# Articles

## Southern Hemisphere regional precipitation and climate variability: Extremes, trends, and prediction

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*(This article is a summary of Caroline Ummenhofer's PhD thesis, which was awarded the Uwe Radok Award for best thesis at the 2010 AMOS Conference – Ed.)*

This PhD thesis investigates the relative importance of oceanic and atmospheric influences on extremes, long-term trends, and seasonal to interannual variability of precipitation for different regions in the Southern Hemisphere (SH) using observations, reanalysis data, and output from general circulation models.

**Southwest Western Australia**

Examination of interannual rainfall extremes over southwest Western Australia (SWWA) reveals a characteristic dipole pattern of Indian Ocean sea surface temperature (SST) anomalies, with features of both the tropical and subtropical Indian Ocean dipoles (England et al. 2006). This coincides with a large-scale reorganisation of the wind field over the tropical/subtropical Indian Ocean and changing SST anomalies, via anomalous Ekman transport in the tropical Indian Ocean and anomalous air-sea heat fluxes in the subtropics (Figure 1). These changes modify the advection of moisture onto SWWA. The potential impact of these Indian Ocean SST anomalies in modulating mid-latitude precipitation across southern and western regions of Australia is assessed in atmospheric general circulation model (AGCM) simulations (Figure 2). The SST anomalies give rise to changes in the thermal properties of the overlying atmosphere, meridional thickness gradient, subtropical jet, thermal wind, moisture advection, and baroclinicity over southern regions of Australia, thus modulating precipitation (Ummenhofer et al. 2008).

**East Africa**

Links between extreme wet conditions over East Africa and Indian Ocean SST are investigated during the core of the so-called "short rain" season in October–November. During periods of enhanced East African rainfall, Indian Ocean SST anomalies reminiscent of a tropical Indian Ocean dipole (IOD) event are observed. Ensemble simulations with an AGCM are used to understand the relative effect of local and large-scale Indian Ocean SST anomalies (cf. Figure 2) on above-average East African precipitation. The importance of the various tropical and subtropical IOD SST poles, both individually and in combination, is quantified (Ummenhofer et al. 2009b). Enhanced East African "short rains" are predominantly driven by the local warm SST anomalies in the western equatorial Indian Ocean (Figure 3).

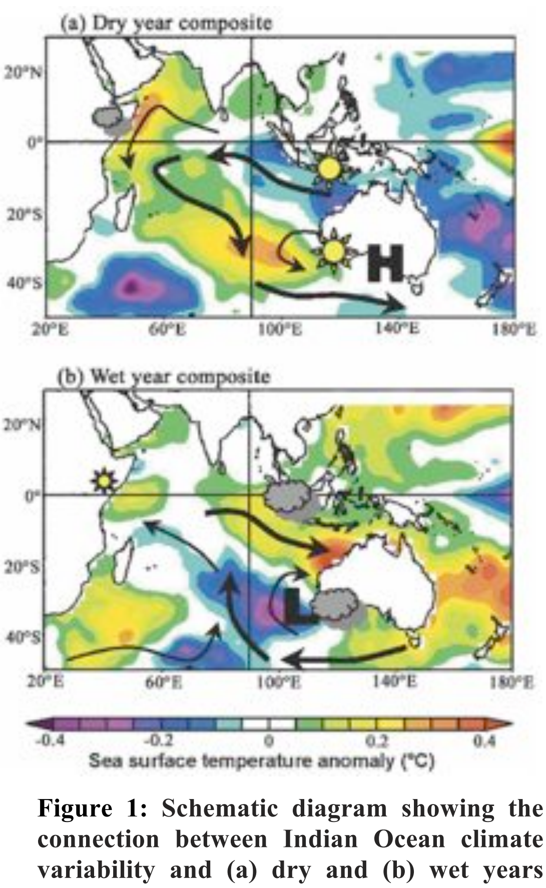


**Figure 1: Schematic diagram showing the connection between Indian Ocean climate variability and (a) dry and (b) wet years over SWWA. SST anomalies are shown colour shaded. Wind anomalies are shown schematically as bold arrows, pressure anomalies are indicated by H (high) and L (low), and rainfall anomalies are shown using sun/cloud symbols.**

The changed East African rainfall distribution can be explained by a reorganisation of the atmospheric circulation leading to increased onshore moisture advection induced by the SST anomalies, consistent with an anomalous strengthening of the Walker cell.

**New Zealand**

Interannual extremes in New Zealand rainfall and their modulation by modes of SH climate variability, namely the Southern Annular Mode (SAM) and El Niño-Southern Oscillation (ENSO), are investigated (Ummenhofer & England 2007). Late twentieth Century trends in New Zealand precipitation are examined for the period 1979-2006 to quantify the impact of long-term changes in the large-scale atmospheric circulation. Increasingly drier conditions over much of New Zealand are found to be tied to changes in the SAM and ENSO (Ummenhofer et al. 2009a).

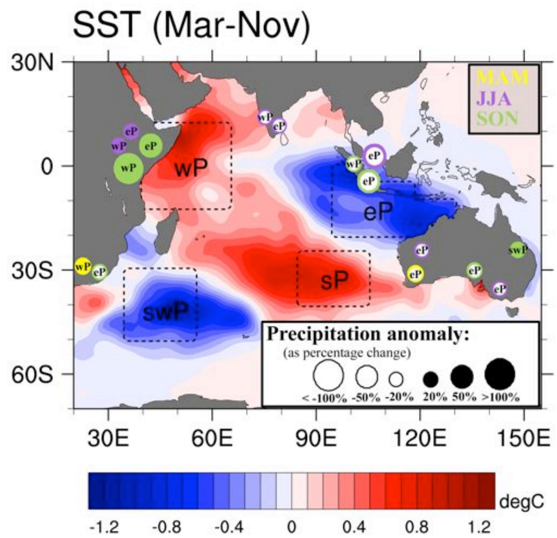


**Figure 2: Schematic of Indian Ocean SST anomalies on rainfall in Indian Ocean rim countries in AGCM simulations for different seasons. The SST anomalies (°C) are shown as average over the March-Nov. months. Specific regions ("poles") of SST anomalies are employed in the AGCM experiments, with the poles indicated by the dashed boxes. The anomalous rainfall associated with these regions of SST anomalies is shown by circles around the Indian Ocean rim countries. Filled (empty) circles denote an increase (decrease) in precipitation (as % change), with the size of the circle reflecting the magnitude of change and the colour the season.**

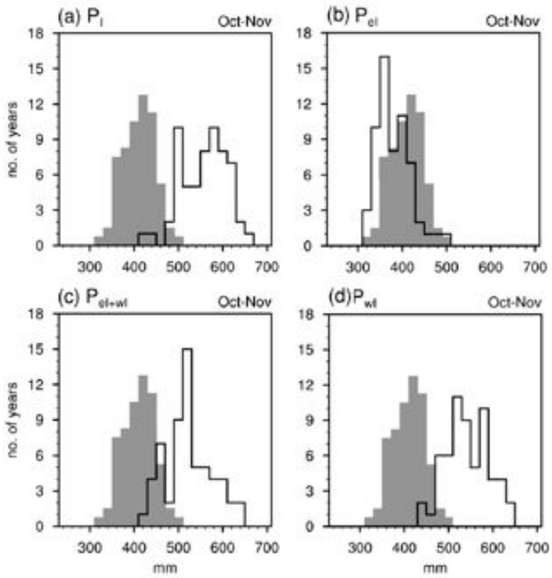


**Figure 3: Frequency distribution of precipitation across East Africa: rainfall amount (mm) summed for the months Oct.–Nov. for the "poles" experiments indicated in Figure 2. The shaded grey rainfall distribution represents the control, while the perturbed cases are indicated with black outlines.**

**Southeastern Australia**

Cool season rainfall variability in southeastern Australia is investigated via a classification and characterisation of the predominant types of synoptic systems occurring in the region, focusing on frontal and cutoff low systems (Risbey et al. 2009). Two definitions of the autumn break developed for northwestern Victoria are employed to produce a synoptic climatology of the break phenomenon. Trends in characteristics of the autumn break indicate that the most recent drought in southeastern Australia is comparable in severity with the two major droughts in the twentieth Century (Pook et al. 2009).

**References**

England, M.H., Ummenhofer, C.C. and Santoso, A. (2006). Interannual rainfall extremes over southwest Western Australia linked to Indian Ocean climate variability. *J. Clim.*, 19, 1948-1969.

Pook, M., Lisson, S., Risbey J., Ummenhofer, C.C., McIntosh, P. and Rebbeck, M. (2009). The autumn break for cropping in Southeast Australia: trends, synoptic influences and impacts on yields. *Int. J. Climatol.*, 29, 2012-2026.

Risbey, J.S., Pook, M.J., McIntosh, P.C., Ummenhofer, C.C. and Meyers, G. (2009). Characteristics and variability of synoptic features associated with cool season rainfall in southeastern Australia. *Int. J. Climatol.*, 29, 1595-1613.

Ummenhofer, C.C. and England M.H. (2007). Interannual extremes in New Zealand precipitation linked to modes of SH climate variability. *J. Clim.*, 20, 5418-5440.

Ummenhofer, C.C., Sen Gupta. A. and England, M.H. (2009a). Causes of late twentieth Century New Zealand precipitation trends. *J. Clim.*, 22, 3-19.

Ummenhofer, C.C., Sen Gupta, A., England M.H. and Reason C.J.C. (2009b). Contributions of Indian Ocean sea surface temperatures to enhanced East African rainfall. *J. Clim.*, 22, 993-1013.

Ummenhofer, C.C., Sen Gupta, A., Pook, M.J. and England M.H. (2008). Anomalous rainfall over southwest Western Australia forced by Indian Ocean sea surface temperatures. *J. Clim.*, 21, 5113-5.

# A retrospective of my years in the Bureau 1959-2009

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**Abstract**

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*"The past is a foreign country; they do things differently there."* – L.P. Hartley

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I shall cover the period from 1959 to 2009, from the perspective of where I was in the Bureau at the time. There won't be much detailed science, and I promise no equations or fancy graphics. I shall mention a few of the people I have met along the way who have influenced me substantially. I shall also try to summarise some of the lessons I have learnt.

**Introduction**

When I was invited to give a departing seminar, I was given the liberty to talk about whatever I wanted. I decided I would try to say at least a bit about each of the significant periods in my time with the Bureau. I would also say something about what I learnt from each of those periods.

For much of my 50 years I have worked in an applied research environment. But this will only be about research in a very general sense. I'll cover what most readily springs to mind about each period, so it will definitely be selective.

It is convenient to split the 50 years 1959 to 2009 into six segments; not equal segments, but each a distinctly different phase. They are:

1. 1959, at the Bureau's Training School;
2. 1960 to 1965, at the South Australian Regional Office;
3. 1966 to 1969, in the Bureau's Head Office Research Branch;
4. 1969 to 1984, in the joint Bureau-CSIRO research organisation, the Commonwealth Meteorology Research Centre (CMRC), subsequently renamed the Australian Numerical Meteorology Research Centre (ANMRC);
5. 1985 to 2006, the Bureau of Meteorology Research Centre (BMRC), no longer a joint centre, but solely part of the Bureau empire; and
6. 2007 to the present, in the Centre for Australian Weather and Climate Research (CAWCR), once again a joint Bureau-CSIRO research organisation.

For these six periods, I have asked myself the following questions:

- What do I remember most about that period?
- What did I learn during that period, that I found most useful?

**1. 1959: Training School**

So to the first period: the Bureau's Training School in 1959.

The one thing I remember most about the training school itself is that, not to mince words, it was a real dump. It was a dilapidated building, located on the corner block of Exhibition and Little Lonsdale Streets, near where the Coopers Inn now stands. If the Training School building stood today, it would never be allowed to be occupied for health and safety reasons. Its plumbing and toilet facilities, and fire safety standards were, to say the least, well below today's accepted standards. Not that the building was much worse or better than its neighbours. For those