Australian Parachute Federation Ltd

Weather Guide

VERSION 01-2021

STATUS: EDUCATIONAL/ADVISORY

Warning

Parachuting and flying in parachuting aircraft can be dangerous.

This guide is not a do-it-yourself guide to skydiving instruction
and should only be used while under the supervision of a qualified APF instructor.

IMPORTANT: Version Control

It is important that members refer to the current version of this Weather Guide. Current Version number is shown on the front cover and in the below table. As this Weather Guide is administered exclusively by the APF, it will be updated and amended when and as required.

Current versions of the Weather Guide can be found on the APF website.

Significant changes made from the previous version are shown in Amendments.

CURRENT VERSION	RELEASE DATE
01-2021	01 July 2021

PREVIOUS VERSIONS	REPLACED BY

AMENDMENTS

VERSION	AMENDMENT DETAILS
	•

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Alternatively, contact the APF Office for a paper copy at a cost of $5.00

CONTENTS

PART 1 - PURPOSE

The intention behind this guide is to present to APF members a synopsis on weather conditions and events which may influence or affect parachuting activities. This is intended as a concise explanation of larger tools and of more numerous weather phenomena.

PART 2 - STRUCTURE

There exist many types of phenomena within 'weather', this guide has sought to simplify the task of explanation by using principally the 21 different types of weather described by Australia's Bureau of Meteorology (BOM) in their Aerodrome Forecasts. This is not because these are the only 21 types of weather, but rather form the basis of forecasts and conditions encountered by jumpers and DZSOs.

Also, within this document is an explanation of how to assess and predict weather using the BOM and other commonly accessed sources.

It is not the intention of this guide to directly comment on how all weather events effect skydivers or aviation in general – as much of that commentary will be self-evident or speculative.

PART 3 - WEATHER

Weather - the state of the atmosphere at a particular place and time as regards heat, cloudiness, dryness, sunshine, wind, rain, etc.

Weather is driven by temperature, air pressure and moisture differences, be it on micro or macro levels, and then nature's endless search to create an equilibrium.

PART 4 - WEATHER MEASUREMENTS AND PRINCIPLES

4.1 Air Temperature

Air temperature readings provided by the BOM are Dry Bulb Temperatures. This means the thermometer is exposed to air but shielded from radiation and moisture.

Air temperature varies greatly based on time of day and regional influences. Generally, the lowest observed temperatures are before dawn- curiously the absolute lowest temperatures are found a few centimetres off the ground, and the highest temperatures generally in the afternoon around 2-3pm.

Important factors for weather conditions in both micro and macro environments are the differences in temperature of bodies of water and adjacent land masses, or white sandy beaches against dense jungle canopy, or the tarmac runway next to the grass landing area.

4.2 Humidity

Humidity is the concentration of water vapour in a space. Humidity is measured in three common ways; absolute, relative and specific.

Absolute humidity is a measure of the total volume of water vapour in the air. It does not take into account the temperature of the air. Absolute humidity in the atmosphere ranges from nearly zero to 30grams of water per cubic metre of air. It is often expressed as g/m^3.

Relative humidity (RH) is an expression of the partial pressure of water vapour in an air mass given temperature and pressure. That is to say what does the current volume of water vapour in the air represent as a maximum of what the current air (based on temperature and pressure) is able to hold.

RH is expressed as a percentage and generally can't go beyond 100% - except by small amounts in complex situations. As the RH nears 100% - its saturation point, the water vapour will begin to condensate back into water droplets and form clouds or fog.

Key to RH is that as the temperature increases, so does the volume of water vapour the same volume of air can hold. A rule of thumb is that the absolute level of humidity can double with every 10 degree increase of air temperature. This means that a cold morning of 5^o with 80% RH will become a dry 29% RH if the temperature increases to 20^o even though the level of absolute humidity hasn't changed from approximately $5.5g/m^3$. This is why the air on commercial airliners feels dry, they are warming very cold air with almost no moisture in it.

Conversely, a decrease in temperature will see a lowering of the saturation point.

Specific humidity (or moisture content) is the ratio of the mass of water vapor to the total mass of the air parcel. It is similar to absolute humidity, except it is expressed as the weight of water vapour in a given weight of air, usually grams of water vapour per kilogram(s) of air, g/kg.

4.3 Dew point

The dew point reflects the temperature at which the current level of absolute humidity would exceed 100% RH. It is given in degrees Celsius.

As we saw in the above explanation of RH, as the temperature drops, so does the amount of water vapour that can be held by the air. As an example, an absolute humidity of $18.4g/m^3$ at 25^o equals 80% RH. As the temperature slowly drops (and the absolute humidity remains constant), the RH will increase. As the temperature drops to 24^o, the RH rises to 85%. At 23^o, the RH rises to 90%. Then, at 21.31^o the absolute humidity of $18.4g/m^3$ hits 100% RH and condensates. 21.31^o is then the dew point for 80% RH on a 25^o day.

With a lower RH, the dew point will be further below the air temperature. If the 25^o day mentioned above had an RH of 40%, the dew point isn't until 10.5^o.

If RH is high, the temperature will have to drop less to reach the dew point. The dew point with 95% RH at 25^o is 24.14^o.

4.4 Air pressure

Air pressure is literally how much all the air currently on your head weighs. Air pressure is measured in Pascals (Pa) or Hecto-Pascals (hPa).

'Ideal' air pressure or plain 'standard', is 1013.25hPa, but, due to the world's changing climate, random air pressures are not at a constant. This is due to uneven heating and cooling and the merging of low- and high-pressure systems and fronts converging.

Pressure decreases with height, that delightful 1013hPa on a delightful day is way down in the 840hPa's at 5,000ft and by just the slightest fraction under 18,000ft will have halved to 506.5hPa.

The tropopause – the boundary layer between the low-level troposphere and the next atmospheric layer, the stratosphere – varies between 70hPa and 400hPa. The lower pressure, and thus higher altitude, is more seen around, or closer to, the equator but then the troposphere is considerably lower, sometimes around 400hPa, nearer earth's poles.

4.5 Convective action

As the sun heats the surface of the earth, it heats the air closest to the ground. This air parcel then expands, which makes it less dense relative to the air around it. This relatively lighter and warmer parcel of air rises into the atmosphere in a column – not unlike a bubble rising through water. As the parcel rises, the cooler air it displaces has a cooling effect on it. As the parcel cools, its temperature and pressure difference with the surrounding air reduces and its rising slows, until it ends up in equilibrium with the air around it and it stops rising.

When the parcel of air rises it leaves behind an area of low pressure which surrounding air rushes in to fill in nature's attempt to maintain an equilibrium. If the rising parcel of air is only very small and it doesn't rise far, the air that rushes to fill the void won't affect much. If, however, the rising parcel of air is the size of the tarmac runway just behind the landing area it might have some effect on any canopies landing nearby and if the rising parcel of air is the same size as the entire land mass adjacent to the cooler mass of the ocean, the effect may be enormous.

Even on a micro level rising parcels of air can cause significant outcomes for vulnerable air users. In a later section we'll discuss dust devils, but they start with small parcels of rising air which may only last a few moments.

Convective action may, as surface air with a high RH rises into cooler skies closer to the dew point, cause that moisture to condensate and form clouds. This can also cause rain, or in quite specific circumstances, thunderstorms.

Convective action generally builds throughout the day. At 9am, updrafts might be reaching 500ft and forming small cumulus clouds. By midday the clouds are larger and the bases higher. By 3pm, they are tall, thick, heavy and ready to produce rain.

4.6 Inversion

An inversion, or a temperature inversion as they are sometimes called, is a deviation from the usual lapse rate of atmospheric temperature. Simply, instead of the temperature decreasing (or lapsing) as altitude increases, with an inversion it will suddenly increase and warmer air will be held above cooler air. The descriptor Inversion comes from the idea that the normal temperature profile of altitude is inverted.

An inversion may be caused by a warm front moving in. Or when the radiation from the earth exceeds that from the sun, often occurring at night or during winter when the sun is at a very low angle.

A strong inversion can act as a glass ceiling – the more dense, colder air, is too heavy to penetrate up into the less dense warm air and cannot mix. This can trap smoke, pollution or humidity close to the surface. In an extreme example, a strong inversion layer was blamed for shock waves from a soviet nuclear explosion bouncing back down and causing more damage than anticipated in the 1955 RDS-37 bomb test.

Any inversion can be broken up by convective action, resulting in a mixing of all levels of weather.

It may, however, be preserved by high overcast, or smoke haze trapped below the inversion, which prevents the earth from heating up, thus reducing convective action.

4.7 Apparent and wet bulb temperatures

Apparent temperature, or 'feels like' temperature, isn't especially critical to jumpers, but it is commonly listed on weather forecasts and often misunderstood. Rather than offering just the straight air temperature, the apparent temperature takes into account factors like wind and humidity. If it is 13^{o} and calm, it feels much warmer than 14^{o} would with a 30 knot wind, as the wind disrupts the air boundary layer our bodies use to maintain some warmth. Equally, 28^{o} with 70% RH will feel cooler and more manageable than 28^{o} and 99% RH as the body's natural evaporative cooling system – sweating – breaks down.

Although the apparent temperature is arrived at through a different process and indeed produces entirely different results, it has some similarities to the Wet Bulb temperature measurement. Discussed above is the Dry Bulb measurement, where a thermometer measures air temperature while shielded from radiation and moisture.

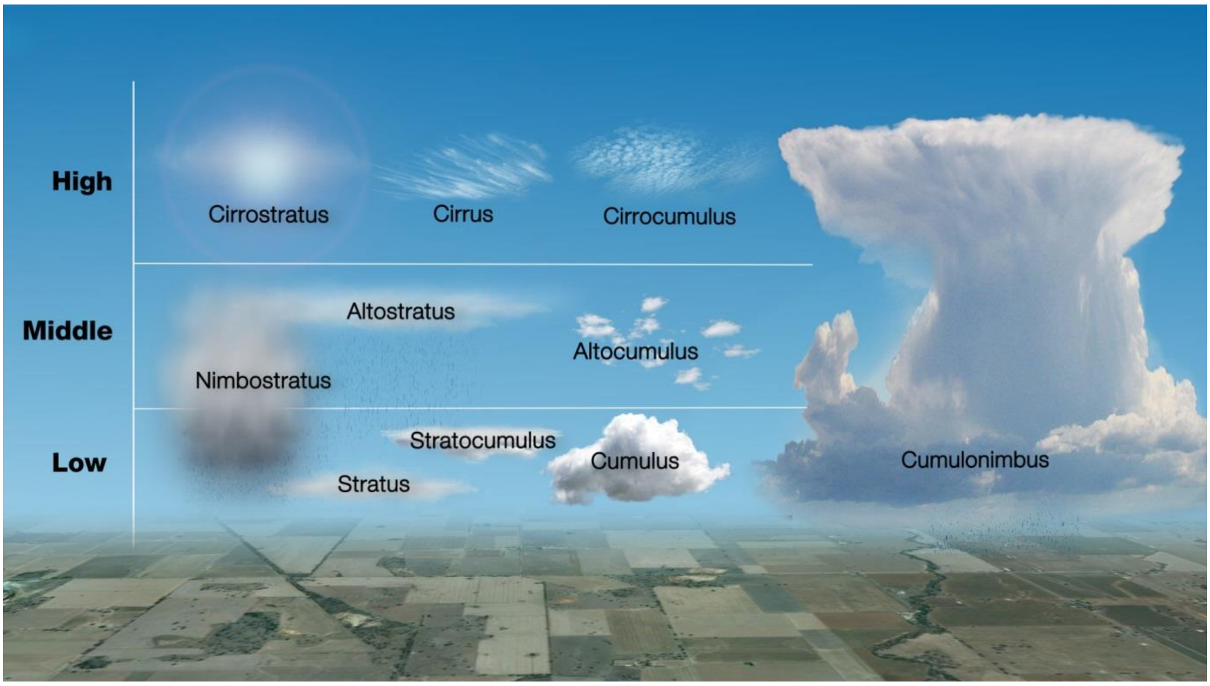
With Wet Bulb measurements, the thermometer is covered with a wet cloth, allowing for evaporative cooling to reduce the recorded temperature. If the ambient air is especially dry, more of the moisture will be able to evaporate, giving a higher level of cooling, thus recording a lower temperature. On a humid day, the moisture covering the thermometer is less able to evaporate, resulting in less evaporative cooling, thus a higher temperature. At 100%RH, the wet and dry bulb temperatures will be the same.

PART 5 - WEATHER SYSTEMS AND PHENOMENA

5.1 Clouds

In 1802, Luke Howard and his seminal essay '*On The Modification of Clouds'* described there were only three different cloud types rolling in the sky. He looked and he saw: cirrus – fibres, cumulus – heaped and stratus – sheet.

With the advent of modern terminology, the names have had to compound to reflect the variations and combinations available to even the least tech savvy of us. The chart below illustrates very neatly the different types of cloud.



Source: BOM.

Why clouds? Why all these different types? Why now? Are they all connected?

The ten main types of cloud

The layer cloud types are known as stratiform and are classified as:

- Stratus - found in the low levels of the atmosphere, tend to produce a light drizzle;
- Altostratus - ('alto' meaning high), found in the middle level, tend to be very good rain producing system for large areas across Australia, particularly inland;
- Nimbostratus - formed when altostratus undergoes further vertical development, allowing the cloud to hold more moisture, and causing the cloud base to lower and produce heavier rainfall; also appears darker in colour; and
- Cirrostratus - found in the higher levels of the atmosphere, white and wispy, and made of ice crystals. We often get a lot of halo activity with cirrostratus cloud, with the ice crystals refracting light around the moon and the sun.

The clumpy cloud, when in the lower part of the atmosphere, is classified as cumulus cloud:

- Cumulus - low level cloud which tends to produce short duration, fairly intense rainfall that is often very localised, meaning that rain falling at your house might not be falling at your neighbour's a kilometre up the road;
- Stratocumulus - found in the lower levels, a blend between stratiform and cumuliform cloud and taking on appearances from both these cloud types, may produce drizzle;
- Altocumulus - found in the middle levels, looks like sheep in the sky, may produce light showers;
- Cirrocumulus - small, rippled, higher level cloud, does not produce precipitation; and
- Cumulonimbus - the largest cloud of all, forms in the lower layer of the atmosphere but extends through all three layers right to the top of the atmosphere. Also known as thunderstorm cloud, producing thunder and lightning.

Some of the more visually spectacular cloud happens very high up in the atmosphere, and is classified as cirrus cloud:

- Cirrus - formed of ice crystals moving very quickly through the atmosphere, occurring at temperatures around –40°C to –60°C, does not produce precipitation.

5.2 Precipitation

Precipitation is any product of the condensation of atmospheric water vapour that falls to the ground under the effect of gravity. This is anything from misty drizzle to heavy hail via rain, snow and graupel.

As RH hits 100%, moisture condenses and falls – normally collecting more moisture on the way day, thus forming into droplets. The rise in RH can be caused by an increase in absolute humidity or the temperature falling to the dew point.

Rain, or liquid precipitation, is measured by either collecting it in a tube and expressing a number in millimetres, or by collecting rainfall over an area an expressing it in g/m^2 or kg/m^2.

As rain falls, it gathers more moisture, forming larger drops. Raindrops can be from 0.1mm to 9mm across. Raindrops aren't teardrop shaped, but look more like a squished ball, with their largest cross-section facing the airflow – think of it as being forced down by gravity, but then compressed by drag.

Snow forms when tiny, supercooled water droplets freeze. They grow, twist and build in the clouds based on varying temperature and humidity. The ice which makes up snowflakes is actually clear, but for complicated reasons the random facets, hollows and imperfections reflect, confuse and tease the light, making them appear white.

Ice pellets are basically snow which has fallen through a warmer layer and melted and then through another below zero layer and frozen, this time in little pellets. If the lower layer of sub-zero air is only just below zero, or only very shallow in depth, the moisture may only partly freeze and fall as freezing rain, or as small ice pellets.

Hail! Forms in storm clouds, rising and falling, turning into bigger, meaner and angrier balls of hail. Hail can grow up to 15cm across and weigh as much as 500grams – this happens with 'wet growth', when the outer surface of the ball melts just enough to allow other bits of hail to adhere to it.

Solid precipitation is generally collected in a tube and expressed as a number in milli- or centimetres. Sometimes the snow may be melted, and the level of precipitation is expressed as a water equivalent in millimetres, but this, due to the varying density of the precipitation, may be a very inaccurate guide to the depth of any snow accumulating on the ground.

5.3 Gust Fronts, wind squalls and clouds

A great variety of cloud features can appear along the leading edge of a gust front or a wind squall. As with advancing cold fronts, they can act as a wedge, driving the warmer air up to cause sometimes spectacular shelf clouds or cloud banks. The complexities of shelf clouds, be it more humid conditions forming thicker cloud or a strong gust front producing rising scud are many and nuanced, but none are inclusive of good skydiving conditions.

5.4 High and Low Pressure systems

Pressure systems are a relative peak or lull in atmospheric pressure. Mean air pressure at sea level is 1013hPa.

Low pressure systems are essentially just the product of atmospheric lift. This can be as localised as a desert gleaming with the sun's radiation causing air to rise or can be continent in scale and drive seasonal monsoons. They can also be caused by divergent winds in the upper levels of the troposphere created by big weather systems and this creates a pressure disparity high in the atmosphere, which lifts air from the surface.

Low pressure systems tend to be associated with cloud, rain and general wintery discontent.

The lowest air pressure recorded was 870hPa during Typhoon Tip in 1979.

High pressure systems are most often the result of a cool air parcel descending from the high troposphere, a process called 'subsidence'– like a downburst, but much gentler. It is subject to adiabatic heating– when the pressure of a gas increases, it also experiences a rise in temperature, which tends to dry out the atmosphere. This is best visualised by putting a bit of tissue paper in a cylinder and rapidly compressing the air in the cylinder with a piston. If done quickly enough, the tissue will catch fire just as a result of the adiabatic heating. This is how diesel engines ignite their fuel/air mix without sparkplugs.

High pressure systems tend to be associated with clear skies and gentle winds. The clear skies will normally result in a higher day/night temperature differential.

The highest air pressure recorded was 1084.4hPa in Mongolia in 2001.

5.5 Cold fronts

Commonly found in the south of Australia. They often:

- Create clouds. Dense cold air wedges the warmer, moist air up, which cools and condenses into cloud and rain.
- Bring changes in wind direction. In the southern areas of Australia, the wind often transitions from a North-westerly to a South-westerly.
- Cause rain. The rainfall is driven by the cold front wedging below the warmer air, so it moves slightly ahead of the cold front. It tends to come from blanket strata-form cloud and the rain steady and consistent. Behind the front, the rain will tend to be driven by cumulus clouds, so more scattered with intervening periods of sun.
- Cause gusty winds – fire conditions in summer and rain, snow and general all-round gustiness in winter.

5.6 East Coast Low

Australian East Coast Lows, or sometimes East Coast Cyclones, are storms that develop between Gladstone in Queensland and the VIC/NSW border. They vary in size and intensity, but they are typically characterised by widespread rainfall. They can vary in size from mesoscale, 10-100km to synoptic scale, 100 – 1,000km. They occur mostly in winter and can occur as often as ten times a year and tend to occur in clusters when the conditions are suitable.

They are intense low-pressure systems which are often very slow moving, so the effects can last much longer than the normal lows which move across the southern states.

It is caused by a confluence of systems: cold air coming up from the south can sometimes end up as a bubble over NSW, then the east coast current supplies warm water, as they interact, warm air rises from the sea to the bubble, intensifying the low off the coast. If there is then a high-pressure system to the south, the low whips the wind across the NSW south coast, rising over the dividing range, causing lots of sustained rainfall.

They are responsible for significant insurance claims and have been the cause of 7% of all major Australian disasters since 1967. They have caused deaths in the Sydney to Hobart yacht race, 390mm of rain in 24 hours in Nowra and the grounding of bulk carriers around Newcastle, amongst other issues.

5.7 Thunderstorms

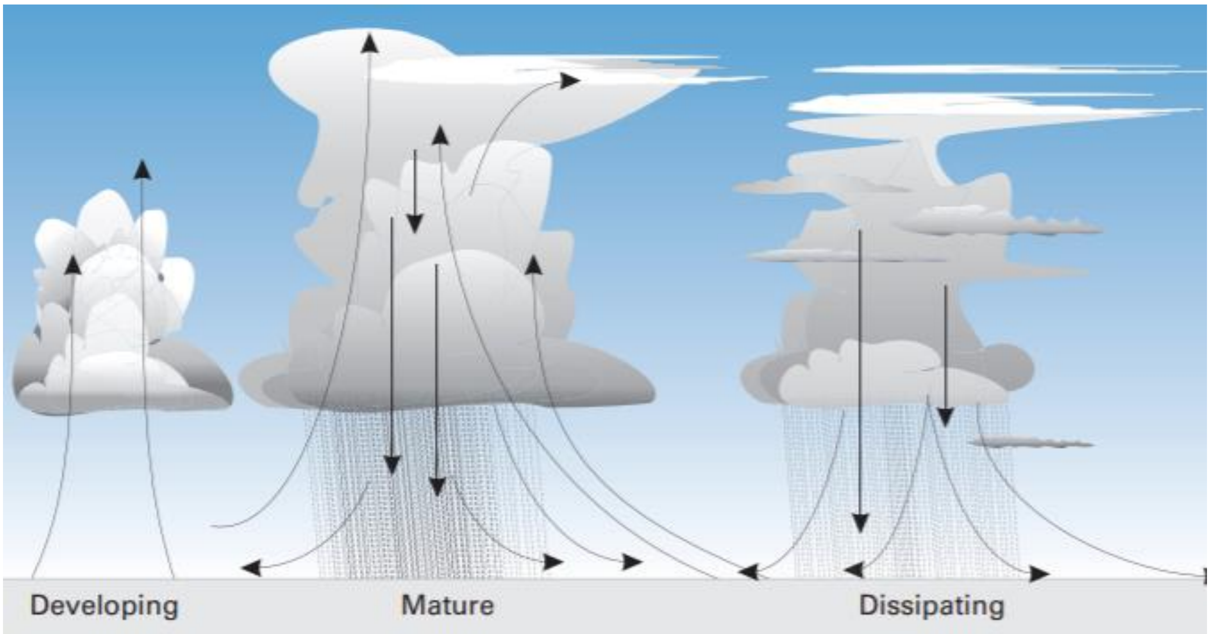
Thunderstorms require three ingredients:

- warm, moist air
- a lifting mechanism:
  - a cold front moving in, forcing the warm air to rise.
  - Orographic lift – i.e. a mountain range driving air upwards
  - A sea breeze convergence
  - Thermal lift
- atmospheric instability – air parcels can rise high.

Normal thunderstorms exist in three stages, dictated by the magnitude and direction of the moving air masses:

- Developing: air rises. This is the cumulus stage
- Mature: air continues to rise, spreading out into an anvil shape when it cools or is too dense to continue to move vertically. Air and precipitation are falling. This the cumulonimbus stage and, excitingly, the peak lightning stage.

- Dissipating: downdrafts throughout the cell as precipitation cools any air still rising – killing the original updraft, which deprives the cell of the warm moist air which feeds the rain and precipitation.



Source: BOM.

5.8 Severe Thunderstorms

Multicell storms are a line of small, short lived cells all at different phases of their life cycles. The cold outflows from all the storms can combine into a gust front which acts as a snowplough or wedge, driving the warm moist air up into the approaching cells, feeding it straight into the heart of storms, allowing them to sustain for much longer and offer greater risk of weather dangerous to all concerned over a wide area.

Squall lines are multicell storms arranged in a long, basically continuous, line of storms. They tend to develop along a linear lifting front, such as a cold front. They can be dangerous to everyone concerned as they present a wall of weather that cannot readily be avoided. Strong vertical wind shear will drive the line forwards as the warm, moist air is scooped into it by the gusty front.

Supercell thunderstorms are the worst kind. They rely on a very strong updraft which rotates as it moves up into its apogee – a general rule is the higher the top of the cloud, the worse the weather it will produce. They are reliant on vertical wind shear to separate out the rising and falling columns of air – so that the heavy and violent precipitation it causes doesn't cool the rising air which feeds it, allowing the storm to continue for as long as it can find warm, moist air to feed into itself – one has been observed at its mature phase for seven hours.

5.9 Fog

Fog is essentially a low-level cloud. It exists when there is a visible suspension of water (or ice) particles in the air close to the ground. It is often generated locally, from a lake, river or moist ground or marshes. It forms when the air temperature is less than 2.5^{o} above the dew point.

5.10 Downbursts

Downbursts are particularly strong downdrafts, generally produced in thunderstorms. A downburst is created by a column of air significantly reduced in temperature by evaporative cooling sinking rapidly, which, after hitting the ground, spreads out in all directions. They can produce straight line winds of up to 250km/h.

They are normally very short-lived, lasting only seconds to minutes. If they affect an area of 4km or less in diameter, they are called Microbursts and Macrobursts if affecting an area over 4km.

When they occur in air free of precipitation (or has virga), they are called dry downbursts – this generally happens as a result of high thunderstorms with their bases as high as 500hPa - that generate no surface rainfall.

Wet microbursts are accompanied by significant rainfall which also helps to accelerate the already rapidly descending air.

5.11 Sea Breezes

When the sun shines brightly on the ground, it heats up a very thin layer at the surface, causing the air close to the ground to warm sharply and rise. This creates an area of low pressure which is filled with air rushing in from over the sea. There is less of a warming effect over the ocean, as sunlight penetrates down as far as 10 metres, dissipating the warm it provides, and, of course, as the water is mostly in motion, the heating effect is applied less directly to a much greater volume.

The warmer air over the land rises, creating an area of relatively lower pressure, which the cooler, higher pressure air over the water rushes in, attempting to maintain an equilibrium.

This effect is normally reversed in the evening. The sea will retain much of its heat, while the land quickly cools. The now relatively warmer air over the sea rises, and air from the land rushes in to fill the void – this is called a land breeze.

If there is a strong offshore wind (10knots or above), it may moderate or negate the effects or appearance of the sea breeze.

5.12 Wind shear

This is the effect created when the air around us is moving at significantly different speeds or in a substantially different direction than the air around it. It can be sudden shifts in direction or rising or falling air along a horizontal path or sharp changes in speed and/or direction on a vertical path.

If the winds are 30kts from the south at 1,500ft, but 25kts from the north at 2,000ft, it is a safe assumption that somewhere in between will be a turbulent and chaotic interface layer. If the wind shear is at 7,000ft, it may be less of a safety issue for most skydivers but will still require a clear understanding in terms of spotting.

Causes of wind shear include: thunderstorms, frontal systems, sea breezes, frictional shearing, temperature inversions, obstacles, rotors and wake vortices.

5.13 Dust Devils

Dust devils are well formed whirlwinds that range from half a metre wide and a few metres high to ten metres across and a kilometre high. To anyone or anything on the ground, they tend to be harmless; a canopy coming in to land, however, is very vulnerable to their effects and dust devils have killed skydivers in Australia in the past.

They are caused by hot air rising rapidly into cooler air, as this air rises, it stretches vertically and can cause a spinning effect. When they rise over desert or dusty terrain, they will lift dust into the air making them clearly visible. The dust they lift doesn't help create or sustain them and dust devils can begin or move over grass or tarmac and will be much less visible.

The BOM doesn't predict or forecast Dust Devils so jumpers must be aware of their conditions that create them. These include flat, empty terrain, clear skies or only limited cloud so the ground can absorb maximum heat, light or no wind and cool atmospheric conditions to allow for the greatest temperature discrepancy with the rising warm air.

5.14 Sandstorm

Sandstorms and dust storms occur when gusty conditions lift fine surface matter, like sand and dust, and then carry them through the air by suspension and deposit them somewhere else.

Once a quantity of sand or dust is in the air, the circulation of particles creates static electricity, which can more readily excite particles on the ground and lift them into the cataclysmic.

Unsurprisingly, they then to happen in arid or semi-arid areas and are exacerbated by drought and poor farming practices which remove vegetation and expose more sand and dust to the wind.

PART 6 - BOM FORECAST AND TOOLS

The BOM make several different and all very useful forecasts available through their Aviation Services.

6.1 Precipitation radars

The BOM have more than 60 radars dotted around the country – the 4th most of any country in the world. They look like a giant golf ball, but unlike actual golf balls, they send out electromagnetic waves at the speed of light and how fast those waves return is what dictates where and how heavy the rain is. The optimal range of the radars is between 5 and 200 kilometres, due to the curve of the earth.

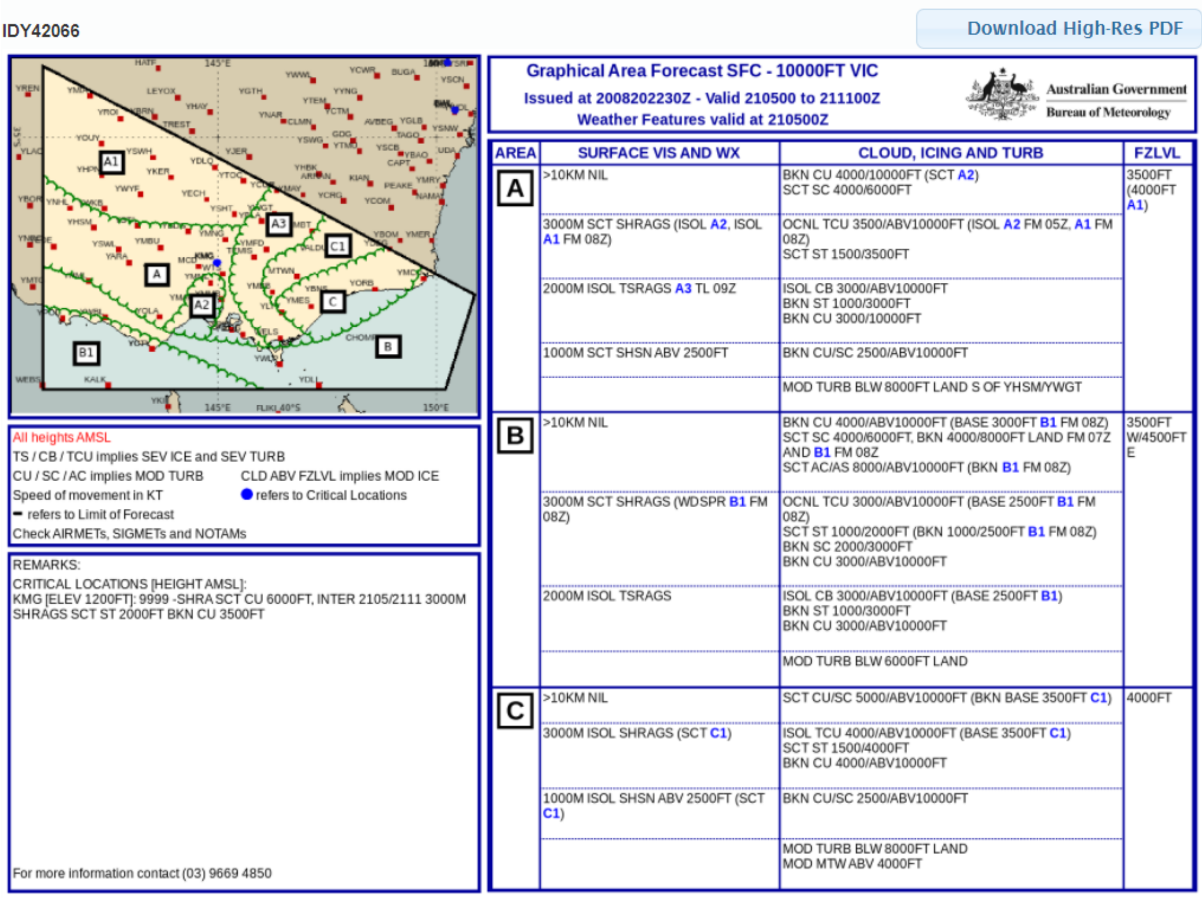
Radar sometimes shows virga, insects and aircraft and it sometimes struggles with drizzle due to the lowness of the rain and small size of the droplets.

Precipitation is represented by a colour scale, with white being the lightest and black being the heaviest.

The images provided to us by our new-fangled electromagnetic god are provided in 6 minute intervals and are played with five frames – so 30 minutes – on loop.

6.2 Graphical Area Forecast - GAF

The GAF provides weather information between the surface and 10,000ft in a graphical layout with supporting text. They are a descendant of the older Area Forecasts.



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Graphical Area Forecast SFC - 10000FT VIC
Issued at 2008202230Z - Valid 210500 to 211100Z
Weather Features valid at 210500Z

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 [HEIGHT AMSL]:
KMG [ELEV 1200FT]: 9999 -SHRA SCT CU 6000FT, INTER 2105/2111 3000M SHRAGS SCT ST 2000FT BKN CU 3500FT

For more information contact (03) 9669 4850

AREA	SURFACE VIS AND WX	CLOUD, ICING AND TURB	FZLVL
A	>10KM NIL	BKN CU 4000/10000FT (SCT A2) SCT SC 4000/6000FT	3500FT (4000FT A1)
	3000M SCT SHRAGS (ISOL A2, ISOL A1 FM 08Z)	OCNL TCU 3500/ABV10000FT (ISOL A2 FM 05Z, A1 FM 08Z) SCT ST 1500/3500FT	
	2000M ISOL TSRAGS A3 TL 09Z	ISOL CB 3000/ABV10000FT BKN ST 1000/3000FT BKN CU 3000/10000FT	
	1000M SCT SHSN ABV 2500FT	BKN CU/SC 2500/ABV10000FT	
		MOD TURB BLW 8000FT LAND S OF YHSM/YWGT	
B	>10KM NIL	BKN CU 4000/ABV10000FT (BASE 3000FT B1 FM 08Z) SCT SC 4000/6000FT, BKN 4000/8000FT LAND FM 07Z AND B1 FM 08Z SCT AC/AS 8000/ABV10000FT (BKN B1 FM 08Z)	3500FT W/4500FT E
	3000M SCT SHRAGS (WDSPR B1 FM 08Z)	OCNL TCU 3000/ABV10000FT (BASE 2500FT B1 FM 08Z) SCT ST 1000/2000FT (BKN 1000/2500FT B1 FM 08Z) BKN SC 2000/3000FT BKN CU 3000/ABV10000FT	
	2000M ISOL TSRAGS	ISOL CB 3000/ABV10000FT (BASE 2500FT B1) BKN ST 1000/3000FT BKN CU 3000/ABV10000FT	
		MOD TURB BLW 6000FT LAND	
C	>10KM NIL	SCT CU/SC 5000/ABV10000FT (BKN BASE 3500FT C1)	4000FT
	3000M ISOL SHRAGS (SCT C1)	ISOL TCU 4000/ABV10000FT (BASE 3500FT C1) SCT ST 1500/4000FT BKN CU 4000/ABV10000FT	
	1000M ISOL SHSN ABV 2500FT (SCT C1)	BKN CU/SC 2500/ABV10000FT	
		MOD TURB BLW 8000FT LAND MOD MTW ABV 4000FT	

Source: BOM.

The header shows the title of the product, GAF area name and the issue and validity times of the forecast.

The image shows weather areas, separated into different sectors where applicable and the legend specifies critical information as denoted within the GAF. In the legend are the GAF's helpful 91 different abbreviations for different forecast elements, from 'FT' for smoke to 'VA' for volcanic ash and 'GR' for hail.

The GAF, and indeed all BOM aviation products, use a mix of units:

- Distance = Nautical miles
- Speed = Knots
- Horizontal Visibility = Metres
- Icing, freezing level, turbulence, cloud height = Feet
- Time = Coordinated Universal Time (UTC), or Zulu.

Aerodrome Forecasts – TAF

The TAF is a coded statement of meteorological conditions expected at and within 5NM of an aerodrome. They ca be searched for via the airport's ICAO code.


Area Map Search Result

AVALON YMAV

TAF YMAV 202316Z 2100/2200
29017G27KT 9999 -SHRA SCT040
FM211500 30015G25KT 9999 -SHRA SCT030
FM212100 26020G30KT 9999 -SHRA FEW020 BKN025
INTER 2122/2200 4000 SHRA SCT012
RMK FM210000 MOD TURB BLW 5000FT
T 10 12 11 07 Q 1000 999 999 999

SPECI YMAV 210130Z AUTO 30022G32KT 9999 // NCD 12/04 Q1000 RMK
RF00.0/000.0

A typical Melbourne day is forecast at Avalon Airport. Source BOM.

The raw, coded TAFs are intimidating for the uninitiated, but there are a great many third-party apps which offer instant decoding.

They are issued for a specific location and time period, which is denoted on the top of the report. They offer:

- Forecasts for 21 different types of weather, including dust, mist, haze, fog, hail, smoke etc.
- Information on ground winds.
- Visibility – unless 'CAVOK' given, is provided in increments of 50 metres up to 800m, then 100m up to 5,000m, then 1,000m increments up to 10,000m.
- Information is offered on up to three separate layers of clouds, with type specified only for cumulonimbus and towering cumulonimbus. Clouds are described by coverage, Few for 1-2 oktas, Scattered for 3-4 oktas, Broken for 5-7 oktas and Overcast at 8 oktas.
- 'CAVOK' – is an abbreviation given for 'cloud and visibility and weather ok'. It means visibility exceeds 10,000m, no clouds below 5,000ft and no weather of significance in the forecast area.
- Remarks – 'RMK' – on any forecast turbulence.
- Temperature and the QNH.

Significant changes are given with the terms 'FM' and 'BECMG'. 'INTER' and 'TEMPO' denote significant intermittent (periods of 0-30 minutes) or temporary (periods of 31-60 minutes) changes to the prevailing conditions.

If there is a 30 or 40% probability of specifically hazardous weather – thunderstorms, haze or fog, the forecast may include a 'PROB' section detailing when and what the weather may be. If the forecast probability is less than 30%, the information will not make the TAF and if the probability is 50% or greater, it will, of course, be on the TAF, but it will not have the 'PROB' prefix.

6.3 METAR and SPECI

A METAR is a routine report of weather at an aerodrome. SPECI is a special report of meteorological conditions when one or more elements meet specified criteria significant to aviation. They are both provided in the same coded format as the TAF or GAF. They report wind, cloud, visibility and weather – with a + or – prefix denoting strong or weak, with no prefix for moderate, e.g. -RA for light rain or +RA for heavy rain.

MAITLAND YMND 21/08/2020 UTC

```
SPECI YMND 210135Z AUTO 29017G27KT 9999 // NCD 17/05 Q1007 RMK
RF00.0/000.0
```

Not always a beautiful day in NSW. Source: BOM.

SPECI criteria include:

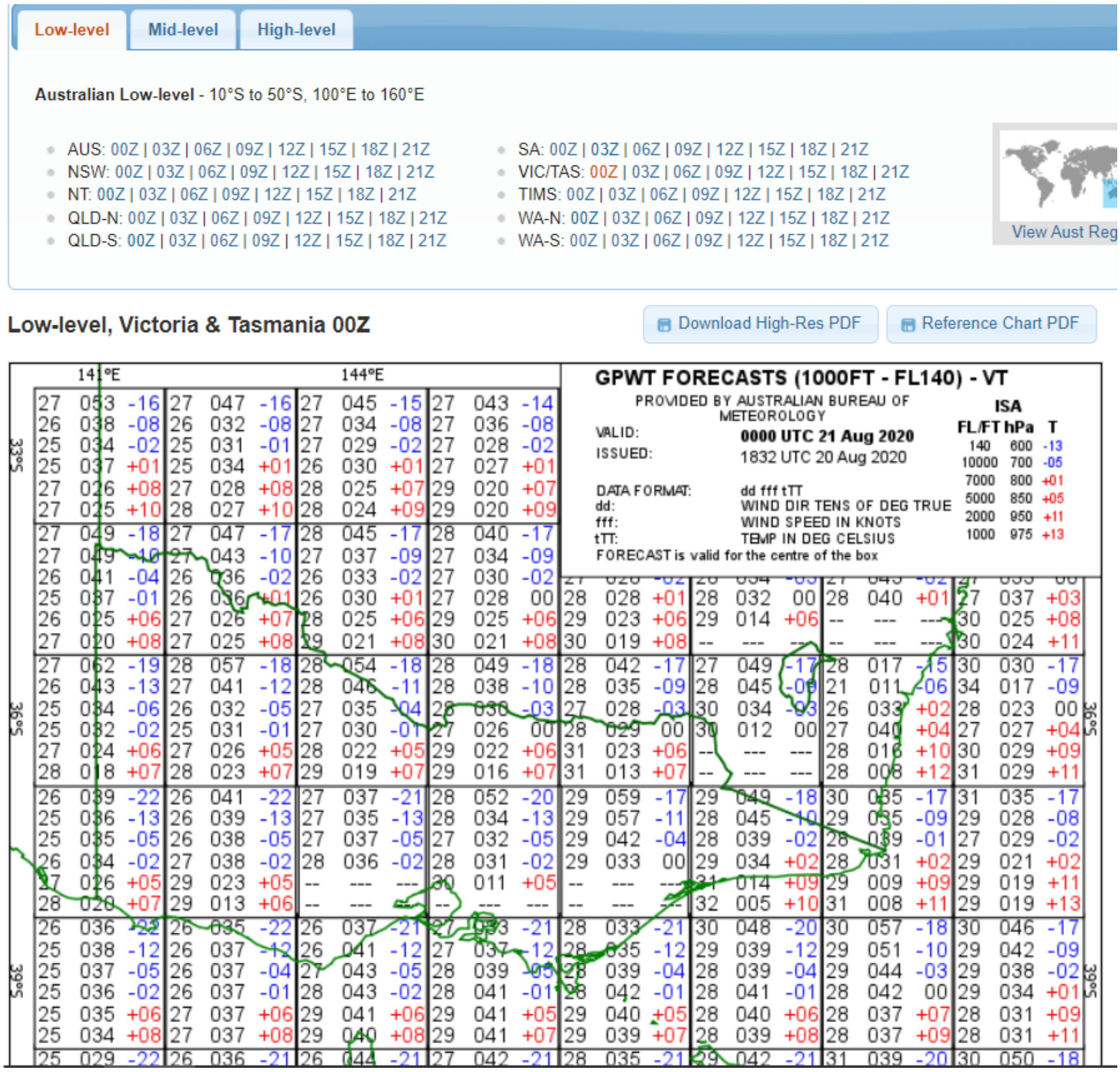
- Wind changes over 30^{o}, gusts of 10knots or more over the 10 minute mean (when the mean is greater than 15knots).
- Low visibility.
- Broken or overcast cloud below 1,500ft.
- Changes in temperature of more than 5^{o}.
- Pressure changes of more than 2hPa since last weather report
- Weather of a serious nature for aviators (thunderstorms, dust, hailstorm, fog, etc) that is beginning, ending, existing or changing in intensity.

6.4 Grid Points – Wind and Temperature Forecasts

Grid Points are a text based display of forecast wind speed, direction and temperature. They available in three MSL altitude offerings;

- Low level: Ground to 14,000ft. Data provided for 1, 2, 5, 7, 10 and 14 thousand feet.
- Mid-level: 5,000ft to 24,000ft. Data provided for 5, 10, 14, 18 and 24 thousand feet.
- High level: 18,000ft to 45,000ft. Data provided for 18, 24, 30, 34, 39 and 45 thousand feet.

The data is presented in latitude and longitude squares overlaid on a geographic background.



Grid point for Victoria. Other map and time forecasts are available towards the top of the image. Source: BOM.

Each geographic box gives; wind direction to the nearest ten degrees, wind speed in knots and temperature in whole degrees Celsius.

Some discrepancy may exist in different level charts at crossover altitudes due to sector sizing and different data sources.

6.5 SIGMET

SIGMETs provide a concise description of a weather occurrence, or an expected occurrence which is potentially hazardous to aviation.

They are concerned with; Thunderstorms, cyclones, severe icing or turbulence, heavy dust or sandstorms, ash, or radioactive clouds. The triggers for SIGMETs are severe – not all thunderstorms warrant SIGMETs and dust or sandstorms have to reduce visibility to 200m or less to be reported.

```
***** Received at 02:15, 21/08/20 *****
WIIZ SIGMET 06 VALID 210215/210800 WIII-
WIIZ JAKARTA FIR VA ERUPTION MT KERINCI PSN S0142 E10116
VA CLD OBS AT 0215Z WI S0142 E10117 - S0204 E10054 - S0154
E10048 - S0139 E10114 - S0142 E10117 SFC/FL130 MOV SW 10KT=
```

CJPM conditions at Skydive Jakarta. Source BOM.

6.6 Trend Forecast – TTF

The TTF is an aerodrome weather report, a METAR/SPECI, to which a trend for wind, visibility, weather and clouds is appended.

WILLIAMTOWN (YWLM)

```
TTF SPECI YWLM 210230Z 30025G37KT CAVOK 18/03 Q1006
RMK RF00.0/000.0
FM0230 29025G36KT CAVOK
FM0230 MOD TURB BLW 5000FT
```

Source: BOM.

The Trend Forecast supersedes a TAF when valid but aren't always a 24 hour service. Remarks in the forecast will note when it reverts to the TAF.

Language and coding are very similar to the TAF, with the addition of 'NOSIG' for 'no significant changes' – NOT, 'no significant weather'.

PART 7 - OTHER FORECASTING TOOLS

Windy.com (formerly Windyty, Windytv)

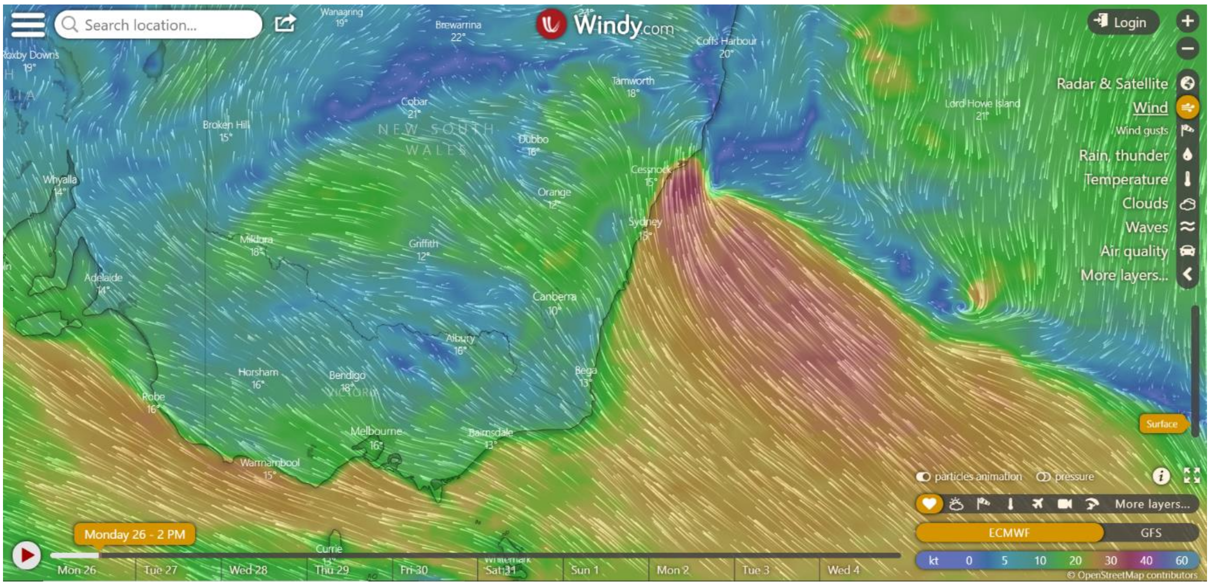
Windy was developed by a Czech tech entrepreneur called Ivo.

It is a visual weather forecasting system, offering insight into wind strength at different heights, rainfall, clouds, precipitation, temperature and much more. It is available freely online or via apps for Apple and Android.

There are few forecasts available for upper winds beyond the next 24 hours, but Windy offers all forecast insights a week into the future.

It draws data from many sources, the Global Forecasting System model run by the US National Weather Service, the European Centre for Medium Range Weather Forecasts and a Swiss company, Meteoblue.

The data is presented over a map which spans continents on one zoom level and streets at the other extreme.



Windy looking at Vic/NSW. Source windy.com

Willy Weather

Willy Weather is an Australian privately run weather service which draws data from the BOM and the US provided National Oceanic and Atmospheric Administration.

Through the website, or available apps, it offers insight into wind, temperature, tides, swell, UV and phases of the moon.

The apps offer easily digested information presented in a user-friendly interface.

Weather for WA on Apple's Willy Weather app.

NAIPS

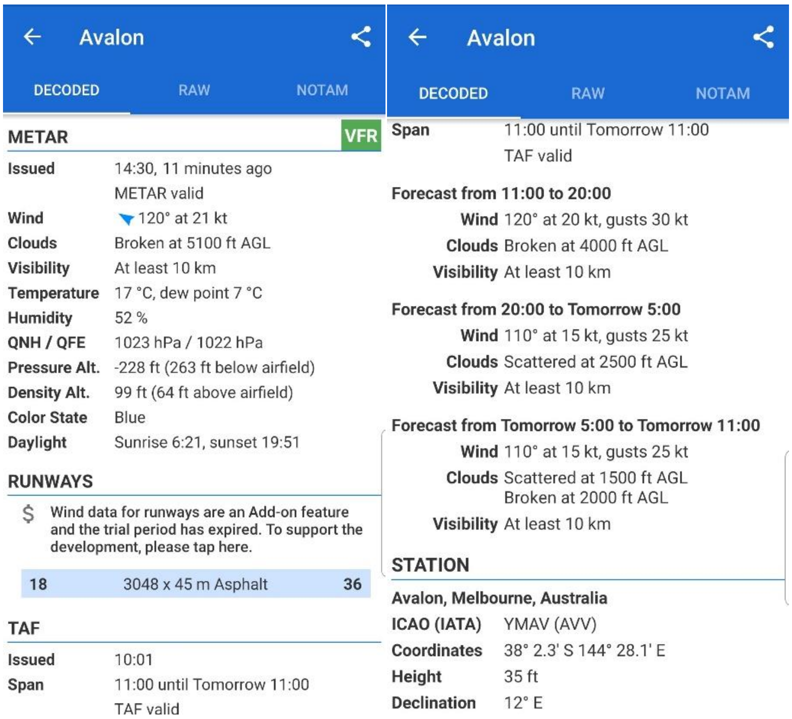
NAIPS is a heavily pilot focussed service which is provided by AirServices and draws from BOM data. It offers access to TAFs, area briefings, first/last light information as well as providing a portal for pilots to lodge flight plans and view NOTAMs.

It requires a login but is a free service.

TAF and METAR decoders

There are a variety of third-party apps which offer TAF and METAR presented in more digestible information for the casual consumer. Data is sourced from the BOM. Some apps may offer other tools with the TAF and METAR, radar, for example.

Current examples of these apps include, Avia Weather, AeroWeather and METARreader.



Decoded METAR and TAF from Avia Weather for Android.