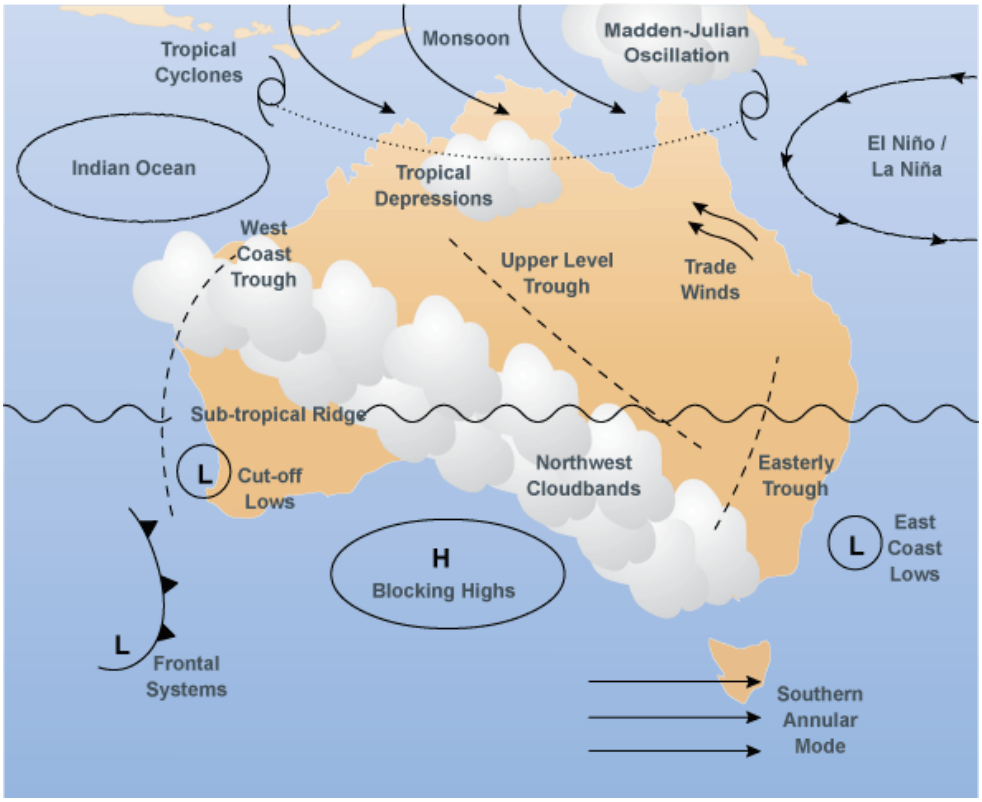
Communicating Climate Change
Module 1
An initiative of the National Agriculture and Climate Change Action Plan
August 2008

Weather drivers in South Australia

Key facts

Major weather drivers in South Australia are:

- El Niño - Southern Oscillation
- frontal systems
- cut-off lows
- blocking highs
- Indian Ocean Dipole
- cloudbands
- Southern Annular Mode



A cooperative venture between

MANAGING CLIMATE VARIABILITY R&D PROGRAM
mla MEAT & LIVESTOCK AUSTRALIA
BCG shared solutions
Australian Government
Department of Agriculture, Fisheries and Forestry
Bureau of Meteorology

Introduction

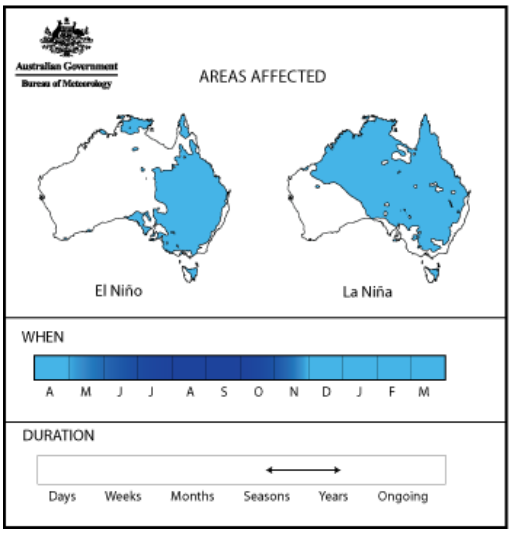
The driving force behind our weather is the general circulation of the atmosphere, caused by unequal heating of the Earth's surface. Energy from the sun causes uneven heating of land and sea surfaces near the equator and evaporation from tropical oceans.

An extensive area of high pressure, known as the **sub-tropical ridge**, is a major feature of the general circulation of our atmosphere. It is a major influence on the climate of southern Australia. The position of the ridge varies with the seasons, allowing cold fronts to pass over South Australia in the winter, but pushing them to the south in summer.

Australia's climate varies across many different regions and timescales. Here we introduce the major elements that affect the weather and climate of South Australia.

El Niño - Southern Oscillation

Sea surface temperatures in the Pacific Ocean can affect rainfall right across Australia, but link most directly to rainfall in the eastern half of Australia.

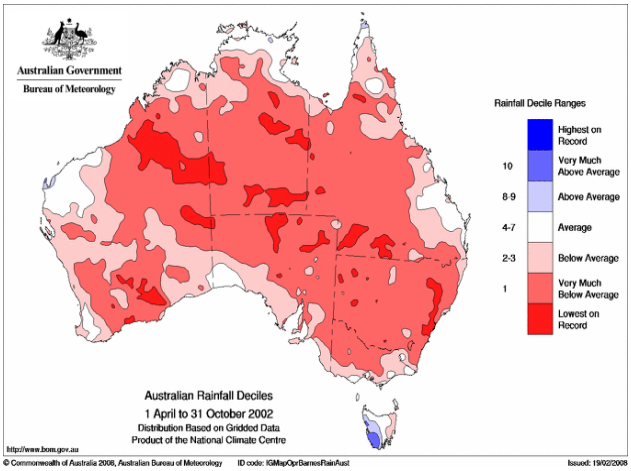


The **El Niño - Southern Oscillation (ENSO)** is a major influence on Australia's climate, though its effect is less marked over much of South Australia than for areas further east. ENSO is the oscillation between El Niño and La Niña conditions, interspersed with neutral periods. These events are triggered by variations in sea surface temperature in the central and eastern tropical Pacific Ocean.

El Niño is associated with extensive warming of sea surface temperatures in the central and eastern tropical Pacific, and, usually, cooling around northern Australia. These changes are normally associated with lower than average winter/spring rainfall over much of eastern Australia. Air temperatures are normally warmer during El Niño events.

La Niña is associated with extensive cooling of sea surface temperatures in the central and eastern tropical Pacific. We usually see a warming of the waters to the north of Australia and higher than average winter/spring rainfall over much of eastern Australia. Temperatures are normally cooler in La Niña events, though there are some indications that when hot spells do occur they can last longer in South Australia.

Not all El Niño and La Niña years are the same. The start and finish times for ENSO events can vary, as can the exact patterns of sea surface temperatures around Australia. This results in varying rainfall for South Australia, especially when combined with the influence of other climate and weather drivers.



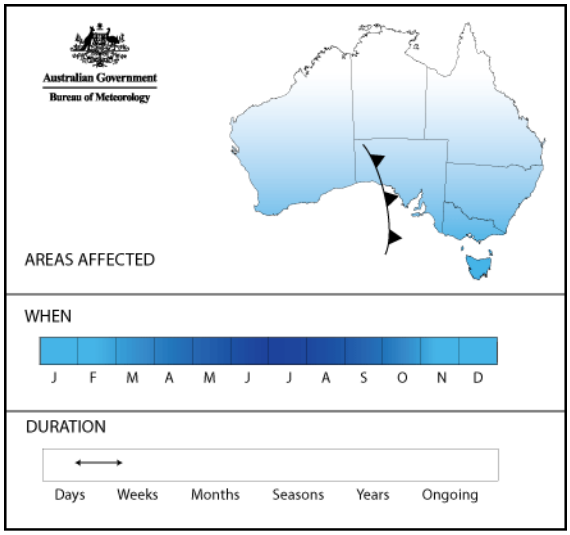
In **2002**, we saw a strong El Niño influence on rainfall across Australia, resulting in record low rainfall across much of South Australia's pastoral areas. This may have been moderated to some extent in South Australia's agricultural area by a strongly negative Southern Annular Mode—the likely cause of the high rainfall in western Tasmania.

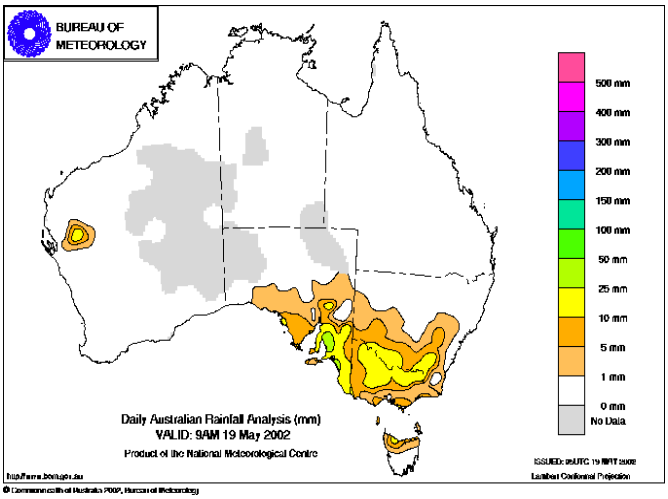
Frontal systems

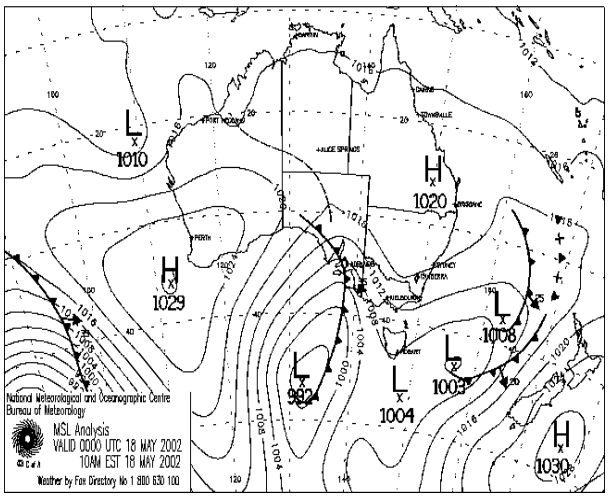
Frontal systems, such as cold fronts, generally move from west to east across the Southern Ocean and vary in their intensity and speed. More **intense systems are generally associated with heavier rainfall**. If frontal systems are slower moving, rainfall may occur for extended periods and may be heavy at times.

The intensity and track of cold fronts is affected by broader scale influences. A period with a stronger sub-tropical ridge or positive Southern Annular Mode can cause frontal systems to track further south and have less effect.

A vigorous cold front moved across southern South Australia on 18 May 2002. It caused severe wind squalls and heavy rain. Tornadoes were reported in Adelaide.





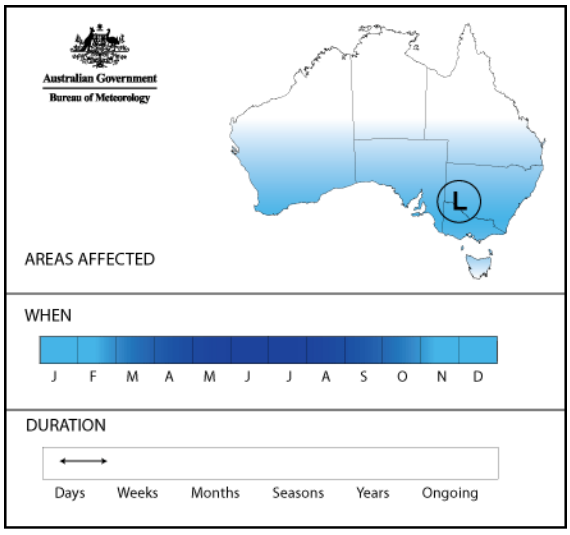


Cut-off lows

Cut-off lows are low-pressure systems that break away from the main belt of low pressure that lies across the Southern Ocean. They are associated with **sustained rainfall** and can produce **strong, gusty winds and high seas**. Each event may last several days, but the heavy rainfall can make or break a season.

Storm surge events along the South Australian coastline are typically associated with prolonged strong west-to-southwest winds associated with cut-off lows, as occurred in late October 2007.

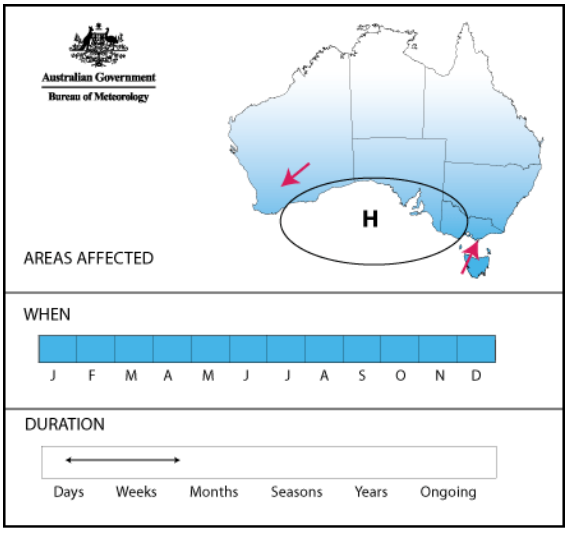
Recent research for western Victoria indicates that **cut-off lows produce, on average, 50 per cent of growing-season rainfall**. Since the early 1990s the number of cut-off lows has declined. These results also apply to South Australia.



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.

A blocking high's impact on the weather varies depending on its location and the systems around it. A blocking high can produce **hot and dry conditions** for South Australia, such as the heatwave of March 2008. Blocking highs can also contribute to **fog and frost** occurrence, due to the lighter winds around the high-pressure system.



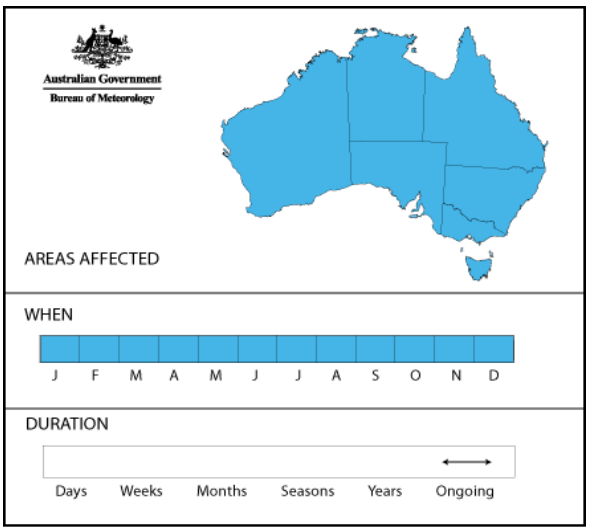
Indian Ocean Dipole

The Indian Ocean Dipole is the 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.

A **positive Indian Ocean Dipole** is seen when waters are warmer than normal near Africa, and cooler than normal near Australia. This is usually observed during El Niño events, and **usually results in less rainfall** over South Australia.

The opposite is broadly true—a **negative Indian Ocean Dipole** is associated with warmer waters off north-west Australia, and **usually results in increased rainfall** over South Australia.



These patterns vary over periods of weeks to months. The dipole can be considered as the tropical Indian Ocean equivalent of the El Niño - Southern Oscillation effect in the Pacific Ocean.

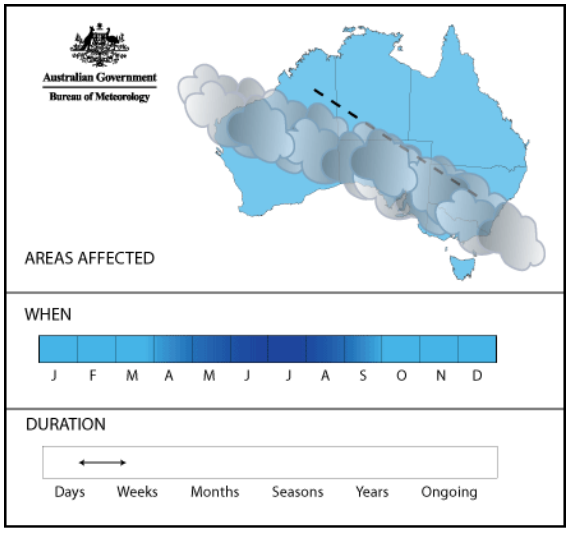
The Indian Ocean Dipole effect was proposed in the late 1990s, and is the subject of further research. As modelling of the ocean and atmosphere improves, the ability to forecast these patterns of sea surface temperature is also improving, so that forecasts several seasons ahead may be useful in the near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

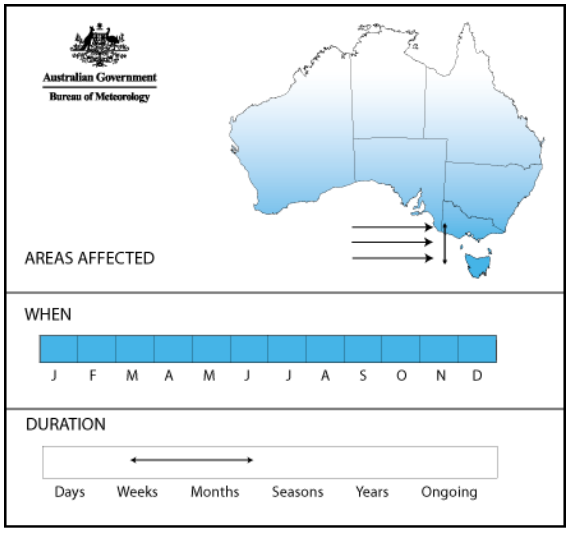


Southern Annular Mode

The Southern Annular Mode (SAM) can affect rainfall in southern Australia. The effect is strongest along the coastal fringe of south-eastern parts of South Australia.

The SAM describes a north-south movement in the belt of strong westerly winds across the south of the continent that varies over periods of weeks or months. 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 causes weaker-than-normal westerly winds and higher pressure over southern Australia.
Winter rainfall may be reduced.



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

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