Walker Institute
for Climate System Research

Rainfall variability in Queensland

Walker Institute research

The importance of rainfall for the economy of Queensland

Australia's economy is very vulnerable to rainfall variability and Queensland's history is filled with floods and droughts that have impacted greatly on individuals and communities as well as costing millions of dollars. For example, the floods in North Queensland in 2009 caused widespread damage and isolated communities for many weeks. During the previous decade, the state has seen long periods of rainfall deficiency and severe drought.

The research collaboration between the Queensland Government and the Walker Institute to analyse past and future extremes is critically important given Queensland's vulnerability to these events. Dr Nicholas Klingaman, the Queensland Research Fellow at the Walker Institute, has already started to investigate what drives rainfall in Queensland and to interrogate the climate models to find out how rainfall variability might change in the future.

Understanding the interactions between the key drivers of rainfall variability in Queensland is crucial, especially as the frequency, location and intensity of some of these drivers is projected to change due to our warming climate.

Observed changes in Queensland rainfall

Seasonal rainfall over Queensland varies considerably from year to year, but there are no clear trends in rainfall over the 20th century. Summers have become a little wetter over the 20th century, mostly due to an increase in the mean rainfall around 1950, while the mean rainfall in winter has not substantially changed.

However, looking only at mean rainfall neglects any changes in extreme events that have occurred and that could potentially have damaging consequences for Queensland. So, it is important to study both, changes in the mean rainfall and changes in variability. A better understanding of these interactions will inform Queensland's response to climate change, particularly in relation to planning policies for future flood or drought risk.

Australian rainfall is heavily influenced by phenomena that extend far beyond the continent (El Niño warming events in the Pacific, for example) and these phenomena vary over a range of timescales from daily to decadal. In our work we will be looking at how these large-scale processes affect the frequency and timing of the regional weather systems that bring rain to Queensland.

Queensland Government

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

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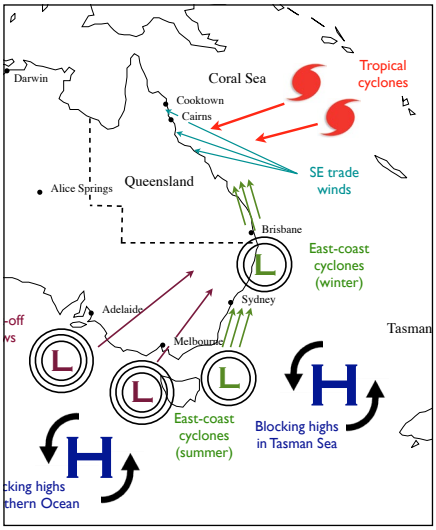

Regional drivers of rainfall variability in Queensland

On a regional scale, rainfall over Queensland is affected by:

- Trade winds
- Atmospheric high pressure (blocking systems) and the cut-off lows that form as a result
- Extra-tropical and tropical cyclones.

For example, east-coast cyclones – formed in regions of strong SST gradient – have become more frequent in recent years, but the physical mechanism for this is unclear. La Niña (El Niño) years are associated with more (fewer) tropical cyclones, while the transition from La Niña to El Niño leads to more east-coast lows.

Climate change will alter the natural variability of Australian rainfall, not only by altering the mean rainfall, but also by affecting the regional climate processes responsible for that variability. For example, Pacific Ocean warming may create a more El Niño-like basic state with consequences for rainfall over Australia and other regions around the world.

Large-scale drivers of rainfall variability in Queensland

Rainfall variability in Queensland is influenced by these large-scale climatic phenomena:

- Madden-Julian-Oscillation (MJO) – intra-seasonal scales
- El Niño Southern Oscillation (ENSO) – inter-annual scales
- Inter-decadal Pacific Oscillation (IPO) – decadal and multi-decadal scales.

These slowly evolving, large-scale climatic drivers are valuable, as they are predictable at longer lead times than the more stochastic local weather. These climatic drivers modulate the temporal and spacial distribution of extreme rainfall events. For example, active MJO phases in the West Pacific enhance tropical cyclones in the Coral Sea and also trade-wind rainfall in NE Queensland.

Improving predictions of rainfall over Queensland

The interactions between temporal scales of variability are key in determining the character of Queensland rainfall. Any predictable inter-annual or decadal signals with a known relationship to Queensland rainfall would lead to more accurate predictions of climate variability and change over the next one or two decades, a key period for climate change adaptation efforts.

Our future work will aim to answer key questions regarding the sources of rainfall variability in Queensland, the interactions between those sources and how their impacts on Queensland are likely to change in a warmer world.

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