ABF Pilot Training Manual

Part 7

Meteorology (MET)

VERSION 1 – MAY 2006

CONTENTS

Meteorology

Reading

Meteorology and Navigation by Trevor Thom (Aviation Theory Centre, 1998 or later edition).
Manual of Aviation Meteorology by the Commonwealth Bureau of Meteorology, 2003. (Read the section on aviation forecasts and reports in one of these books, or in VFG or AIP GEN.)
The Wonders of the Weather by Bob Crowder gives less technical explanations of many weather phenomena with excellent photos and graphics.
Ballooning Handbook by Don Cameron, Pelham Books UK, 1986 (thanks to Don for permission to reprint some of his illustrations here)

Internet access

Is highly desirable – especially for weather reports and forecasts for study and flight planning.

The Meteorology exam

- Twenty question multiple choice exam.
- Time allowed 70 minutes.
- Minimum pass mark is 70%.
- AIP Book may be used in the exam.

Weather and ballooning

In ballooning, the importance of understanding and appreciating the weather cannot be over-emphasised. It has been said that **knowing when not to fly** is one third of being a good pilot. This decision is often due to weather considerations. A good pilot will continue to learn about the weather throughout his flying career. These notes are simply a starting point.

Atmosphere

Atmosphere is the mixture of gases surrounding the earth. The lowest layer is the **troposphere** in which most of the weather activity happens and which extends to an average height of 36,000ft above the earth. The **stratosphere** above this is relatively stable. The boundary between the troposphere and the stratosphere is called the **tropopause**. The main variables in the weather are the air pressure, temperature and humidity of the atmosphere.

Air pressure is measured in hectopascals (hPa) – the same unit is also called a millibar (mb). Air pressure (and therefore air density) decreases as you rise higher above the earth.

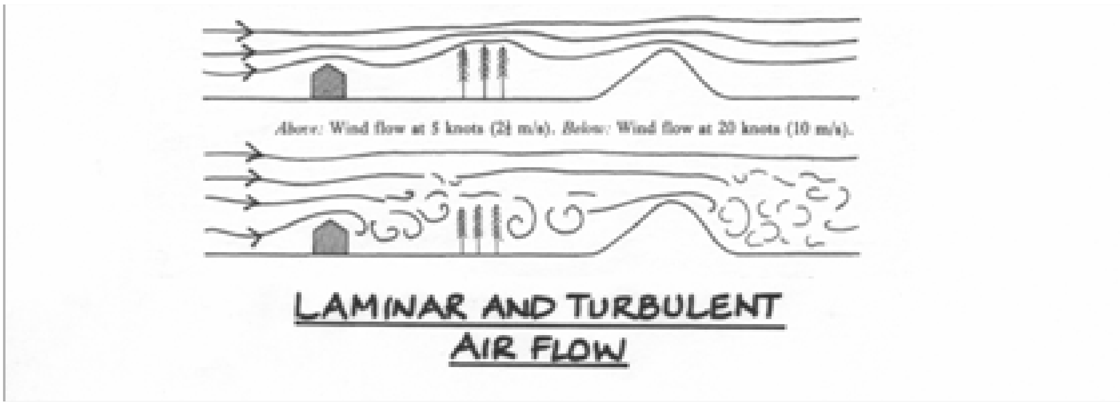
Temperature also typically decreases with height, and this decrease is called the **lapse rate**. In dry air, temperature will decrease about 3°C for every 1,000ft increase in altitude, and this is called the **dry adiabatic lapse** rate (DALR). In moist air this is reduced to about 1°C per 1,000ft. The actual rate of decrease of temperature with height is called the **environmental lapse rate** (ELR). It can be useful to compare actual conditions with a convenient but imaginary standard known as **ISA** (International Standard Atmosphere). ISA assumes that at sea level the air pressure is 1013.2 hPa, the temperature is 15°C, and the temperature decreases by 2°C per 1,000ft above sea level.

Humidity is moisture contained in atmospheric air in the form of tiny droplets of water vapour. Warm air can hold a greater amount of moisture than cold air. So a convenient measure is **relative humidity**, which is the amount of moisture in the air compared with the maximum it can contain at that temperature, expressed as a percentage. As warm moist air is cooled, its relative humidity increases until it reaches 100% (saturation). The temperature at which this occurs is called the **dew point.** Beyond this point water vapour will condense as dew, fog or cloud.

The earth is heated by intense short wave radiation from the sun (**insolation**). The land surface heats more quickly during the day than the sea, and cools more quickly at night. Some obvious effects of diurnal heating and cooling are anabatic and katabatic winds, sea breezes and surface inversions (all described later in these notes). Reflective surfaces like snow and water heat less quickly than absorbent surfaces like ploughed fields. Clouds act as a blanket, shielding the earth from the sun and reducing surface heating by day. At night they prevent heat energy escaping from the surface, so cloudy nights are not as cold as clear nights.

Laminar flow

Balloons generally move exactly at the speed and direction of the wind they are in, and they rely entirely on horizontal air movement for their forward propulsion. **Laminar flow** is the term for air movement in layers or graduations approximately parallel to the surface of the earth. It is essential for safe ballooning. Winds of different speed and direction are often found at different heights above the ground, so that a pilot can 'steer' a balloon within the available wind directions simply by choosing to fly at particular heights. In other words, vertical control also provides horizontal control.



Vertical control of a balloon comes from varying the heat of the contained air and, with practice, a skilful pilot can achieve extremely fine control especially when flying near the ground surface where it is easier to judge the balloon's vertical movement.

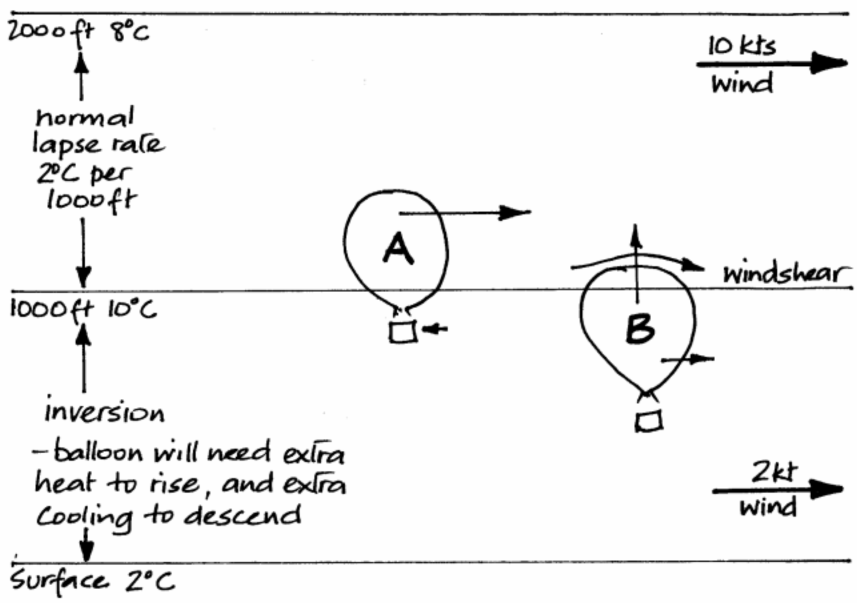
Air movement which has a vertical component is known as **turbulence**. Vertical air movement causes loss of control, as the balloon will rise or descend in ways the pilot has not intended. Balloons should therefore avoid all but the most manageable mild, small-scale and local turbulence. Various kinds of turbulence and their effect on balloons are discussed later in these notes as well as in Aerostatics.

Inversions

An **inversion** is a layer of air in which **temperature increases with height** (ie, the opposite of the normal lapse rate). A **surface inversion** can occur when air near the ground is cooled as the ground cools down at night. A surface inversion is typically shallow (up to a few hundred feet thick), but quite intense with a temperature rise of up to 10°C, and it is likely to form over land in conditions of calm or light wind and a clear sky. An **upper air (subsidence) inversion** typically occurs in a high pressure system somewhere between 2,000ft and 6,000ft above the surface, and may be up to 500ft thick and have a temperature rise of up to 15°C.

Flying in inversions

To counteract the rise in temperature in an inversion, a **balloon needs to be heated more than usual to climb, and cooled more than usual to descend**. The first obvious sign of an inversion in flight is often the feeling that the balloon is not responding as quickly as usual to the controls – it feels heavy when climbing, and unusually buoyant when descending. The upper surface of an inversion is often clearly recognisable when any air pollution in the inversion is trapped from rising further, and the air immediately above is much clearer.



Balloon at A moving with upper wind - reverse breeze felt in the basket. Balloon at B in lower wind - false lift occurs when upper wind flows over the top.

SURFACE INVERSION AND WINDSHEAR

Windshear

Wind speed and direction often changes quite gradually with height. 'Windshear' is the name given to a sudden change of wind speed or direction, which typically occurs between adjacent layers of air. **Frictional windshear** occurs when the wind at the surface is slower than the wind above (due to friction). This is often obvious from watching a pibal (small helium filled balloon). **Inversion windshear** is common at the top of an inversion, and can be quite strong. It can also be found at the base of a surface inversion as the sun heats the land and causes mixing of the adjacent air, creating a shallow layer of mild turbulence (and sometimes increased wind speed) just above the surface.

Flying in windshear

False lift may occur briefly whenever the top of the balloon passes through a windshear. Strong windshear may also cause the pilot lights to blow out, or the mouth of the balloon to narrow so that it may be necessary to wait a moment till it opens before using the burner. The pilot must be very attentive whenever there is **windshear at low level**, ready to relight pilot lights and apply heat to the balloon promptly to avoid unintended ground contact.

When launching below a frictional windshear, allow extra space to clear downwind obstacles. Apply extra heat before releasing the launch rope, or immediately on reaching the windshear, and maintain vigilance until the balloon is through the shear and is moving with the faster wind. When descending to land, frictional windshear is recognised by a slight breeze in your face, a sign that your landing is likely to be slower and more relaxed. If you squirt shaving cream (or spit) over the edge of the basket and watch as it descends, you can spot any change in wind speed and direction below you and be prepared for it. To make the landing as gentle as possible, descend a little earlier and then fly as close as possible to the ground for a few seconds to allow the balloon to lose momentum before making ground contact.

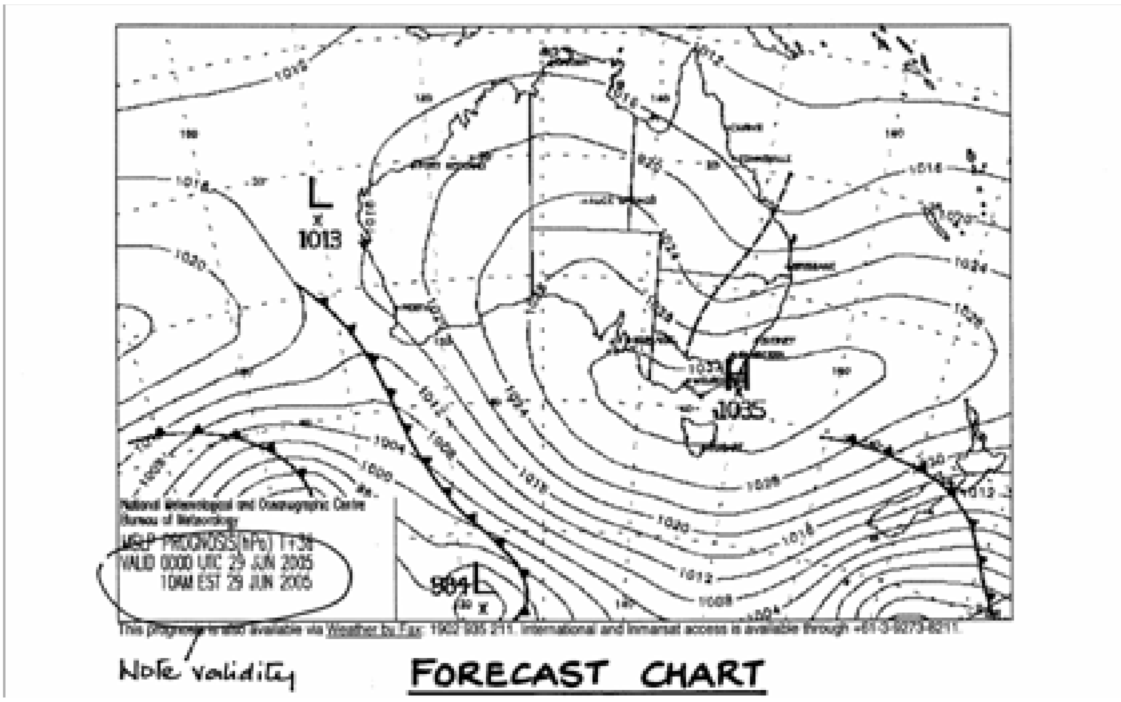
When descending through the base of an inversion a balloon may be momentarily buoyant due to the false lift created by the wind shear, then descend more quickly as it enters air with a positive lapse rate. If this occurs near the ground, any increase in wind speed below the inversion should be evident from the movement of vegetation (or again, spitting over the side!). Allow extra downwind distance for landing, and be ready to heat slightly to counteract any sudden descent.

Synoptic Charts

Besides decreasing with height, air pressure also varies widely from place to place and day to day. A convenient way to show this variation is by **isobars** which are lines joining points of equal atmospheric air pressure superimposed on a map and known as a **synoptic chart**. The chart gives a general view (synopsis) of the weather, showing air pressure variations and the resulting major weather systems. You must be able to identify a centre of high or low pressure, a ridge of high pressure, a trough of low pressure, a col, and a warm or cold front, which are discussed below, and understand the relevance of these to the general weather situation and to ballooning.

Pressure gradient (or steepness) is the rate of change of pressure over a given distance. Wind speed is relative to the pressure gradient, and is easily visualised from how close or far apart the isobar lines are. An **'open' gradient** (isobars well spaced) indicates light winds and good ballooning, while a **'steep' or 'tight' gradient** (isobars close together) indicates strong winds. A word of warning – while the isobar intervals on a synoptic chart are usually every 2 millibars or hectopascals (eg 1020, 1022, 1024 etc), some charts show only every 4 millibars (1020, 1024, 1028 etc) which makes the gradient look deceptively open!

Wind direction is not straight from a high to a low pressure area as you might expect. The **coriolis force**, due to the earth's rotation, causes the wind to approximately follow the direction of the isobar lines. In the *southern hemisphere*, winds circulate *anticlockwise around a high* pressure centre and *clockwise around a low* (in the northern hemisphere the directions are the opposite). The **geostrophic or gradient wind** (at around 2,000ft above the surface) follows the direction of the isobars fairly precisely. Due to the friction effect of the earth's surface, the **surface wind** is turned at an angle of about 5° to 15° to the isobars, pointing away from areas of high pressure and towards areas of low pressure. This means that in the *southern hemisphere* the gradient wind is usually to the left of the surface wind, remembered as *'left with height'* (in the northern hemisphere it is 'right with height'). When the wind changes direction it **backs** to the left (anticlockwise when viewed from above) or **veers** to the right (clockwise from above).



A **high** pressure centre (shown H on the chart) indicates stable and often fine conditions, with the lightest winds at its centre, while a **low** (L) tends to be unstable, stormy and unsuitable for ballooning, with the strongest winds at its centre. An extended area of high pressure is a **ridge**, while an extended area of low is a **trough**. A **col** is an open area between two high and two low pressure areas (the equivalent of a 'saddle' if you think of isobars as similar to contours on a topographic map).

A **cold front** is caused by a mass of cold air moving into contact with a mass of warmer air and pushing it upwards. Cold fronts are a frequent occurrence in southern Australia, typically accompanied by a sudden change of wind direction. Unstable conditions and sometimes rain may occur before as well as immediately after the front. Relatively calm conditions just before a front may seem tempting for a balloon flight, but should be avoided as conditions are likely to deteriorate quite suddenly. **Warm fronts**, in which a warm air mass moves in and pushes the cooler air downwards, are generally not found in Australia. A **tropical revolving storm** is an intense low, which is common in the north of Australia during the summer monsoon (tropical rainy season), and may develop into a tropical cyclone.

Major weather movements vary with different latitudes and times of the year. In southern Australia weather patterns generally move from west to east. Practice looking at synoptic charts from day to day to see the typical progression, and to identify isobars and other symbols and the weather associated with them.

Clouds and precipitation

The presence of clouds can help us to understand the weather, as the type and extent of cloud are usually a good indication of the conditions which have caused the cloud to form. Different clouds can indicate suitable or unsuitable ballooning conditions. Absence of cloud, on the other hand, is no guarantee of suitable conditions, as various kinds of turbulence (including thermals) may be present without accompanying cloud. Clouds typically form when warm moist air is cooled to dew point and water droplets condense out - visible but light enough not to fall to earth. At higher altitudes (cirrus clouds) the droplets freeze into ice crystals.

Cloud formation can be due to:

- convection (thermal turbulence)
- orographic uplift (warm air cooling as it moves up a slope)
- turbulence and mixing, or
- slow widespread ascent of a frontal air mass.

Learn to recognise the **10 main cloud types** (see photos in the suggested reading), and the weather associated with them.

CI - cirrus - wispy, ‘mares tails’	**high level**
CC - cirrocumulus - grained or rippled cirrus	above
CS - cirrostratus - veil of cirrus, may have a sun halo	20,000ft
AC - altocumulus - high layer of small puffy clouds	**middle level**
AS - altostratus - even, like sun through ground glass	bases
NS - nimbostratus - darkish grey layer, blots out sun, brings rain or snow	7500 - 20,000ft
SC - stratocumulus - low layer of cumulus	**low level**
ST - stratus – layer, soft or like fog, but above ground	bases
CU - cumulus - puffy, cotton wool shapes, small or large	below
CB - cumulonimbus – large, dense, high CU, with flat or anvil shaped top, thunderstorm cloud	7500ft

‘Alto’ means medium height, ‘stratus’ means layered (regardless of the cloud height, and the layer can be made up of separate clouds), ‘cumulus’ means heaped up, and ‘nimbus’ means dark grey.

The amount of cloud is measured by how many 'oktas' (eighths) of the sky it covers – so a quarter of the sky covered is 2 oktas, half is 4 oktas. Weather reports and forecasts use 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

Flying around clouds

The presence of any form of cirrus cloud usually indicates fine weather, though it may also be an early indication of a cold front a day or more away. ST usually indicates good ballooning conditions, since it acts like a blanket maintaining fairly stable conditions beneath it, and SC in an unbroken layer is generally the same. On a warm day, when a layer of cloud starts to break up and the sun shines through in places, the air mass beneath the cloud may quickly become less stable, and it may be necessary to land without delay. CU is typically associated with thermal or other turbulence, and should be treated with caution. TCU (towering cumulus, a stage between CU and CB) should be given a wide berth.

Turbulence increases as CU develops into TCU then CB – take a moment to watch these cloud types and you will see the constant 'boiling' movement. **Thunderstorms** are likely to occur in CB. Warm updrafts are cooled inside the CB cloud and become cold downdrafts, resulting in strong windshear and turbulence. Rain indicates the storm is maturing. Hail can occur at the mature stage, and may fall up to several miles away in clear air due to powerful drafts.

Due to the severe instability associated with CB, it must be avoided without question. If CB clouds are present, do not fly. If CB clouds are observed while flying, even at a distance of several miles, you should consider landing as soon as safely possible.

A **microburst** is caused when a strong local downdraft hits the surface and turns into horizontal winds extending outwards from a central point like a mini cold front, resulting in strong windshear and turbulence, possibly extending several kilometres. A **wet microburst** can occur when rain falls from CB or other convection cloud. When rain falls from a cloud and then evaporates in warmer air before it reaches the ground it is known as **virga**. This may look innocent enough, but the extra cooling of the air caused by evaporation can in fact amplify the downdraft effect and cause a very strong **dry microburst**. Possible microburst conditions should be given wide clearance – on the positive side, a typical microburst only lasts a few minutes and extends about 5km, so a balloon caught in one is probably safer riding it out than trying to land at very high speed.

Flying in rain

While a balloon can fly safely in light drizzle or an occasional light shower, any more than this is not advisable. Extra heat is required to counteract both the weight of moisture and the cooling effect on the envelope fabric. Rain spilling down inside the balloon can wet the occupants and may extinguish pilot lights, and a heavy shower can make powerlines impossible to see. When rain is about, it is important to keep an eye on the weather *behind you* as showers will often be travelling faster than you are. A wet balloon is no fun to pack up and should be dried out thoroughly by hot inflation within a few days, otherwise mildew can seriously damage the fabric.

Atmospheric stability

It can be helpful to understand the concept of atmospheric stability. The atmosphere is said to be **stable** when an imaginary 'parcel' of air raised vertically would tend to return to its previous position. It is **unstable** when the same parcel of air would tend to continue moving in the same direction. Stability depends on the environmental (actual) lapse rate - when this is greater than the dry adiabatic lapse rate, the atmosphere is unstable, as the parcel of air will remain warmer than the surrounding air, and so will stay buoyant (see Thermals later in these notes).

Characteristics of stable air:
- stratiform (layered) clouds
- precipitation (if any) will be steady rain or drizzle
- may have poor visibility, due to particles in the air
- possible inversions and fog
- little or no turbulence, smooth flying

Characteristics of unstable air:
- cumuliform (heaped) clouds likely (unstable atmosphere promotes vertical growth)
- turbulence due to rising air (eg, thermals)
- showery rain or hail may occur
- good visibility between showers.

ARE YOU UP TO DATE?
New regulations and procedures may apply from time to time.
Check on the ABF website that you have the latest version of these study notes.

Fog

When air cools below dew point, the results depend on the wind and temperature. In calm conditions above 0°C, **dew** will form on exposed surfaces – below 0°C **frost** forms instead. Light wind conditions produce fog or mist, while stronger winds may cause stratus cloud to form.

Fog is defined as water droplets reducing horizontal visibility to less than 1,000m at the earth's surface. If the visibility is 1,000m or more it is called **mist**. Fog is effectively cloud at ground level.

Radiation (or advection) fog forms above cold ground or water, and includes sea fog and shoreline fog as well as fog in inland areas. This is a common reason for fog to form in inland areas where balloons may fly.
Frontal fog can occur when 2 air masses interact.
Upslope fog is due to adiabatic cooling of warmer moist air mass moving up a slope.
Steam fog is the light mist which can form in very cold air over warm water.

Conditions likely to cause fog – a clear night, moist air, light wind (5 to 7 knots), temperature close to dewpoint and falling fast. The minimum overnight temperature is usually reached up to half an hour after first light, so fog can start to form, or can thicken, after first light. If fog exists at sunrise you should consider waiting 30 minutes to observe developments before deciding to fly.

Conditions likely to disperse fog – the sun warming the surface will evaporate the fog; increasing wind speed will cause mixing of lower air with the air above, which may form low ST cloud in place of fog. Thick radiation fog may last all day if the sun does not penetrate easily.

Flying through and above fog

A balloon may launch in fog provided that there is at least 100m horizontal visibility, and that it can fly clear of the fog above 500ft AGL. Before launching in fog, the pilot should be confident that the fog is not so extensive or thick that it would be difficult to land again if necessary. When flying above fog, judgement of wind speed and direction is difficult, so **check the forecast wind** and **carry a GPS while flying** if possible. Judgement of the balloon's vertical movement can also be affected, so **check the variometer frequently**, especially if landing in foggy conditions, and keep a sharp lookout for obstacles like powerlines that may be very hard to see. One of the great delights of ballooning is to see one or more full rainbows surrounding the balloon's shadow on the fog surface below you.

Turbulence

Air turbulence can occur for a variety of reasons, and any turbulence will reduce vertical and horizontal control in a balloon. Flying should not be attempted or continued in anything but the mildest local turbulence, eg frictional turbulence or mild thermal mixing. A prompt landing should be made whenever turbulence is expected to increase.

Frictional or mechanical turbulence is caused when airflow is disturbed over and around surface obstacles. The extent depends on the wind speed, how rough the surface is, the height of any surface obstacles, and the atmospheric stability. Frictional or mechanical turbulence is more likely to occur at wind speeds greater than 15 knots, so a windy landing is usually best made in a flat open area free of upwind obstacles.

Fronts can give rise to severe turbulence, and while relative calm may exist shortly before the passage of a front, it could be extremely risky to fly in case conditions suddenly deteriorate.

Thermals

Thermal convection is caused by rising warm air. When the sun strikes the ground surface in the early morning, the surface radiates heat to the adjacent air. After a short period of gentle then moderate air movements (**'mixing'**) near the surface, thermals develop quite quickly as bubbles of superheated air break free from the land surface and start to rise. They will tend to form first over surfaces which radiate more heat (eg, an open rock quarry, scrub adjacent to arable land, and built-up areas of towns) and may even be triggered by the heat of a hot air balloon flying at low level.

Thermals can happen all year round, whenever there is enough change in air temperature from night to day and clear enough sky. Low level cloud cover will delay thermal formation. As a thermal rises, a cumulus cloud may form at the top extent of the rising air if adiabatic cooling and humidity are sufficient. However, while scattered cumulus clouds may indicate the presence of thermals, the absence of cloud does not mean there are no thermals, and the strongest thermals occur in clear air. Thermal strength increases with ambient surface temperature. On a day in the low 20's, thermals may rise to around 4,000ft at speeds of 200 to 500ft per minute. In the low 30's, they will often go to 8,000ft at speeds of 800 to 1,000fpm. In the high 30's even higher and faster.

Downdrafts are a normal part of thermals – and are almost as fast as updrafts, as cooler air descends to replace the rising hot air. But there is no precise pattern to thermals, and neat diagrams of thermals in textbooks are really only a general guide.

A dust devil or 'willy-willy' is the visible centre of a wider thermal. Most thermals are much more extensive.

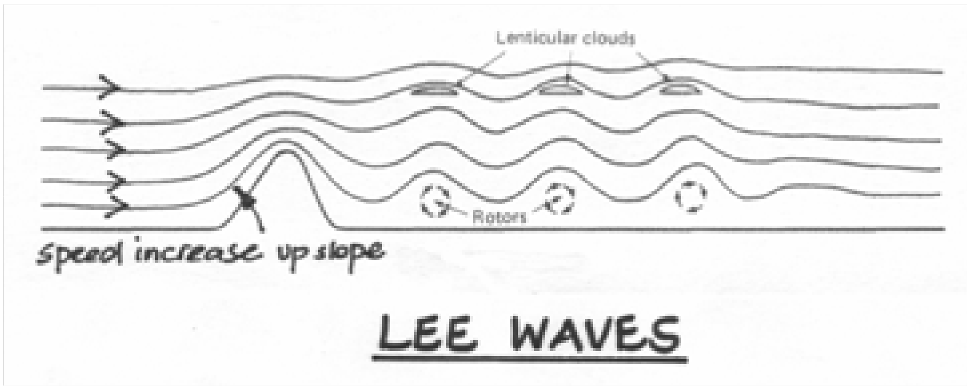
Flying in thermals

From the figures above, it is obvious that the turbulence of thermals can cause severe loss of control and be extremely dangerous to a balloon. So it is important to watch for early signs of thermal formation on a morning flight – circular or random movement of the balloon, including vertical movement not caused by use of the burner. When this occurs, land promptly in a large clear area before the thermals become stronger, after preparing passengers for a possible hard landing. Use a double burner if necessary to counteract unexpected descent. Deflate the envelope quickly even if conditions are calm at landing, to avoid being carried sideways or leaving the ground unexpectedly in a sudden strong gust.

As thermals become mild and die away in the late afternoon, an evening flight may be possible. Wait for gusts at ground level to become weaker and less frequent, and cumulus clouds to start breaking up. Aim to land a little before last light when conditions should be more stable.

Hills and mountains

Wind speed typically increases as air rises up a slope, which can result in quite fast speeds across the hilltop and possible **rotors** (circular air motion) and **downdrafts** (or **curlover**) due to suction on the lee side. Strong winds flowing over a range of hills combined with an inversion just above can result in air being drawn down so strongly that it can bounce back up, creating a **mountain wave (lee wave)** effect over a distance of several miles. **Lenticular (lens-shaped) clouds** may form where the wave bounces against the base of the inversion, and are a sure sign of a lee wave. These clouds may appear stationary but they are in fact constantly forming at a point in a moving airstream. Cumulus clouds may also form in rotors at lower level. Stronger wind speeds can be expected at ground level where the wave is at its lowest.



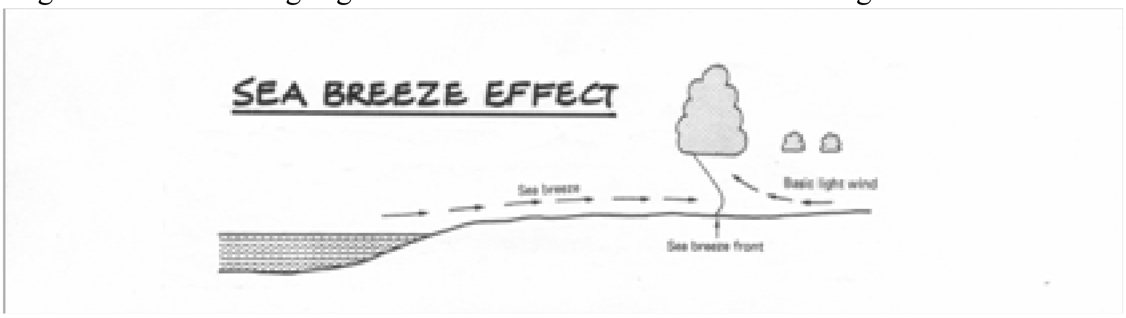
Flying in hills

On upslopes and hilltops, maintain extra ground clearance and anticipate burns well in advance relative to the wind speed. Near the top, increase envelope temperature to maintain altitude and counteract any curlover or rotors. Any descent on the lee side should be made with caution. A calmer landing may be found some distance beyond the hills.

Sea and land breezes

A **sea breeze** is an onshore wind during daylight, caused by warm afternoon air rising up from the land surface, causing cooler air to be drawn in from the surface of the sea to replace it. This sets up a 'box' effect as the warm air above then moves out to sea, is cooled and descends. The sea breeze layer and the air moving out to sea above it are each about 1,000ft thick. A sea breeze ‘front’ may travel 10km or more inland, with its cooler air mass wedging under the warmer existing air and replacing thermal convection with more laminar flow as it goes. While balloons are said to have flown this ‘box’, it should only be tried in mild temperatures and well clear of the coast.

A similar but opposite **land breeze** (offshore wind) may occur before dawn and into the cool hours of the morning. It is usually less powerful and less deep than a sea breeze, and may not produce a full box effect. A balloon drawn towards the coast or the shore of a large lake on a morning flight should land well before the water’s edge!

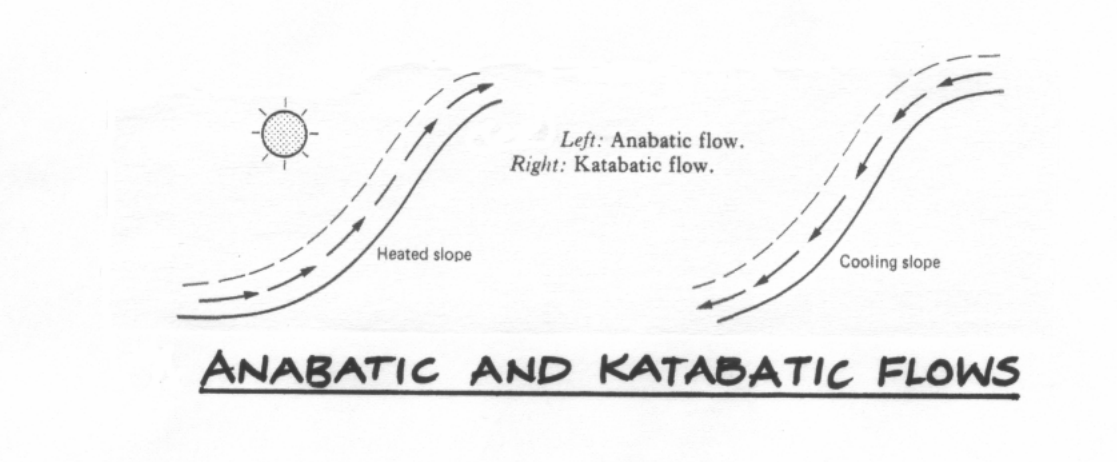


Local wind and airflow effects

Being a fluid, air flows like water, but on a larger scale. In the early morning, cool surface air tends to follow the physical contours of valleys and low areas. A gentle slope will usually produce a gentle **drainage flow** towards the lowest point. This effect is most noticeable when the surface wind speed is light, and typically disappears as wind speed increases.

A steeper downslope may lead to a **katabatic** wind or ‘gully breeze’, when air cooled by contact with the surface at night starts to flow down the slope. This effect often continues into the cool hours of early morning. ("The cats come down the hills at night" is a phrase to help remember it). Katabatic winds can be quite strong and alarming in a balloon, but they typically ease again once the surface flattens out at the foot of the hills. If you find yourself caught in a katabatic wind it may help to be patient and ride it out.

The opposite is an **anabatic** wind, in which air is warmed by contact with a westward facing slope during the afternoon, and rises up the slope. It is usually less strong than a katabatic wind.



Curlover and small **rotors** can form in the lee of even a small isolated hill, especially when the downslope on the lee side is steep. Apply extra heat to a balloon just before flying over the brow of a hill or the edge of an escarpment, to counteract any downward airflow or slight turbulence. A cautious descent clear of the downslope may achieve a very comfortable calm landing in the lee of the hill.

The downwind side of a forest or thick bank of trees can offer a good launch or landing site, with less likelihood of rotors or wind gusts than the lee of a more solid object such as a hill or a building. When launching from **tree shelter**, take off hotter than usual to allow for false lift, and allow extra clearance of downwind obstacles. Landing in the lee of trees can be assisted by allowing the basket to brush through the soft top of the last tree before the clearing, causing enough resistance to reduce forward speed. Before the balloon's momentum pulls the basket clear of the tree again, vent enough hot air to ensure that the balloon will descend positively to a landing. Needless to say, this technique needs practice and good timing, but it can be used to make a safe stand-up landing in a small clearing.

YOUR FEEDBACK PLEASE!
If you have any corrections or suggested improvements to these study notes please advise the ABF Operations Manager.

Weather reports and forecasts

Note the difference between **reports** (actual weather observations and measurements) and **forecasts** (estimates of expected weather).

Obtaining a weather forecast should be considered an essential part of preparation for any flight. If forecast information is not readily available, a sensible pilot will ask local advice, fly only in very suitable weather and monitor weather developments closely.

The combination of weather sources that you choose to use – and exactly how and when you access them – will depend on personal preference and what is available. You may start the night before or even several days ahead with a look at the public weather forecast. In the last hours before a planned flight, you should check reports as well as forecasts, eg read the TAF but also pay attention to the METAR (see below).

The table below is a quick guide to the kinds of reports and forecasts that may be available to you, and how to obtain them. **Internet access is highly recommended**, as it provides a huge amount of free weather information, with more detail about more locations constantly becoming available.

Source	**What it provides**	**Available from**
Public reports and forecasts	Useful general guide, visual media show synoptic chart	TV/radio/daily newspapers Recorded phone services Internet weather services
Bureau of Meteorology	Provides the public info above but with a lot more detail available	www.bom.gov.au
Aviation reports and forecasts	Area forecasts, TAF, TTF, METAR and SPECI (see below) include more detail relevant to flying. Key items given in ATIS and AWIS.	www.bom.gov.au and www.airservicesaustralia.com Fax (Avfax) Phone (Dectalk recording, or speak to aviation forecaster) VHF radio (ATIS)
Local private resources	Weather stations for specific locations and special interest groups (examples below)	Internet, UHF radio, etc as appropriate
Personal observation	Local weather and micro-weather patterns, a level of detail not usually available elsewhere	Local knowledge, pibal, windreader, pilot and ground crew observations before and during flight.

Local resources

Some examples used by balloons in Canberra (updated every few minutes):

- UHF channel 19 ('lady on the hill') – current hilltop winds and temperatures (3 clicks for Lake George to the E, 5 clicks for Spring Mount to the NW, 7 clicks for Pig Hill to the W) – indicators of inversion strength and wind aloft
- www.actewagl.com.au - current wind and temperature at Canberra City and Canberra Stadium
- www.canberrayachtclub.com.au – current wind at Canberra Yacht Club – indicates surface wind on Lake Burley Griffin.

Similar resources exist or are being set up in many areas, so ask around.

Personal observation

Weather conditions in practice are sometimes not exactly as forecast, and may be very different, so it is important to compare the forecast with **your own observations**. Your personal assessment of the weather becomes increasingly important as a flying session approaches, and is paramount when making a decision to fly or not, as well as during a flight. Pilots typically build up **local knowledge** of a flying area from talking to other balloonists and to farmers, other aviators and weather bureau staff.

A **pibal** (abbreviation for 'pilot balloon') is a standard part of most balloonists' kit, and is highly recommended – a small helium-filled balloon usually released at the launch site or on the way there, to check low level wind speed and direction. **A well-filled 30cm pibal rises at around 300ft/min.** The initial track is easily read with a compass, but it will often turn left or right higher up and the track from there on can only be estimated. A **windreader**, consisting of a tracking theodolite connected to a computer, can be used to provide more precise and higher altitude readings from a larger helium balloon of specific size. The ABF has a windreader for use at balloon meets and competitions.

It is important to observe weather developments regularly throughout a flight. Ask your **ground crew** to report changes in surface wind, using extra pibals if necessary. Local indicators include trees beginning to shake, ripples on water, smoke, dust behind cars, other balloons in flight, and changes in the sky (clouds, showers, fog) especially upwind. It is wise to look behind you occasionally during flight.

ARE YOU UP TO DATE?
New regulations and procedures may apply from time to time.
Check on the ABF website that you have the latest version of these study notes.

Bureau of Meteorology

Pilots are recommended to get familiar with the Bureau's website www.bom.gov.au. It provides a general forecast for each state, and specific forecasts for capital cities, synoptic charts (including 4 days ahead), and a range of forecast warnings. It also has educational information about weather services, and a range of other reports and forecast data that you may find useful.

Fire bans and fire danger seasons

Fire danger seasons and fire bans generally apply between about October and May throughout the southern half of Australia. Balloon flights may require special precautions during fire danger season (dates vary by area) and flight on total fire ban days may require a permit and notification in some areas. Fire ban information is given as part of Bureau forecasts. For more information refer to your state or territory fire service website.

Aviation reports and forecasts

Aviation weather is available on www.bom.gov.au). It is also available, together with NOTAMs, from Airservices Australia website www.airservicesaustralia.com (see 'What to do next' below), or from their briefing offices by fax or phone. The internet is free, but fax and phone require advance preparation and payment (see details in VFG or AIP).

The Bureau website also includes a national list of sites where there is an **Aerodrome Weather Information Broadcast** (AWIB) attached to automatic weather stations (AWS), with their phone numbers or frequencies. A lot of these are located at or near favoured ballooning areas. AWIB gives current information on wind speed and direction, temperature, dew point, QNH, and rainfall in the last 10 minutes.

Aviation reports and forecasts are summarised below. Having obtained a forecast, it may be helpful to speak to an aviation forecaster for more specific ballooning information and analysis. Met briefing numbers are listed in VFG.

Area forecasts

- for the general area where you intend flying
- in fairly plain language
- valid for a stated period (between 9 and 15 hours)
- updated every 6 hours.

Forecast area boundaries are shown on the PCA chart and ERSA (GEN-Preflight section). ERSA also has a list of which aerodromes are in each forecast area.

22:02 UTC, 27/06/2005
AREA FORECAST 272300 TO 281100 AREA 21

OVERVIEW:
SCATTERED SHOWERS SEA/COAST N OF YMRY, EXTENDING TO N OF
YMRY/YGLB/YPKS AFTER 03Z. ISOLATED SHOWERS REMAINDER. BROKEN LOW
CLOUD E RANGES CONTRACTING TO N OF YSCB AFTER 02Z. BROKEN LOW
CLOUD
IN PRECIPITATION. FOG/MIST PATCHES TILL 01Z.

SULDIVISIONS:
A: E OF YORG/YCRG
B: W OF YORG/YCRG

WIND:

2000	5000	7000	10000	14000	18500
090/20	080/20	070/15	060/15 MS05	050/15 MS12	030/15 MS22

CLOUD:
A:BKN ST 1000/2000 SEA/COAST, 3000/4500 RANGES IN PRECIPITATION.
BKN ST 3000/4500 RANGES/E SLOPES, MAINLY IN N, CONTRACTING TO N
OF
YSCB AFTER 02Z.
BKN CU/SC 2500/10000 SEA/COAST, 4500/10000 RANGES, WITH ISOL
TOPS TO 16000 SEA.
SCT AC/AS 10000/20000 IN NORTH.
B:SCT ST 2000/4000 IN PRECIPITATION.
SCT CU/SC 4000/9000, LOCALLY BKN.

WEATHER:
FOG, MIST, SH.

VISIBILITY:
0500M FOG, 2000M MIST, 4000M SH.

FREEZING LEVEL:
7000 SE/ 8000 NW.

ICING:
MOD IN CLOUD ABOVE FREEZING LEVEL.

TURBULENCE:
MOD IN CU AND AC.

CRITICAL LOCATIONS: [CLOUD HEIGHTS ABOVE MEAN SEA LEVEL]
MT VICTORIA: -SHRA BKN ST 3700 [CLOUD ON GROUND]
BOWRAL: -SHRA BKN ST 2200 [CLOUD ON GROUND]
FM00 9999 -SHRA SCT ST 3000 BKN CU/SC 3500
TEMPO 0011 4000 SHRA BKN ST 2500

AREA FORECAST

Aerodrome forecasts (TAF)

- useful if you are flying within 10NM of an aerodrome for which TAF is available (see list in AIP GEN and on Airservices website)
- valid for a stated period up to 24 hours, and usually issued every 6 hours
- use a simple code which is easily remembered with a little practice.

Aerodrome reports (METAR or SPECI)

- may be issued in conjunction with a TAF
- METAR are observations made routinely on the hour or half hour
- SPECI are special reports made when weather conditions fluctuate or deteriorate.

Remember they are not forecasts but recent actual weather conditions measured at that location at the time indicated.

Trend type forecasts (TTF)

- relate to conditions reported in a METAR or SPECI
- valid for only 3 hours (TTF overrides the TAF for that period).

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*CANBERRA YSCB

00:21 UTC, 28/06/2005
TAF AMD YSCB 280019Z 0120 06006KT 9999 SCT025
FM08 06005KT 9999 -SHRA SCT020
FM10 15004KT 9999 -SHRA BKN020
T 12 13 12 09 Q 1030 1028 1028 1030

      01:31 UTC, 28/06/2005
TTF METAR YSCB 280130Z 16007KT 9999 FEW024 BKN032 12/07 Q1030
      RMK RF00.0/000.0
      NOSIG


PARKES YPKS

01:00 UTC, 28/06/2005
TAF YPKS 280059Z 0214 12010KT 9999 -SHRA SCT012 BKN030 SCT100
INTER 0214 4000 SHRA BKN010
T 16 17 14 12 Q 1027 1025 1026 1026

      01:38 UTC, 28/06/2005
SPECI YPKS 280136Z AUTO 08015KT //// // ////// 17/09 Q1026
      RMK RF00.0/000.0
```

AERODROME FORECASTS

What to do next

For examples of aviation forecasts and reports, and to become fluent at reading them, study the relevant section in one of the books listed, or VFG, or AIP GEN. You should know how to decode a TAF, METAR, SPECI and TTF, and be familiar with the terms and sequence of forecast information.

For example, the term 'CAVOK' indicates:

- visibility is 10km or more
- no cloud below 5000ft, and no cumulonimbus
- no significant weather (precipitation, thunderstorm, shallow fog, low drifting snow or dust devils)

Be aware of some variations between different sources. Public forecasts usually show wind speed in km/hr, but aviation forecasts show it in knots. Cloud heights in an Area Forecast are AMSL, but in a TAF/METAR/SPECI/TTF they are above aerodrome height.

Log on to www.airservicesaustralia.com . You need to register first, using your ABF membership number if you do not have an ARN. After 24 hours you will get confirmation and can access the briefing service. Select 'pilot centre', then 'pilot briefing', and log in. Then select 'area briefing' and follow the instructions to select a forecast area. You can view and print out all reports and forecasts and NOTAMs for that area.

Log on to www.bom.gov.au and explore the range of information there. To access the aviation section enter user name 'bomw0007' and password 'aviation'.

When you fly regularly in an area, compare the forecast with the actual weather. You are likely to find local variations, and soon will be able to tell if a particular forecast indicates whether conditions are likely to be flyable or not.

Learning about the weather never ends – make it a lifelong habit, and enjoy it.

YOUR FEEDBACK PLEASE!
If you have any corrections or suggested improvements to these study notes please advise the ABF Operations Manager.