Australian Government
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# The distribution of climate zones across Australia: identifying and explaining changes during the past century

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The paper describes the application of the *Australian Water Availability Project (AWAP)* (Jones *et al*., 2009 and Raupach *et al*., 2009) analyses of monthly rainfall, maximum temperature and minimum temperature to a climate classification scheme. By this means, changes (both long-term trends and short-term fluctuations) in the distribution of climate zones across Australia during the past century are identified and explained.

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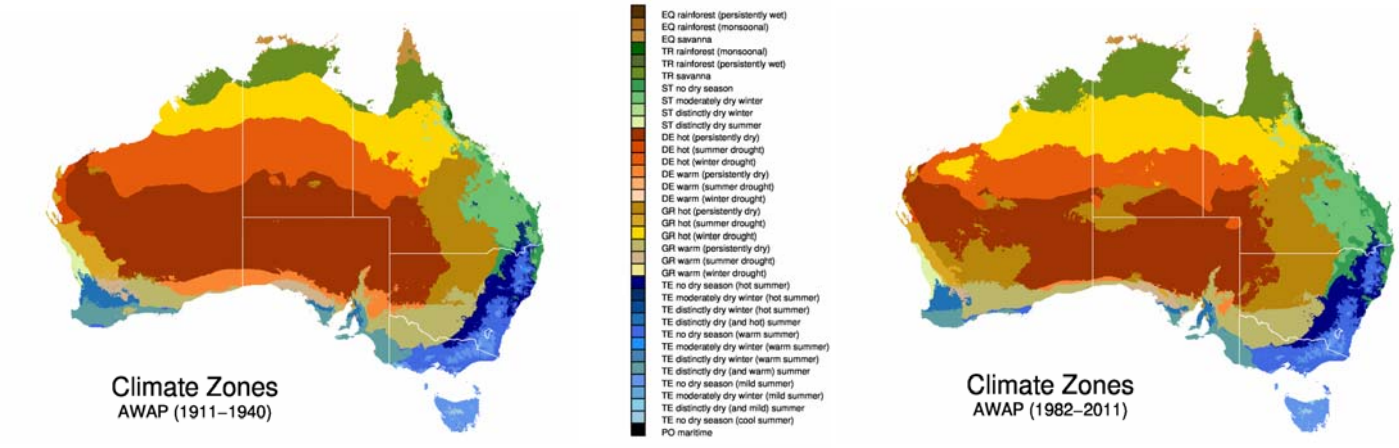


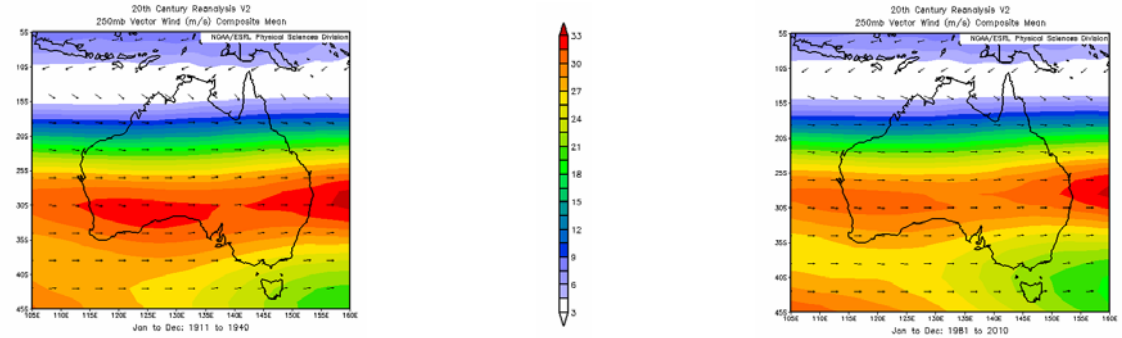


*Note: at the time of publication, the 1982-2011 reanalysis was not available*

Köppen's scheme to classify world climates was devised in 1918 by Dr Wladimir Köppen (Köppen, 1931) and is based on the concept that native vegetation is the best expression of climate, climate zone boundaries having been selected with vegetation limits in mind (Trewartha, 1943). A modification, which addressed some concerns that had been expressed about the Köppen scheme, was developed by Stern et al. (2000) and illustrated with its application to Australia. This modified climate classification is shown for Australia, using data from the standard 30-year period 1961-1990, on the Bureau of Meteorology's (BoM) website at: http://www.bom.gov.au/climate/environ/other/kpn.jpg.

There are many reasons to classify climates aside from that expressed by Köppen (1931). 'People classify the climate in many different ways depending on who needs the information, how much they know about the climate system and what information they need to know' (WMO, 2012).

One may undertake studies that examine climate change in terms of shifts in climate classification boundaries by using data from different historical periods. One may also view such schemes as a potential diagnostic tool for general circulation models, with the aim of developing future climatologies (Löhmann et al., 1993). This has become possible now (Institute for Veterinary Public Health, 2012) with the ready availability of model output data bases such as CliMond (Kriticos et al., 2012).

Recently, as part of an investigation led by the Victorian Commissioner for Environmental Sustainability (CfES), climate change data from the output of global climate models were applied to IPCC scenarios in the context of the modified Köppen climate classification scheme. For details, refer to Chapter 1 of the *'State of the Environment Foundation Paper 1 – Climate Change'* at: http://www.ces.vic.gov.au/victorias-environment/state-of-environment-victoria-2009-2013/climate-change.

The AWAP analyses represent an updated representation of the distribution of the individual weather elements that make up the nation's climate and incorporate the use of data that was hitherto unavailable or had not yet been subject to the Bureau's new quality climate data management system. The AWAP analyses are shown on the BoM's website at: http://www.bom.gov.au/climate/maps/. It is found that, during the past century, many changes in the distribution of Australian climate zones have taken place (refer to the large maps), the most notable one being the contraction of the area covered by 'Desert' climates and the corresponding increase in the area covered by 'Grassland' and 'Tropical' climates.

Other changes include the expansion, and southward advance, of the 'Tropical' zone; the contraction of the 'Temperate' area of southwest Western Australia; an increase in the area covered by 'Hot Desert' just inland from the Head of the Bight; a decrease in the area of coastal Victoria classified as having a 'cool summer'; an increase, followed by a decrease, in the area covered by 'Temperate' climates; and the highland regions of Tasmania classified as 'Polar' having all but disappeared.

Key drivers of the Australian climate include the ENSO phenomenon, the Indian Ocean Dipole, the Madden Julian Oscillation, the Southern Annular Mode, the monsoons and the SE trades. Other drivers include synoptic features such as the position and intensity of long wave troughs, the jet streams, the subtropical ridge and the 'blocking' phenomenon.

Using global reanalysis data from the NOAA/ESRL Physical Sciences Division (Boulder, Colorado), data sets from the BoM's Australian Data Archive for Meteorology, data sets reflecting the key drivers of the Australian climate, in addition to some very old data sets pre-dating the BoM (Hunt, 1911), possible explanations for some of the detected changes in the distribution of climate zones may be given.

For example, the contraction of the area covered by 'Desert' climates, and the corresponding increase in the area covered by 'Grassland' and 'Tropical' climates, may be attributed to the apparent northward shift of the sub-tropical jet over the past century (refer to the small maps), and the associated increase in the frequency of the 'blocking' phenomenon over the Tasman Sea, especially during summer.

To summarise, over the past century, the percentage area of Australia designated *Desert*, has decreased from 51.1% to 37.9%; *Grassland*, has increased from 26.3% to 36.1%; *Temperate*, has decreased from 10.9% to 10.1%; *Tropical*, has increased from 5.5% to 9.0%; *Subtropical*, has increased from 5.5% to 6.5%; *Equatorial*, has decreased from 0.7% to 0.3%; and, *Polar*, has decreased from 0.004% to 0.001%.

So, it may be seen how the AWAP analyses have enabled changes in the distribution of climate zones across Australia to be both identified and explained.