Westerly influence determines southern rainfall?

Photo: Kondinin Group

Lindsay Smail
FOR KONDININ GROUP

Traditional weather forecasters and farmers have looked to the El Nino Southern Oscillation as the main driver behind rainfall and drought. However a shift in thinking has revealed that Australian farmers are perhaps more at mercy of the Indian Ocean Dipole than any other weather pattern.

From the west: *A south-easterly moving cloud band generated by the Indian Ocean can often produce rain in the cropping and grazing areas of southern Australia.*

At a glance

- El Nino Southern Oscillation (ENSO) in the eastern states, the Madden-Julian Oscillation (MJO) — mainly in northern areas, the Antarctic Oscillation (AAO) in the south and the Indian Ocean Dipole (IOD) across the centre and south-east all influence Australia's weather and climate.
- Some weather forecasters claim Australia relies too heavily on the influence of ENSO effect, purported to bring drought to eastern Australia in an El Nino and rainfall during an La Nina.
- During recent years the effect of the IOD on rainfall in southern Australia has been more closely examined and researchers now claim it has more impact on rainfall in southern Australia than the ENSO.

The known major suspects and culprits that bring about changes to Australia's weather and climate conditions include the El Nino Southern Oscillation (ENSO) in the eastern states, the Madden-Julian Oscillation (MJO) — mainly in northern areas, the Antarctic Oscillation (AAO) in the south and the Indian Ocean Dipole (IOD) across the centre and south-east.

For more 20 years it was suspected that the temperature fluctuations of the Indian Ocean to Australia's west were responsible for the development of the well-known north-west cloud bands.

These bands spread across the continent mainly during the cooler months and result in growing season rains.

Especially since the advent of satellite images, with which the cloud bands could actually be seen forming, developing and moving south-eastwards over Western Australia, South Australia, Victoria and New South Wales, climate researchers have been working on ways to link the strength of the Indian Ocean effect to seasonal rainfall.

A private long-range forecaster, Ian Holton of Adelaide, had suspected the link for a long time and several years ago incorporated statistical data from the Indian Ocean into his highly successful models for predicting rainfall across the south-eastern states. Ian saw the existing predictive models used by the Bureau of Meteorology (the Bureau) relied too heavily on the then recently discovered ENSO effect, purported to bring drought to eastern Australia in an El Nino and rainfall during an La Nina.

The problem was that droughts in most of SA and Victoria were only sometimes associated with El Nino, and La Nina only sometimes brought floods. For example there is only a 60 per cent correlation between El Nino and drought in southern Victoria. Many El Nino years had average rainfalls. And so forecasters believed there had to be other factors involved in rainfall variations across the south-eastern states.

One of these other factors is the Antarctic Oscillation, which will be described in an upcoming edition of *Farming Ahead*, and the other is what has become known as the Indian Ocean Dipole (IOD).

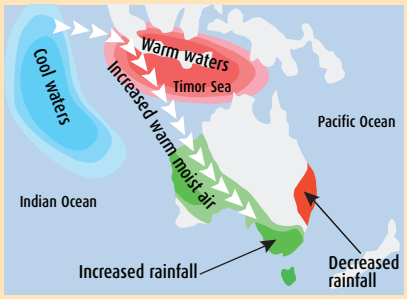
The Indian Ocean Dipole

Ian's web site explains the nature of the IOD:

"The IOD encompasses some of the warmest ocean areas in the world, which evaporate large quantities of water into the surrounding lower and middle atmosphere. This water vapour is a major source of potential heat energy ready to fuel the southern Australian weather systems.

"The large area of warm and moist air forms during the summer months. As

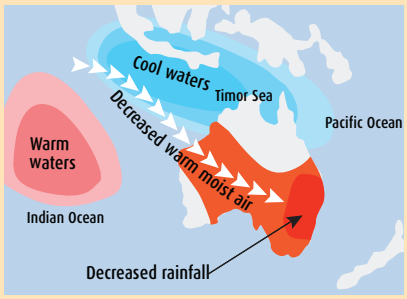
FIGURE 1 Negative phase



Cool Indian Ocean water drives moist warm air and brings average rainfall

Source: UNSW Faculty of Science

FIGURE 2 Positive phase



Warm Indian Ocean water leads to weaker, drier winds and less rainfall

Source: UNSW Faculty of Science

autumn approaches, (the) westerly wind-belt moves north-ward and starts to react with the (Indian Ocean) moisture to the west of the Australian continent.

"If a seasonal long wave trough is just to the west of WA, the north-westerly wind ahead of the trough will feed this moisture south-eastwards, ahead of short-wave frontal features. This south-eastward moving cloud band (called a north-west cloud band) will rise ahead of the front. The cloud band will then thicken and often produce good rains in the cropping and grazing areas of southern Australia."

Ian goes on to explain that the generation of these cloud bands is dependent on sea-surface temperatures and gradients, and to prepare forecasting models he uses measurements over the Indian Ocean and northern and western Australia as input variables.

His pioneering research has only recently been verified and extended by other climatologists.

Furthering IOD research

A team of Australian scientists has detailed for the first time how the IOD — a variable and irregular cycle of warming and cooling of ocean water, and made visible by north-west cloud bands — determines whether moisture-bearing winds are carried across southern Australia.

The new study explains the recent long drought in south-eastern Australia and further shows why a series of La Nina events in the Pacific Ocean — which usually bring rain — had failed to break it.

Dr Caroline Ummenhofer and Professor Matthew England of the University of NSW Climate Change Research Centre, who led the study, also revealed that the IOD was the cause of other extreme droughts in Australia's history, notably the World War II Drought of 1937–1945 and the Federation Drought of 1895–1902.

They explained the influence of the IOD on southern Australia:

"When the IOD is in its negative phase, a pattern occurs with cool Indian Ocean water west of Australia and warm Timor Sea water to the north.

This generates winds that pick up moisture from the ocean and then sweep down towards southern Australia to deliver wet conditions.

In its positive phase, the pattern of ocean temperatures is reversed, weakening the winds and reducing the amount of moisture picked up and transported across Australia. So the south-east misses out on its usual quota of rain."

The study notes that the IOD has mostly been in its positive or neutral phase since 1992 (see Figures 1 and 2), the longest period of its kind since records began during the late 19th Century.

Dr Ummenhofer explained:

> "An IOD event usually starts about May or June, peaks between August and October and then rapidly decays."

"The ramifications of drought for this region are dire, with acute water shortages for rural and metropolitan areas, record agricultural losses, the drying-out of two of Australia's major river systems and far-reaching ecosystem damage".

Their study confirmed that the state of the Indian Ocean is highly important for rainfall and, subsequently droughts in south-east Australia. More important than the variability associated with the El Nino/La Nina cycle in the Pacific Ocean, the Indian Ocean Dipole is the key factor for driving major south-east Australian droughts during the past 120 years (See Figure 3).

Better times ahead

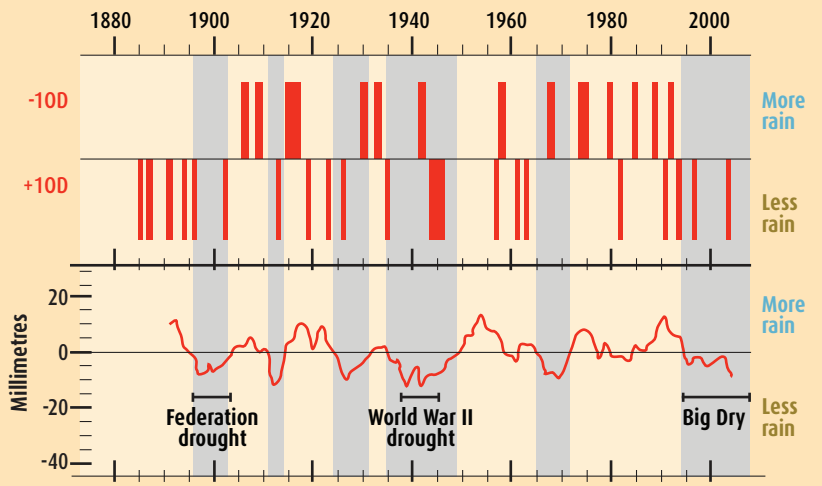
But on the bright side Ian believes that more strongly negative IOD figures leading to increased rainfall may be just around the corner. His research shows the strong likelihood of a return to a wetter growing season rainfall cycle for Australia's south-east in the next few years.

He qualifies this conclusion by stating:

"These forecasts do not mean that every year will be wet in a wetter forecast cycle, or that every year will be drier in a dry forecast cycle — just that the majority of years in a wetter cycle will have average to above average growing season rainfall in SA, VIC and NSW.

Each individual year will be moderated by the Dipole-Nino and other ocean effects for that particular year." FA

FIGURE 3 The phases of Indian Ocean Dipole from 1880–2000



*Average rain declines in positive phase. Grey bars indicate drought. Bottom graph shows rainfall anomalies

Source: UNSW Faculty of Science

ABOUT THE AUTHOR ▶ Lindsay Smail is the director of Geelong Weather Services, a private operational meteorology and consultancy business.

CONTACT ▶ Lindsay Smail
(03) 5241 5332
info@geelongweatherservices.com
www.geelongweatherservices.com