WHAT MAKES IT RAIN?

Understanding the teleconnections between atmospheric systems over the Pacific, Indian and Southern oceans and local weather systems will improve long-term forecasting

By Peter McIntosh

WEATHER SYSTEMS ARE complex beasts influenced by a combination of relatively local and distant factors. A new project under the Managing Climate Variability program is trying to establish the relationships between these factors and rainfall in different parts of Australia.

Individual rainfall events are generally associated with the local effects of particular synoptic weather systems. However, drivers such as the mostly tropical El Niño–Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) and the high-latitude Southern Annular Mode (SAM) alter the seasonal behaviour of these individual weather events, causing wetter or drier seasons.

Previous research identified that rainfall in south-east Australia is related to local mid-latitude weather systems. Therefore, the long-distance teleconnections between these mid-latitude weather systems and the remote drivers is of prime importance.

In south-east Australia, a synoptic weather system known as a cut-off low has been identified as important in providing about half the total rainfall to this region, and nearly all of the effective high-rainfall events.

A cut-off low is an isolated low-pressure system that has broken away from the low-pressure belt to its south and extends vertically through much of the atmosphere.

Climate models are capable of simulating cut-off lows, but so far they account for a much smaller proportion of the modelled rainfall than is observed.

This appears to be related to the inability of models to represent atmospheric blocking accurately. Atmospheric blocking has been observed to be an important factor in the development of cut-off lows and their subsequent slow eastwards movement.

The relatively slow movement of these cut-off systems appears to explain, at least in part, how these can produce substantial rain in south-east Australia.

What is unknown is how ENSO and the other remote drivers influence atmospheric pressure patterns, including cut-off lows and blocking. It may be through changes in the large-scale wind patterns connecting the tropics with mid-latitudes, or it may be through changes to the moisture inflow, which is an important factor in the production of rainfall.

There is also some evidence to suggest that atmospheric blocking in the Australian region may be linked to blocking in other regions of the hemisphere such as the South American region where ENSO is a known influence.

This new project aims to diagnose and explain the dynamic and physical processes that underlie how the tropical (ENSO and IOD) and high-altitude (SAM) drivers alter the behaviour of mid-latitude rain-bearing weather systems. This information will then validate and improve computer climate models used for medium and long-term forecasting.

For more information on this project visit the Managing Climate Variability website (www.managingclimate.gov.au) and subscribe to the publication *CliMag*. Recent issues include a series of articles looking at the factors that drive the weather in each state. In a new project, Clare Mullen, of the Bureau of Meteorology, is collating more of this type of information for various states and adding it to the Climate Kelpie website (www.climatekelpie.com.au). □

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The **El Niño–Southern Oscillation** (ENSO) is a coupled ocean (El Niño) and atmosphere (Southern Oscillation) interaction in the equatorial Pacific Ocean that changes ocean temperatures, wind patterns and rainfall in the Pacific and neighbouring continents. The **Indian Ocean Dipole** (IOD) is a similar phenomenon to ENSO in the Indian Ocean; it is sometimes triggered by ENSO and sometimes acts alone. The **Southern Annular Mode** (SAM) is a pressure variation over Antarctica and the Southern Ocean that changes the intensity and location of the westerly wind belt and embedded fronts over southern Australia.