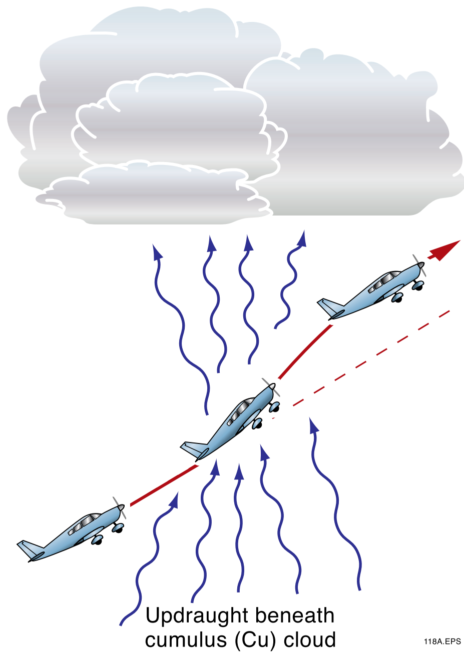


Figure 9-15
Updraught beneath cumulus (Cu) cloud.

9.26 The characteristics of unstable air are:

- turbulence in the rising air;
- the formation of cumuliform (cauliflower) clouds;
- showery rain from these clouds (if there is precipitation); and
- good visibility between the showers (due to the rising air carrying any obscuring particles away).

9.27 The characteristics of stable air are:

- the formation of stratiform (smooth layers) cloud with little vertical development;
- steady rain (if any);
- poor visibility if there are any obscuring particles; and
- possibly smooth flying conditions with little or no turbulence.

Inversion

9.28 An extreme case of stable air is a temperature inversion where, instead of temperature decreasing with altitude, it increases. This can happen on a cold, clear night when the land cools by giving off heat, and so the lower level of the atmosphere, usually below 1,000 ft, becomes very cool (sometimes causing fog to form). There will be no tendency for the cooler air to rise, and so flying conditions may be smooth with poor visibility.

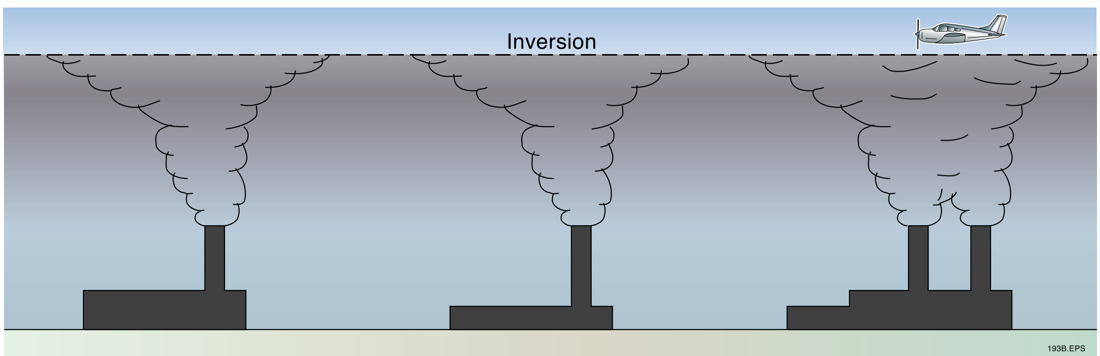


Figure 9-16 Inversions can lead to reduced visibility.

Winds

9.29 The term *wind* refers to the flow of air over the earth's surface. We describe it in terms of:

- the direction from which it is blowing, for instance a north wind blows from the north (i.e. from 360°); and
- its strength in knots.

9.30 Meteorologists relate wind direction to true north, and so a wind appearing on a meteorological forecast as 32015 kt means a wind strength of 15 kt from a direction of 320°T. When taking off or landing, however, you will be using a runway described in terms of its magnetic direction, and so winds passed to you over the radio by the tower or on an automatic terminal information service (ATIS) will be expressed in degrees magnetic.

9.31 Wind is caused to blow by pressure differences resulting from uneven heating of the earth. Air will want to flow from a high-pressure area to a low-pressure area, but other effects resulting from the rotation of the earth modify its direction of flow. The result is that air flows anticlockwise around high-pressure areas and clockwise around low-pressure areas in the southern hemisphere. (The direction of flow is reversed in the northern hemisphere.)

9.32 The surface wind is important to a pilot because of its effect on take-offs and landings. It is usually measured at about 30 ft above ground level. Friction effects between the flow of air and the earth's surface may cause the surface wind to be less strong and different in direction from the wind at altitude. The resulting effect for a pilot taking off or landing may be some turbulence and/or windshear.

Sea Breeze

9.33 The sea breeze, which occurs usually in the afternoon in coastal areas, is the result of uneven heating of the land and sea. On sunny afternoons after the land has warmed, the hot air above it rises. Cool air from over the sea moves in, causing an onshore breeze and lower temperatures on the beach. These are called *anabatic winds*, and examples of these include the "gully winds" in Adelaide and the "Fremantle doctor". A small circulation pattern is set up, possibly only up to 1,000 or 2,000 ft, causing a very different wind at circuit altitude compared to ground level.

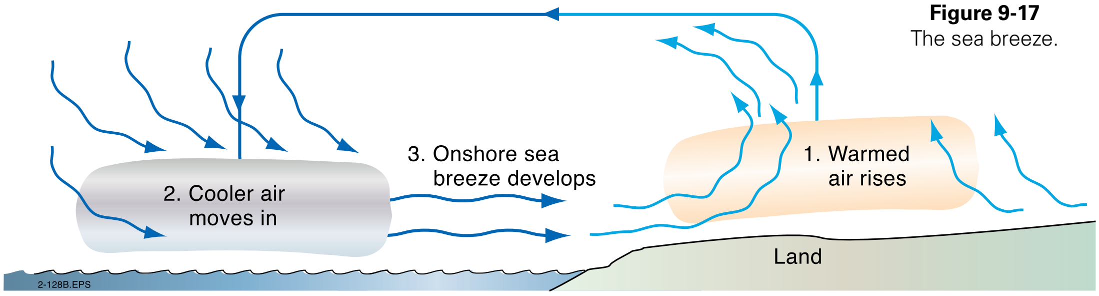


Figure 9-17
The sea breeze.

Katabatic Winds

9.34 Katabatic winds are winds that flow down mountain slopes and out of valleys at night and in the early mornings. They are caused by cooling of the earth's surface at night and the cooling of the air in contact with it. The cooler and heavier air tends to sink, and strong winds could be flowing down the slopes by the end of the night and maybe causing problems for pilots at nearby aerodromes.

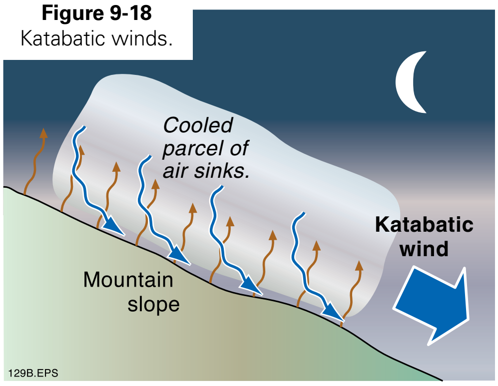


Figure 9-18
Katabatic winds.

Turbulence

9.35 Some degree of turbulence is almost always present in the atmosphere and pilots quickly become accustomed to slight turbulence. Moderate or severe turbulence, however, is uncomfortable and can even overstress the aeroplane.

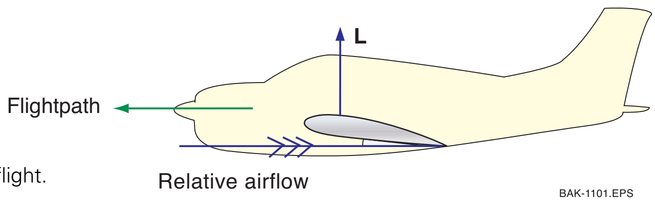


Figure 9-19 Cruise flight.

9.36 Vertical gusts increase the angle of attack, causing an increase in the lift generated at that particular airspeed and therefore an increased load factor. Of course, if the angle of attack is increased beyond the critical angle, the wing will stall and this can occur at a speed well above the published 1g stall speed.

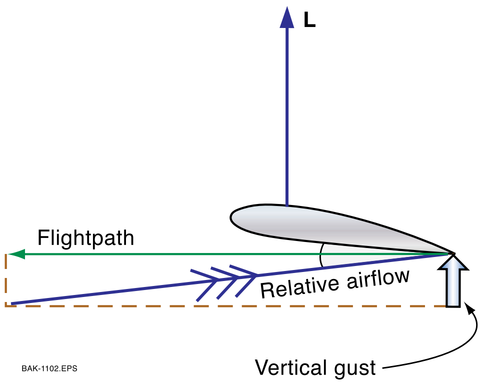


Figure 9-20 Small vertical gust.

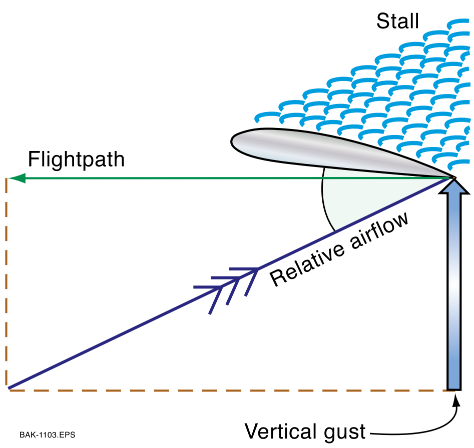


Figure 9-21 Large vertical gust.

9.37 Load factor (or g-force) is a measure of the stress on the aeroplane, and each category of aeroplane is built to accept specified maximum load factors. It is important that these load factors are not exceeded.

9.38 One means of achieving this is to fly the aeroplane at or below the turbulence penetration speed (V_B) which is usually slower by some 10%–20% than normal cruise speed, but not so slow as to allow the aeroplane to stall, remembering that in turbulence the aeroplane may stall at a speed higher than that published.

9.39 When encountering turbulence:

- fasten seat belts;
- hold the level flight attitude for the desired flight phase (i.e. climb, cruise, descent) using whatever aileron movements are needed to retain lateral control, but being fairly gentle on the elevator to avoid overstressing the airframe structurally through large changes in angle of attack and lift produced, and being prepared to accept variations in altitude; and
- since the airspeed indicator will probably be fluctuating, it will be less useful than normal, so aim to have the airspeed fluctuate around the selected turbulence penetration speed, which may require reduced power, by using power to maintain speed.

9.40 It is, of course, better to avoid turbulence, and to some extent this is possible by:

- avoiding flying underneath, in or near thunderstorms where changes to airflow can be enormous;
- avoiding flying under large cumulus clouds, because of the large updraughts that cause them;
- avoiding flying in the lee of hills when strong winds are blowing, since they will tumble over the ridges and possibly be quite turbulent as well as flowing down and into valleys at a rate which your aeroplane may not be able to outclimb; and
- avoiding flying at a low level over rough ground in strong-wind conditions.

Classification of Turbulence

9.41 So that pilots and air traffic controllers can communicate efficiently regarding turbulence, turbulence is given three basic classifications.

Light

9.42 In light turbulence, there is no significant changes to the aircraft attitude and/or altitude.

Moderate

9.43 In moderate turbulence, there may be moderate changes in aircraft attitude and/ or altitude, but the aircraft remains under positive control at all times. Usually, there are small variations in airspeed and changes in accelerometer readings of 0.5g to 1.0g at the aircraft's centre of gravity. Occupants feel a strain against seat belts. Loose objects move about.

Severe

9.44 In severe turbulence, there are abrupt changes in aircraft attitude and/or altitude; the aircraft may be out of control for short periods. Usually, there are large variations in airspeed, and changes in accelerometer readings greater than 1.0g at the aircraft's centre of gravity. Occupants are forced violently against seat belts. Loose objects are tossed about.

Windshear

9.45 If two parcels of air are moving relative to one another, which is the same as saying that the wind speed and/or direction of each parcel is different, then a windshear exists between them. The greater the difference over a short distance, the stronger the shear.

9.46 Windshear affects the climb path. . .

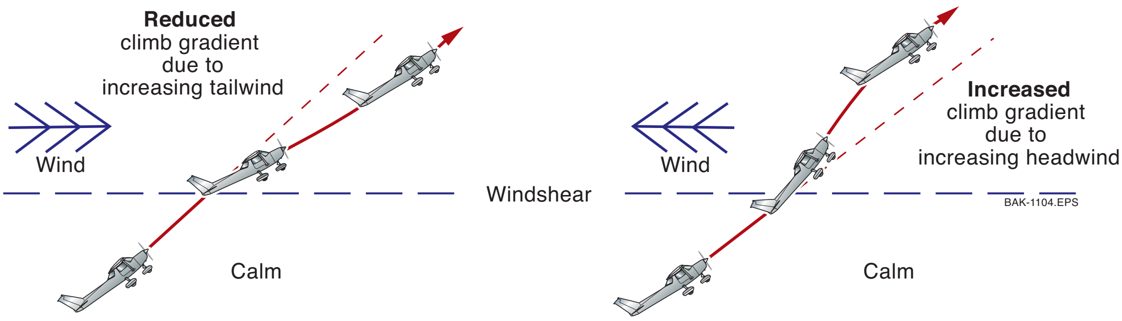


Figure 9-22 Effect of windshear on the climb path.

9.47 . . . but it affects more seriously, the descent and approach path.

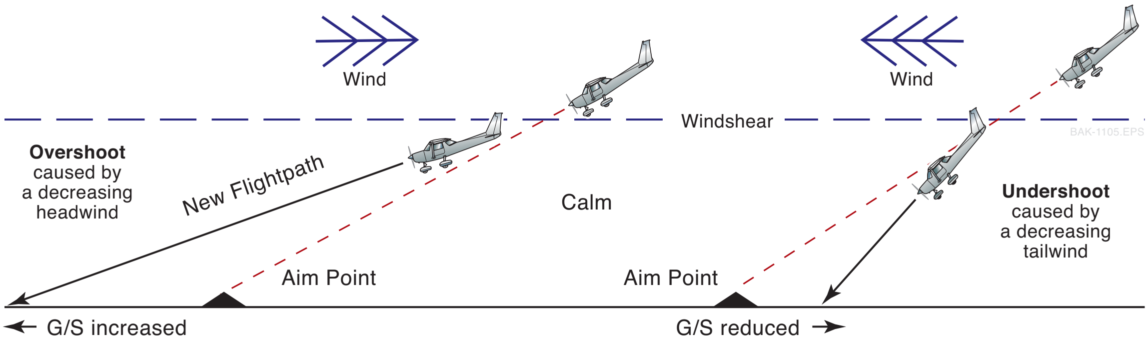


Figure 9-23 Effect of windshear on the descent path.

9.48 As well as the effect of wind, there are vertical currents that directly change the flightpath. . .

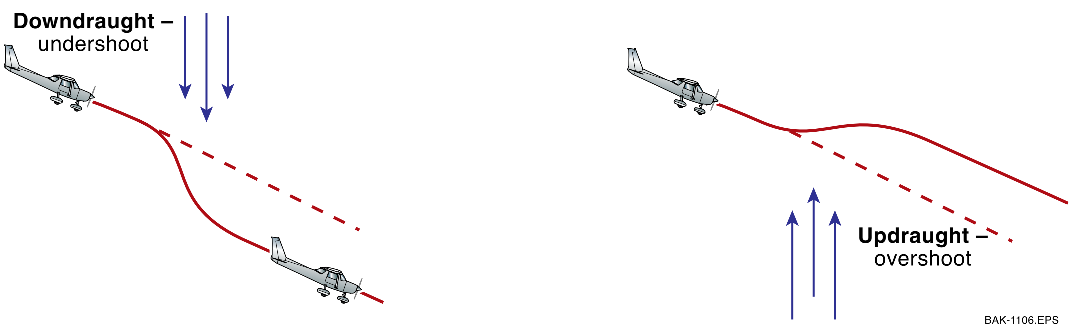


Figure 9-24 Common windshear situations.

9.49 . . . and a combination of both:

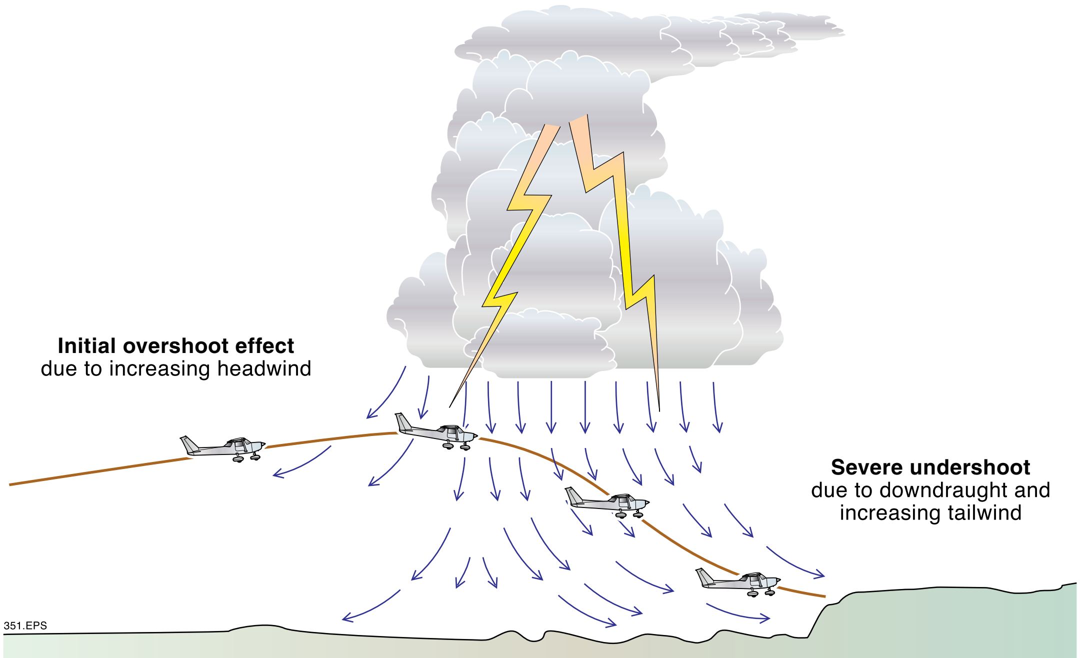


Figure 9-25 Avoid thunderstorms and cumulonimbus clouds.

9.50 The most significant effects seen by a pilot as the aeroplane passes suddenly from one parcel of air into the other are:

- a sudden change in airspeed;
- a tendency for the nose to pitch and the flight-path to change; and
- possibly some turbulence.

Figure 9-26 Potential hazard.

9.51 The sudden loss or gain of airspeed, if it is great enough and if it lasts more than a few seconds, will affect the performance of the aeroplane, since performance is determined to a large extent by the aeroplane's speed through the air. An increase in airspeed will improve performance, whereas a decrease in airspeed will degrade performance.

9.52 Turbulence is often associated with windshear due to friction between the two parcels of air moving relative to each other. There will be some form of wind gradient (wind change with distance) between the two parcels, with windshear and turbulence often being stronger in direct proportion to the wind gradient. Be very careful on final approach.

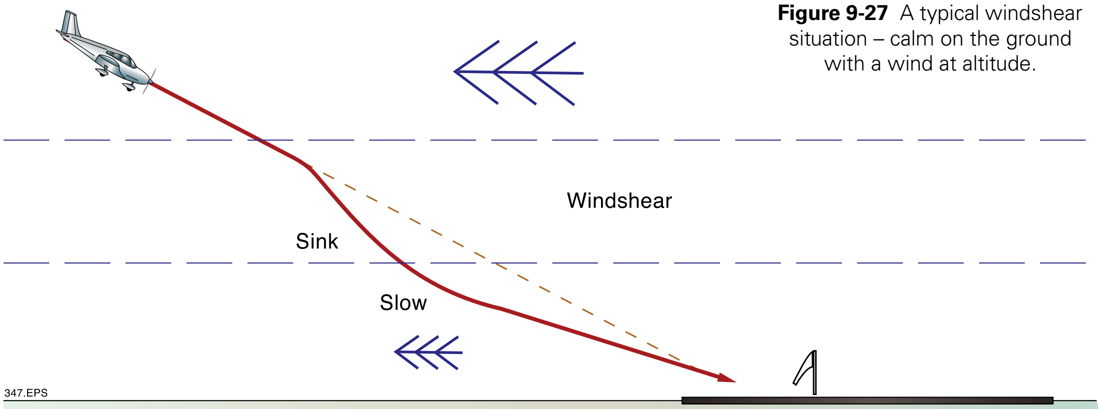


Figure 9-27 A typical windshear situation – calm on the ground with a wind at altitude.

Clouds

9.53 Clouds are made up of small water droplets or ice particles and take many forms. They are classified into many families according to the height of their base, and are named individually according to their nature.

9.54 Clouds belong to one of four families, depending upon height. These are:

- high-level clouds with a base above approximately 20,000 ft, and composed mainly of ice crystals in the below-freezing upper atmosphere (cirrus, cirrocumulus, cirrostratus);
- middle-level clouds with a base above approximately 7,500 ft (altocumulus, altostratus, nimbostratus);
- low-level clouds with a base below approximately 7,500 ft (stratocumulus, stratus, fair weather cumulus, nimbostratus); and
- clouds with extensive vertical development (towering cumulus, cumulonimbus).

Cloud Types

9.55 Clouds are named according to the following types:

- cirriform (fibrous), consisting mainly of ice crystals;
- cumuliform (heaped), formed by unstable air rising and cooling;
- stratiform (layered), formed by the cooling of a stable layer;
- nimbus (rain-bearing);
- mammatus (bulging downwinds);
- fractus (fragmented);
- castellanus (common base with separate vertical development – like towers on a castle – often in lines); and
- lenticularis (lens-shaped, often formed in strong winds over mountainous areas).

9.56 For example, nimbostratus means stratified clouds from which rain is falling. Altocumulus are middle-level heaped clouds. Cumulus fractus are fragmented cumulus clouds. Cirrostratus are high-level stratified clouds consisting of ice crystals. Standing lenticular altocumulus clouds are lens-shaped middle-level clouds standing in the one position, usually over a mountain range in strong winds. Nimbostratus is a hybrid cloud in terms of classification since its base can be low level or middle level, and it can have great vertical depth. Sometimes nimbostratus is 10,000 ft or even 15,000 ft thick, making it very dark when seen from underneath and capable of causing heavy rain for many hours. The abbreviations for the various cloud types in table 9-1 are used in weather forecasts and reports.

Abbr.	Type	Height
Ci	cirrus	high
Cc	cirrocumulus	high
Cs	cirrostratus	high
Ac	altocumulus	medium (base)
As	altostratus	medium (base)
Ns	nimbostratus	low (base)
Sc	stratocumulus	low (base)
St	stratus	low (base)
Cb	cumulonimbus	low (base)
Cu	cumulus	low (base)
TCu	towering cumulus	low (base)

Table 9-1 Cloud types.

Formation of Clouds

9.57 Clouds are formed by air cooling to below its dewpoint temperature and the water vapour condensing as water droplets (or ice crystals). The air can be cooled by rising to higher altitudes (hence clouds form above thermals and where the air is forced to rise above mountains), or by lying over a cold surface (which is how fog can form on cold nights with clear skies and little or no wind). The air can be caused to rise by being heated, or by being forced aloft by a mountain range (a process known as orographic uplift).

If the air is unstable, it will continue to rise, and any cloud that forms will be cumuliform. Stable air has no tendency to rise further, and so stratiform cloud will form. Unstable conditions can lead to thunderstorm development. Whether the air is stable or unstable depends upon conditions in that part of the atmosphere at the time.

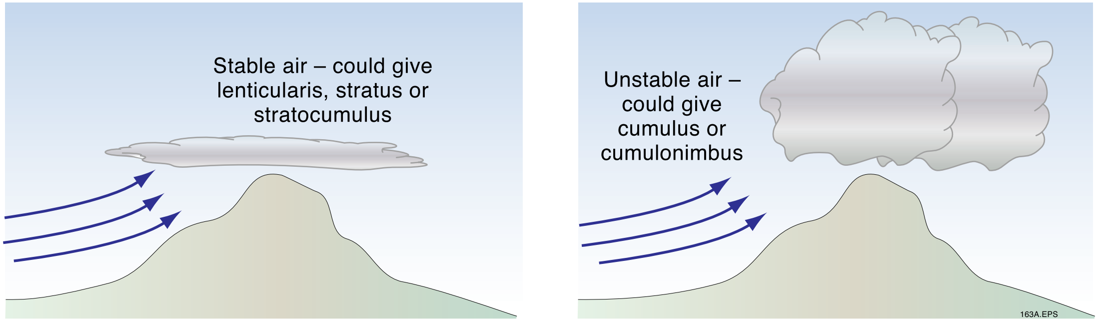


Figure 9-28 Orographic uplift can lead to cloud formation.

9.58 Large cumuliform clouds can also develop when cold air moves in at the surface and forces warmer air aloft.

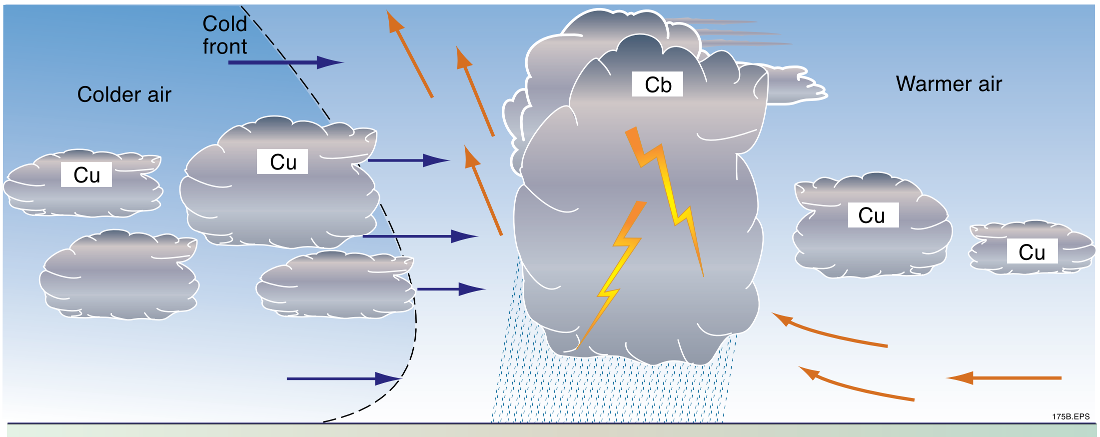


Figure 9-29 Cross-section of a cold front.

9.59 This is known as a cold front, and the passage of a fast-moving cold front can be quite dramatic (as people who live in Melbourne well know).

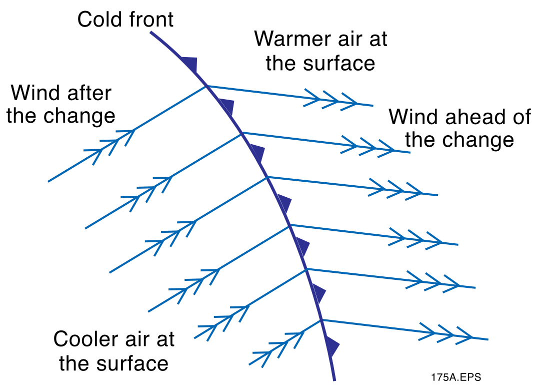


Figure 9-30 Depiction of a cold front on a weather chart.

Precipitation

9.60 Precipitation refers to falling water that reaches the ground, including:

- rain, consisting of liquid water drops;
- drizzle, consisting of fine water droplets;
- snow, consisting of branched and star-shaped ice crystals (snap-frozen);
- hail, consisting of small balls of ice;
- freezing rain or drizzle, which are liquid drops or droplets that freeze on contact with a cold surface (such as the ground or an aircraft in flight); and
- dew, frost or ice.

9.61 Steady precipitation and drizzle is typical from stratiform clouds, whereas precipitation from cumuliform clouds is likely to consist of showers and large droplets.

Weather Data

9.62 Weather conditions vary from time to time and from place to place. You can observe the weather around your local aerodrome and then assess the likely conditions over the next few hours using your local knowledge. Television weather programmes and newspaper weather forecasts and charts can give you an idea of "the big picture", but aviation forecasts and reports are much more specific.

Synoptic Charts

9.63 The weather map that you see in the news is called a *synoptic chart*. A synopsis is a summary – in this case, of the atmosphere. The chart is characterised by *isobars* (lines joining regions having the same surface pressure) and *fronts* (line symbols showing the passage of another air mass at a substantially different pressure or temperature). Usually in Australia, we see only cold fronts – which are shown as a line with triangular 'teeth'.

Pressure Systems

9.64 By convention, the isobars are normally drawn at intervals of 2 or 4 hPa, with 4 hPa intervals being more commonly used. When the isobar patterns have been drawn, they show areas, or systems, of either reduced pressure (called a low) or increased pressure (called a high).

9.65 Isobars plotted on the surface analysis chart produce a variety of simple, basic patterns, each of which has its own associated weather characteristics. Frontal systems are also plotted on the chart. The types of patterns that we can expect to find are described in the following.

Anticyclones (Areas of High Pressure)

9.66 An *anticyclone*, or *high*, is an atmospheric pressure distribution in which there is a higher central pressure relative to the surroundings. It is characterised on a synoptic chart by a system of closed isobars, generally approximately circular or oval in form, enclosing the central high pressure. *The circulation of winds about the centre of a high is anticlockwise, in the southern hemisphere.*

9.67 In comparison with low-pressure systems, highs tend to cover a greater area, are slower moving and persist for a longer period of time – and have a slacker pressure gradient. Near the surface, the effects of friction tend to cause the wind to blow slightly outwards across the isobars. *When flying directly towards the centre of the system, an aeroplane will experience right drift.*

9.68 The three-dimensional flow of air associated with an anticyclone is as follows:

- an outflow of air from the high-pressure area in the lower layers of the atmosphere (*divergence*) – in an anticlockwise direction;
- the slow subsidence (settling) of air over a wide area from above; and
- an inflow of air in the upper layers (*convergence*).

In effect, the high acts like a vertical, downward funnel.

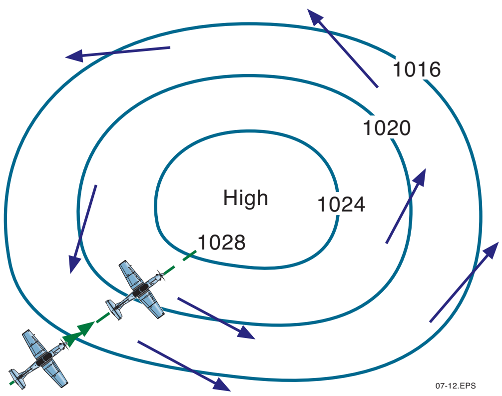


Figure 9-1 An anticyclone or high.

Weather Associated with a High

9.69 The subsiding air in a high-pressure system will be warming as it descends. Cloud will tend to disperse as the dewpoint is exceeded and the relative humidity decreases. Subsiding air is very stable. It is possible that the subsiding air may warm sufficiently to create a subsidence *inversion*, with the upper air that is descending warming to a temperature higher than that of the air beneath it, and possibly causing strati-form clouds to form (*stratocumulus, stratus*) or trapping smoke, haze and dust beneath it. This can happen in winter in some parts of the country, leading to rather gloomy days with poor flight visibility. In summer, heating by the sun may disperse the clouds, leading to a fine but hazy day.

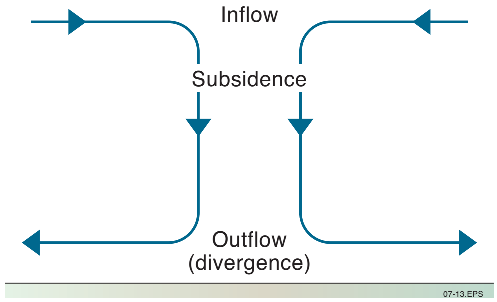


Figure 9-2
The three-dimensional flow of air near a high.

9.70 If the sky remains clear at night, as is often the case with high-pressure systems, greater cooling of the earth's surface by radiation heat loss may lead to the formation of radiation fog. If the high pressure is situated entirely over land, the weather may be dry and cloudless, but with any air flowing in from the sea, extensive stratiform clouds in the lower levels can occur, possibly leading to steady precipitation. In stable air, there is usually little or no turbulence.

Depressions (Areas of Low Pressure)

9.71 A *depression* appears on a surface analysis chart in a similar pattern to an anticyclone, except that the closed isobars surround an area of low pressure. It is the converse of a ridge of high pressure. Depressions are generally more intense than highs and extend over a smaller area. They have a stronger pressure gradient (change of pressure with distance), and the more intense the depression, the *deeper* it is said to be. The winds circulate in a clockwise direction in the southern hemisphere, and near the surface, friction tends to cause the wind to blow slightly inwards across the isobars. *When flying directly towards the centre of the system, an aeroplane will experience left drift.*

Note: Low-pressure systems, (depression), are sometimes referred to as *cyclones* (as opposed to anticyclones or high-pressure systems). You may also see the term *cyclonic flow* to describe the direction of the wind around a depression. In the Australian region, the term *cyclone* is reserved for intense tropical low-pressure systems, such as *Cyclone Tracy.* (Cyclones in the Australian region are no different to *hurricanes* as often reported in the Atlantic Ocean and *typhoons* in the Indian and northern Pacific Oceans.)

9.72 Because the pressure at the surface in the centre of the depression is lower than in the surrounding areas, there will be an inflow of air, known as *convergence*, with the wind strength increasing towards the centre. Towards the centre, the air will rise (an upward funnel effect), and there will be a divergence, or outflow, at the upper levels.

9.73 The three-dimensional pattern of airflow near a depression is as follows:

- convergence (inflow) in the lower layers, in a clockwise direction;
- rising air above the centre; and
- divergence (outflow) in the upper layers.

It should be noted that not all depressions develop from the formation of fronts. Such non-frontal depressions can be caused by a variety of means, such as intense inland heating.

9.74 A fairly common non-frontal depression is formed by strong divergence in the upper levels of the atmosphere, leading to falling pressures at the surface. This gives rise to widespread vertical ascent, reducing the stability of the air. If the air is moist, there may be extensive cloud development and precipitation.

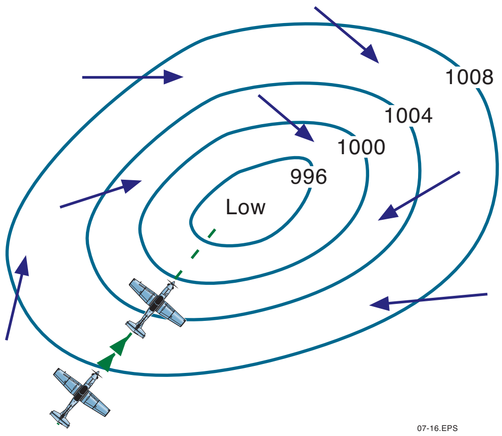


Figure 9-3
A depression or low.

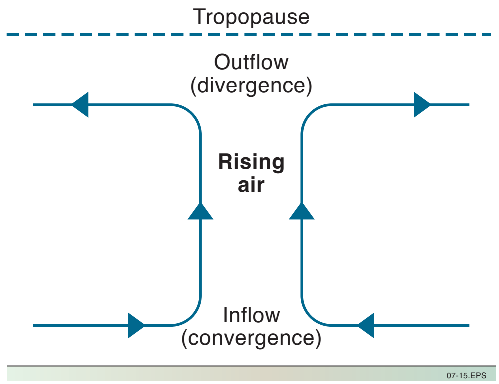


Figure 9-4
The three-dimensional flow of air near a low.

Weather Associated with a Low

9.75 In a depression, the rising air will be cooling and so cloud will tend to form. Instability in the rising air may lead to quite large vertical development of *cumuliform* clouds accompanied by rain showers. Good visibility (except in the showers) may be expected since the vertical motion will tend to carry away particles suspended in the air. Some turbulence can be expected.

Fronts

9.76 A *front* is a narrow boundary or zone separating air masses of different temperatures. They are generally mobile and rotate in a clockwise direction around the centre of a low, and in an anti-clockwise direction around the centre of a high. As the air mass rotates the layers closest to the earth are slowed and then more influenced to move inwards or outwards, due to the pressure gradient.

9.77 Typically, a cold front has a slope of about 1 in 75, whereas the slope of a warm front might be as shallow as 1 in 200. Additionally, because the cold front is formed by cold air pushing in under the warm air, the slope of the front tends to be curved, with a possible reverse nose at the surface.

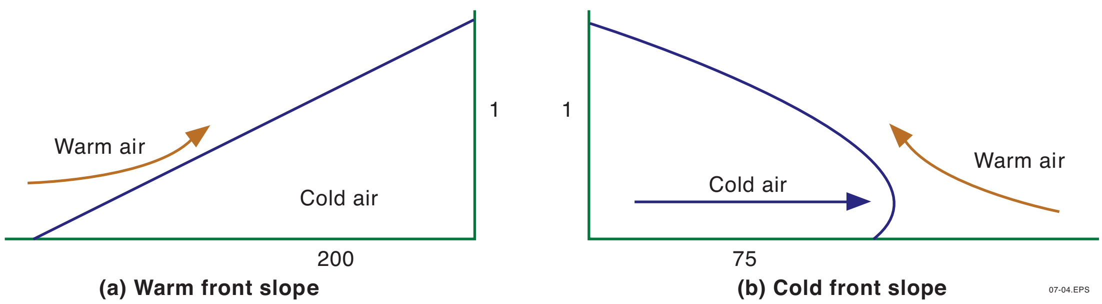


Figure 9-5 Typical slopes of warm and cold fronts.

Cold Front

9.78 The air that is forced to rise with the passage of a cold front is unstable and so the clouds that form are cumuliform in nature, such as *cumulus* and *cumulonimbus*. Severe weather hazards such as thunderstorm activity, line squalls, severe turbulence and windshear, may accompany the passage of a fast-moving cold front.

9.79 The majority of cold fronts in Australia tend to be fast moving, have a relatively steep slope and produce severe effects. However, slow-moving cold fronts can occur and these produce less severe weather conditions. The slope of a slow-moving front is shallower and the cloud formation is similar but in a reverse order; that is, the low cloud will appear first, followed by the high stratiform cloud as the front moves away.

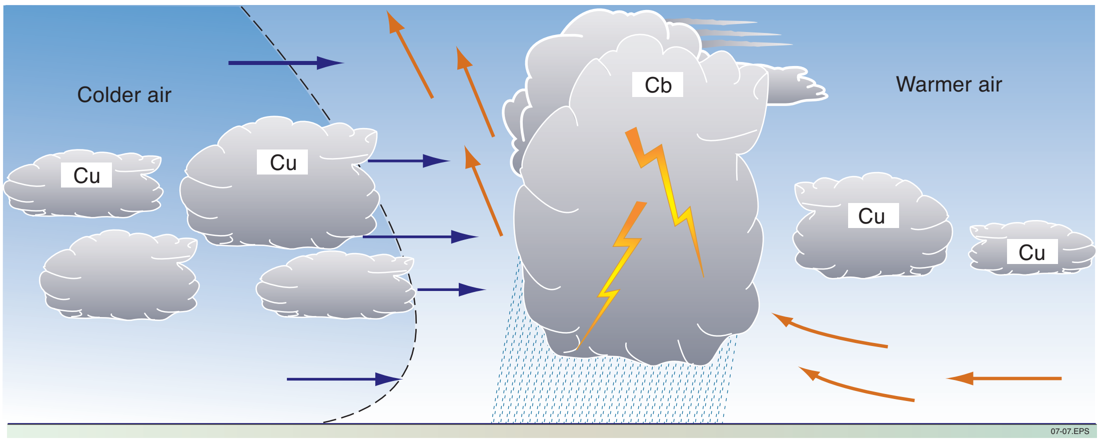


Figure 9-6 Cross-section of a fast-moving cold front.

9.80 The passage of a cold front is characterised by the following:

- the wind backs to south-west (from the previous north-west);
- the temperature falls;
- humidity rises;
- pressure starts to rise;
- there could be a thunderstorm/squall; and
- usually, low cloud.

Chart Analysis

9.81 The chart in Figure 9-7 shows typical pressure systems and associated fronts, troughs and ridges. You can identify pressure systems and associated fronts, troughs and ridges and make an assessment of the surface wind at selected locations.

- What are the names of the pressure systems labelled *A*, *B*, *C* and *D*?
- What would you expect the surface pressure to be at Broken Hill (YBHI), Brisbane (YBBN) and Alice Springs (YBAS)?
- What are the names of the features marked (*ZW*), (*WB*), (*DX*) and (*CY*)?
- What would you expect the direction of the surface wind to be at Melbourne (YMML), Townsville (YBTL) and Port Hedland (YPPD)?

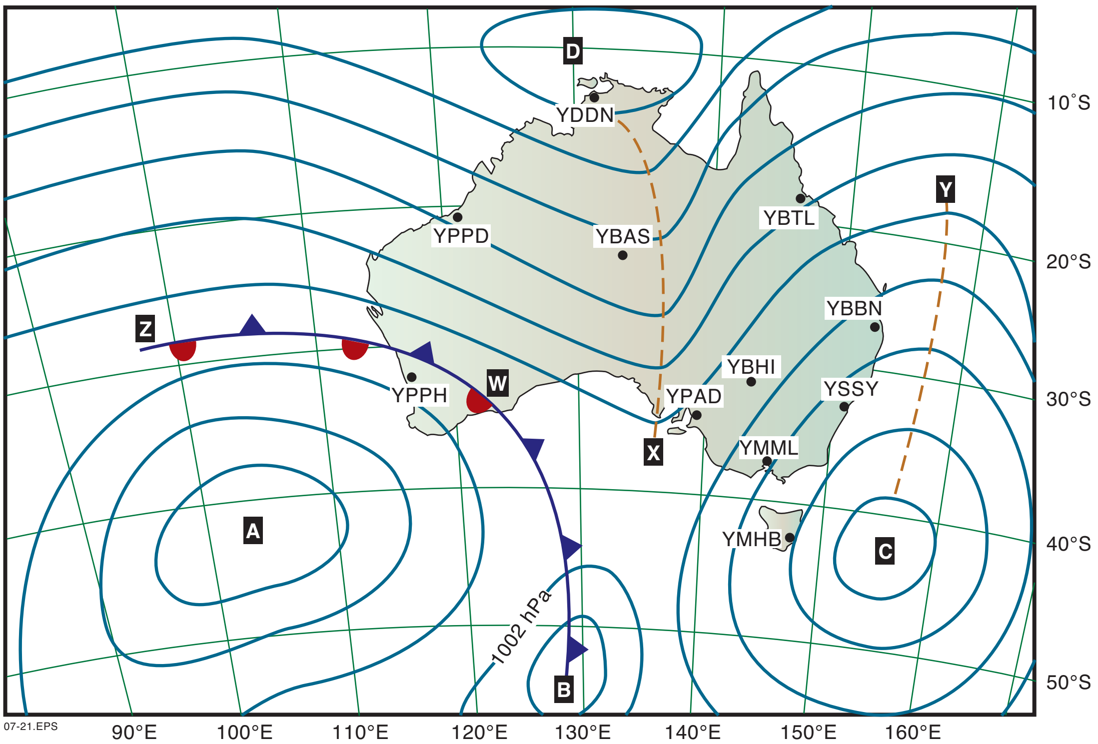


Figure 9-7 Typical mean sea level analysis chart.

9.82 When analysing a surface chart, there are four key points to remember:

- a front always originates from an area of low pressure (but not necessarily a depression);
- the circulation around a low is clockwise and around a high is anticlockwise (remember a rule named, *Buys Ballot's law,* which is a guide and states that with your back to the wind, the area of low pressure is to your right);
- the pressure gradient runs down into low-pressure areas and up to high-pressure areas; and
- the gradient wind (the wind that blows around the isobars) cannot flow in a reverse direction at any point.

9.83 Using this knowledge, we can see that the closed system marked at *B* must be a low. Now we can draw arrows on all the isobars, remembering the clockwise flow around low-pressure areas and anticlockwise around high-pressure areas. Having drawn in the isobars, we see that the flow around systems *A* and *C* is anticlockwise, and they are therefore highs, while around *D* the flow is clockwise and it is therefore a low.

9.84 The next step is to mark in the isobar values. We have been given one value of 1,002 hPa just to the west of *B*. You should have the isobar around *A* marked as 1008, around *B* as 1000, around *C* as 1010 and around *D* as 992 hPa. Therefore, the pressure at Broken Hill is 1003, at Brisbane 1005 and at Alice Springs just over 996 hPa.

9.85 The feature marked *ZW* is a quasi-stationary front (note the barbs pointing from the cold air to warm air, and the semicircles from warm to cold), feature *WB* is a cold front, *DX* is a trough line and *CY* is a ridge of high pressure.

9.86 Finally, we need to estimate the direction of the surface wind at various locations. You should remember that because of friction in the lower layers, the surface wind always veers towards the low pressure, in other words it is deflected outwards around a high and inwards around a low. The amount of deflection varies: over water it veers about 10°, while over land it may be as much as 30°, depending on the nature of the surface.

9.87 The surface-wind direction at the various locations are as follows:

- At YMML, the gradient wind direction is approximately 045°T. As the wind is coming from over the land, it will veer by about 30°, and therefore the surface wind can be expected to be about 075°T.
- At YBTL on the other hand, the wind is coming off the ocean, and the gradient wind of 050°T will veer only about 10°, so the surface wind can be expected to be about 060°T.
- At YPPD, the gradient wind is 120°T from over the land, and the surface wind will therefore be 150°T.

Forecasts & Reports

9.88 A weather *forecast* is a prediction of what the weather is likely to be during a certain period of time. A weather *report* is an actual observation of the weather at a particular time. It may be that a recent weather report specifying the actual conditions at the time of observation has a trend forecast attached to it, which is a prediction of what the weather is likely to be over the following few hours. A most useful weather report is the information passed to you by air traffic control, either directly or in the form of an automatic terminal information service (ATIS) broadcast on a specific COM, VOR or NDB frequency. (These are radio communications and radio navigation aid frequencies.) Normally you listen to the ATIS prior to taxiing for take-off or when approaching an aerodrome for a landing. A typical ATIS at a controlled aerodrome will nominate a duty runway as well as advise the weather conditions, e.g.:

> *Camden terminal information Bravo, Runway two four, wind two three zero degrees, one two knots, QNH one zero zero four, temperature one nine, visibility eight kilometres, cloud four oktas three thousand five hundred, on first contact with Camden Tower or Ground, notify receipt of Bravo.*

9.89 The wind direction in an ATIS is given as degrees magnetic (°M). This allows you to relate it directly to the runway in use. Wind speed is in knots so that you can relate its effects to your aircraft's performance.

Preflight Weather (Meteorological) Briefing

9.90 The provision of weather briefing information (and other necessary briefing material such as NOTAM) is now automated. There are three basic ways in which you can obtain a preflight briefing via:

- *DECTALK*, an automated national weather service available from a synthesised voice on selected 008 telephone numbers in Brisbane and Melbourne;
- *AVFAX*, which has all meteorological products, including charts, plus NOTAM information, available by facsimile; and
- *Telephone Briefing Service* from the Weather Service Office (WSO) or the Regional Forecasting Centre (RFC) servicing the area.

9.91 Full details of the various briefing facilities available are contained in the En Route Supplement Australia (ERSA) and Visual Flight Guide (VFG), which your flying school will have for you to study. At this stage of your flying career, it will be the responsibility of your flight instructor to ensure that the weather is suitable for your flight. However, it is in your own interest to become familiar with the systems, and learn to interpret the different types of weather forecast that you may see. It's also fascinating. The two basic meteorological forecasts that you will use are:

- the graphical area forecast (GAF) for the general areas in which you intend flying; and
- the terminal area forecast (TAF) for the specific aerodromes that are appropriate to your planned flight.

Forecasts

Forecast Abbreviations

9.92 To read weather forecasts and reports, you will need to become familiar with some new abbreviations and terms.

Cloud Coverage

9.93 To describe the amount of cloud cover, we use the term *okta*, which means an eighth. For example, 4 oktas means that half the sky is covered by cloud, while 8 oktas means complete cloud cover, i.e. overcast. In reports, forecasts and low-level area forecasts, however, rather than referring to oktas, the amount of cloud will be indicated by the following abbreviations:

SKC (sky clear)	0 oktas
FEW (few)	1-2 oktas
SCT (scattered)	3-4 oktas
BKN (broken)	5-7 oktas
OVC (overcast)	8 oktas

Table 9-2 Cloud amount abbreviations.

Figure 9-1
Scattered cloud.

9.94 These terms are not particularly precise since they refer to large areas. SKC is seldom used, since a completely clear sky is relatively rare. Similarly, OVC is seldom used, since a completely overcast sky without a single break is also rare.

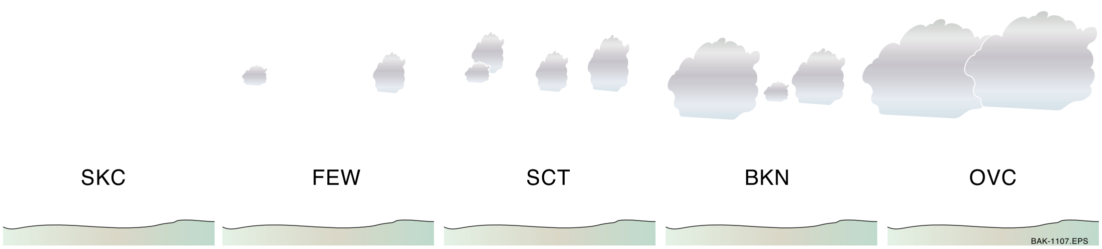


Figure 9-2 Cloud amount abbreviations.

Thunderstorms

9.95 Thunderstorms, which you should avoid, are associated with cumulonimbus (Cb) clouds. The amount of Cb cloud in an area is indicated by:

- ISOL (isolated), for individual Cbs;
- OCNL (occasional), for well-separated Cbs; and
- FREQ (frequent), for Cbs with little or no separation.

9.96 These three terms are also used to describe the concentration of showers (not necessarily thunderstorms or Cb clouds) in an area. In practical terms, ISOL Cbs should not cause you much trouble unless they are situated near the aerodrome, since they should be easy to see and to avoid. OCNL Cbs will be more difficult to avoid of course, since there will be more of them, and be vary wary of Cbs being hidden in a layer of stratocumulus. FRQ Cbs should encourage you to stay on the ground or choose another route.

Cloud Heights

9.97 In an *area forecast (ARFOR)*, the heights of the cloud bases and tops are given above mean sea level (AMSL). A typical example of how cloud is reported in an ARFOR is:

BKN ACAS 10000/20000

9.98 This means that there will be 5–7 oktas of altocumulus/altostratus with a base at 10,000 ft AMSL and tops at 20,000 ft AMSL.

9.99 In *terminal area forecasts* (TAF) and reports (METAR/SPECI), only the cloud base is given. It is shown as a three-figure group of tens of thousands, thousands, and hundreds of feet, and is measured above aerodrome level (AAL). This means that we must add the aerodrome elevation to the reported cloud base so that we can relate it to our altitude on QNH. It is done this way as it gives the actual vertical space between the cloud and the ground.

CAVOK

9.100 You will sometimes see the term CAVOK used in a TAF to indicate that "ceiling and visibility are OK". In practice, it means slightly more than this:

- visibility of 10 km or more;
- no cloud below 5,000 ft AAL, and no cumulonimbus clouds; and
- no precipitation, thunderstorms, shallow fog, low drifting snow, or dust devils.

TEMPO & INTER

9.101 TEMPO and INTER are used to indicate significant variations of a temporary or intermittent nature in aerodrome and landing forecasts:

- TEMPO is used to indicate change in prevailing conditions expected to last for a period of more than 30 minutes and less than 60 minutes in each instance; and
- INTER is used to indicate changes expected to occur frequently for periods of less than 30 minutes duration, the conditions fluctuating almost constantly, between the times specified in the forecast.

FM

9.102 If you come across this abbreviation, which means "from", in a forecast, it indicates there will be a change in the forecast conditions. The change will last from the time quoted, e.g. FM 0830 means from 0830, until the end of the forecast validity period, or until the start of another significant change. If turbulence is forecast, its start time will be shown as "FM" and its cessation time within the forecast coverage will be indicated by the word "TILL", e.g. "FM 02 MOD TURB TILL 08".

Graphical Area Forecasts

Introduction/History

9.103 In 2017, the Bureau introduced *Graphical Area Forecasts* (GAF) to replace the ARFORs.

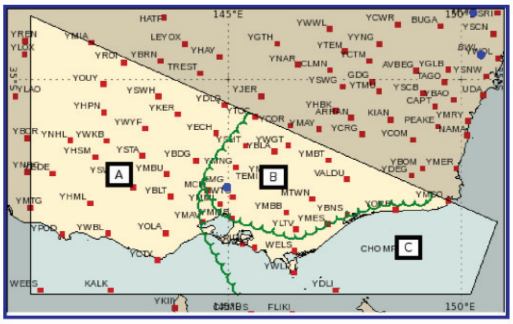
9.104 The ARFOR was replaced with two separate new forecasts:

- *Graphical Area Forecasts* (GAFs); and
- *Grid Point Wind and Temperature* (GPWT) Forecasts.

9.105 GAFs will cover the airspace between the surface and 10,000 feet *Above Mean Sea Level* (AMSL) and will provide information on weather, cloud, visibility, icing, turbulence and freezing level in a graphical layout, with supporting text. The GAF is quicker and easier to interpret but will also allow greater flexibility when distinguishing between weather boundaries, and utilising automated systems. GPWT forecasts will include wind velocity and temperature forecasts at specified heights AMSL, presented in a grid format. The *Graphical Area Forecast* (GAFs) is presented in this format.

Graphical Area Forecast SFC - 10000FT VIC
Issued at 1709150030Z - Valid 150500 to 151100Z
Weather Features valid at 150500Z

Australian Government
Bureau of Meteorology



All heights AMSL
TS / CB / TCU implies SEV ICE and SEV TURB
CU / SC / AC implies MOD TURB
CLD ABV FZLVL implies MOD ICE
Speed of movement in KT
● refers to Critical Locations
- refers to Limit of Forecast
Check AIRMETs, SIGMETs and NOTAMs

REMARKS:
CRITICAL LOCATIONS [HEIGHTS AMSL]
KMG [ELEV 1200FT]: 9999 SCT SC 4000FT, TEMPO 1505/1511 5000M RA BKN ST 1500FT

For more information contact (03) 9669 4850

AREA	SURFACE VIS AND WX	CLOUD, ICING AND TURB	FZLVL
A	>10KM NIL	SCT AC/AS 9000/ABV10000FT	ABV 10000FT
B	>10KM NIL	SCT SC 4000/7000FT SCT AC/AS 9000/ABV10000FT	ABV 10000FT
	5000M SCT RA	BKN ST 1500/4000FT BKN SC 4000/7000FT BKN AC/AS 7000/ABV10000FT	
	4000M ISOL FU BLW 10000FT		
C	>10KM NIL	SCT SC 2500/7000FT, BKN SEA SCT AC/AS 9000/ABV10000FT	ABV 10000FT
	8000M ISOL RA	BKN SC 2500/5000FT BKN AC/AS 7000/ABV10000FT	
	4000M ISOL FU LAND BLW 10000FT		
		MOD TURB BLW 7000FT FM 09Z	

Figure 9-3 Example GAF for Victoria

9.106 The *Grid Point Wind and Temperature* (GPWT) Forecast is represented in this way.

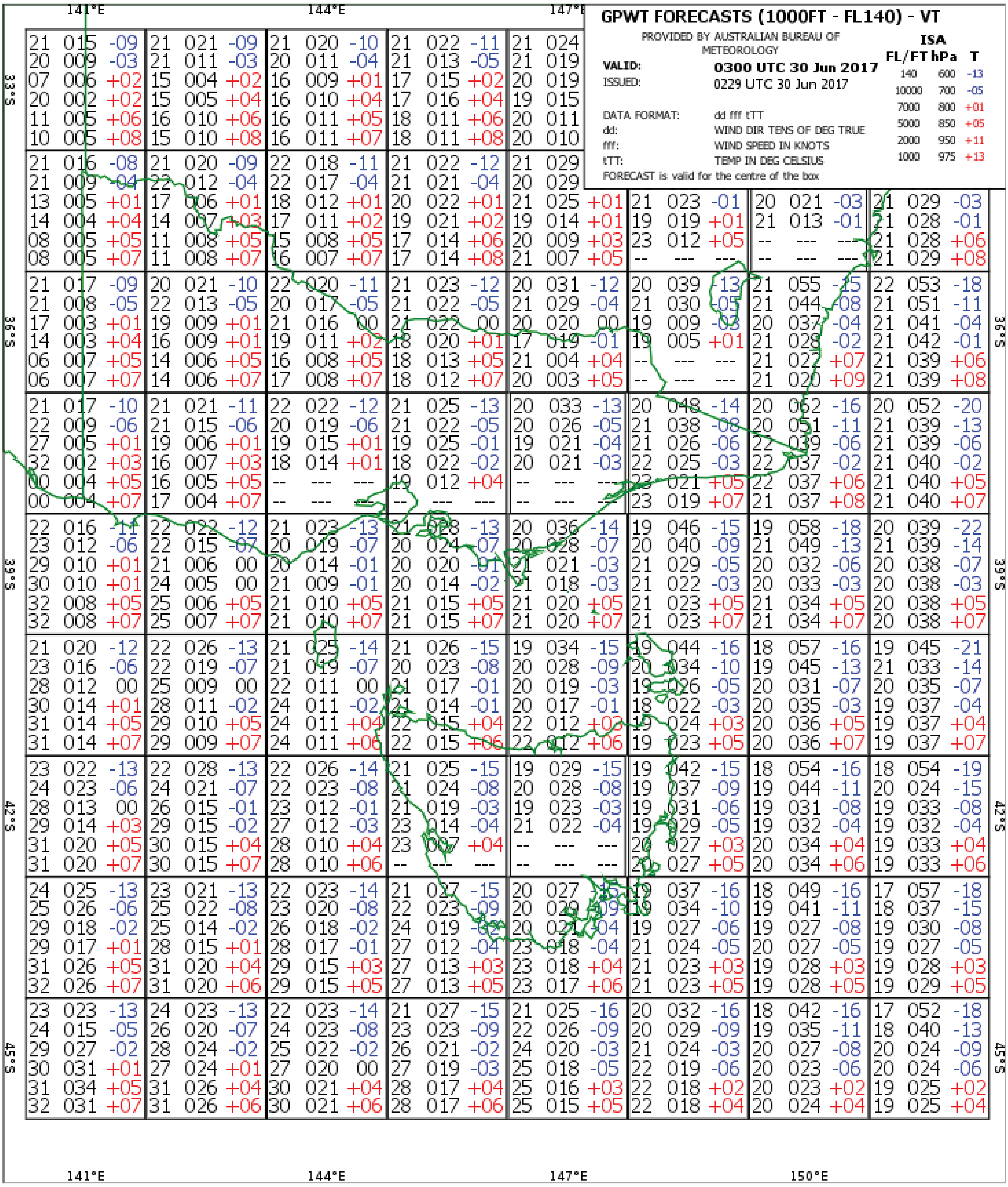


Figure 9-4 Example GPWT Forecast (VIC/TAS)

Area Briefing (NAIPS)

9.107 Area QNH areas are retained as briefing areas in NAIPS. As NAIPS briefings need to include GAF products, GAF and Area QNH boundaries are aligned. The briefing areas will be renamed as Area QNH/Briefing Areas in *En Route Supplement Australia* (ERSA). After GAF implementation, AREA QNH forecasts were still displayed in the text content of each briefing page, similar to the previous practice.

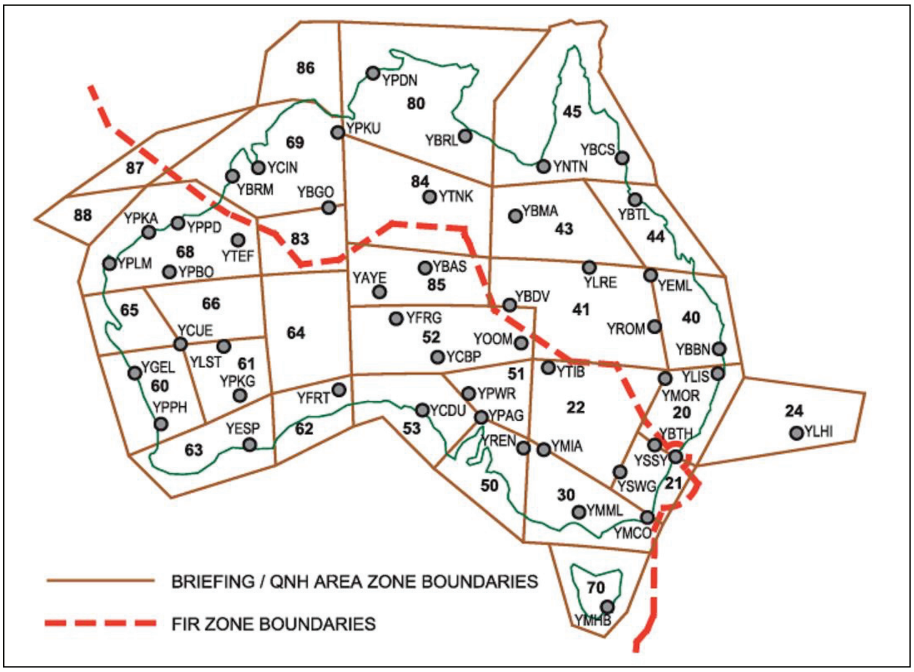


Figure 9-5 NAIPS Briefing / Area QNH Boundaries

9.108 It should be noted that when a NAIPS briefing is returned, the text content of the briefings (Area QNH, TAF, SIGMET, NOTAMs etc.) will appear first in the briefing; the images, including GAF and GPWT images and/or Mid-level SIGWX Charts (where relevant) will follow the text - it will be necessary to scroll down the web page to view these images.

9.109 Furthermore, if a pilot requests a briefing for a number of areas, all the images will displayed at the end, following the text messages.

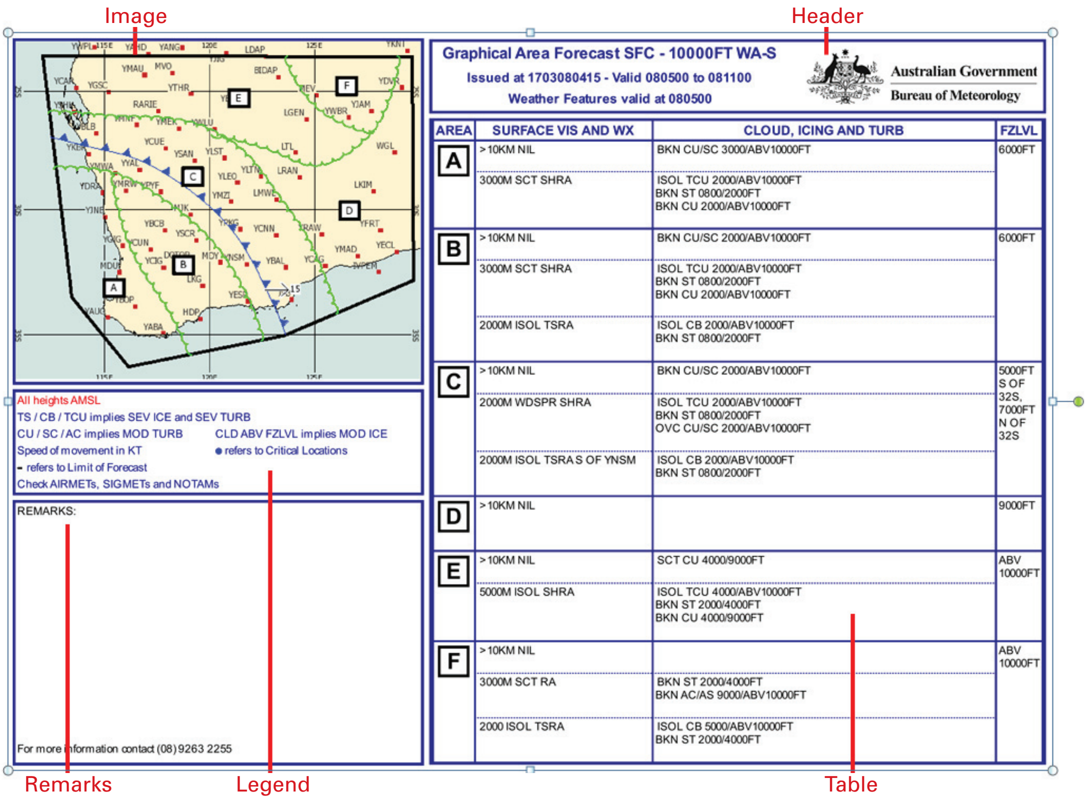


Figure 9-6 GAF Layout

Terminal Area Forecast (TAF)

9.110 A terminal area forecast (TAF) is a statement of meteorological conditions expected for a specified period of time. The area covered by the TAF extends for a radius of 8 kilometres from the centre of the aerodrome or runway complex. AIP MET provides complete details of the composition of a TAF, and a simple graphic explaining the sequence of information in a TAF. There is also a complete decode of weather details used in forecasts and reports. However, you will not normally have to concern yourself with these details since, in a TAF received by AVFAX, the weather details will be spelt out in plain language.

Composition of the TAF

9.111 The TAF comprises:

- message identification, location indicator, time of origin and validity period;
- forecast surface wind in degrees true and knots;
- forecast visibility in metres – a visibility in excess of 10 km is shown as “9999”;
- forecast significant weather;
- forecast cloud amount and height;
- forecast significant changes and variations;
- any probability of poor visibility;
- statement of turbulence; and
- forecast temperatures and QNH.

9.112 In forecasts, the time of origin is a six-figure date–time group. All times are in GMT (same as UTC) but symbolised as “Z” for the GMT time zone “Zulu”.

9.113 For example:

TAF YMMB 290650Z 2908/2920 15004KT CAVOK
FM14 00000KT 3000 HAZE PROB40 1720 0400FOG
T 14 15 17 14 Q 1016 1014 1013 1014

9.114 This decodes as follows:

- The TAF for Moorabbin (YMMB) issued at 0650Z on the 29th of the current month (290650Z), and valid for the period from 0800Z (i.e. 1 hour and 10 minutes after the time of issue) to 2000Z (0820).
- The surface wind is forecast to be 150°T/04 kt (15004KT).
- The weather is CAVOK.
- The conditions are expected to change significantly from 1400Z (FM14) for the remainder of the period, with the wind dropping to calm (00000KT) and the visibility reducing to 3,000 m in haze (3000 HAZE); there is a 40% probability (PROB 40) of fog with visibility reduced to 400 m between 1700 and 2000 (1720 0400FOG).
- The temperatures (T) and QNH (Q) at three-hourly intervals from the commencement of the period of validity of the TAF are:
  - 0800Z, 14°C, 1016 hPa;
  - 1100Z, 15°C, 1014 hPa;
  - 1400Z, 17°C, 1013 hPa; and
  - 1700Z, 14°C, 1014 hPa.

9.115 Note that the temperature and QNH do not appear for the end of the forecast period at 2000Z.

Provisional Forecasts

9.116 A forecast is prefixed with PROV when it is compiled from insufficient synoptic information. Therefore, there is less confidence in the predictions. When later or revised data is received, MET will confirm or amend the provisional part of the forecast.

Aerodrome Weather Reports

9.117 Aerodrome weather reports are actual observations (not forecasts) of meteorological conditions at aerodromes, made by approved observers.

Routine Reports (METAR)

9.118 METARs are issued at fixed times, hourly or half-hourly, and are available on request to aircraft in-flight.

Special Reports (SPECI)

9.119 SPECIs are aerodrome weather reports issued whenever the actual conditions fluctuate about, or are below, specified criteria. For example, if a cold front had just passed through the vicinity of an aerodrome, a SPECI would be issued. As with METARs, SPECIs are available on request.

Composition of METAR/SPECI

9.120 A METAR/SPECI comprises:

- message identification, location indicator, and time;
- surface wind, with gusts if appropriate;
- visibility, including sector variations;
- present weather;
- cloud;
- temperature and dewpoint temperature;
- pressure setting; and
- supplementary information, including recent weather.

METAR YPPH 0600Z 27020KT 8000 SCT025 SCT060 12/06 Q1019

9.121 This is a METAR for Perth, issued at 0600 UTC, at which time:

- the surface wind was 270°T at 20 kt;
- the visibility was 8,000 m;
- there were 3–4 oktas of cloud, base 2,500 ft AAL and, 3-4 oktas, base 6,000 ft AAL;
- the temperature was +12°C and dewpoint +06°C; and
- the QNH was 1019 hPa.

Trend Type Forecast (TTF)

9.122 At some aerodromes, specific forecasts known as *trend type forecasts* (TTFs) are issued. The TTF is an aerodrome weather report (METAR/SPECI) with a trend statement added. The TTF relates to weather conditions expected to affect the aerodrome of origin for three hours following the time of the report. Because it is more accurate and precise, the TTF supersedes the TAF for its validity period which is three hours commencing from the time the observation is made. It becomes the current forecast for pilots of aircraft with an arrival time falling within this three-hour period.

Composition of a TTF

9.123 As a TTF is only issued with a METAR/SPECI, it includes the same information, and uses the same abbreviations and weather code details as a TAF. For example:

TTF SPECI YBBN 2000Z 02001KT 0400S 8000N PATCHES
FOG 18/17 Q1022 FM2030 02003KT 8000 NO SIG WX SKC

9.124 This example, for Brisbane, indicates that there will be a significant change in the conditions from 2030Z. The visibility will increase from a minimum of 400 m to the south, maximum of 8 km to the north, patches of fog to 8 km visibility in all directions. The observed weather will change from patches of fog to no significant weather and the sky clear.

Automatic Terminal Information Service (ATIS)

9.125 At aerodromes where air traffic services are provided by a tower (see ERSA FAC for details), there is usually a tape-recorded radio message of the current aerodrome terminal information. It is transmitted on a specific frequency in either the COM or NAV groups, and sometimes on both. The message runs continuously and is updated periodically as conditions change. This service is known as the automatic terminal information service or ATIS (pronounced ay-tiss).

9.126 The information provided on the ATIS will usually include:

- runway in use details;
- wind direction and strength;
- cloud (amount and base), plus visibility and other conditions as appropriate;
- aerodrome QNH; and
- temperature.

9.127 An example of an ATIS broadcast is:

Essendon terminal information Delta
Runway three five
wind three five zero degrees one three knots
QNH one zero one seven
temperature two six
cloud few two thousand
Essendon terminal information Delta

9.128 There is quite a bit of information, so you should jot down the important aspects as you listen to the ATIS for later reference to avoid having to listen to it again. (Once familiar with the procedures, you may find it unnecessary to write down simple ATIS messages.)

9.129 The ATIS is prepared by air traffic control personnel, and includes details from the latest meteorological reports. To signify changes in the information, the ATIS code letter will be changed, e.g. from information Alfa to information Bravo, or from information Echo to information Foxtrot, etc.

Note: At certain non-towered aerodromes at which a CTAF has been established, an aerodrome weather information broadcast (AWIB) may be available on the VOR or NDB frequency. At this time some of the aerodromes with this facility are as follows: Canberra, Devonport, East Sale and Wynyard.

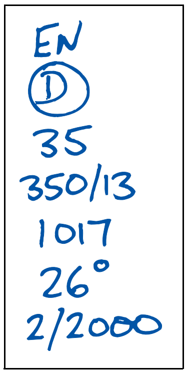


Figure 9-7
Note down the ATIS.

ATIS may be Transmitted on a Discrete (Separate) VHF Frequency

9.130 At many of the busier aerodromes, where there may be many basic training aeroplanes with just VHF communication radio equipment, a discrete VHF-COM frequency is made available purely for broadcasting the tape-recorded ATIS. At Class D aerodromes – Melbourne/Moorabbin, Perth/Jandakot, Brisbane/Archerfield, Sydney/Bankstown and Adelaide/Parafield – the ATIS is broadcast on 120.9 MHz, a discrete VHF-COM frequency reserved exclusively for this purpose. You can select the discrete ATIS frequency on your VHF-COM and obtain the ATIS whenever you want. (Only the VHF-COM set can be used to receive this, as it is outside the range of frequencies that the VHF-NAV can be tuned to.) Consequently, unless you have two separate VHF-COM radios you will have to break your listening watch on the COM frequency.

ATIS is often Transmitted on a Radio Navaid Frequency

9.131 When you are about to use a radio navaid, the first thing you must do after tuning the frequency is to identify the aid. This is done by listening to a two- or three-letter Morse code group (e.g. PF for Parafield) transmitted at regular intervals with the navigation signals from the radio navaid. The Morse code table that is printed on each VTC and ERC.

A	•—	N	—•
B	—•••	O	———
C	—•—•	P	•——•
D	—••	Q	——•—
E	•	R	•—•
F	••—•	S	•••
G	——•	T	—
H	••••	U	••—
I	••	V	•••—
J	•———	W	•——
K	—•—	X	—••—
L	•—••	Y	—•——
M	——	Z	——••

Figure 9-8 The Morse code.

9.132 Alternatively a taped voice message, the ATIS, containing the current terminal information for the aerodrome, will be broadcast as the station identification.

9.133 The aircraft equipment that receives the VOR is the VHF-NAV and that which receives signals from the NDB is the ADF. Thus:

- a VOR frequency is selected on your VHF-NAV set; and
- an NDB frequency is selected on your ADF.

9.134 You can obtain the ATIS on these radio navaids simply by listening to them – there is no need to know how to use them for navigation to do this.

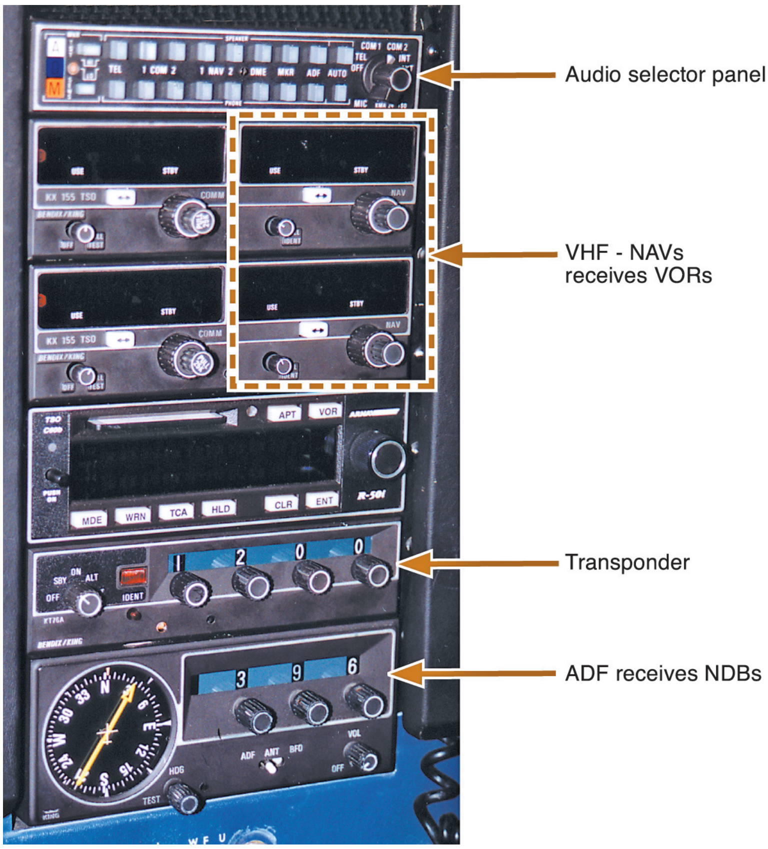


Figure 9-9 Some NDBs and VORs carry the ATIS.

The ADF (for NDBs) and the VHF-NAV (for VORs) are different radios from the VHF-COM, and at certain aerodromes you may listen to the ATIS on them without interrupting your listening watch on the VHF-COM frequency.

9.135 To listen to the ATIS being transmitted on the voice channel of a radio navaid, you must ensure that the volume control of the appropriate radio receiver is turned up, and that it is selected to the headset or speakers via a switch on the audio selector panel, as desired. This is the small panel immediately above the no. 1 VHF-NAV/COM in the radio stack pictured above.

9.136 Not all training aeroplanes have the same audio selector panels. Ask your flying instructor for details on your specific aircraft type.

ATIS at Controlled Aerodromes

9.137 The major difference in the ATIS at controlled aerodromes compared with that at uncontrolled aerodromes is that the duty runway is nominated. An example of such an ATIS is the following:

Camden terminal information Echo
Runway two four
wind two one zero degrees eight knots
QNH one zero zero eight
temperature two eight
cloud scattered four thousand five hundred
Camden terminal information Echo

9.138 This could be jotted down as in Figure 9-10.

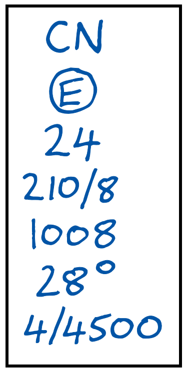


Figure 9-10 Example of noted down ATIS details.

9.139 Some of the Class D aerodromes have many runways and taxiways, and a lot of aeroplanes operating in the vicinity, both in the circuit and the local training area. The radio at these aerodromes can be very busy at times so, to minimise messages on the VHF-COM frequency, as many general operational instructions as appropriate are placed on the ATIS, along with the standard weather and runway information.

9.140 To simplify operations at these aerodromes, the traffic is directed to use different runways and different circuit directions (depending upon the intentions of the pilot in command). Detailed information on this is provided in AIP ENR 1.1, as well as the En Route Supplement Australia (ERSA) FAC listing for the aerodrome. At Class D aerodromes, the ATIS may contain more operating instructions than the ATIS at a less busy aerodrome.

9.141 If you are unfamiliar with the aerodrome, you may have to listen to the ATIS a number of times before you have absorbed and/or noted down all the vital details. Below is an example of such an ATIS.

Moorabbin terminal information Papa
Runway one seven
wind two two zero degrees up to one two knots crosswind at times eight knots
QNH one zero one nine
temperature one eight
CAVOK
arrivals and departures east and circuits, Runway one seven left frequency one one eight decimal one
arrivals and departures west, Runway one seven right frequency one two three decimal zero
northern part of taxiway Golf closed due works in progress
aircraft taxiing for Runway left, obtain clearance to cross Runway right
Moorabbin terminal information Papa

9.142 And this could be jotted down as in Figure 9-11.

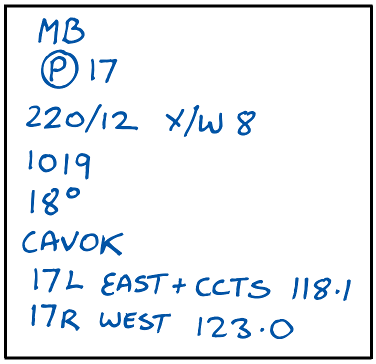


Figure 9-11 Example of notes for more complex ATIS.

9.143 ERSA is your reference for how to navigate around an aerodrome. The runways and taxiways are clearly marked on the aerodrome diagrams contained in the FAC section. Always ensure you obtain a clearance to cross an active runway.

Note: There may be other messages appended towards the end of the ATIS such as "*aircraft calling ready, nominate their first tracking point*", "*when taxiing or reporting inbound, notify receipt of information Papa*" or "*parachuting in progress at Lower Light*".

9.144 ATIS at aerodromes in Class C CTRs can be received up to a radius of 90 nm, and up to 30 nm for Class D aerodromes.

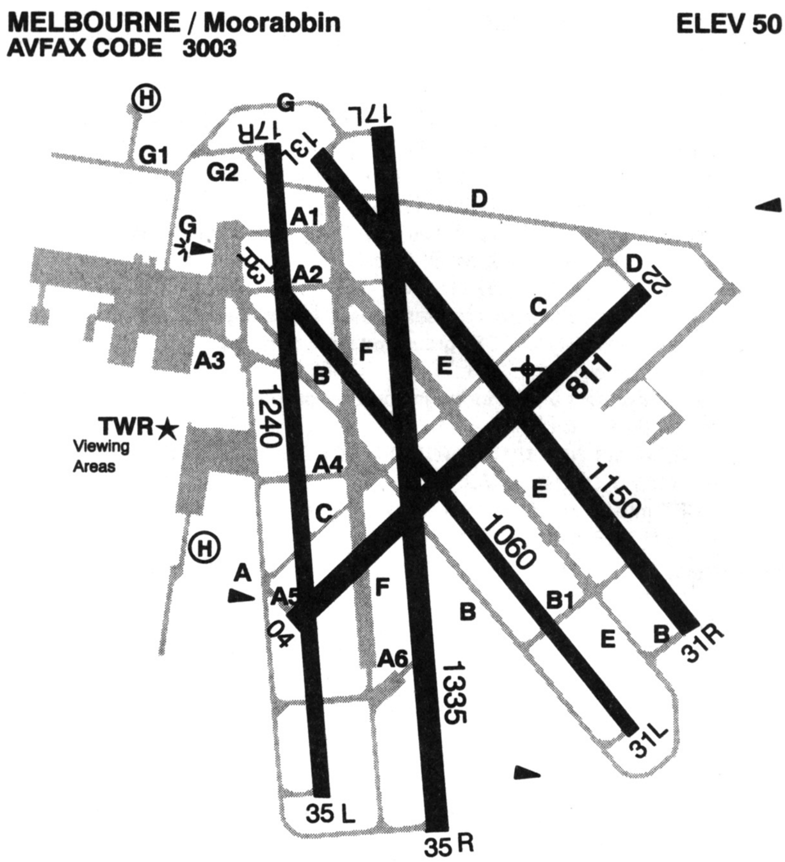


Figure 9-12 Runway layout at Melbourne/Moorabbin Airport from ERSA.

Weather Details in an ATIS

9.145 The term CAVOK (pronounced kav-oh-kay) will be encountered frequently on the ATIS. For VFR operations, CAVOK indicates that the visibility, cloud and present weather are all better than:

- visibility 10 kilometres or more;
- no cloud below 5,000 ft AAL (above aerodrome level); and
- no precipitation, thunderstorm, shallow fog, low drifting snow or dust devils.

9.146 Where CAVOK conditions do not exist, the met report on the ATIS will include cloud, visibility and any significant weather, e.g.

cloud broken one thousand
overcast one zero thousand
visibility three thousand metres
light rain
patches of fog in valleys adjacent to the aerodrome

Listen to the ATIS prior to Taxiing

9.147 At controlled aerodrome, you should listen to the ATIS broadcast before taxiing for take-off, and notify receipt of it in your taxi call, e.g.

Parafield Ground
Delta Alfa November, Warrior
received Bravo, VFR
for the training area
*Runway two one right**

Note: If more than one runway is in use at a Class D aerodrome, the runway to be used should be nominated by the pilot, to advise the tower and other taxiing aircraft.

9.148 This is an example of a taxi report at a Class D aerodrome.

9.149 A typical request for taxi clearance at an aerodrome in a Class C or D CTR is:

Townsville Ground
Papa November Romeo, Tobago
received Uniform
for the training area
request taxi

Listen to the ATIS prior to making your inbound call

9.150 When about to enter a control zone (Class C, Class D), your inbound report is normally made at a designated VFR approach point to the zone. You should listen to the ATIS several minutes prior to reaching the approach point, and when making your inbound report, notify receipt of the ATIS broadcast, in the same way as you did before taxiing.

9.151 Do not forget to listen to the ATIS, as failure to do so will require the controller to transmit the aerodrome information to you. This unnecessarily increases his or her workload and clutters up the COM frequency for everyone. Try and organise yourself to listen to the ATIS at an appropriate time; however, keep your priorities and think ahead.

What if you do not receive the ATIS?

9.152 Sometimes you do not have the radio equipment to receive the ATIS, or perhaps it is difficult to read. In these cases, at controlled aerodromes, the controller will pass you the relevant information on the communications frequency when you make your initial contact. If this is not forthcoming, then simply "request terminal information" if departing, or "request landing information" for an arrival.

ATIS at Deactivated Control Zones

9.153 When a control zone is deactivated outside normal (i.e. published) hours of operation, the zone becomes an CTAF. When this happens, the ATIS may be used to broadcast operational information of an unchanging nature. This might include confirmation of the CTAF frequency, preferred runways or expected re-opening time of the zone. These outside-hours broadcasts use the code letter ***Zulu***. You are encouraged to monitor the ATIS outside normal operating hours, but do not need to nominate receipt of Zulu in your inbound report. ATIS Zulu will advise if AWIB is available for that airfield.

Aerodrome Weather Information Broadcasts (AWIB)

9.154 Broadcasts of actual weather conditions may be made on navigation aids from automated weather station (AWS) sites that use Bureau of Meteorology AWS equipment. Basic AWSs provide wind direction and speed, temperature, humidity, pressure setting and rainfall. Advanced AWSs provide automated cloud and visibility elements, which will be appended to the meteorological report as remarks for guidance only.

9.155 Information provided in AWIB broadcasts is in similar format to that of an ATIS broadcast and will contain some of the following additional items:

- test transmissions identified as "Test";
- station identifier as a plain language station name;
- identifier "AWS Aerodrome Weather";
- wind direction in degrees magnetic and speed in knots;
- altimeter settings (QNH);
- temperature in whole degrees Celsius;
- low cloud below 12,500 ft;*
- visibility;*
- dew point in whole degrees Celsius;**
- percentage relative humidity;** and
- rainfall over previous ten minutes.**

* *Provided from advanced AWS as guidance material*

** *Provided as supplementary information.*

9.156 Information broadcast from AWS is considered to be "real-time" data. When information is not available about a particular item, either because of invalid data or an inoperative sensor, the element of the broadcast will be identified as "currently not available", e.g. "temperature currently not available". The integrity of the barometric system is such that they are an approved source of QNH. The QNH may be used as the actual aerodrome QNH. The wind and temperature information does not have the same degree of integrity and should be used at pilot discretion. The AWIB is transmitted on the VOR or NDB frequencies and is available by phone; details in ERSA and Jeppesen.

Review 9

BAK Level of Knowledge Only

1. Name the layers of the atmosphere.
2. At what altitude is the tropopause in ISA?
3. Wind velocity has two elements. They are . . . . . and . . . . .
4. What is meant by an okta?
5. By how many nautical miles should we avoid a thunderstorm?
6. What happens if the air is cooled to below dewpoint temperature?
7. What causes thermals?
8. Turbulence and vertical wind gusts can cause the wing to stall or can overstress the aircraft. What is the speed below which the aircraft should be flown in turbulence?
9. What are the three levels of severity of turbulence?
10. When air is forced to lift over a mountain range, the phenomenon has a special name. It is called . . . . . lift.
11. List three types of precipitation.
12. What is the difference between a weather forecast and a weather report?
13. What is meant by stratiform?
14. AVFAX is . . . . .
15. DECTALK is . . . . .
16. BROKEN cloud means a certain sky coverage. What is the range of oktas in this case?
17. What is meant by CAVOK?
18. The terms TEMPO and INTER mean a deterioration in conditions for certain periods. What is the period of time in each case?
19. What is meant by ARFOR and TAF?
20. When is a forecast considered provisional (PROV)?