Earth Systems and Climate Change Hub

National Environmental Science Programme

climate change **science brief**

What causes dry extremes across southern Australia?

From a season to several decades, dry conditions can have major impacts on water resources, ecosystems and agriculture across Australia. But what causes these extreme dry periods and how likely are we to experience them again across Australia?

Examining how weather systems and large-scale circulations have changed can shed light on the reasons behind dry periods.

Earth Systems and Climate Change Hub researchers have investigated the causes of dry periods across southern Australia to determine how unusual these extreme dry periods are and how likely we are to see more of them in the future.

Winter rainfall decline across southern Australia

Significant downturns in rainfall were seen in south-west Australia in the late 1960s, and in south-east Australia during the Millennium Drought that started in the late 1990s.

To better understand long-term rainfall declines across southern Australia, Earth Systems and Climate Change (ESCC) Hub researchers looked at linkages between rainfall and circulation to help understand why it has been so dry.

Researchers delved into better understanding storm activity (a major source of rainfall) on a multi-decadal timescale to help explain some of the winter rainfall changes these regions of Australia have experienced.

TOP: iStock.com/tsvibrav
BELOW: iStock.com/lindsay_imagery

Changes in winter storms and rainfall

Using a new analysis method to describe the storms that bring rain, Hub researchers analysed historic records of the fastest growing storms and discovered that their frequency and intensity is related to rainfall variability.

Researchers found that over south-west Australia during the period 1975-1994, the frequency and/or intensity of the fastest growing storms declined compared to the period 1949-1968, with a decrease in rainfall of about 15%. More recently this decline in 'storminess' has persisted, resulting in rainfall reductions in the south-west as well as the south-east.

This provides a measurable connection between rainfall and storm development over decades, helping us understand how major storm regimes change. This new analysis method has allowed Hub researchers to better inform observational and projection studies on why Australian rainfall is changing in a warming world.

Circulation changes due to human-induced climate change

Major atmospheric circulation changes are projected for the Southern Hemisphere under a warmer climate, and many of these changes are already evident.

One key pattern of change is described by the Southern Annular Mode (SAM) shifting to its more positive phase. The SAM refers to the difference between low pressure circling Antarctica, and high pressure north of that. In the positive phase that high pressure pushes north over southern Australia, leading to dry conditions over Tasmania in spring, and dry conditions over south-west and south-east Australia in winter.

Understanding dry extremes and their causes

Climate change projections point to continued drying across southern Australia over coming decades. At the same time, demand for water is steadily increasing.

Understanding the changes in our weather systems and how much climate change influences our rainfall provides insights for water management and adaptation measures.

Season-long extreme dry periods can have major impacts. For example, the record dry spring of 2015 in Tasmania had major impacts on the state's agriculture productivity, water supply and hydroelectric power generation.

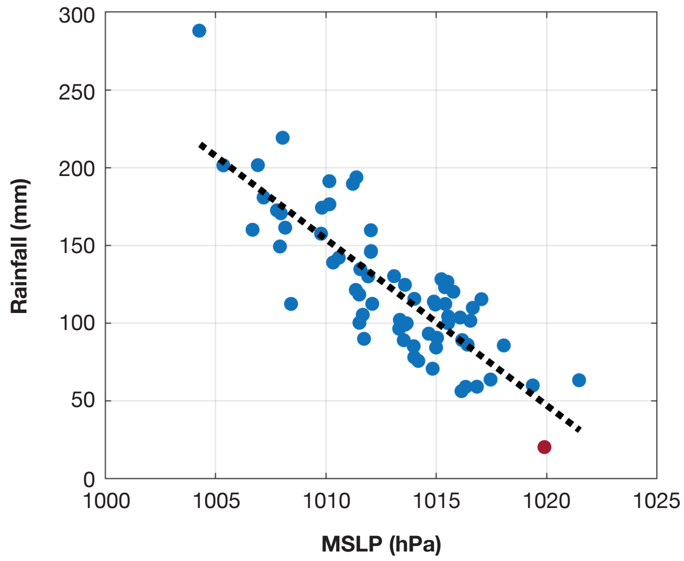

FIGURE 1 **Tasmania experienced an extreme dry in the Spring of 2015.** Tasmanian October average rainfall totals in all years during the 1948-2015 period (vertical axis) compared to the average October mean sea-level pressure (MSLP, horizontal axis). The red dot is October 2015, with the lowest rainfall on record, and the second highest pressure.

Did human-induced climate change play a role in the Tasmanian extreme dry spring of 2015?

There are now several different approaches to determining the contribution of human-induced climate change to an extreme event, including a new approach developed by Hub researchers (the Sub-seasonal Prediction Attribution approach).

Using more than one method can provide higher confidence in the results. Hub researchers applied three different methods to determine how human influence contributed to the dry 2015 spring in Tasmania, particularly over October.

Each of the methods compared climate model simulations of the present world with a 'counterfactual' world, that is, a world without any human influences on the atmosphere.

Results from each method showed model agreement that human-induced climate change did play a role in the very dry Tasmanian 2015 spring. All three methods indicated that human-caused warming since the pre-industrial era had increased the risk of such an extreme dry event occurring by 25%, 48% or 75%. Two of the approaches used also explored the weather patterns which occurred during this period and found that the shift towards the positive SAM is already evident, with higher pressure over Tasmania. These results indicate that human-induced climate change has shifted the odds towards drier conditions.

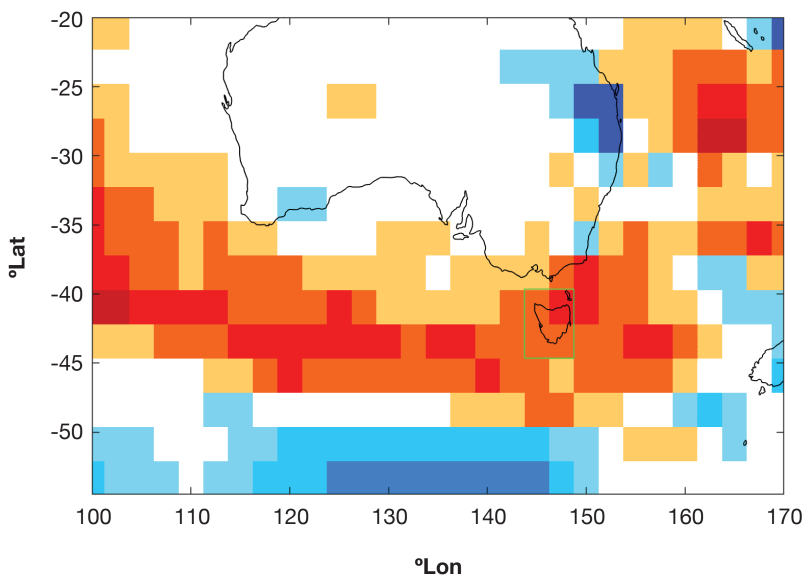

FIGURE 2 **Rainfall change due to enhanced greenhouse gas levels over the last 50 years.** Factual minus 'counterfactual' worlds for October 2015. Red shading means October 2015 was drier than it might otherwise have been.

This research was led by ESCC Hub
Project 5.2 Understanding climate variability and change – past, present and future

For more information: **Pandora Hope**
Email: **pandora.hope@bom.gov.au**

www.nespclimate.com.au

The Earth Systems and Climate Change Hub is funded by the Australian Government's National Environmental Science Program