Rangelands NRM
Western Australia

Western Australian Rangelands – Climate drivers and forecasts report

WA climate and climate change forecasts

This review of climate drivers and forecasts was prepared in 2013 by Northwest Carbon for Rangelands NRM, for the Regional Plan update.

Natural resource management integrates the management of social, economic and environmental values by involving the community and industry in planning and decision making. To better inform future decision making by the people that manage country and that see different uses of the land, it is important to have an understanding of the current forecasts for future climate, and to consider how the predictions of future climate may influence NRM planning and resource allocation.

Climate change is a change in the average pattern of weather over a long period of time. Climate change happens over and above natural climate variability that occurs over short term cycles, including the "wet" (La Nina) and "dry" (El Nino) patterns. The climate that we have become accustomed to, as variable as it can be, is changing.

There is clear evidence that the changing climate, over and above the normal range of variability, is largely due to human activities. From a Regional Natural Resource Management perspective, existing land management and land use is driven to a significant extent by the long term average climate conditions in the region. If these conditions change away from the long term average conditions that local species, ecosystems, and forms of land use are adapted to, then these biological assets and their associated human uses may be subject to change also.

Environmental factors such as water availability, soil quality, fire risk and the incidence of pests, weeds and disease will also likely change. As such, biological and other environmental assets that the local communities see as important may be subject to adverse environmental conditions under future climate scenarios. If the environmental asset of concern is already in a modified state relative to its pristine or the condition stakeholders desire it to be in, these impacts may be further exacerbated by future climate change. Future climate change may have impact on efforts to repair or rehabilitate environmental assets. So, having an understanding of current and projected climate and how those changes are going to interact with local environmental assets is an important part of Regional NRM planning, especially for the Rangelands region of WA that covers such a vast area and already covers a range of climatic regions.

Climate has been a major diver of ecology and human use in WA Rangelands.

When considering climate change impacts in WA Rangelands sub-regions, it is important to have an understanding of the broad agricultural, climatic and ecological zones that the planning region encompasses. **Figure 1** is taken from a recent study by ABARES (2012) looking at the general forms of economic activity associated with different ecological zones across Australia. From the economic and ecological perspective, the WA Rangelands is mostly seen to be "Arid", followed by "Tropical" and a small

representation of “Western wheat belt”. CSIRO (2008) described similar agro-climatic zones. Each zone has relatively consistent patterns of seasonal growth and climate related drivers of that growth. The vegetation types and associated human uses also tend to be reasonably consistent within each zone.

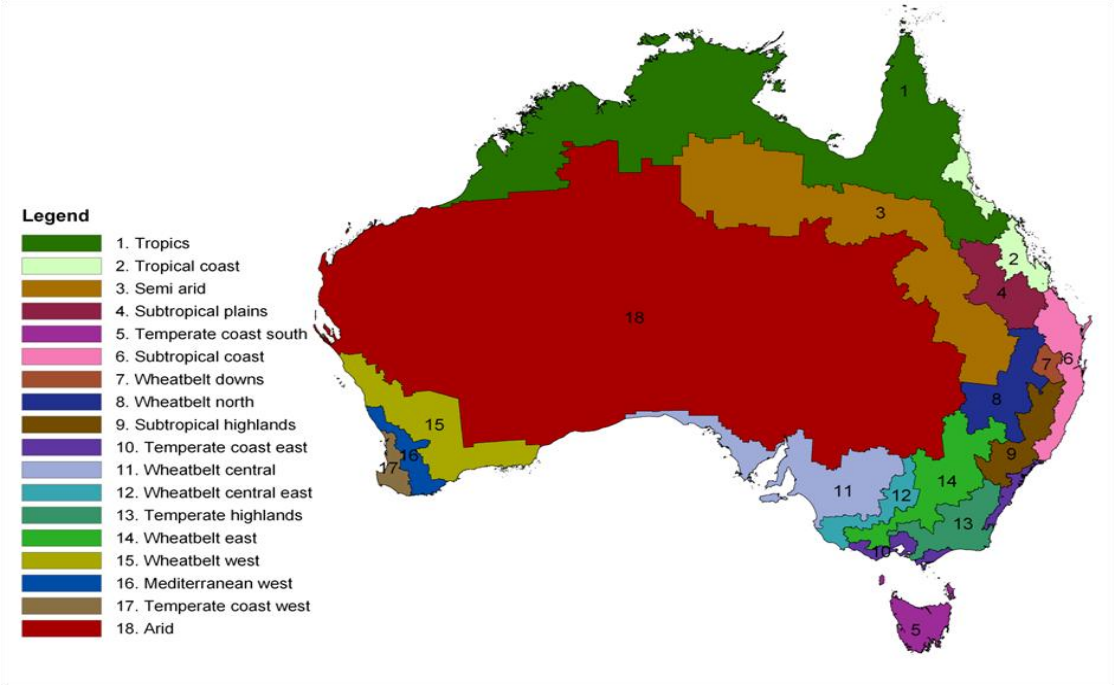


Figure 1. Broad climate and vegetation regions of Australia. Taken from ABARES 2012 (confirm reference).

The things that influence climate in Rangelands

Australia's climate can vary greatly from one year to the next; the cycle of drought and flooding that occurs over years to decades. We know that this variability is influenced by long term climate conditions. **Figure 2** presents the main influences upon the West Australian climate and the Rangelands NRM region in particular. These meteorological conditions will have varying levels of impact in different regions of the Rangelands at different times of year. These influences are impacted by the complex interactions that occur in the global atmosphere and ocean circulation systems. These systems are ultimately also impacted by human impacts. Below, a brief description of each meteorological feature is provided so that when we consider potential future climate change, we can consider how each of these features may change.

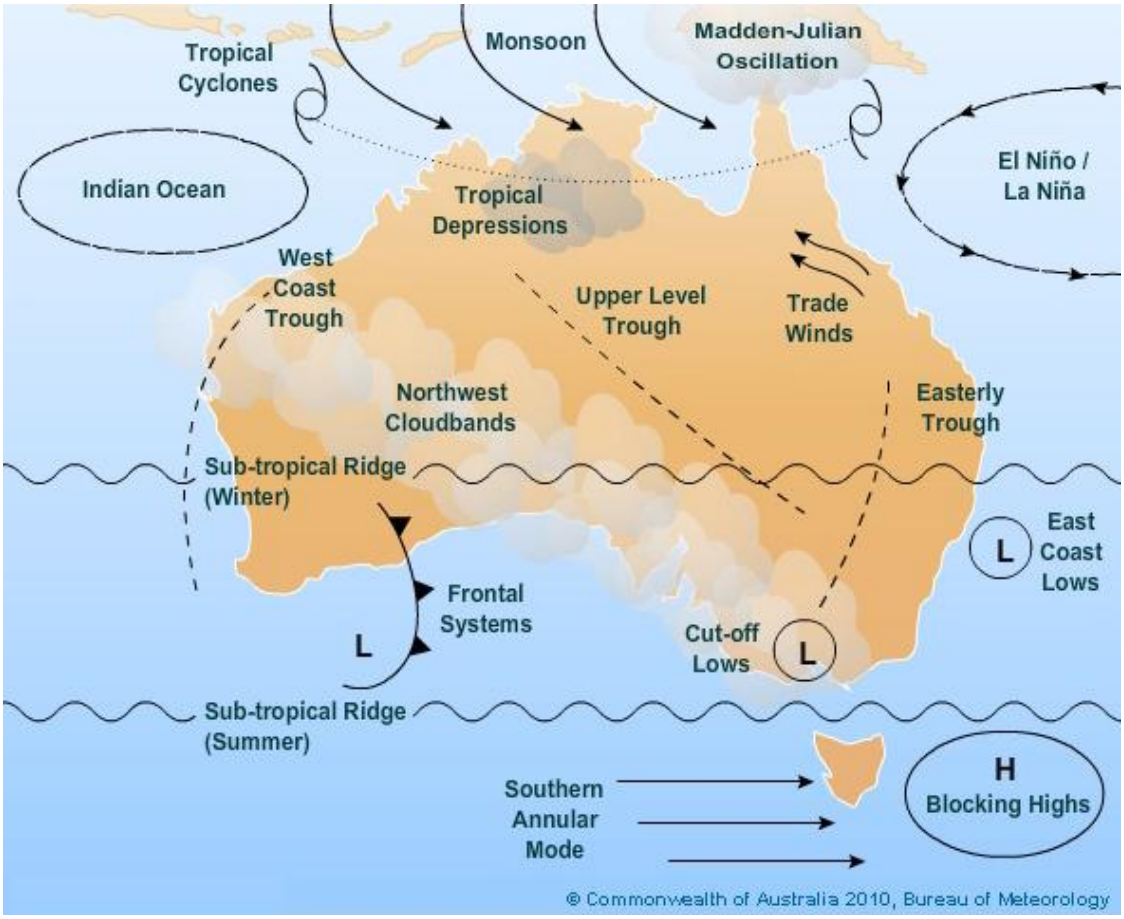


Figure 2. Broad drivers of Australian climate.

Tropical cyclones

Tropical cyclones occur across all northern Australia and the WA Rangelands Kimberley & Pilbara regions are the most cyclone prone part of Australia's coastline. Cyclones are expected to occur in this region between December and April. Tropical cyclones are best known to be made up of destructive winds, heavy rains and flooding, and storm surges at the coast. The cyclones can continue to be sources of heavy rainfall well away from the coast as they move across central and southern parts of the continent, but they often lack destructive wind strength as they move away from the coast.

Indian Ocean

Generally speaking, warmer than average sea surface temperatures in the Indian Ocean near Indonesia will result in higher than average rainfall over Australia, and cooler than average sea surface temperatures in this region can be an indicator of lower than average Australian rainfall.

West coast trough

The West Coast trough generally forms as the land over the Pilbara region warms, during the September to April period. As the air over the Pilbara warms, the rising warm air pulls air from down south. The wind strength in this trough grows, and typically the trough moves in a general eastward direction, being pulled across the continent by the passage of moving high pressure systems across the Great Australian Bight. As low pressure (cold front) systems move east after the high, the West Coast trough again grows as winds

turn generally easterly. The temperatures to the east of a trough are often very hot, often with thunderstorms with temperatures cooler on the western side of a trough.

Northwest cloudband

A northwest cloudband is an extensive layer of cloud which can stretch from northwest to southeast Australia. Northwest cloudbands are formed when warm, moist tropical air moving eastward from the Indian Ocean. This warm air rises up and over cold air body and the moisture condenses to form clouds, and usually happens in winter & spring (March-October). These cloudbands often produce widespread rains across the Pilbara and central Rangelands (Gascoyne Desert & Goldfields).

Cold front

A cold front is formed when cold dense air from the Southern Ocean advances north & east, causing warm air to be forced up and over the advancing cold air , and happen most commonly in winter. These are the systems that bring the most consistent winter rains to the southern half of the Rangelands region.

El Niño Southern Oscillation (ENSO)

The El Nino/Southern Oscillation described the cycle that can flip between an El Nino (dry) or La Nina) (wet) climate cycle across the Pacific Ocean. The flip between the dry and wet cycles is determined by the sea surface temperature in the Pacific Ocean. A warmer than usual sea surface temperature in the central and eastern Pacific indicated an El Nino pattern; conversely a cooler than normal central and eastern Pacific Ocean sea surface temperature indicates a La Nina pattern. While the ENSO/ El Nino typically has its greatest influence on east & central Australian rainfall, the Kimberley and central Desert sub-regions of the Rangelands NRM region do tend to receive higher than average rainfall during La Nina years.

Collectively, all of these meteorological structures are responsible for the weather we can observe at any given point in time, and are the dominant sources of weather in the Rangelands regions of WA. It is expected that future climate change will influence these local meteorological structures and how they interact to create the local weather.

Climate change already seen

In terms of long term average changes that have occurred to the climate on average in Australia, the Climate Change in Australia website, run by CSIRO, Department of Climate Change & Energy Efficiency and the Bureau of Meteorology has the following to say:

"Temperature

Australian average temperatures have increased 0.9°C since 1950, with significant regional variations. The frequency of hot days and nights has increased and the frequency of cold days and nights has declined.

Rainfall

Since 1950, most of eastern and south-western Australia has experienced substantial rainfall declines. Across New South Wales and Queensland these rainfall trends partly reflect a very wet period around the 1950s, though recent years have been unusually dry. In contrast, north-west Australia has become wetter over this period, mostly during summer.

From 1950 to 2005, extreme daily rainfall intensity and frequency has increased in north-western and central Australia and over the western tablelands of New South Wales, but decreased in the south-east and south-west and along the central east coast.

Oceans

Global sea levels rose by about 17 cm during the 20th century, and by around 10 cm from 1920-2000 at the Australian coastal sites monitored. Substantial warming has also occurred in the three oceans surrounding Australia, particularly off the south-east coast and in the Indian Ocean."

More recently, the CSIRO and Bureau of Meteorology State of the Climate 2012 reports that:

- *"Australian annual average daily mean temperatures have increased by 0.9 °C since 1910.*
- *Global average mean sea level for 2011 was 210 mm above the level in 1880.*
- *Sea surface temperatures have increased by about 0.8 °C since 1910.*
- *The main cause of the observed increase in carbon dioxide concentration in the atmosphere is the combustion of fossil fuels since the industrial revolution.*
- *Australian average temperatures are projected to rise by 1.0 to 5.0 °C by 2070 when compared with the climate of recent decades*."

There has been a demonstrable increase in rainfall intensity and volume in the north in the past decade (**Figure 3**), and a marked decrease in rainfall towards the south west, and a general trend for drying at the coast.

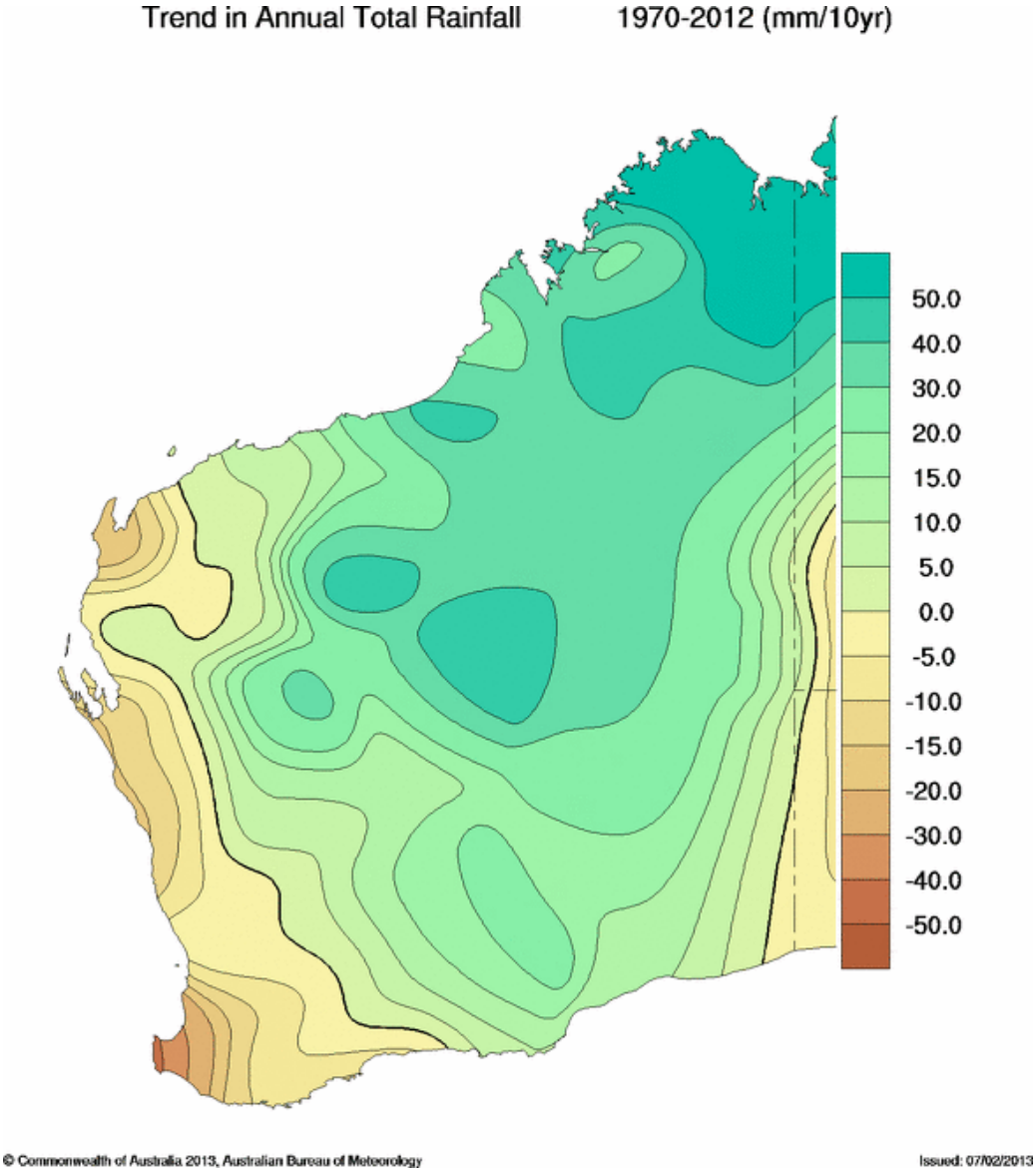


Figure 3. Trend in annual average rainfall in WA. Taken from the Bureau of Meteorology.

Forecasts of climate change

CSIRO (2007) documented a comprehensive report that is seen as the most up to date publicly available report on the causes of climate change and predictions for future climate change in Australia. The complete report is available on the Climate Change in Australia website (currently at http://www.climatechangeinaustralia.gov.au/technical_report.php), and contains far more information than is required in the context of this report. You are encouraged to spend some time reading the CSIRO report, as well as some of the other climate change resources provided throughout this document. The important outputs of the CSIRO report are the computer model predictions of future climate in West Australia. The model outputs presented here are taken directly from the CSIRO report. The model outputs recreated here are the "average" response of 23 separate computer model predictions for what the climate will be like in the future, relative to the average conditions that prevailed from 1990 - 2007. The models are making these predictions based on the expectation that there are three alternative "futures" in

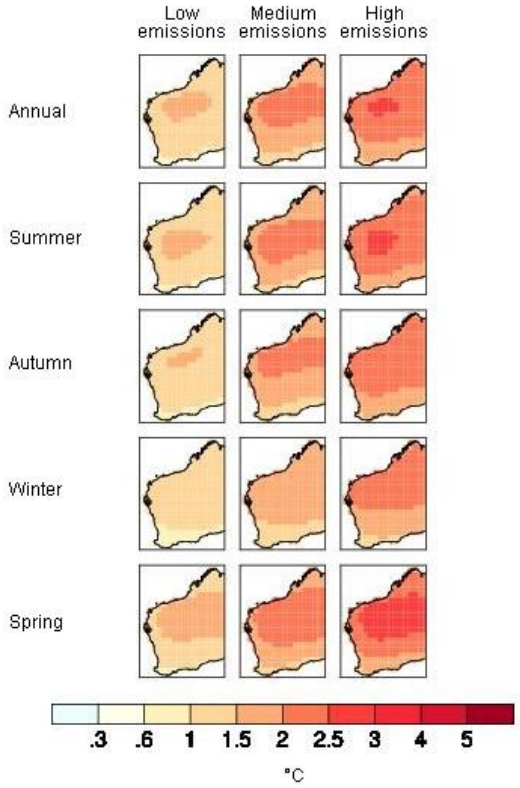
terms of total human emissions of greenhouse gasses: a low emission, medium emission and high emission future. With increasing levels of greenhouse gases being put into the atmosphere under each different model scenario, it can be seen how global climate responds to more emissions being put into the atmosphere. You are able to see the different model predictions for different environmental variables in West Australia at different points in the future for yourself on the Climate Change in Australia website.

The following maps have been taken to assist in guiding the discussion regarding Rangelands WA regions (using 50th percentile or "average" model outcomes taken from 23 separate climate prediction models that included forecast impacts of additional (low, medium and high) greenhouse gas emission levels on future climate, as described in detail in CSIRO 2007):

- temperature change (by season, by climate scenario) for 2050
- rainfall change (by season, by climate scenario) for 2050
- humidity change (by season, by climate scenario) for 2050
- sea surface temperature (10th, 50th and 90th percentile, by emission scenario) for 2050
- wind speed change (by season, by climate scenario) for 2050
- evapotranspiration (by season, by climate scenario) for 2050.

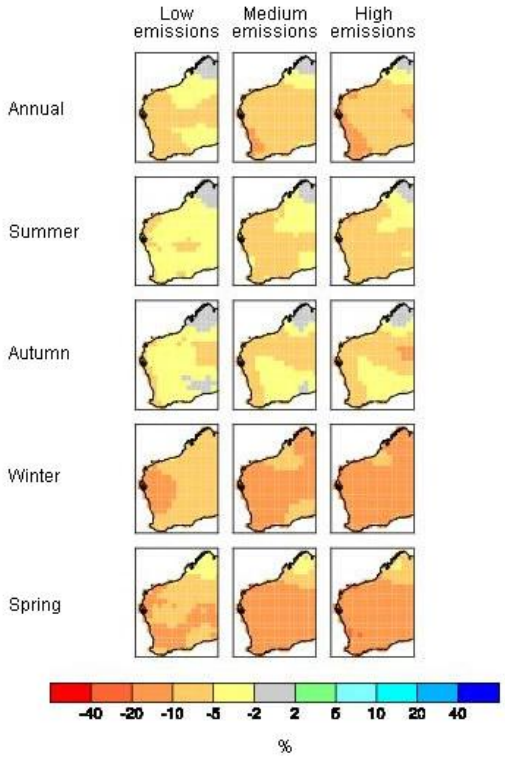
The effect of these predicted changes away from the 1990-2007 average climate are considered in more detail in each of the sub-regional chapters of the Rangelands NRM plan.

Western Australia Temperature change 2050 50th Percentile



http://www.climatechangeinaustralia.gov.au/watemp20.php

Western Australia Rainfall change 2050 50th Percentile



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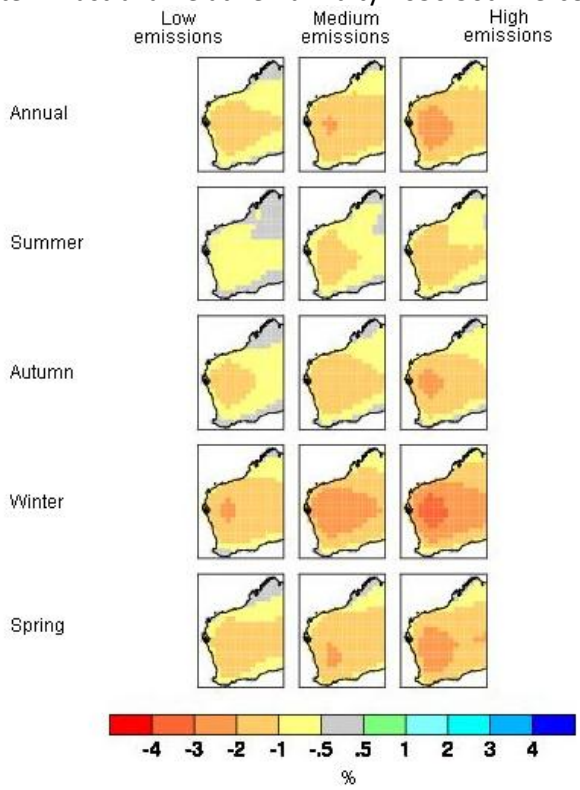
Western Australia Relative humidity 2050 50th Percentile



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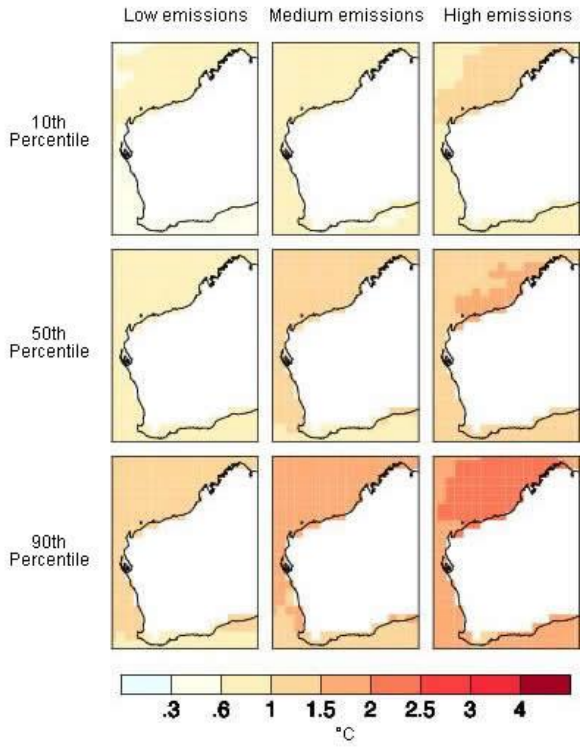
Western Australia Annual Sea surface temperature change 2050



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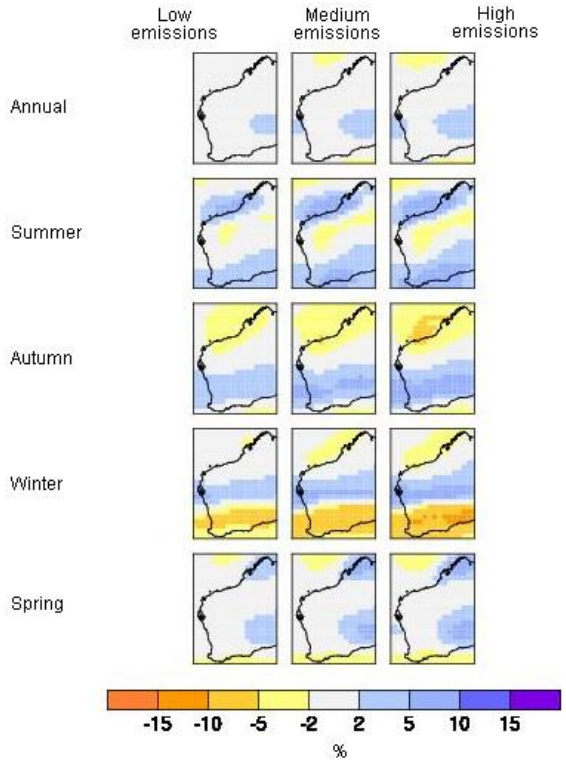
Western Australia Wind speed change 2050 50th Percentile



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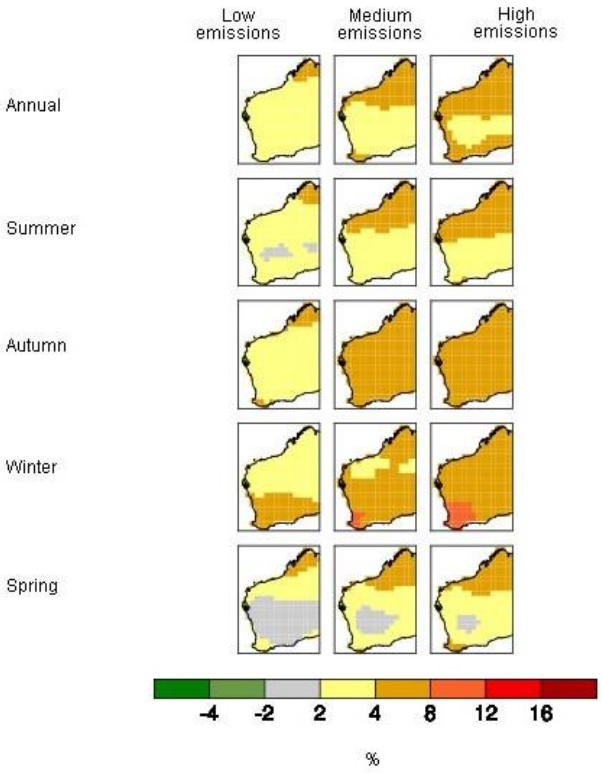
Western Australia Potential Evapotranspiration 2050 50th Percentile



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