WEATHER & BUSHFIRE BEHAVIOUR

NSW has a history of droughts and severe fire weather which has caused some devastating fires, causing extensive loss of life and property and such tragedies are high on the list of "Natural Disasters":

As such it is important for each level of our Service to understand the weather, where they can access the information and the potential for its adverse influence on bush fire behaviour either immediately or within a few days.

Firefighters - should be aware of the strategies and tactics to be implemented, their surroundings, fuel levels, fire behaviour, current and forecast weather and not just rely on their crew leader's knowledge and competencies, so that they work as an integrated team supporting each other.

Crew Leader (CL) - (Officer in Charge (OIC) of a tanker) – should obtain weather information from their Fire Control Centre or the Bureau of Meteorology (BOM) website. On a duty day or when responded to an incident, you should know the Keetch Byram Drought Index (KBDI) (scale of 1 – 200), number of days since rain and the amount of rain that fell in the last 24 hours, the drought factor (scale of 1 – 10), relative humidity, temperature, wind speed, wind gust and direction and any forecast change.

It is essential to be aware of a change in wind strength or direction either by being provided with the forecast or by observing the "tell-tale" signs – a flank can quickly become a front and could seriously affect the safety of your crew. Apart from a front, a wind may also be associated with a storm downdraught, a dry downburst (microburst or macroburst), willy-willy or the arrival of a sea breeze. Firefighters can deduce the likely change of wind direction from a downburst by the location and direction of travel of the stormcell. Any such change if not forecast must be communicated immediately to FireCom and all crews on the fireground.

It is important to take weather readings on the fireground, which should be relayed to FireCom. This weather information will enable you to utilise the forest or grassland fire danger meter and assist in predicting the fire behaviour.

The BOM require your accurate fireground observations to provide a special fire weather forecast.

You should be aware of current and predicted weather - see the BOM website for:
- Weather Forecasts, Warnings and Observations
- Weather Charts
- Radar Images
- Satellite Images
- National Weather Charts including Mean Sea Level (MSL) Analysis and Prognosis
- Rainfall and Temperature Maps
- Seasonal Outlooks

Sector Commander (SC), Divisional Commander (DC), (Group Captain) is expected to have a superior understanding of weather prediction and the effects on fire behaviour. Interpretation of information in an Incident Action Plan, analysis of weather maps and an understanding of the Haines Index map will be of great assistance.

Incident Controller (IC) - is responsible for obtaining and analysing all relevant weather information, current and forecast, to establish and implement strategies to ensure the safety of all involved. The weather information forms an integral part of the Incident Action Plan (IAP), which details the efficient and effective use of all resources to effectively contain the fire in the shortest possible time, minimising life, property and environmental loss.

Fire Control Staff have access to the "Registered User" section of the BOM website, which provides additional information including:
- **Special Fire Weather Forecast Request Form**
- Latest Weather Chart and Satellite Picture
- Current NSW Observations
- **Weather Radar** and Thunderstorms
- Recent Conditions including Rainfall and Temperature Maps
- Drought and Stability Indices including **Keetch Byram Drought Index Map, Drought Factor Map** and **Haines Index Map**
- Weather Bulletins including weather and rainfall data
- **Forecast Charts** including MSL Analysis and Prognosis
- Forecasts and Warnings including **NSW Fire Danger Ratings**, **Four Day Rainfall** and **Four Day Fire Weather**, **Smoke Dispersion Forecasting Model** (NSW Trial) for hazard reductions and fires (State Operations controls for all agencies)
- Long Term Conditions and Outlook

State Operations During the Bush Fire Danger Period, State Operations facilitates a weather briefing for the next four days during a phone conference at 14.00 hours each Thursday for all agencies' regional fire managers around the State.

Total fire bans (Tobans) are based on the ratings (derived from forecasts of weather elements – temperature, relative humidity and wind speed - as well as the Drought Factors and Grassland Curing at specified locations in each NSW Fire Area) received daily from the Bureau of Meteorology, during the bush fire danger period, at approximately 16.30 hours. After consultation by the State Duty Operations Officer with the relevant Regional Duty Operations Officer/s, who is aware of the situation in each District/Team/ Zone within their Region, a recommendation is made to the Commissioner who then makes the decision regarding the NSW Fire Areas to be declared.

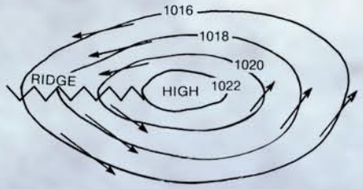
NSW RURAL FIRE SERVICE

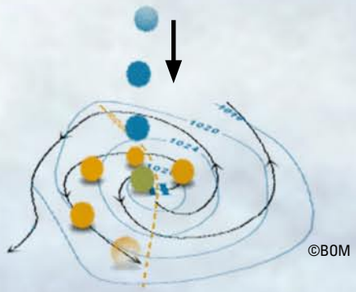
WEATHER AND BUSHFIRE BEHAVIOUR www.bom.gov.au

HIGH PRESSURE SYSTEM

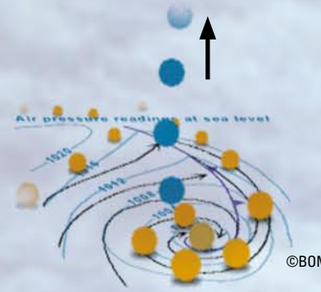
High pressure systems provide dry, warm weather with the possibilty of a lead up to critical fire weather. Winds circulate anti-clockwise

Isobars showing a ridge or wedge of high pressure





(High) Sinking air near the surface spreads out.

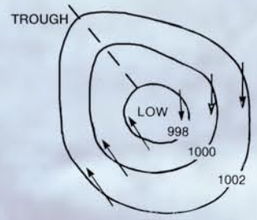


(Low) Converging air near the surface rises.

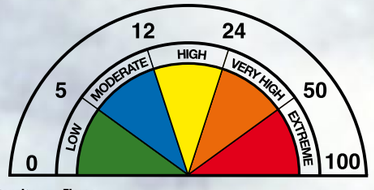
LOW PRESSURE SYSTEM

Winds circulate clockwise

Isobars and winds of a typical low



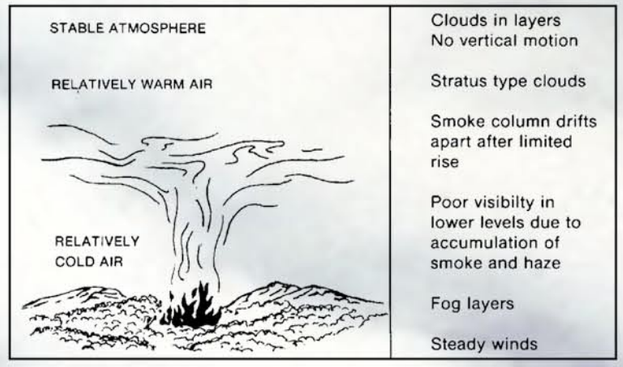
FIRE DANGER INDEX AND RATING



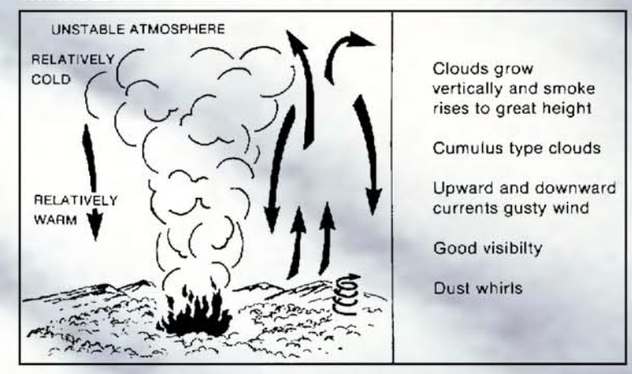
Intensity (kw/m)	Flame Height (m)	FDR	Forest Fires
0 – 50	0 – 0.5	LOW COOL CALM	Fires generally self extinguishing
50 – 500	0.5 – 1.5	MODERATE COOL LITTLE WIND	Hand tool lines should hold the fire. Direct attack recommended
500 – 2000	1.5 – 3.0	HIGH WARM SOME WIND	Fire too intense for direct attack. Parallel attack recommended
2000 – 4000	3.0 – 10.0	VERY HIGH HOT WINDY	Crown fire at upper intensities. Indirect attack recommended
over 4000	over 10.0	EXTREME VERY HOT VERY WINDY	Crowning, spotting and major fire runs likely. Control efforts probably ineffective. Defensive strategy recommended

Fuel loads heavier than 12.5 tonnes per hectare may produce more extreme fire behaviour

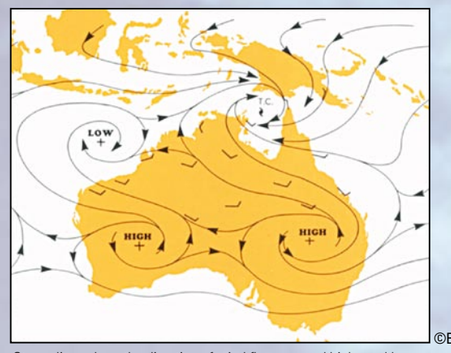
STABLE ATMOSPHERE



UNSTABLE ATMOSPHERE



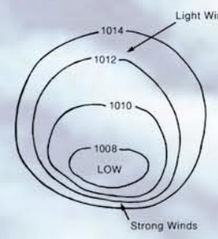
WIND PATTERNS



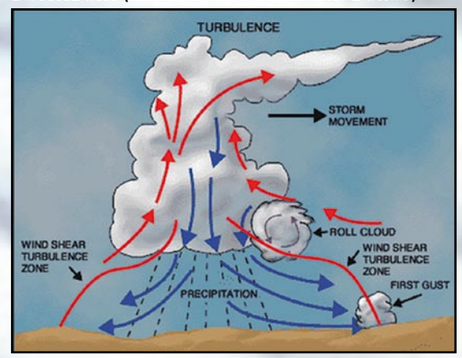
Streamlines show the direction of wind flows around highs and lows.

WIND STRENGTH

Wind strength according to pressure gradient



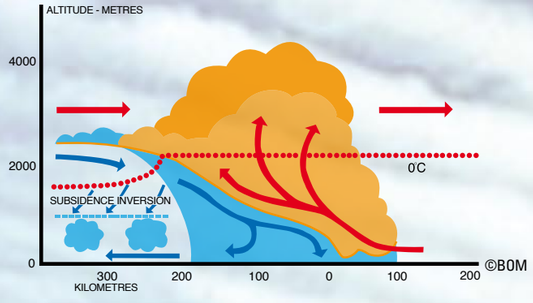
DOWNBURT (MICROBURST OR MACROBURST)



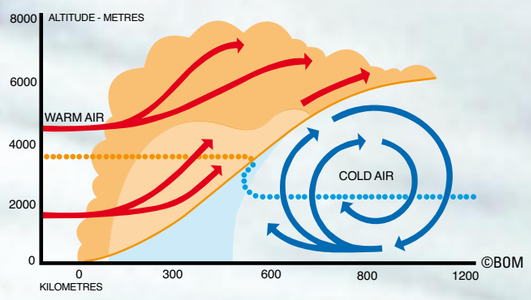
Cool dense air that sinks rapidly out of a downburst spreads out rapidly in all directions typically 80kph but can be up to 270kph causing a dangerous situation for firefighters.

FRONTAL SYSTEMS

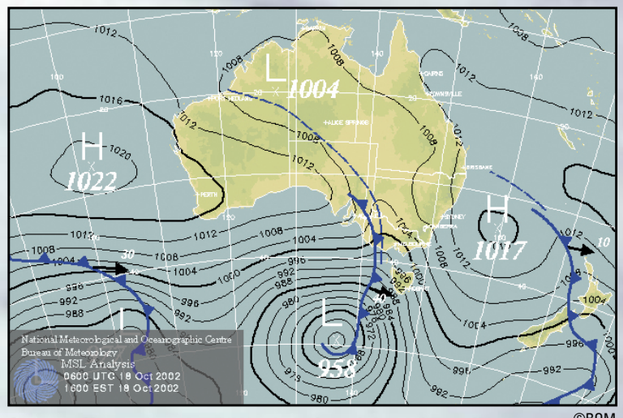
When one air mass moves into an area occupied by another, the two do not mix substantially unless their temperature and moisture are similar. A boundary zone known as a front forms between the two.



Diagramatic cross section of a typical cold front



Diagramatic cross section of a typical warm front



Summer Heatwave - hot NW winds from inland Australia

BUSHFIREbulletin // WEATHER AND BUSHFIRE BEHAVIOUR

Beaufort Scale - is a scale that uses observations of the effects of wind to estimate its speed. Refer to the October 2005 Firefighters' Pocket Book P51

Cold Front - In some areas along the polar front, cold, dense air advances towards the equator, causing the warmer, less dense air to be forced upwards over its sloping surface with the consequent reduction in temperature. This portion of the polar front is known as a cold front. Cold polar air is replacing warm tropical air. This action is usually rather violent and the sudden uplifting causes large cumulus clouds to develop (provided sufficient moisture is present) with shower type weather, and sometimes thunderstorms, at and near the front. If the air is very dry, a cold front can also bring a "dry change" with a change in wind direction and drop in temperature but with little or no cloud. Cold fronts are much shallower (less vertical height) in summer and move quickly up the coast and over western inland, but take much longer to pass through the ranges, where it is often a race between the easterly and westerly winds. The coastal and inland arms of the front meet somewhere on the ranges creating an "occlusion"

Convection - is the process generally associated with warm, rising air and the formation of cloud. Local breezes, showers and thunderstorms are a result of convection in the atmosphere.

Downburst (Microburst or Macroburst) - is a strong downdraught generated by a falling shaft of rain, associated with an isolated storm or shower, which rarely lasts more than 10 – 15 minutes. Dry microbursts can occur when the rain evaporates before it reaches the ground, where the intense cooling caused by the evaporation causes the descending air to become denser and sink even faster. When the downdraught hits the ground the wind spreads out rapidly in all directions, 80kph is typical but can be up to 270kph. Macrobursts are the same as microbursts but come from larger storm clouds.

Drought Factor - is a scale of 1 – 10, used when calculating the forest fire danger with the McArthur fire danger meter. It is based on the Keetch Byram Drought Index, the number of days since rain and the rainfall amount at the time of last rain.

El Niño - Nowadays, the term El Niño refers to the extensive warming of the Central and Eastern Pacific Ocean that leads to a major shift in weather patterns across the Pacific. In Australia (particularly Eastern Australia), El Niño events are associated with an increased probability of drier conditions.

Front - is the boundary between air masses having different characteristics.

Gust - is any sudden increase of wind of short duration, usually a few seconds.

Haines Index - is a measure of lower atmospheric stability and moisture. It ranges from 2 to 6, the higher the value, the drier and more unstable the lower atmosphere.

Highs - in the Southern Hemisphere are atmospheric circulations that rotate anti-clockwise with sinking air spreading out in a spiral away from centre. Anti-cyclones are areas of higher pressure and are generally associated with lighter winds and fine and settled conditions.

Isobars - are lines on weather maps joining places, which have the same mean sea level air pressure. Mean sea level pressure is an "equivalent pressure at sea level" that allows stations at different heights to be compared by taking their heights into account.

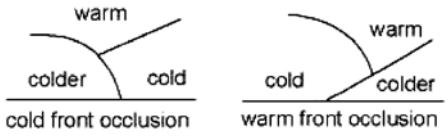
Keetch Byram Drought Index (KBDI) - provides an estimate of soil dryness (moisture deficiency). The number indicates the amount of rainfall in mm that would be required to reduce the index to zero or saturation. It is very useful for planning fire and hazard reduction operations. The KBDI is calculated daily by the BOM at around 180 sites across NSW using rainfall to 9am and yesterday's maximum temperature. The meanings of the various KBDI ranges are as follows:

- 0 – 24mm Mild
- 25 – 62mm Average
- 63 – 100mm Serious
- 101 – 200mm Extreme

La Nina - The extensive cooling of the Central and Eastern Pacific Ocean. In Australia (particularly Eastern Australia), La Niña events are associated with increased probability of wetter conditions.

Lows - in the southern hemisphere are atmospheric circulations that rotate clockwise with converging air rising in the centre. Cyclones are areas of lower pressure and generally associated with stronger winds, unsettled conditions, cloudiness and rainfall.

Occluded Front - When the cold front moves faster than the warm front and as it overtakes the warm front, the warm sector is closed and a combined front forms. This process is called occlusion. The front formed in this way is called an occluded front.



Relative Humidity - is a traditional indicator of the air's moisture content. It is the ratio of the amount of moisture actually in the air to the maximum amount of moisture, which the air could hold at the same temperature. Relative humidity is normally expressed as a percentage and at saturation the relative humidity will be very close to 100%. The air can hold more moisture at higher temperatures, hence the relative humidity alone does not give an absolute measure of moisture content.

Ridge - A ridge is an elongated area of relatively higher pressure. It is indicated by rounded isobars extending outwards from an anti-cyclone (high) and has a ridge line associated with it. The ridge axis is occasionally shown as a wavy line on the weather chart, but is often not indicated at all.

Southern Oscillation Index (SOI) - is calculated from the monthly or seasonal fluctuations in the air pressure difference between Tahiti and Darwin.

Squall - comprises a rather sudden increase of the mean wind speed which lasts for at least several minutes before the mean wind returns to near its previous value. A squall may include many gusts.

Thunderstorms - Deep convective clouds or clusters of clouds from which lightning (electrical discharges resulting in flashes of light) and the resulting thunder occur. This is usually associated with precipitation (rain or sometimes hail). A thunderstorm may have lightning to peripheral areas where no rain falls or it may be a completely dry storm creating lightning strikes to ground, which have the potential to start fires.

Tropical Cyclones - are intense low pressure systems which form over warm ocean waters at low latitudes. Tropical cyclones are associated with strong winds, torrential rain and storm surges (in coastal areas). Tropical cyclones can cause extensive damage as a result of the strong wind, flooding (caused by either heavy rainfall or ocean storm surges) and landslides in mountainous areas as a result of heavy rainfall and saturated soil. If they attain maximum mean winds above 117 kph (63 knots) they are called severe tropical cyclones. In the North Western Pacific severe tropical cyclones are known as typhoons and in the North East Pacific and Atlantic/Caribbean they are called hurricanes.

Troughs - A trough is an elongated area of relatively lower pressure. It is indicated by rounded isobars extending outwards from an area of low pressure and has a trough line associated with it. The trough axis is usually shown as a dotted line on the weather chart.

Warm Front - In some areas along the front, warm air of lower density moves towards the pole, climbing up over the sloping surface of the colder and denser air mass. This portion is called a warm front. Warm tropical air replaces cold polar air. When sufficient moisture and lifting are available, the cloud sheet is usually more extensive than that produced by a cold front and rain usually falls ahead of the surface front.

Wind is movement of air and is experienced as a continuous succession of gusts and lulls (quiet intervals) associated with equally rapid changes of direction over a range, which may exceed 30°. The mean wind speed over a period of time is therefore the mean of many gusts and lulls. Usually only the mean wind is forecast, unless the gusts are expected to be a significant feature. For instance, Fresh, gusty south-west winds indicates that the mean wind speed will be between 17 and 21 knots (refer to Beaufort Scale in the October 2005 Firefighters' Pocket Book P51) and the mean wind direction will be from the south-west, but that there will also be gusts to speeds significantly higher than the mean.

Thanks to Andrew Haigh, Bureau of Meteorology for his assistance.

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Manager Operations, Policy and Standards