

Communicating Climate Change

Module 1

August 2008

An initiative of the National Agriculture and Climate Change Action Plan

Weather drivers in Western Australia

Key facts

Major weather drivers in Western Australia are:

- frontal systems
- cut-off lows
- west coast trough
- blocking highs
- Southern Annular Mode
- Indian Ocean Dipole
- cloudbands
- tropical systems

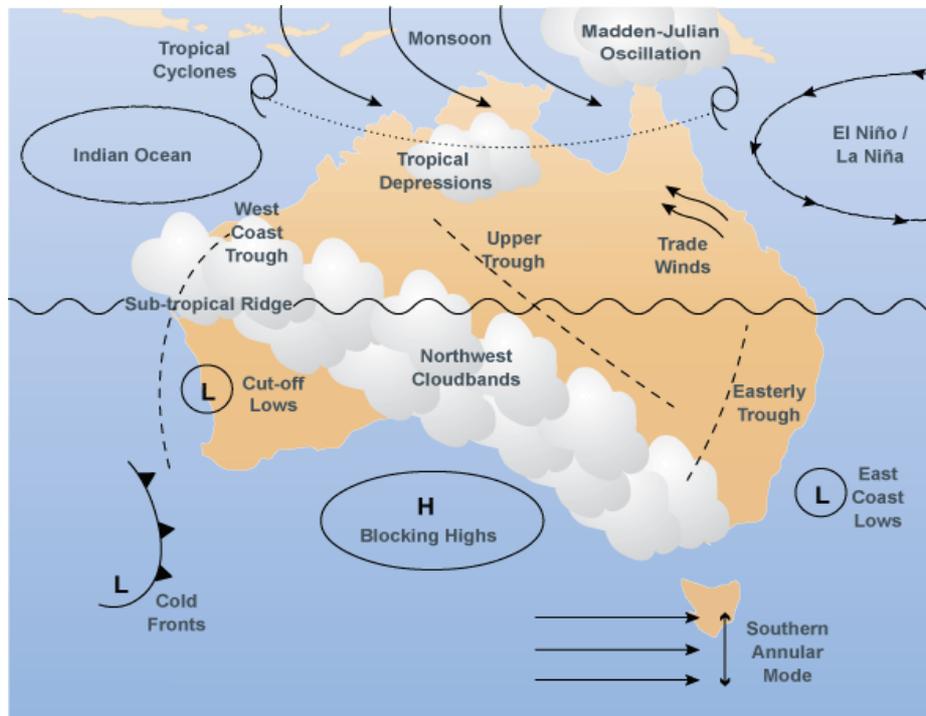


Figure 1: The major weather and climate drivers across Australia

A cooperative venture between



Australian Government
Department of Agriculture,
Fisheries and Forestry
Bureau of Meteorology



Introduction

The driving force behind our weather is the general circulation of the atmosphere, caused by unequal heating of the Earth's surface. Energy from the sun causes uneven heating of land and sea surfaces near the equator and evaporation from tropical oceans.

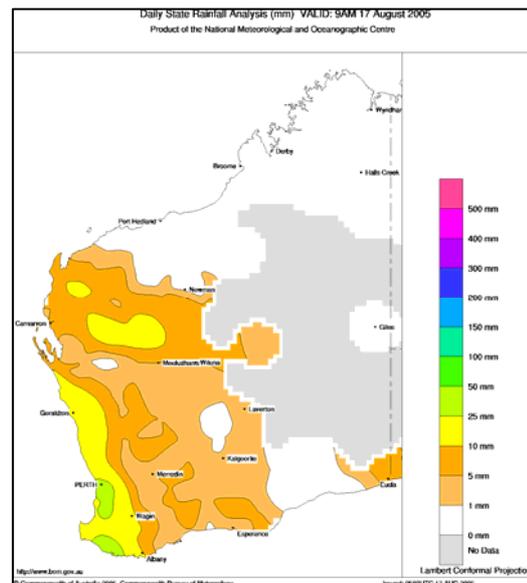
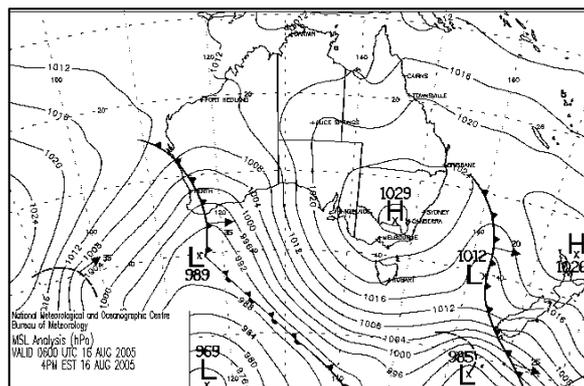
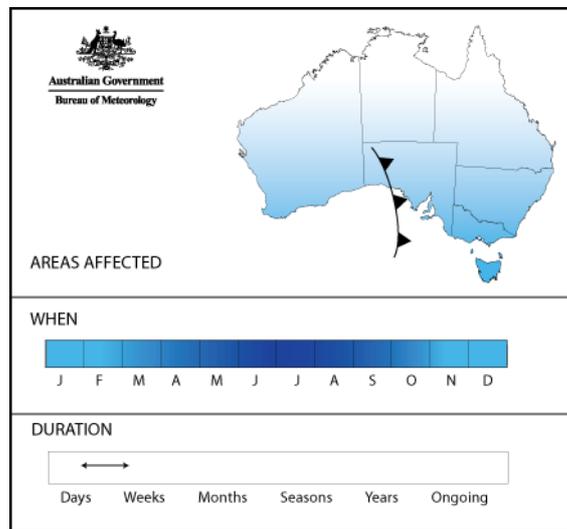
An extensive area of high pressure, known as the **sub-tropical ridge**, is a major feature of the general circulation of our atmosphere. This belt of high pressure encircles the globe at the middle latitudes. The position of the ridge varies with the seasons, allowing cold fronts to pass over southern Western Australia in the winter, but pushing them to the south in summer. Conditions along the ridge tend to be stable and dry because of descending air in the high-pressure systems.

Australia's climate varies across many different regions and timescales. Here we introduce the major elements that affect the weather and climate of Western Australia, and in particular south-west Western Australia.

Frontal systems

Frontal systems such as cold fronts, generally move from west to east across the Southern Ocean and vary in their intensity and speed.

More **intense systems are generally associated with heavier rainfall**. If frontal systems are slow-moving, rainfall may occur for extended periods and heavy falls are possible.

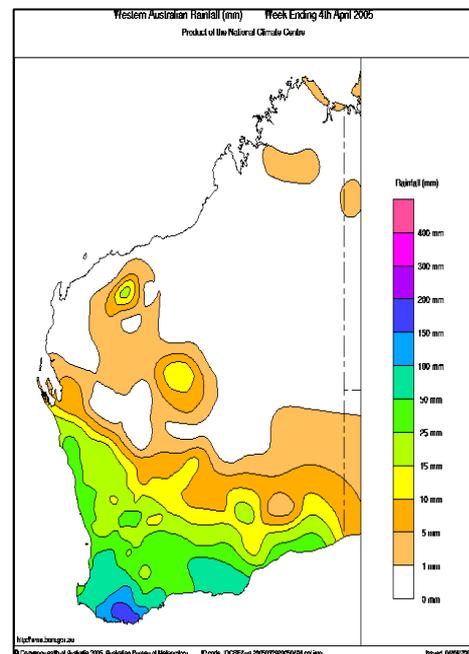
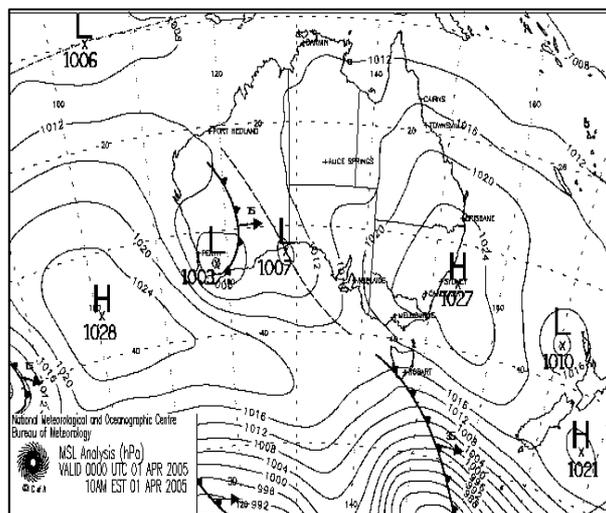
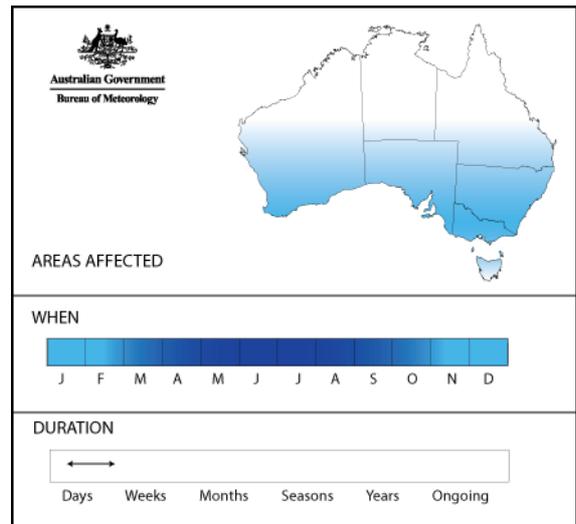


Figures 2 and 3: Front crossing the Western Australia coast (left) and resulting rainfall (right)

Cut-off lows

Cut-off lows are low-pressure systems that form away from the main belt of low pressure that lies across the Southern Ocean.

They are associated with **sustained, often heavy, rainfall**, and can produce **strong, gusty winds and high seas**.

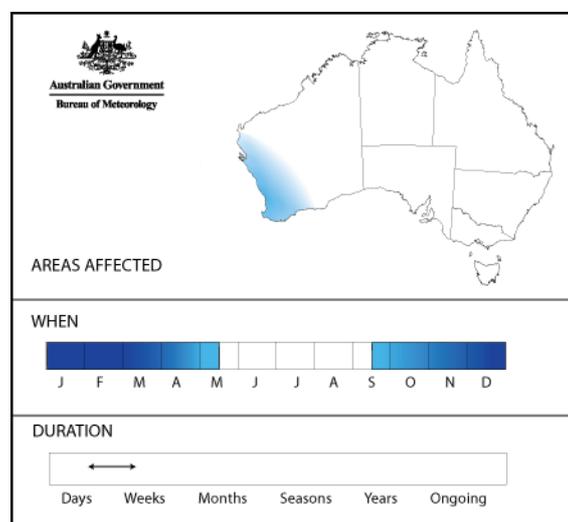


Figures 4 and 5: A cut-off low over south-west Western Australia (left) and resulting rainfall (right)

West coast trough

The **west coast trough** is a semi-permanent feature of the synoptic pressure pattern near the west coast of Australia **during the warmer months**. It is the **dominant influence on west coast weather** at that time of the year.

Depending on the location of the trough, areas to the east of it can experience hot days, with temperatures above 40°C, and the possibility of thunderstorms, given sufficient atmospheric moisture. To the west of the trough, milder conditions with sea breezes generally prevail.

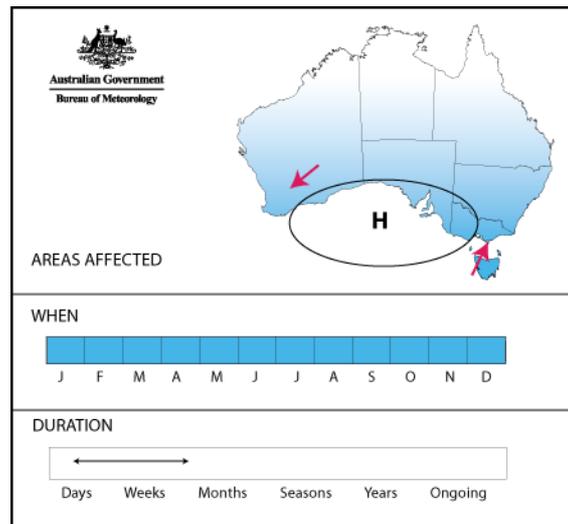


Blocking highs

Blocking highs are strong high-pressure systems that form further south than usual, and remain near-stationary for an extended period of time. They block the west-to-east progression of weather systems across southern Australia, and are usually formed in the Great Australian Bight or Tasman Sea.

Blocking highs have a wide range of impacts depending on their location and strength. They can produce a hot spell, a cold spell, dry conditions or wet conditions depending on their location and the systems around them.

Blocking highs in the Great Australian Bight are responsible for extended dry weather in south-west Western Australia, and heat waves in summer.



Southern Annular Mode

The Southern Annular Mode (SAM) can affect rainfall in southern Australia.

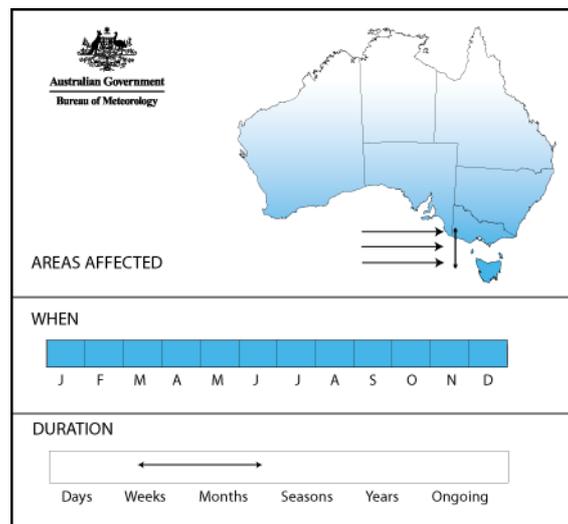
It describes a north-south movement in the belt of strong westerly winds across the south of the continent. This region of strong westerly winds is associated with cold fronts and storm activity, and heavily influences weather in southern Australia.

The mode can be positive or negative.

During a **positive SAM** event, the belt of strong westerly winds contracts towards the South Pole. This results in weaker-than-normal westerly winds, higher pressure and fewer storm systems over southern Australia. **Autumn and winter rainfall may be reduced** in south-west Western Australia.

In spring months, a positive SAM event can be associated with increased rainfall over parts of Western Australia.

A SAM event can be identified by observing the pattern in westerly wind flow and pressure to the south of Australia, which is measured by the Antarctic Oscillation Index as produced by the US National Weather Service.



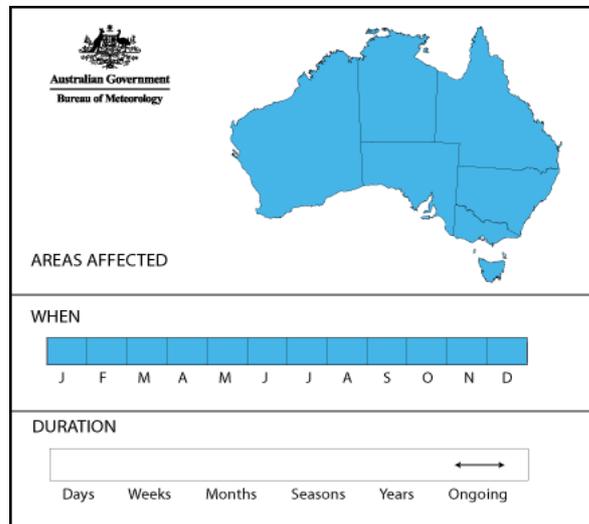
Indian Ocean Dipole

Sea surface temperatures in the Indian Ocean have a profound impact on the rainfall patterns over much of Australia.

The Indian Ocean Dipole is a measure of changes in sea surface temperature patterns in the northern Indian Ocean. It is derived from the difference in sea temperature between the western Indian Ocean near Africa, and the eastern Indian Ocean near northern Australia. These changes in sea surface temperature contribute to the formation of cloudbands.

A **positive Indian Ocean Dipole** is seen when waters are warmer than normal near Africa, and cooler than normal near Australia. Cloud near Australia reduces, with less resultant rainfall.

A **negative Indian Ocean Dipole** is seen when waters are cooler than normal near Africa, and warmer than normal near Australia. Warmer waters near Australia, particularly near Indonesia, enhance cloud formation and **increase rainfall**.



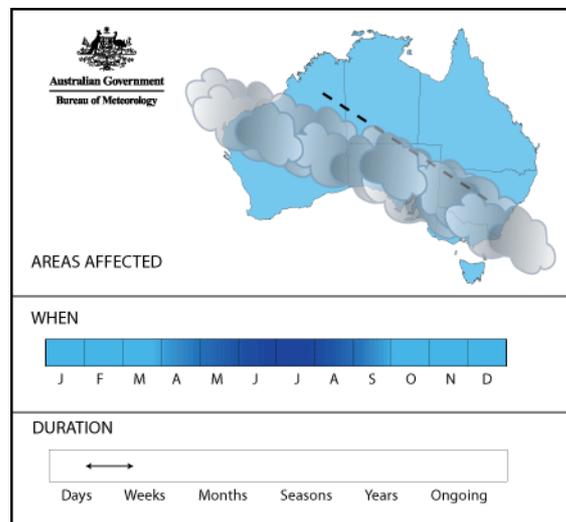
The Indian Ocean Dipole effect was proposed in the late 1990s and is the subject of further research. As modelling of the ocean and atmosphere improves, the ability to forecast these patterns of sea surface temperature is also improving, so that forecasts several seasons ahead may be useful in the near future.

Cloudbands

A cloudband is an extensive layer of cloud that can stretch across Australia, often from north-west to south-east.

Cloudbands can form when a trough of low pressure occurs in the upper levels of the atmosphere, or when warm, moist tropical air originating over the Indian Ocean moves towards the pole (generally south-eastward), and is forced to rise over colder air in southern Australia.

Cloudbands **can bring good rainfall**.



Tropical systems

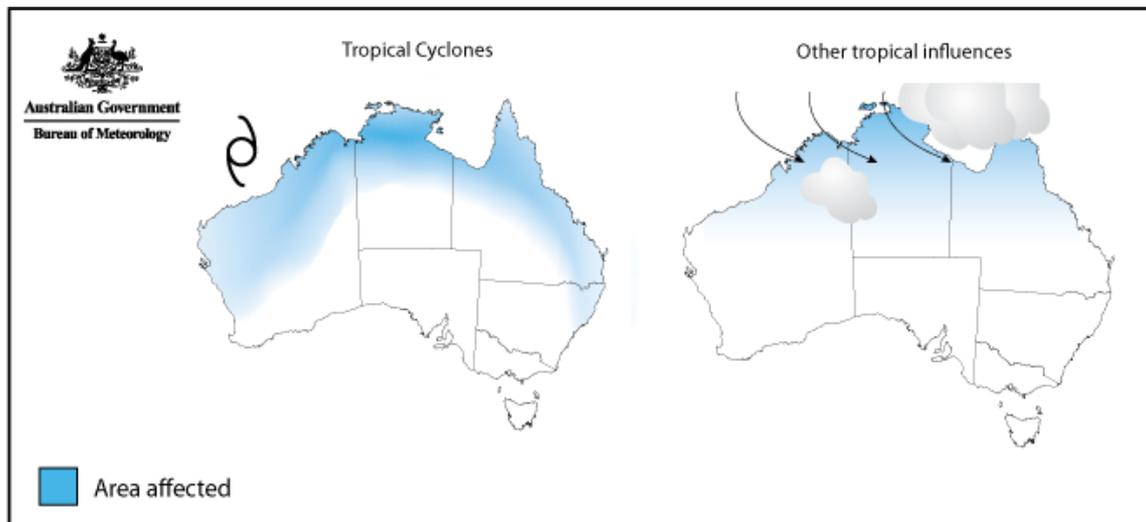
The southern hemisphere's wet season is experienced between November and April. During this period, tropical systems affect mainly northern and central parts of Western Australia but can occasionally also affect south-west Western Australia.

Tropical systems include:

- tropical cyclones
- tropical depressions
- the monsoon
- the Madden-Julian Oscillation

Tropical cyclones are very intense low-pressure systems that produce heavy rainfall, destructive winds and damaging storm surges.

Tropical depressions are moderate strength low-pressure systems, often associated with the monsoon trough. They may develop into tropical cyclones if they are in a favourable location. They often produce significant rainfall.



Further Information

The Bureau of Meteorology – weather drivers:

<http://www.bom.gov.au/watl/about-weather-and-climate/australian-climate-influences.html>

US National Weather Service – Antarctic Oscillation Index (SAM):

http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/aao/aao.shtml