

What drives NSW weather?

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To understand our State's weather we must view our climate in conjunction with the factors that govern weather and climate across the whole of Australia. The position and topography of our continent produce a diverse range of climatic conditions, many of which have marked seasonal variations. The driving force is the general circulation of the atmosphere. Although this is a global process, it is possible to describe some dominant hemisphere circulation patterns that will help us to understand the seasonal changes of climate in Australia.

The sun drives the system

In our simplified model, energy from the sun in equatorial regions heats the land surfaces and evaporates water from the tropical oceans. The heated air, plus water vapour, rises to the top of the atmosphere, causing low pressure at the surface, and moves slowly away from the equator in each hemisphere. On the way, the air gradually loses heat and moisture and starts to sink back towards the surface, at about 30° of latitude, causing a high pressure system in that region.

This descending dry air gives the clear skies of the subtropical high pressure systems so common in Australia. One branch of the descending air moves back towards the equator, completing the 'Hadley' air cell circulation (see Figure 1), while another branch of warm air moves towards the poles. At the same time, high pressure in the polar regions causes cold air to move towards the equator near the surface.

These two air masses, with markedly different temperatures, meet at the polar front (see Figure

1), and – in combination with a general longitudinal flow – result in mid-latitude (or 'extra-tropical') low pressure systems, which have a profound influence on weather conditions in southern and eastern Australia.

Effect of the earth's rotation

Coriolis forces, resulting from the rotation of the earth about its axis, cause the air moving back towards the equator in the Hadley cell to flow as south-easterly winds over the ocean, with some deflection over the land. These are known as 'trade winds'. Air moving towards the poles from the subtropics is deflected into westerlies, eventually becoming the 'roaring forties'. The net result of the global and hemispheric interchange of air masses is to maintain long-term climatic equilibrium across the globe.

Eastward movement of systems in the mid-latitudes

One result of all this is a general eastward movement of the subtropical high pressure systems and the mid-latitude cyclones or depressions. Typically, these systems take from five to seven days to migrate across the continent. In general, regions of high pressure have a large longitudinal spread – often several thousand kilometres.

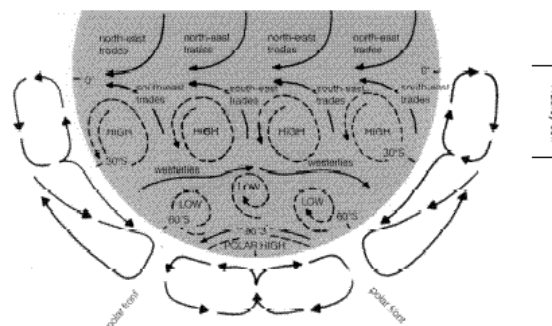


Figure 1. The general circulation

In high pressure regions, pressure gradients near the centres are small, wind speeds are usually light and conditions stable. In contrast, regions of low



pressure are often more concentrated and have larger pressure gradients, resulting in stronger winds and more severe weather conditions. In the southern hemisphere, under the influence of Coriolis forces, air rotates anticlockwise around regions of high pressure, and clockwise around low pressure systems. (See Figure 1.)

Effect of the north south movement of the sun with the seasons

The apparent movement of the sun with the seasons of the year causes the atmospheric circulation pattern to migrate north in winter (furthest north in June) and south in summer (furthest south in December). Australia extends over a large range of latitudes, and changes in the positions of high and low pressure systems as a result of seasonal changes in the general circulation of the atmosphere have a dramatic effect on weather in NSW. This is best illustrated by examining seasonal changes in the tracks of high pressure systems across the continent, and examples of summer and winter weather patterns.

A typical summer synoptic chart

The summer synoptic chart (Figure 2) shows one region of high pressure in the Great Australian Bight, with a ridge extending along the NSW coast. A cold front is in the Tasman Sea. This front would previously have passed through Victoria and up along the NSW coast.

This particular chart, a classic case but only one of innumerable possibilities, also shows a low pressure trough extending southwards from Queensland into inland NSW. This is known as an 'easterly dip'. Such a dip provides an influx of moist air from the Coral Sea. Together with the instability due to the trough, this type of situation provides conditions that can lead to the formation of thunderstorms.

A second front is shown westward of the high in the Bight. As the high gradually moves eastward, winds over southern NSW will become hot north to north-westerly, generally increasing in strength before the arrival of the front. Thunderstorm activity may precede the cool change, with temperatures falling dramatically in coastal regions. For the following few days conditions remain unsettled – especially near the coast – as the wind slowly moves around to the east then north-east with the movement of the high pressure system across eastern Australia.

Also present on the chart are the semi-permanent heat lows of northern Queensland and the Pilbara region of Western Australia; these are a product of intense solar heating of the ground in summer.

Another feature typical of summer is a tropical cyclone (not shown on the chart), which may occur

in the low pressure regions off the northern Australian coast. Although tropical cyclones do not directly affect NSW, occasionally intense low pressure systems form off the coast of Queensland and move slowly down the coast, causing strong winds and torrential rain in northern and central parts of eastern NSW.

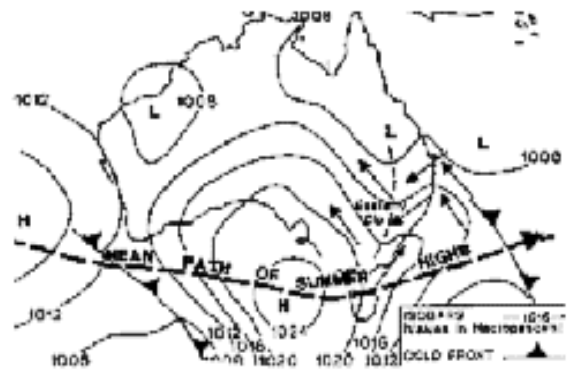


Figure 2. Typical summer chart

A typical winter synoptic chart

In winter, as the sun moves into the northern hemisphere, the subtropical high pressure systems move northwards. On average, these high pressure systems cross Western Australia north of Perth and leave the eastern shores at about Brisbane. This northward movement of the high pressure systems and the mid-latitude cyclones results in predominantly west to south-west winds across most of NSW in winter.

The winter synoptic chart (Figure 3) shows the more northern path of the high pressure systems and the presence of a polar depression south of the Bight. During winter it is not uncommon for these depressions to be over Tasmania, and in some cases to be over Victoria or NSW. The situation shown produces fine weather over eastern New South Wales in the short term, but is followed by several cold fronts, which usually penetrate well into the State. There are a number of possible developments, but the most likely result is for rain and strong west to south-westerly winds over NSW. The rain will mainly occur on the western slopes and plains and the highlands. Along the coast, although conditions are likely to be cloudy and windy, there will be only a small chance of rain.

As the low pressure system moves east, conditions will be dominated by the high pressure system now west of Western Australia. Because of the more northward winter track, winds will normally remain westerly over NSW, briefly turning north to north-westerly as this high slips away into the Tasman Sea, and is replaced by the next mid-latitude depression and high pressure system. These

westerly winds are frequently very strong, reaching gale force over the Snowy Mountains.

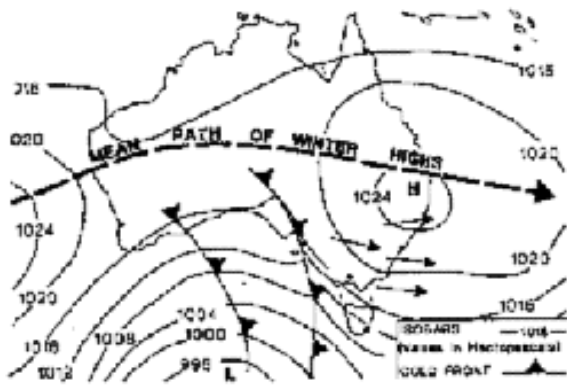


Figure 3. Typical winter chart

Daily variations

Although the synoptic charts show the average paths of the high pressure systems and the typical weather conditions, there are large day-to-day variations in the tracks of anticyclones (highs) as they move across Australia. On some occasions the eastward movement of the highs and lows stops for a number of days, interrupting the normal sequence of summer (or winter) weather.

Local effects

While the synoptic charts give an indication of the strength and direction of winds driven by the circulation of the atmosphere, localised effects can produce quite different winds. This is particularly true along the NSW coast, where sea breezes during the day and local offshore winds at night are common. Sea breezes are more common in summer than winter because of the stronger heating of the land.

Hills and valleys can cause local variations to the general direction and speed of winds, although usually the type of variations will be the same if the high or low is at the same position and strength.

While the sun powers all weather, and the earth's position in its rotation around the sun provides the seasons, the general circulation is modified by a number of influences, including Coriolis forces from the earth's rotation, and local topography, to provide the weather we each receive.

References

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Replaces Agnote ET-1

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