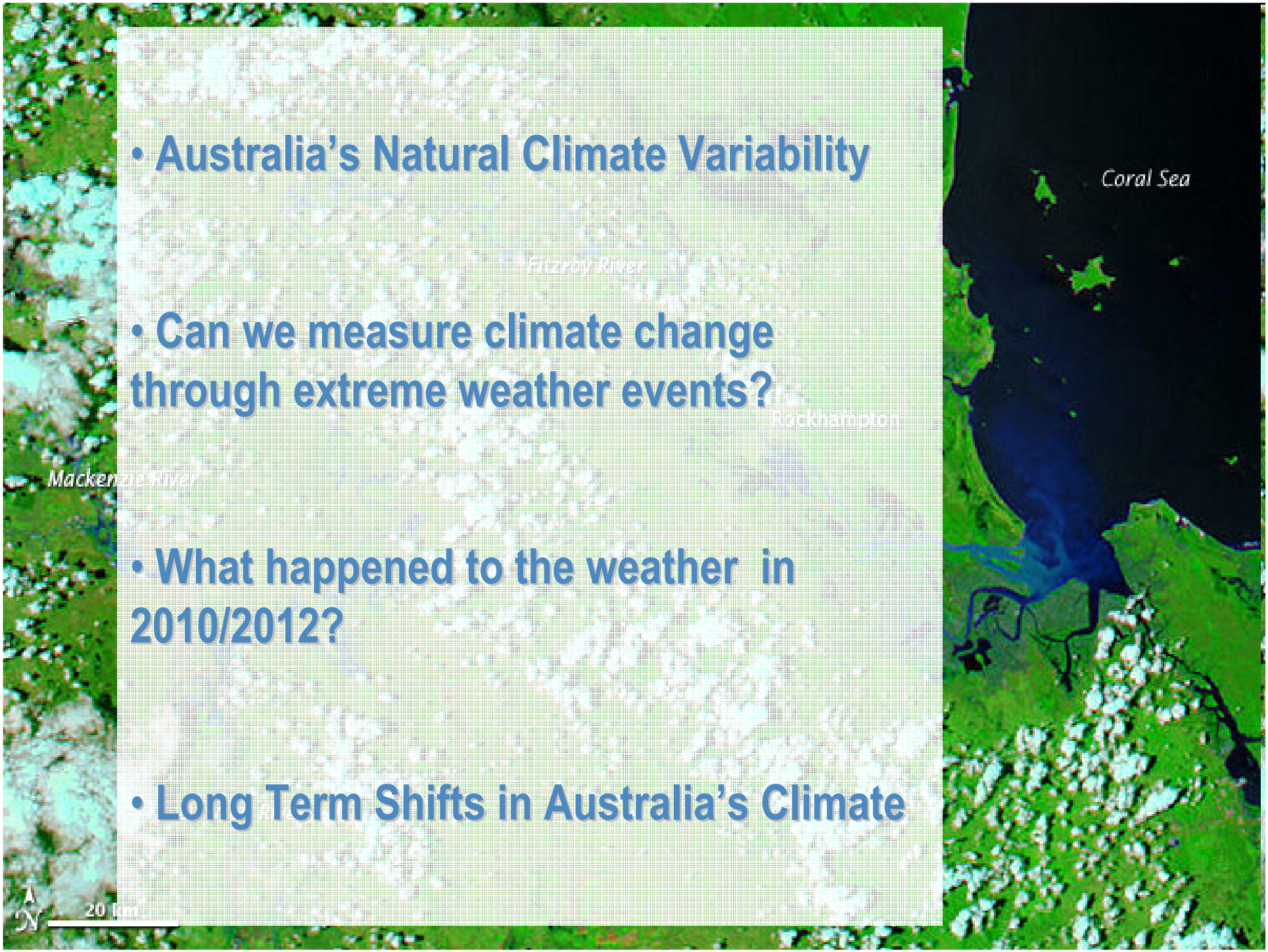
Parliamentary Library Lecture
Wednesday 23rd March 2011

Droughts and Flooding Rains; Australia's Climate Variability

Dr Karl Braganza
Climate Monitoring Manager
Bureau of Meteorology, National Climate Centre



- Australia's Natural Climate Variability
- Can we measure climate change through extreme weather events?
- What happened to the weather in 2010/2012?
- Long Term Shifts in Australia's Climate

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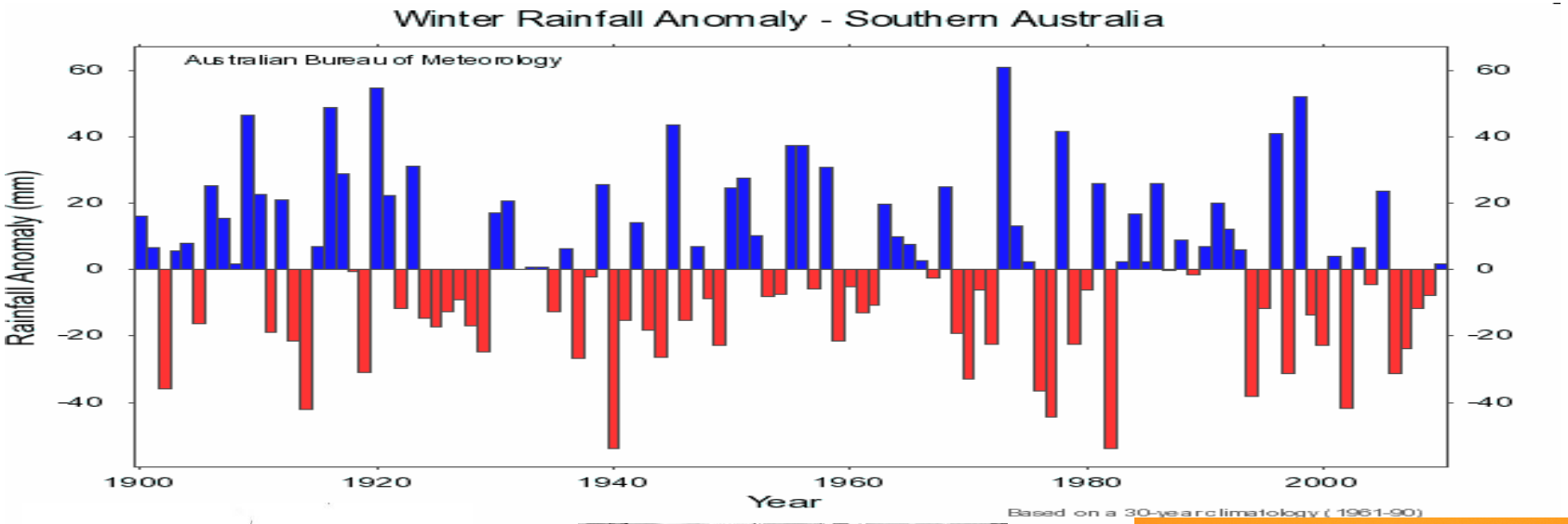
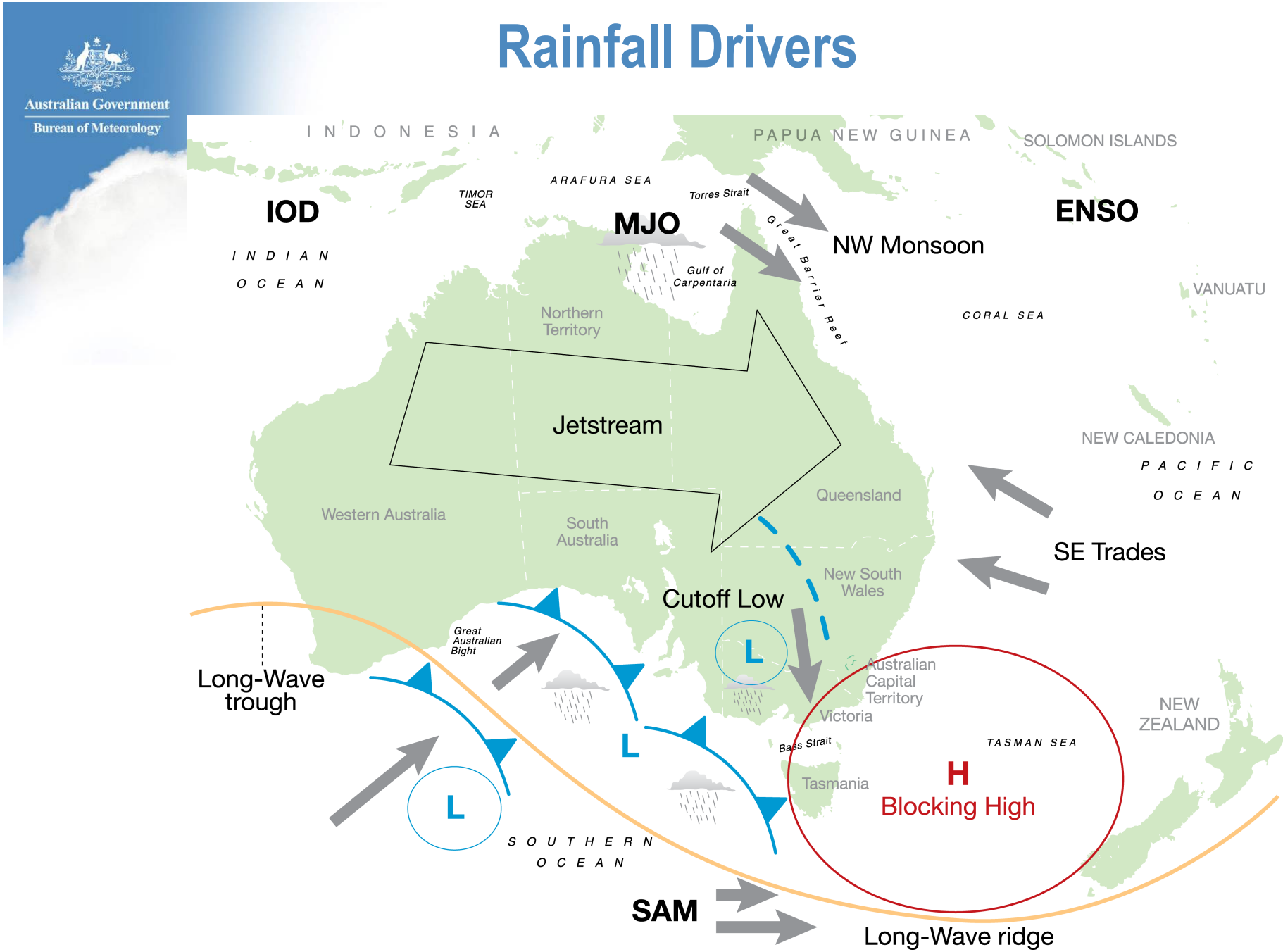
"…..of Droughts and Flooding Rains"



Rainfall Drivers



Source: Risbey et al (2009)

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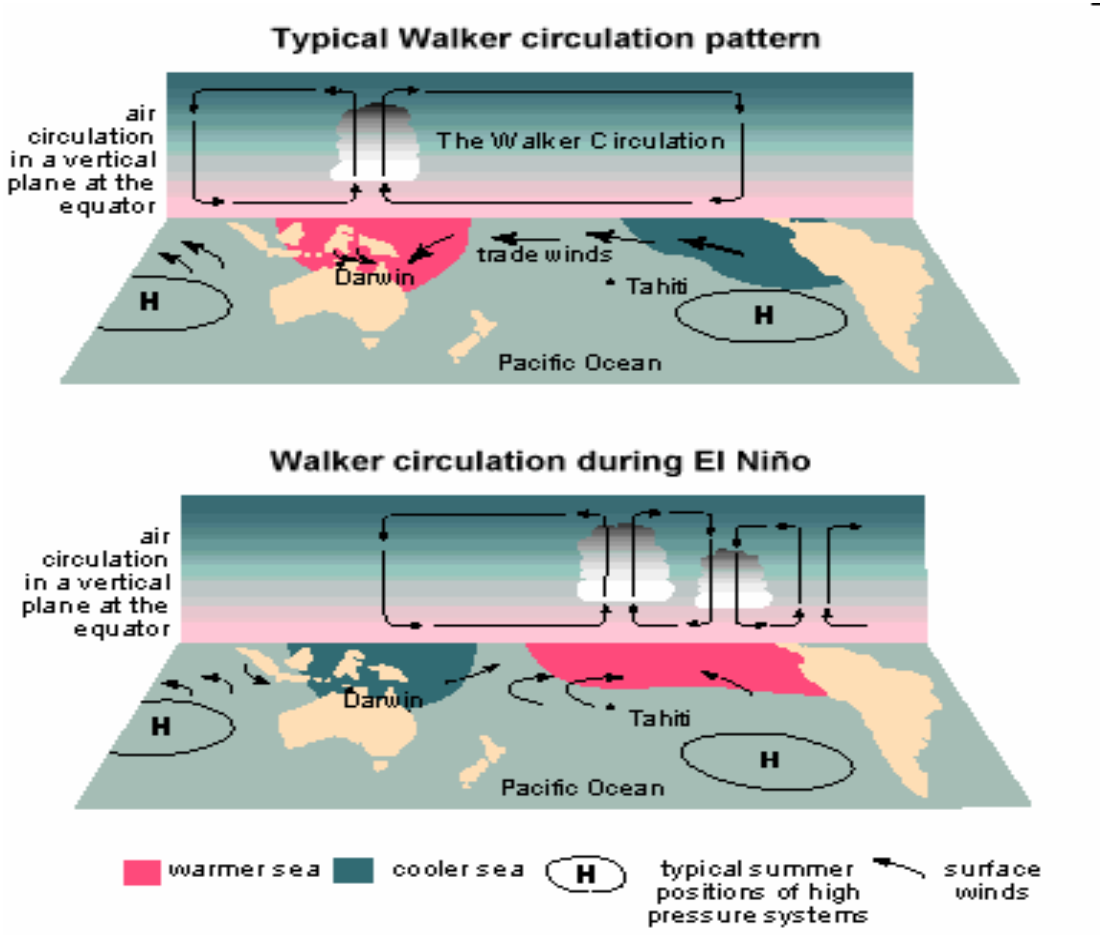
Tropical Sea Surface Temperatures are the single Biggest Influence on Australian Rainfall Variability

Tropical convection tends to 'follow' the warmest waters in he tropical Pacific and Indian Oceans.

That convection pulls very moist air into the atmosphere.

Depending on the phase of the El Nino Southern Oscillation, the warmest water is either in the Australian Region (La Nina) or in the central Pacific (El Nino)



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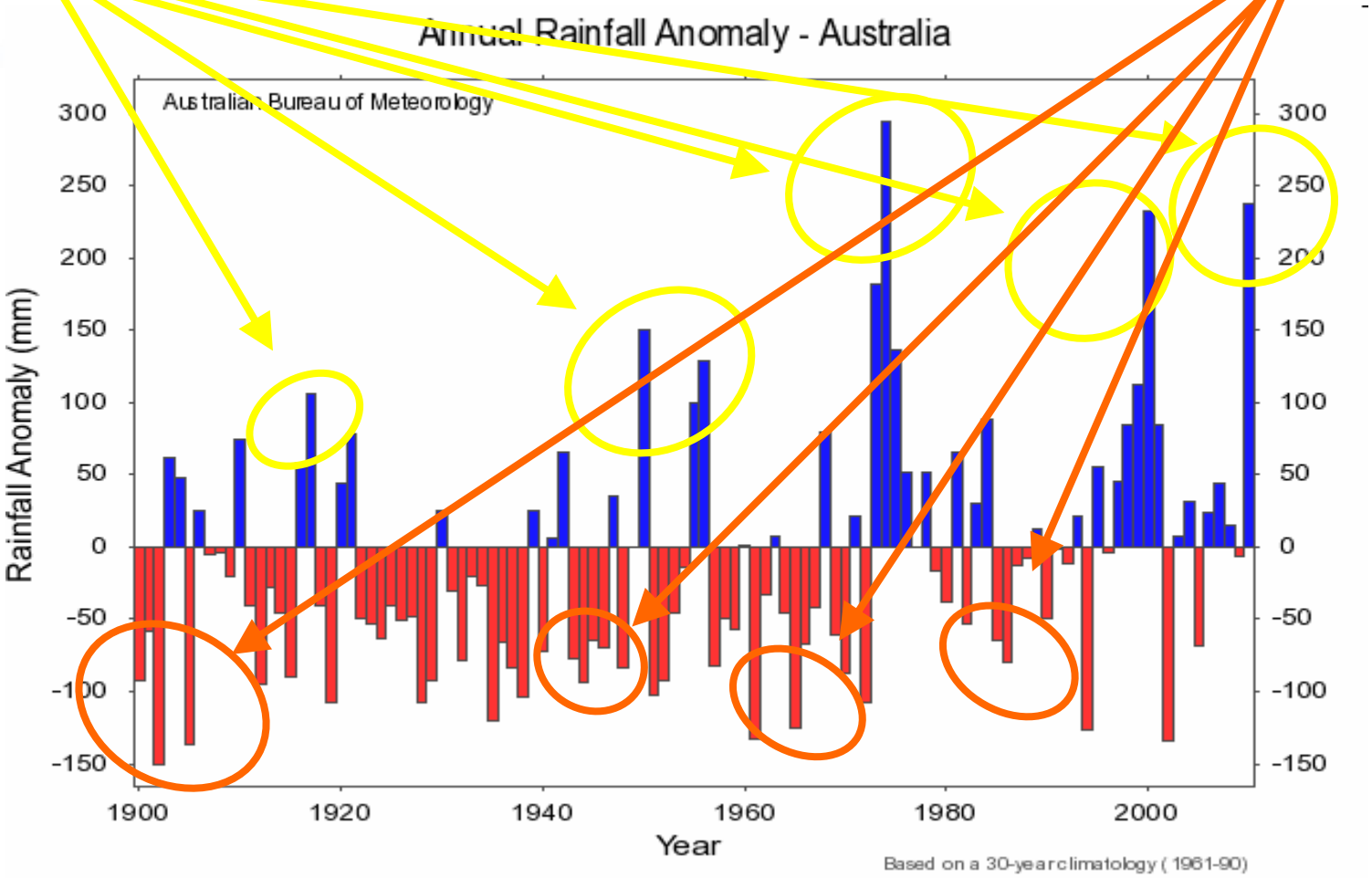
Annual Rainfall Anomalies for Australia

La Nina Events

El Nino Events



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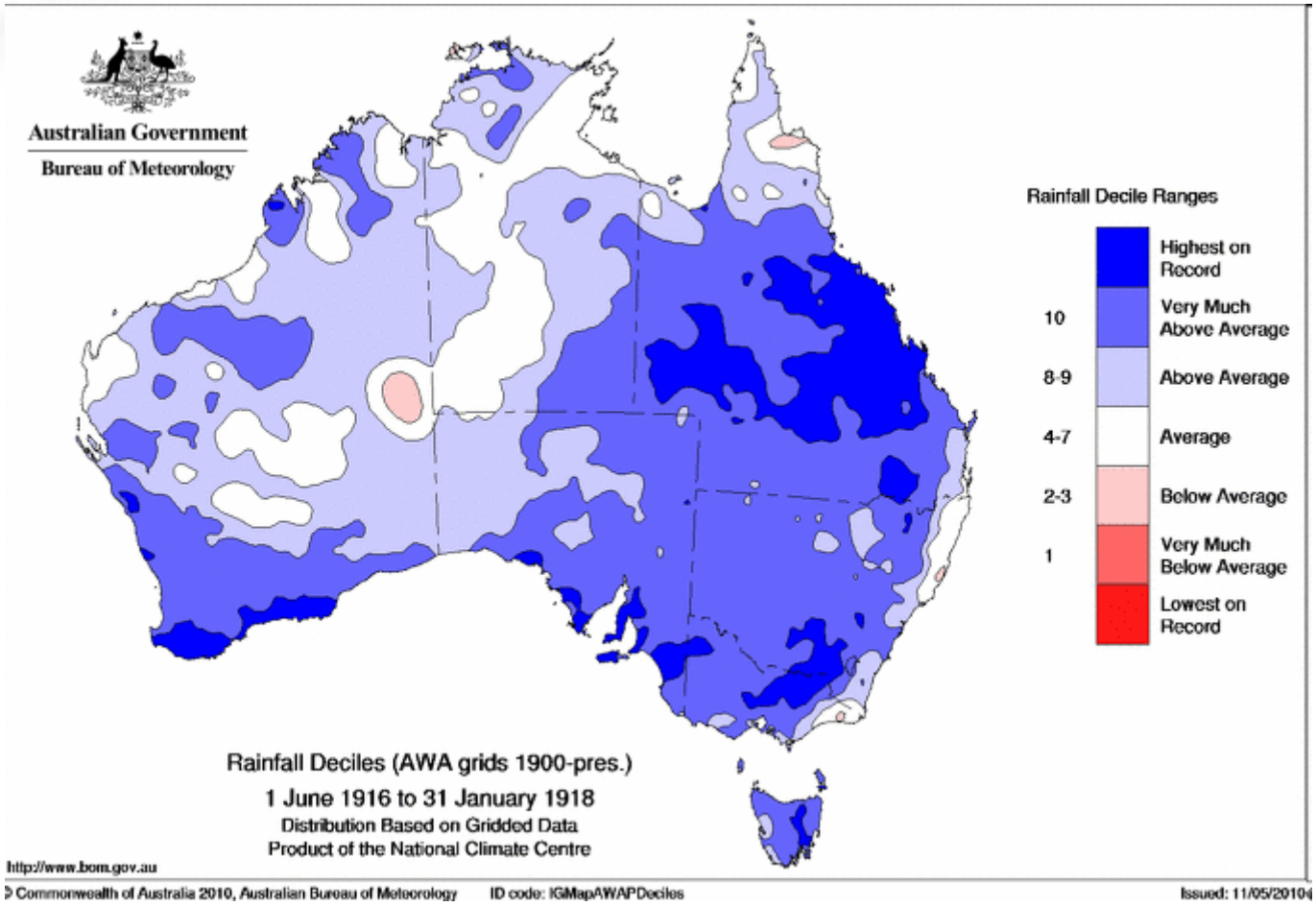
Strong La Nina Events and Australian Rainfall



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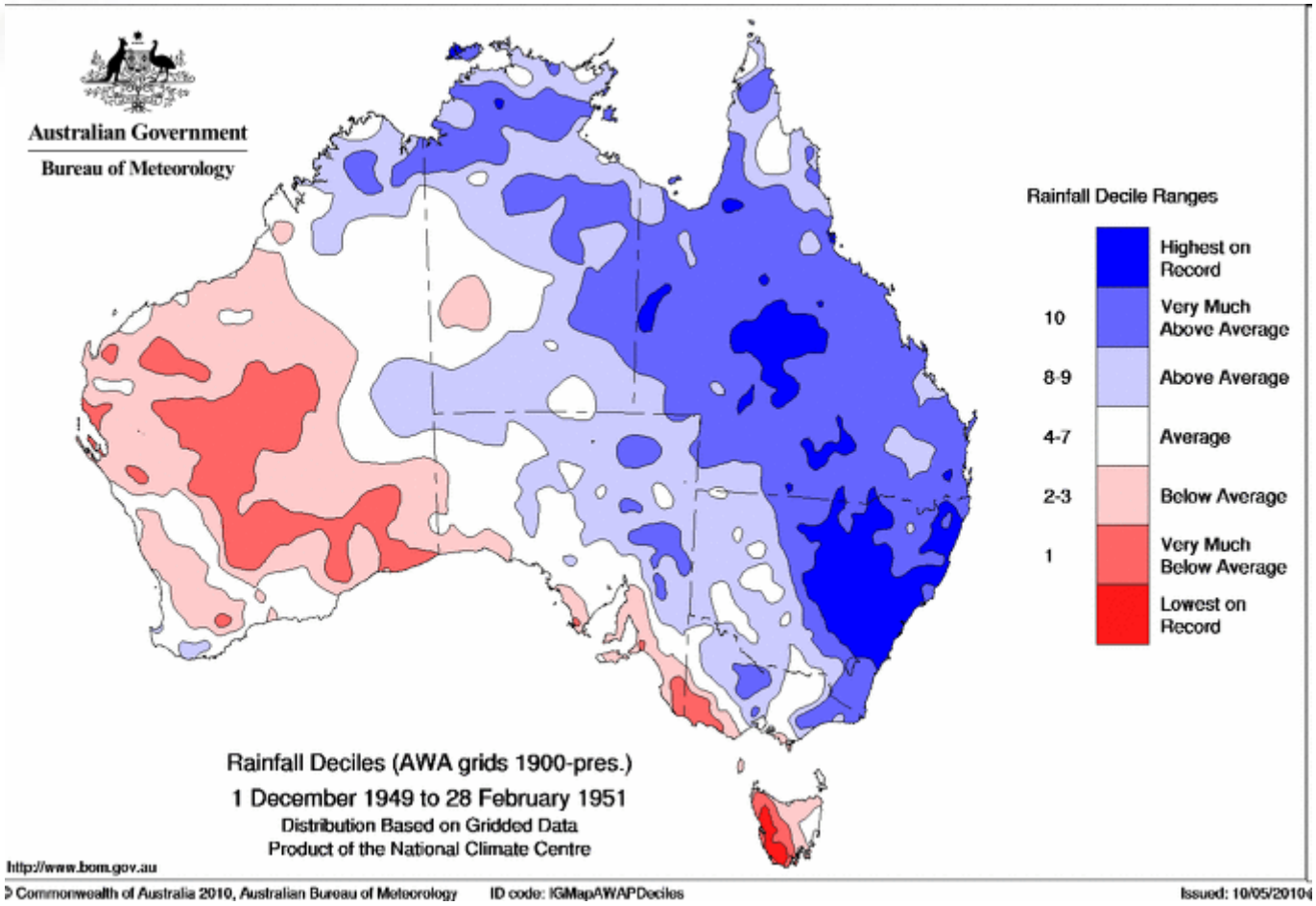

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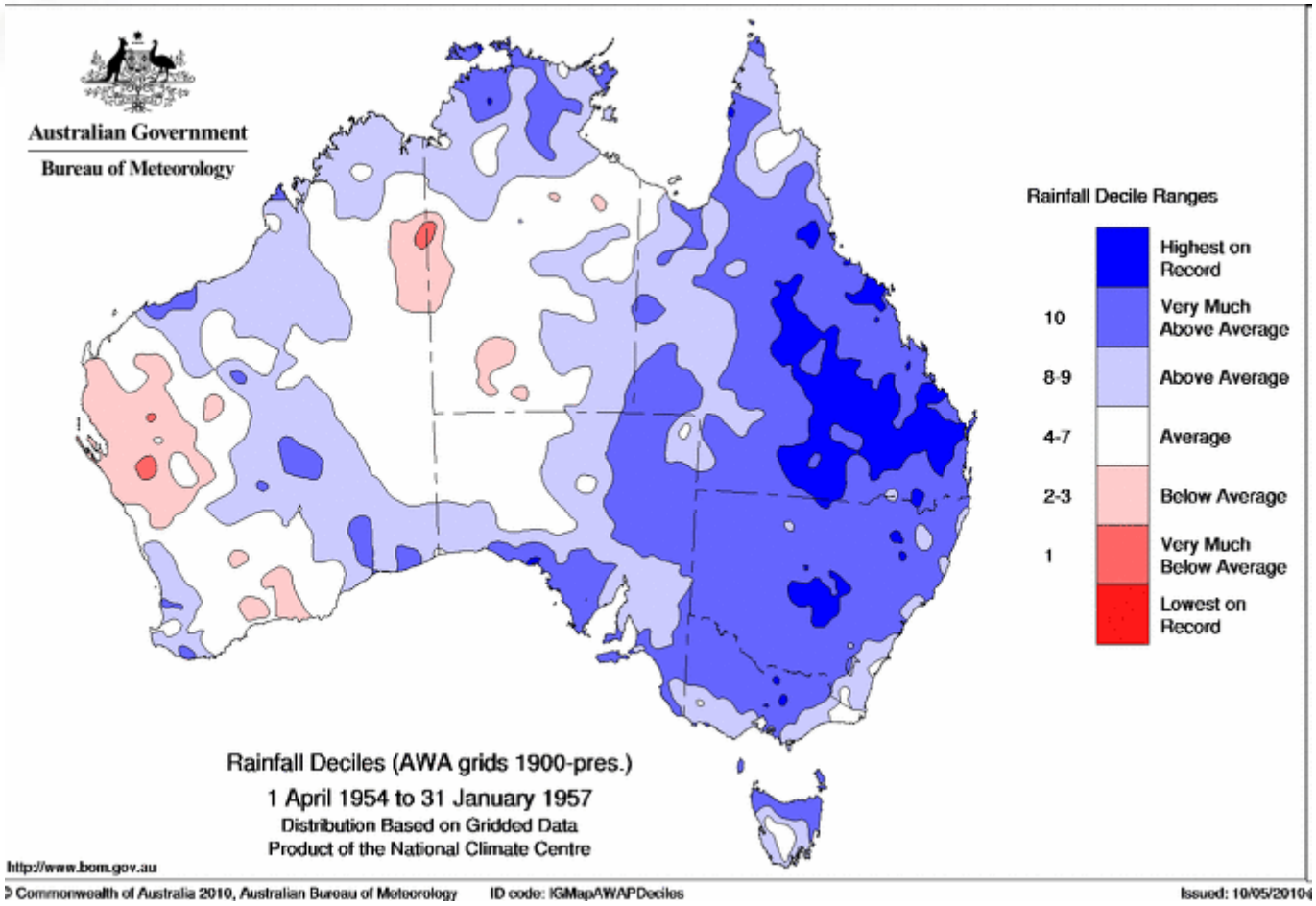
Strong La Nina Events and Australian Rainfall



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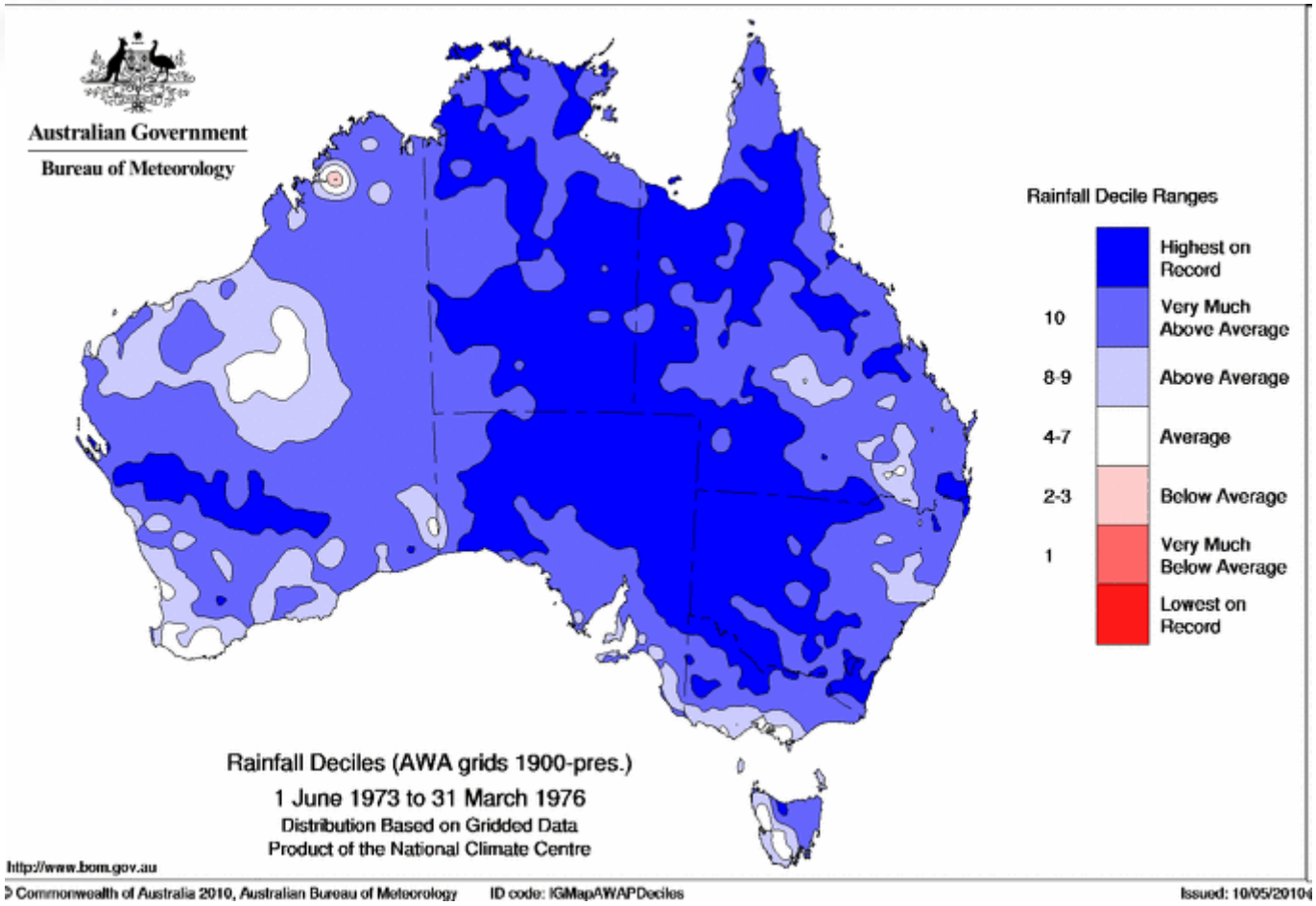
Strong La Nina Events and Australian Rainfall



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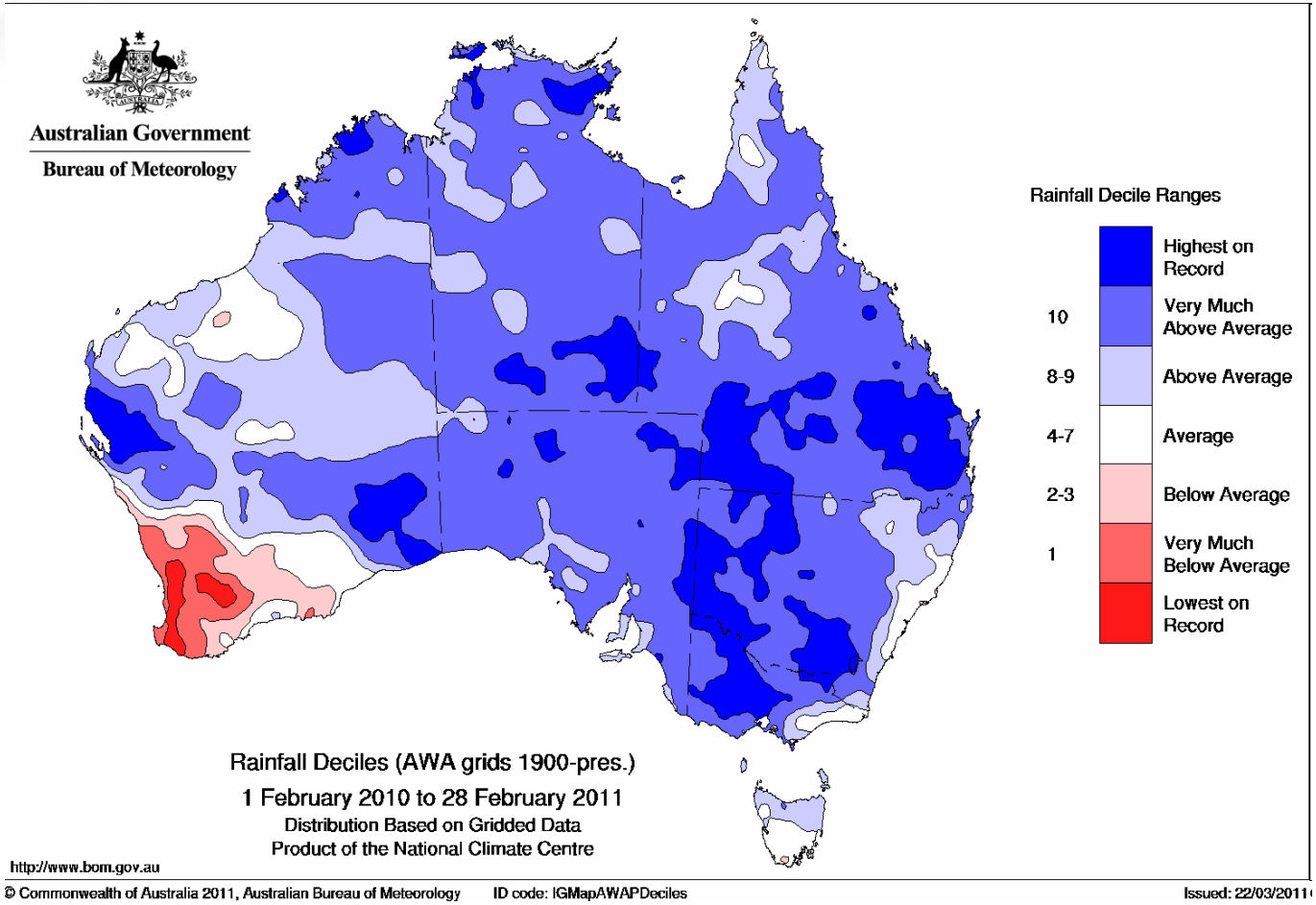
Strong La Nina Events and Australian Rainfall



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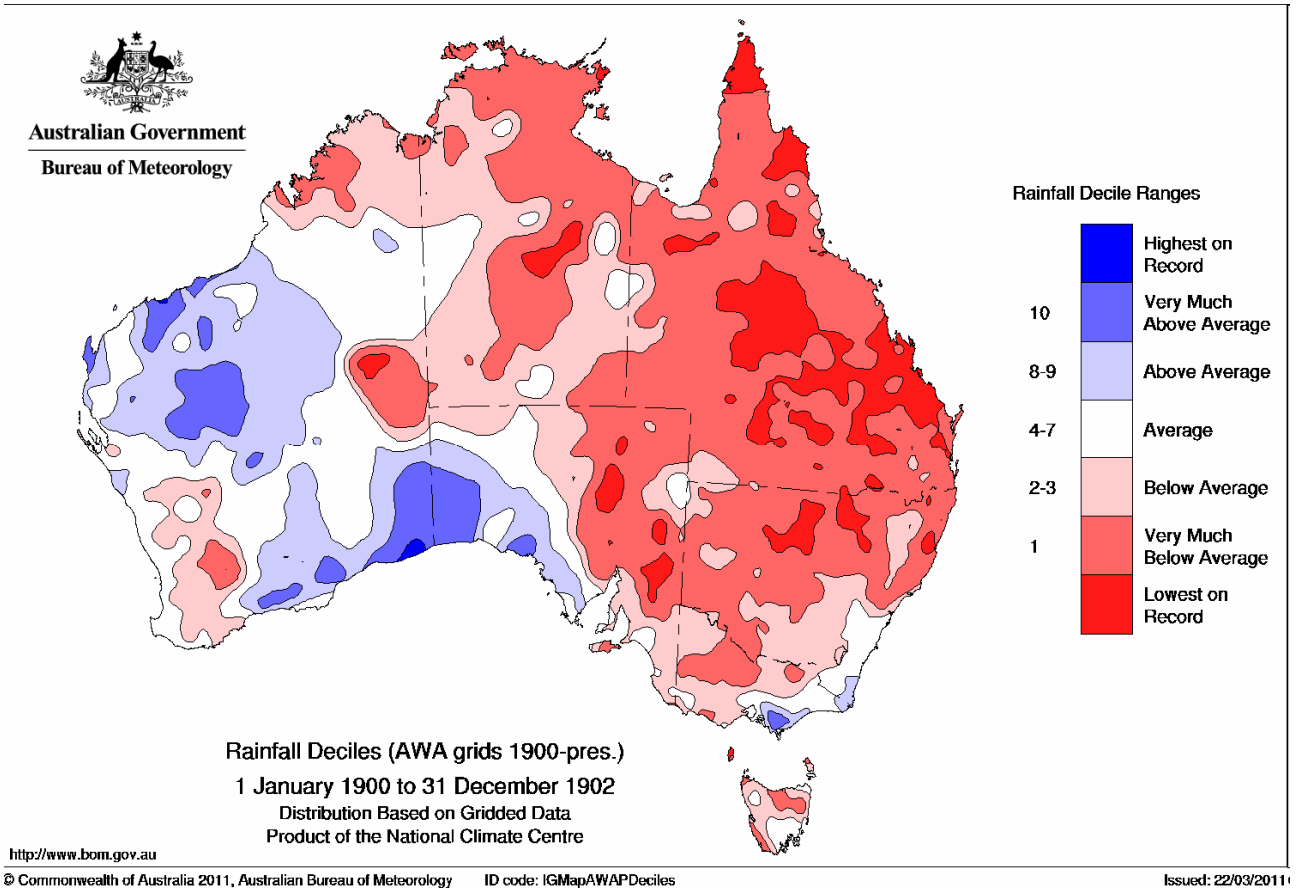
El Nino Events and Australian Drought



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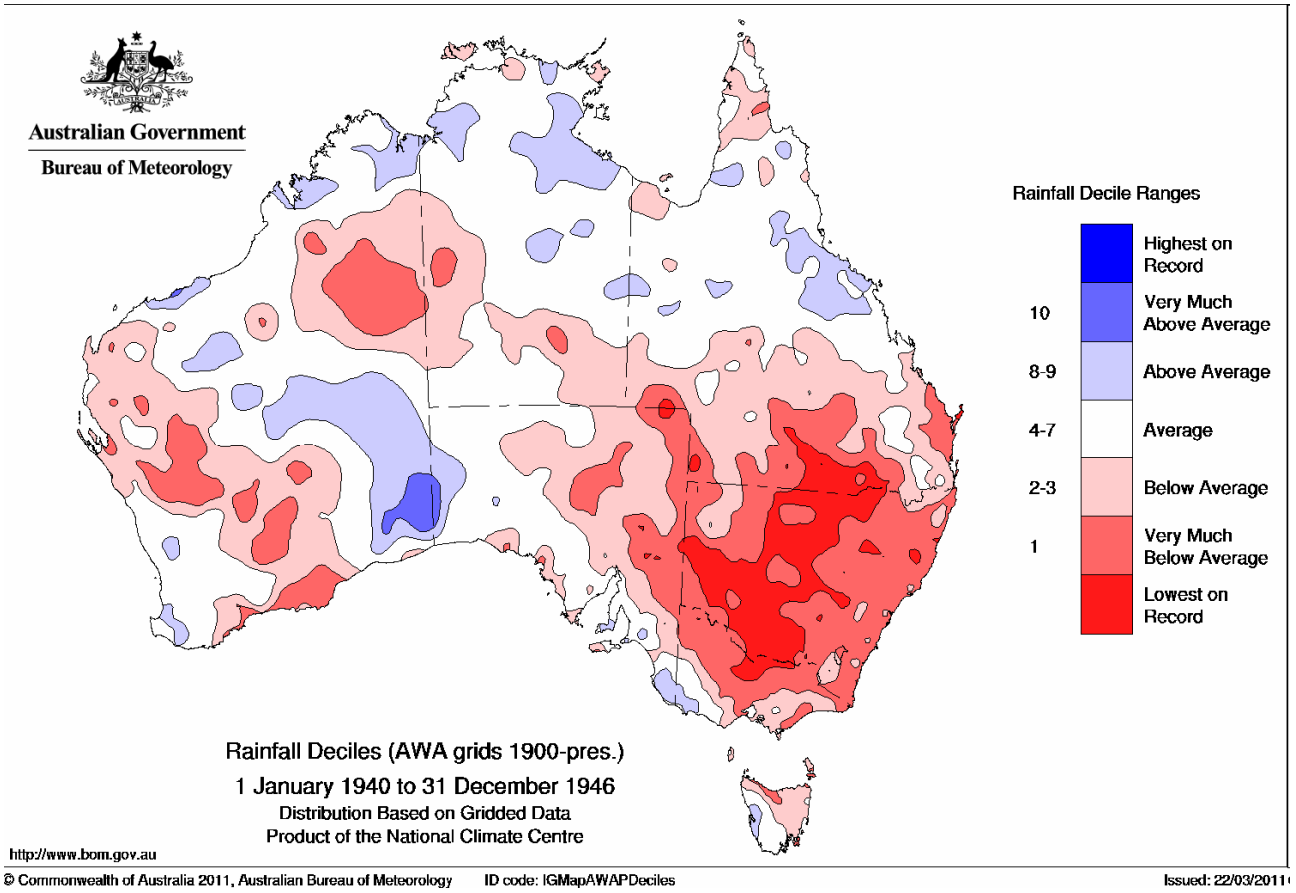
El Nino Events and Australian Drought



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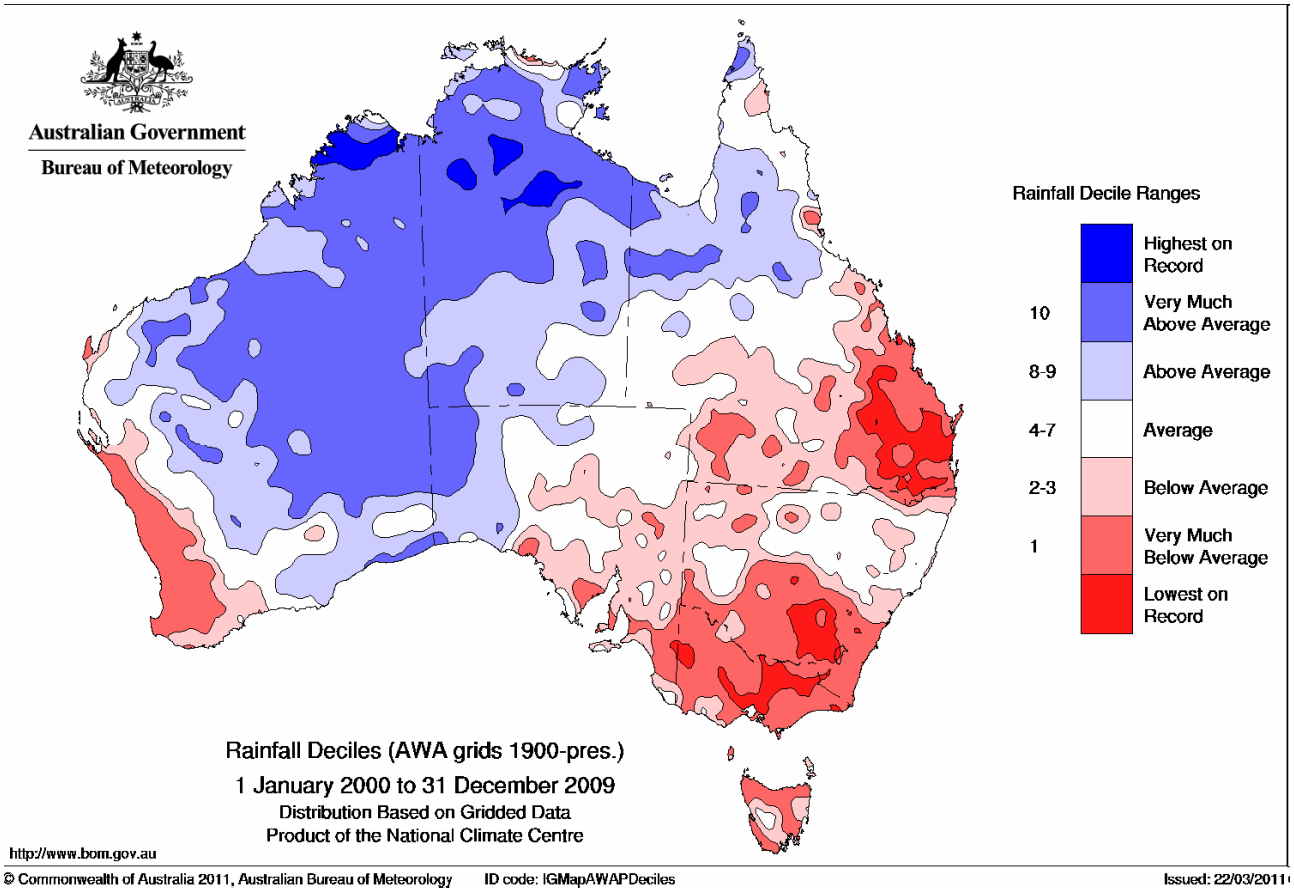
El Nino Events and Australian Drought



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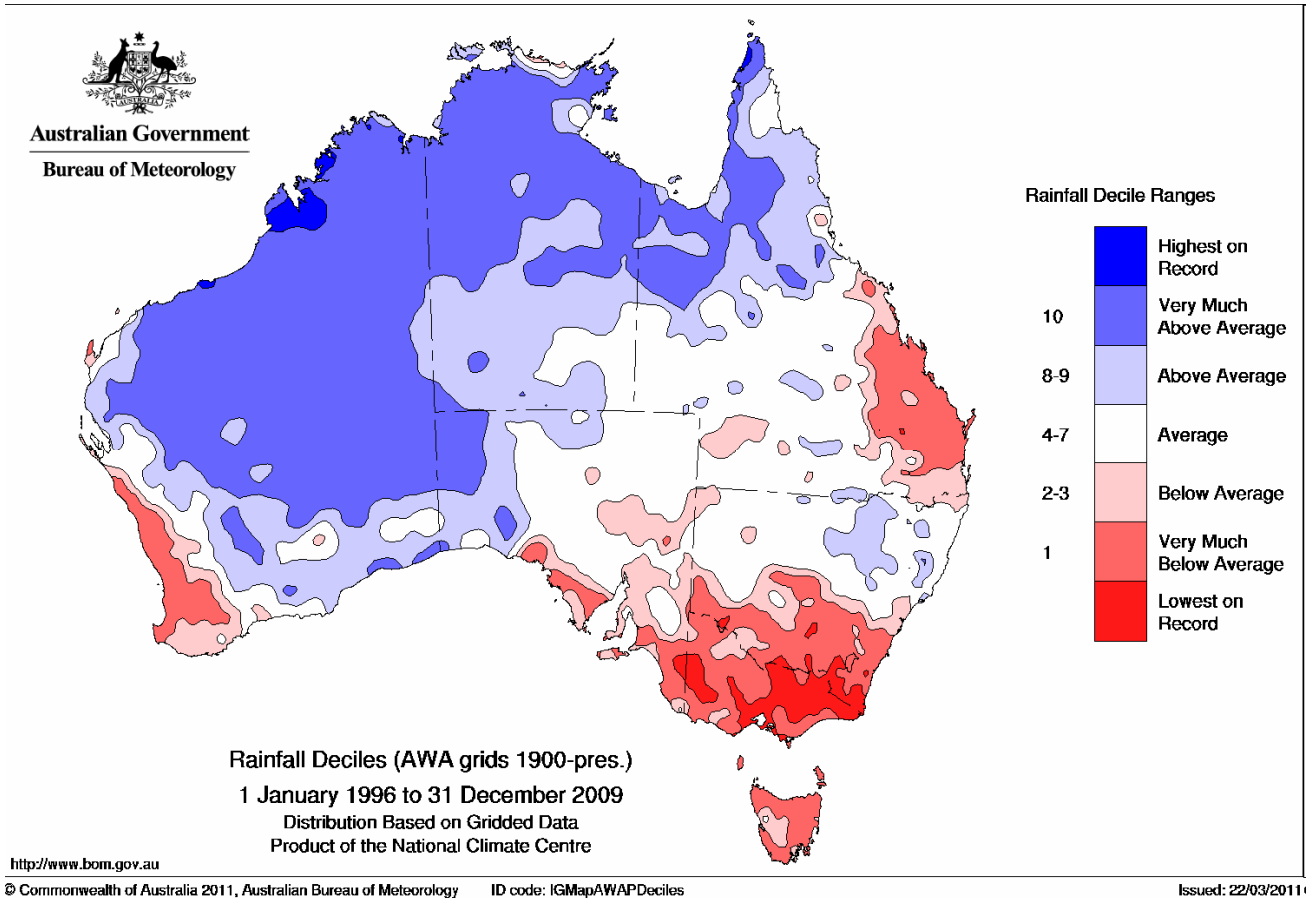
El Nino Events and Australian Drought



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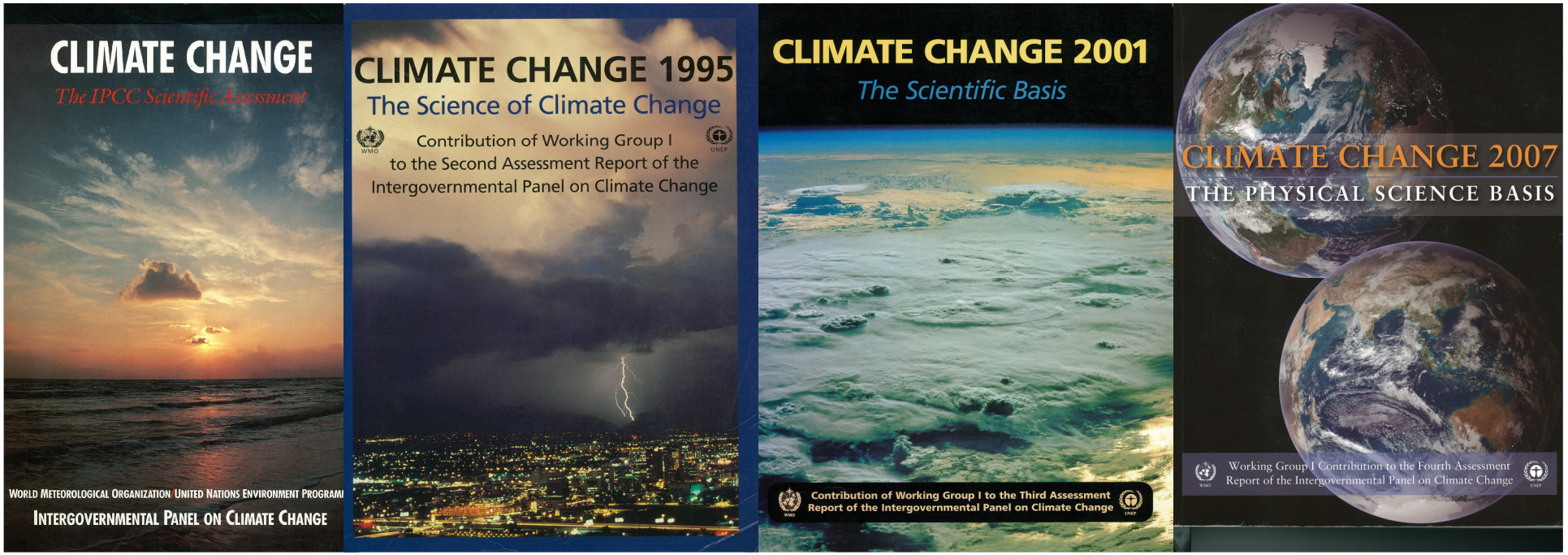
The IPCC scientific conclusions

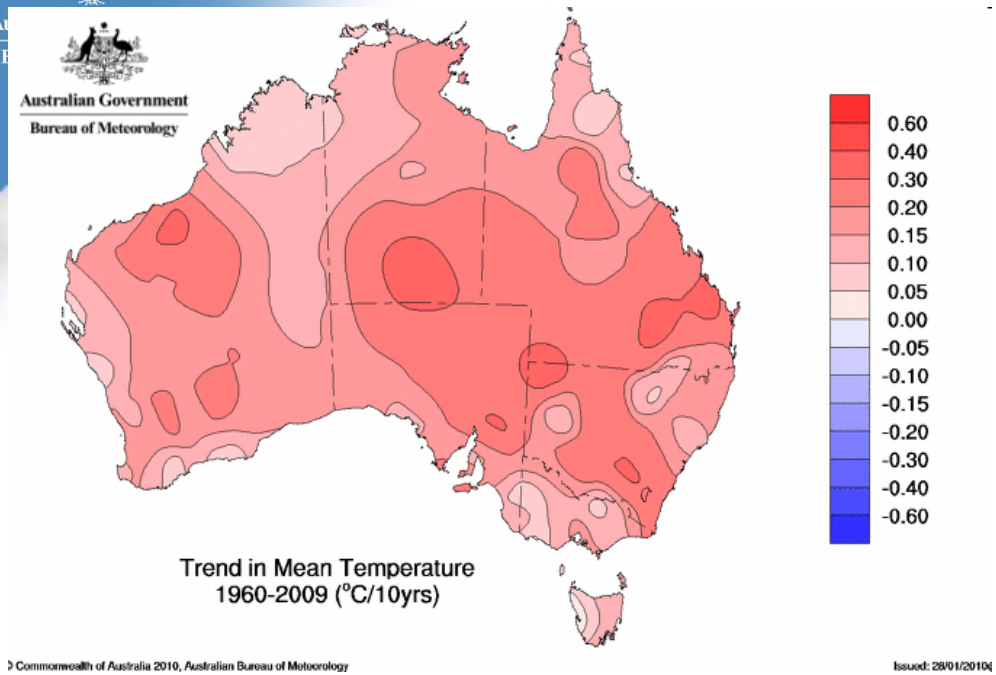
IPCC 2007:

"Warming of the climate system is unequivocal."

"Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic (human) greenhouse gas concentrations."

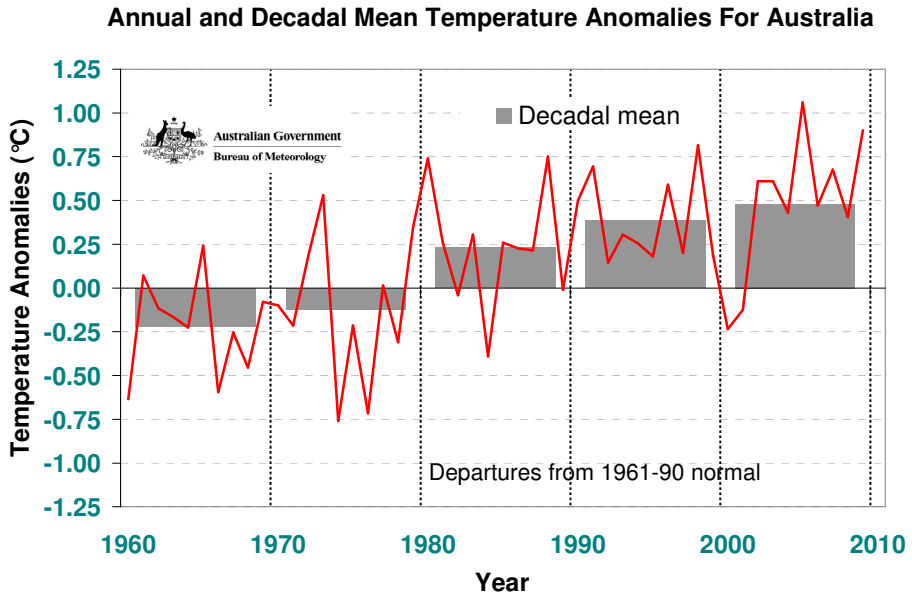


Australian Temperatures



All of Australia has experienced warming over the past 50 years

Some areas, have experienced a warming of 1.5 to 2 °C



Warming, as measured by decadal averages, has been constant since the middle of last century

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Normal Distribution (Bell Curves) for height from two different population samples- Males and Females

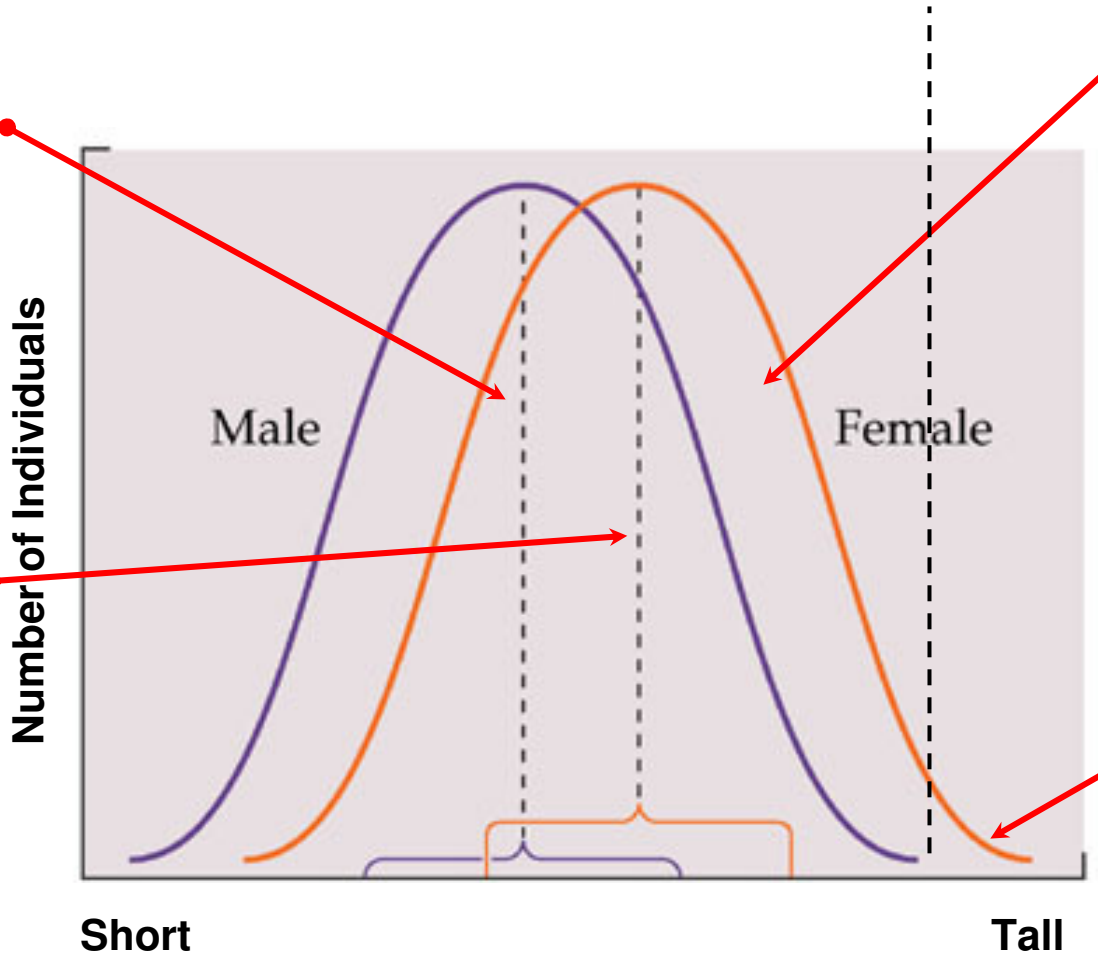
Average Male

Average Female

Overlap in Measure of Trait.

But greater incidence in females

Clear difference in Measure of Trait



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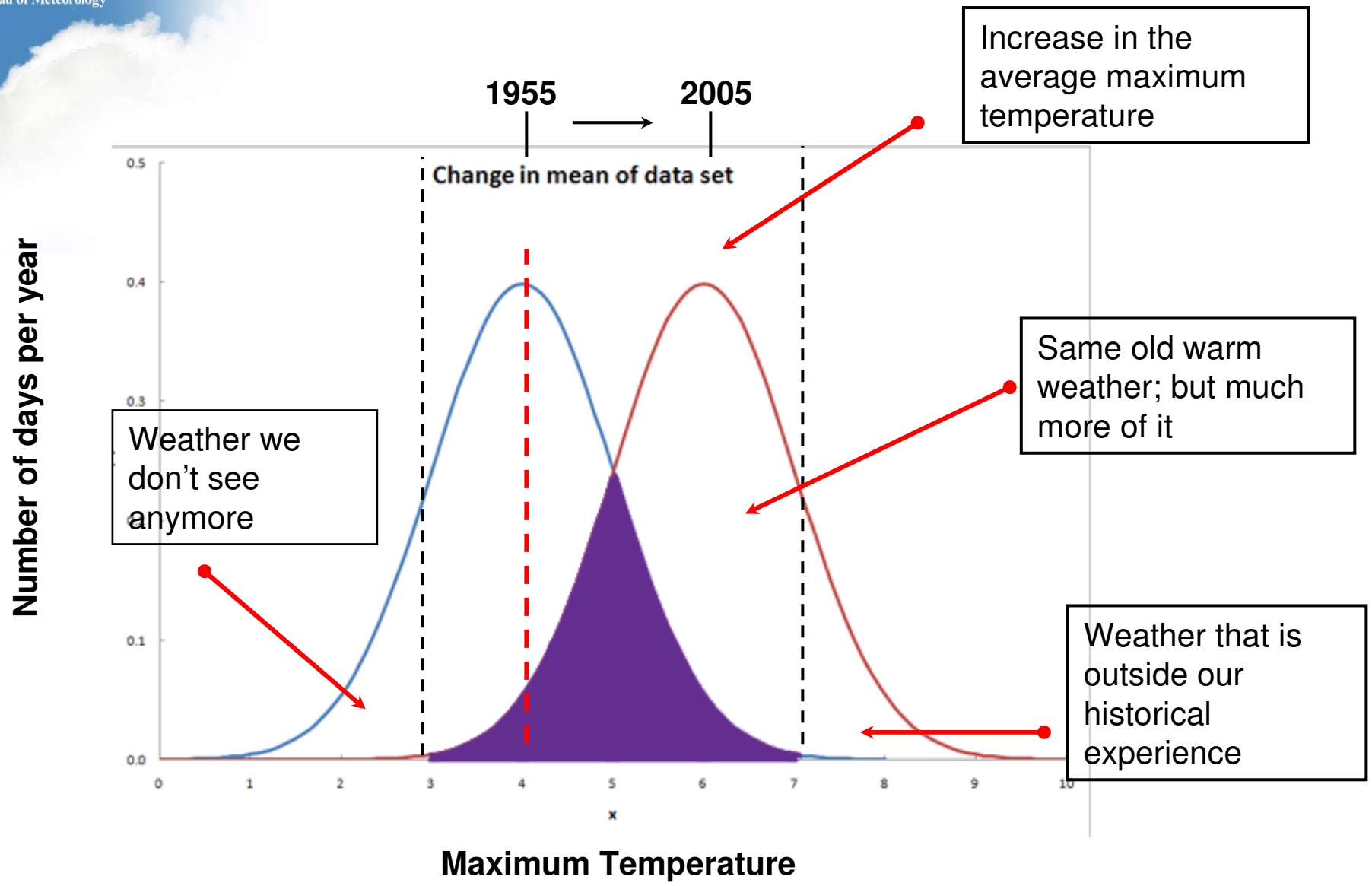
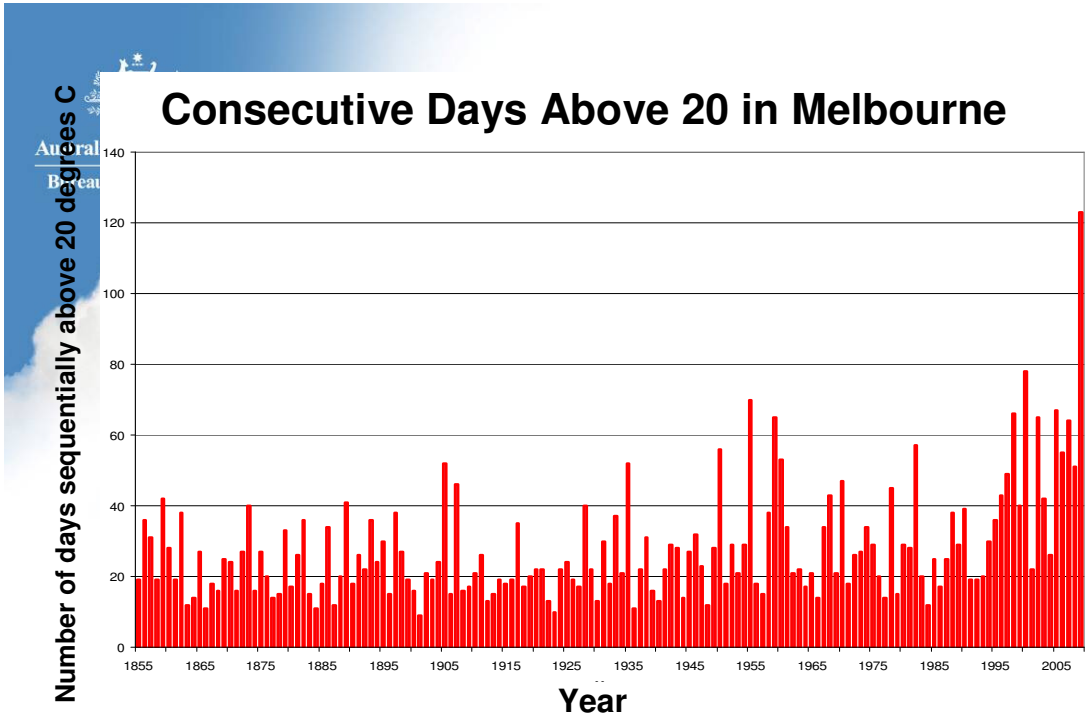
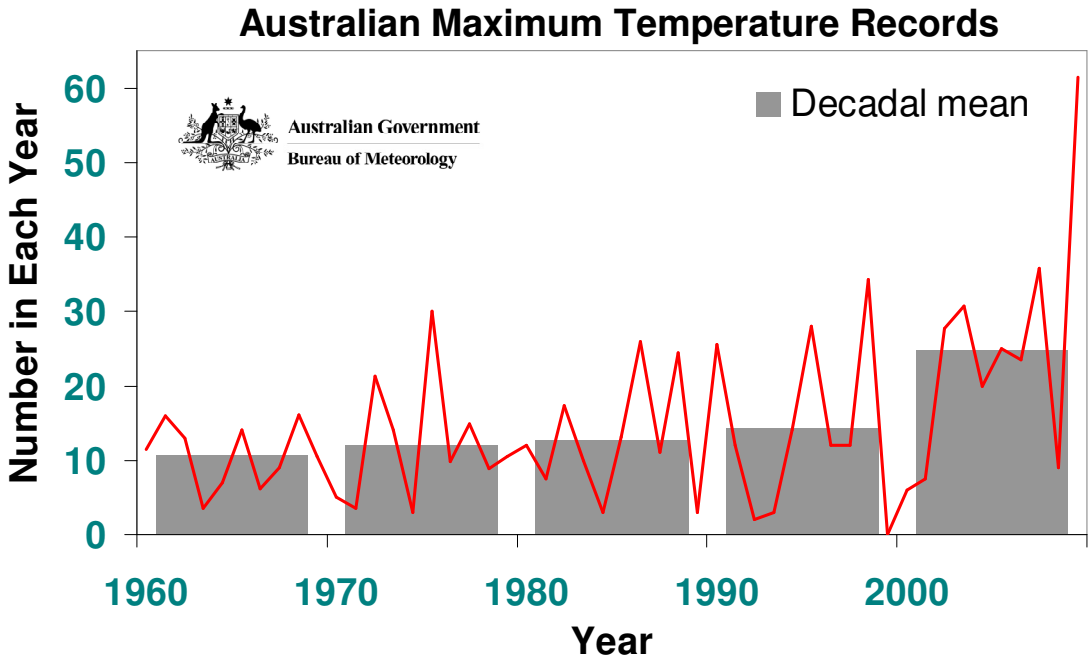
Shift in the frequency of warm weather events





Changes Temperature Extremes

Locations across Australia have experienced less cold weather in recent decades



There is a trend in record heat events for Australia.

More sites recorded highest daily maximum temperatures in 2009 than in any other year

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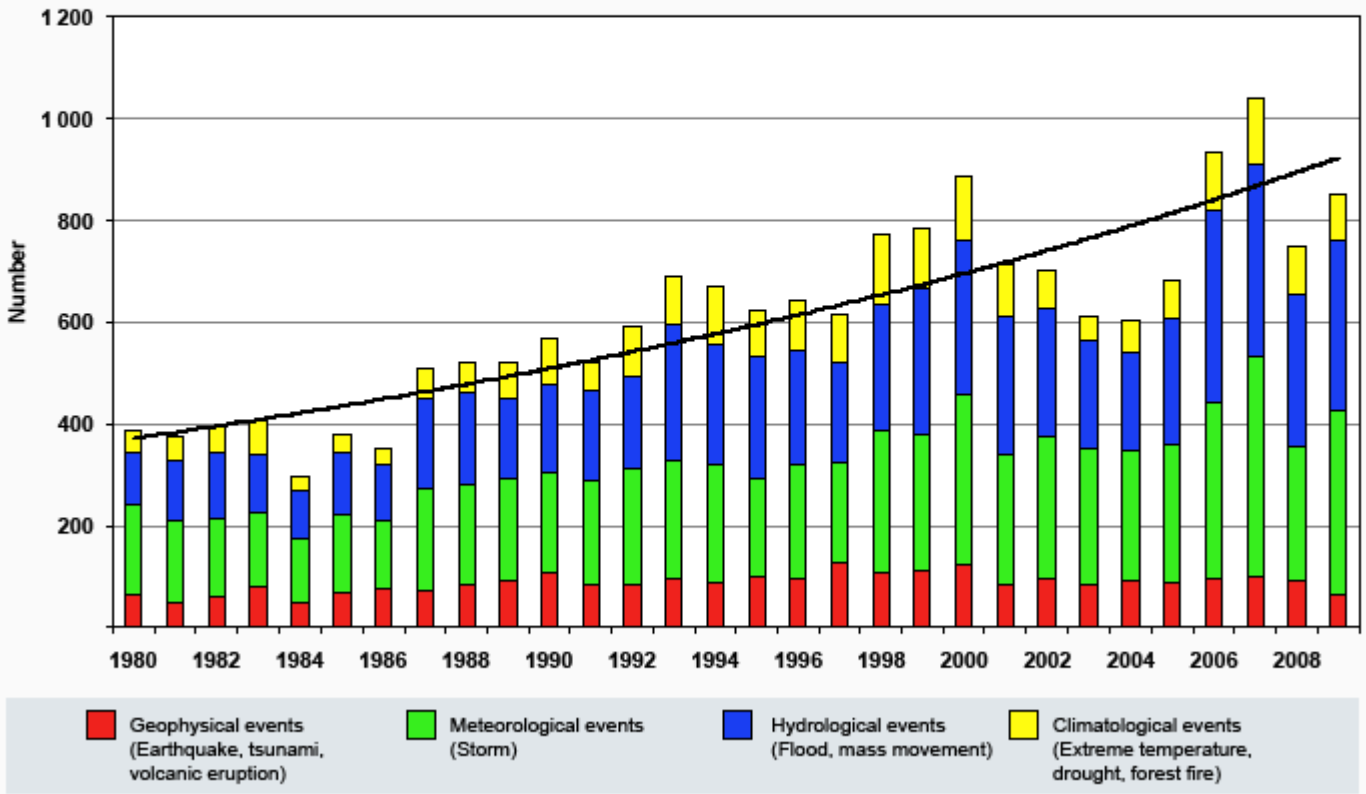
Munich RE Natural Catastrophe Data

NatCatSERVICE

Natural catastrophes worldwide 1980 – 2009

Number of events with trend

Munich RE



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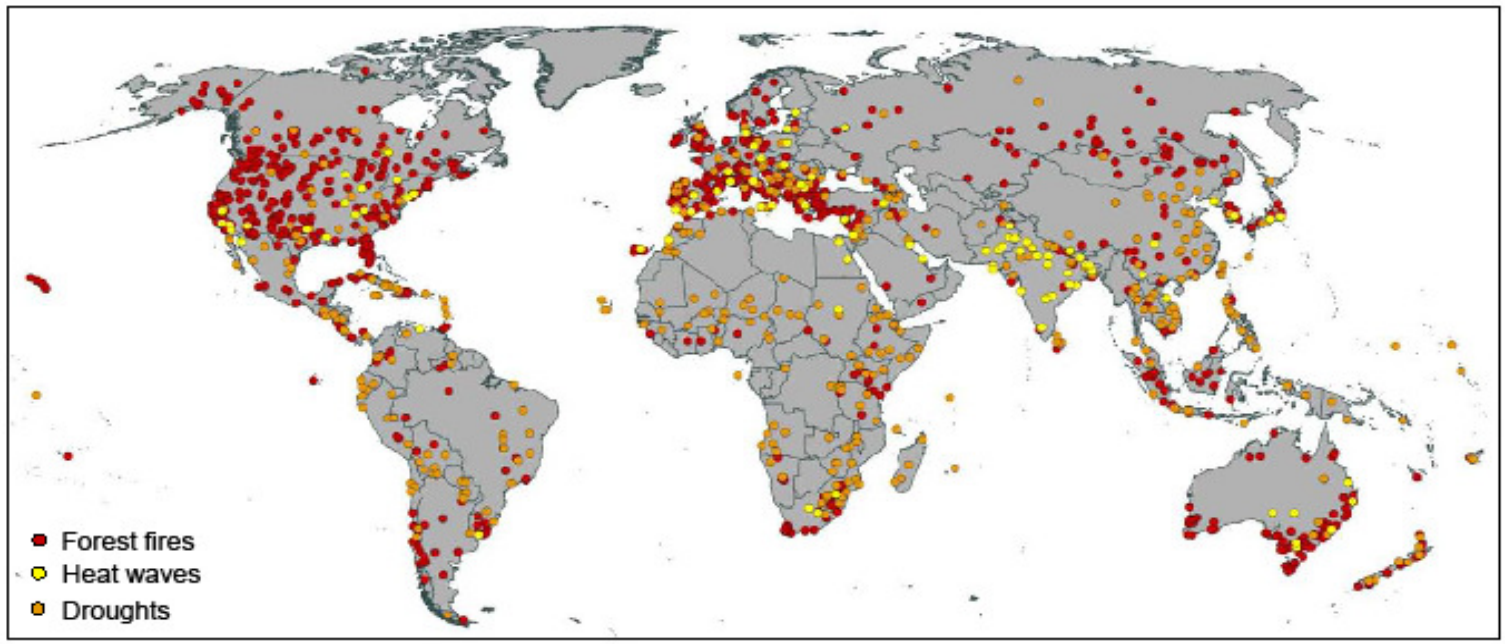
Munich RE Heat Related Events

NatCatSERVICE

Forest fires, heat waves and droughts 1980 – July 2010

Worldmap

Munich RE



The symbols show the most affected regions. The map shows events with property losses and/or fatalities.

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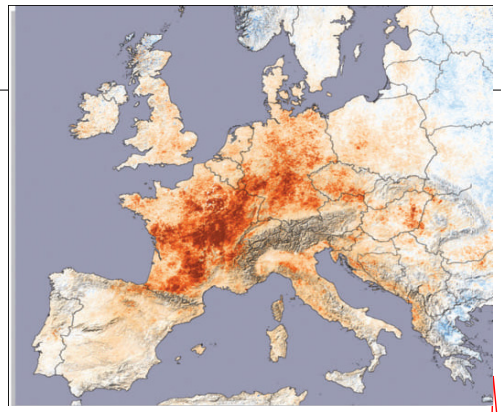
Consider the European Heat Wave of August 2003
Observed Temp. 10W-40E, 10N-50N

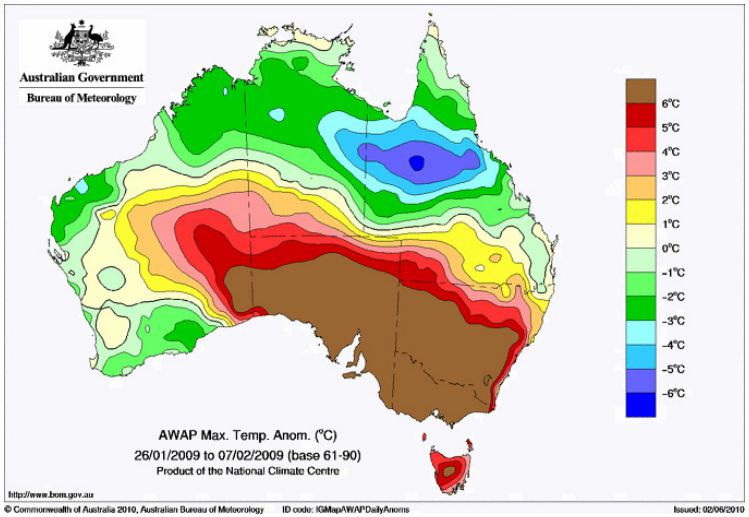


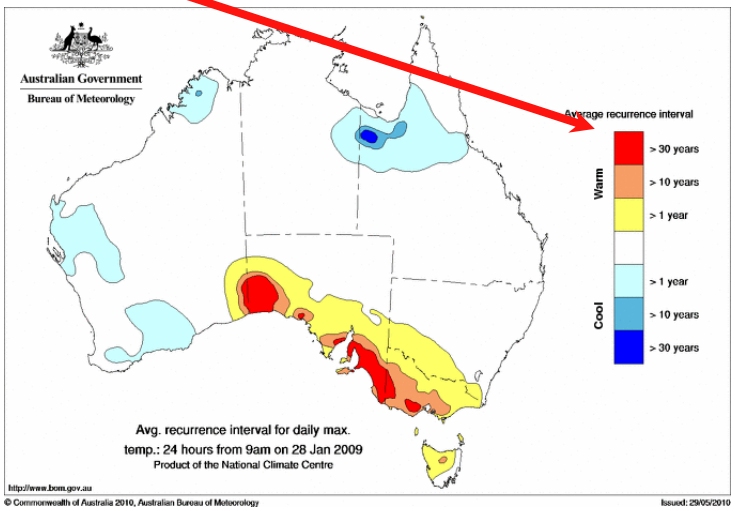
Source of data: UK Met Office

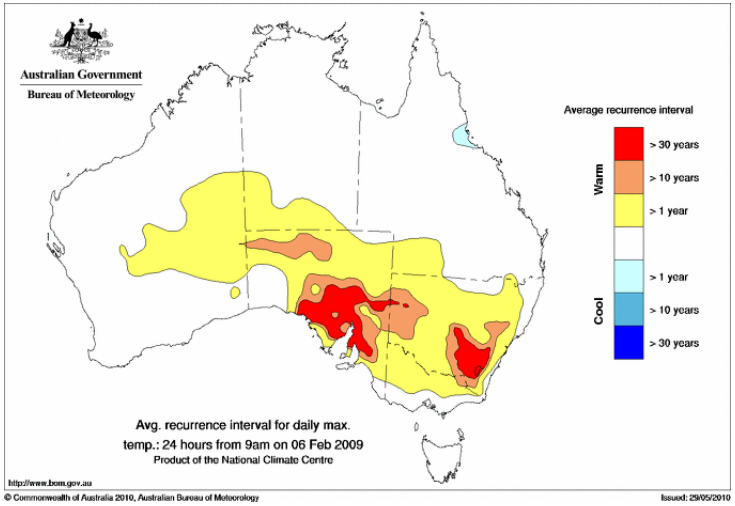
More frequent and severe heat waves

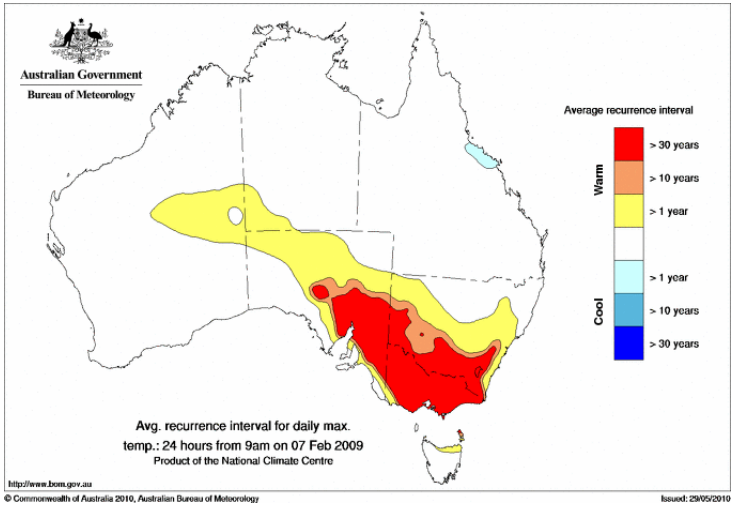
Return Periods (Recurrence Interval)

Indicate the Historical Frequency of an Event.









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Small Shifts can have Large Effects:

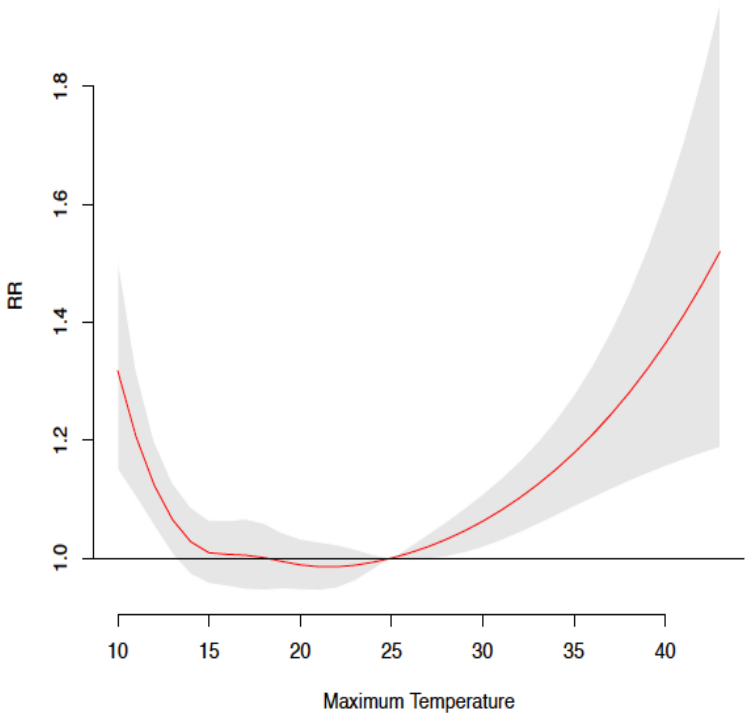
Case Study: Black Saturday, Melbourne 2009

173 Deaths from Bushfires, 414 Injured.

374 Deaths from Extreme Heat

Mortality versus Maximum Temperature

Overall effect of temperature over 30 days of lag



46.4 ℃

Nicholls (2010)

Key findings of the Chief Health Officer's report on the January 2009 heatwave

- 25 per cent increase in the metropolitan Ambulance Victoria total emergency cases and a 46 per cent increase over the three hottest days
- 34-fold increase in metropolitan Ambulance Victoria cases with direct heat-related conditions (61 per cent in those 75 years and older)
- 12 per cent increase in emergency department presentations, with a greater proportion of acutely ill patients and a 37 per cent increase in those 75 years and older
- eight-fold increase in direct heat-related emergency department presentations (46 per cent in those aged 75 years and older)
- an almost three-fold increase in patients dead on arrival (69 per cent being 75 years and older) at emergency departments
- 374 additional deaths over what would be expected, which was a 62 per cent increase in total all-cause mortality
- the greatest number of deaths occurred in those 75 years or older.

Vic Gov (Aged Care, 2010)

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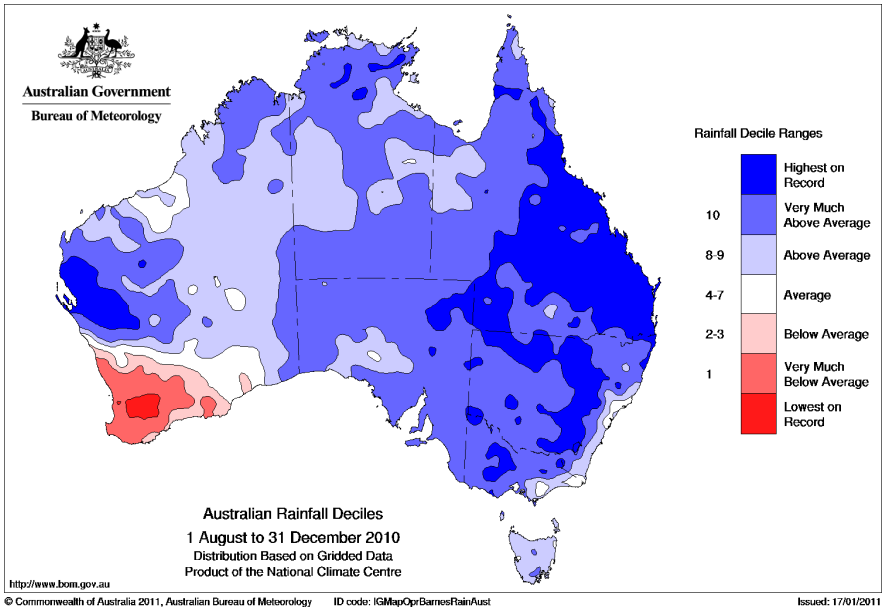
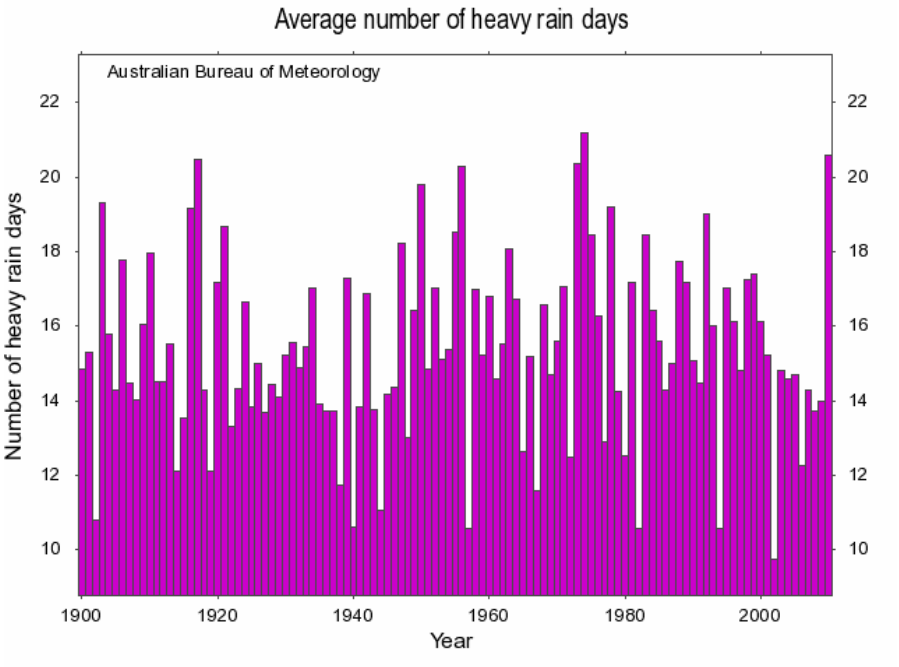
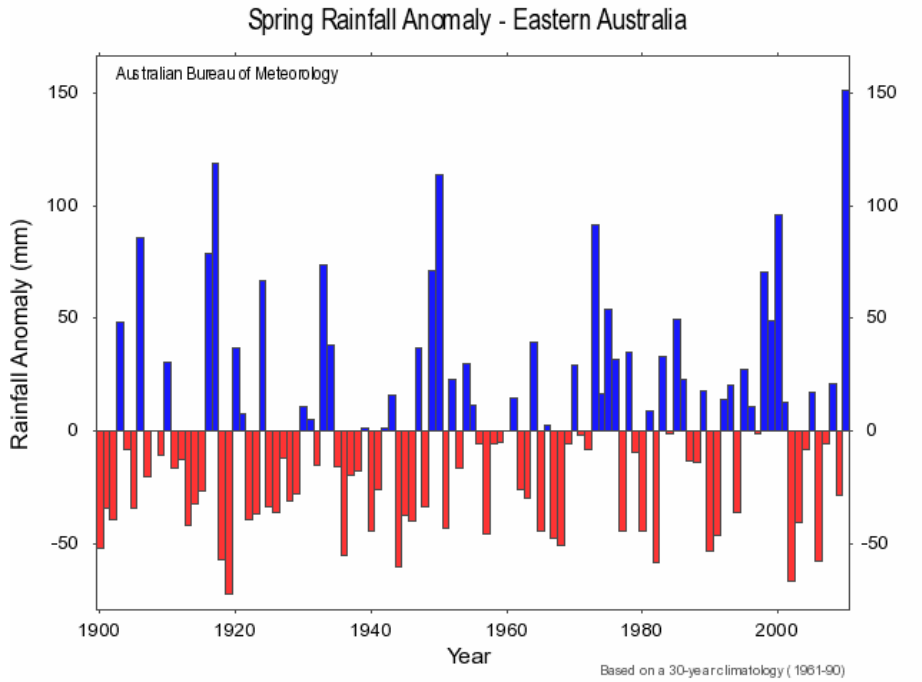
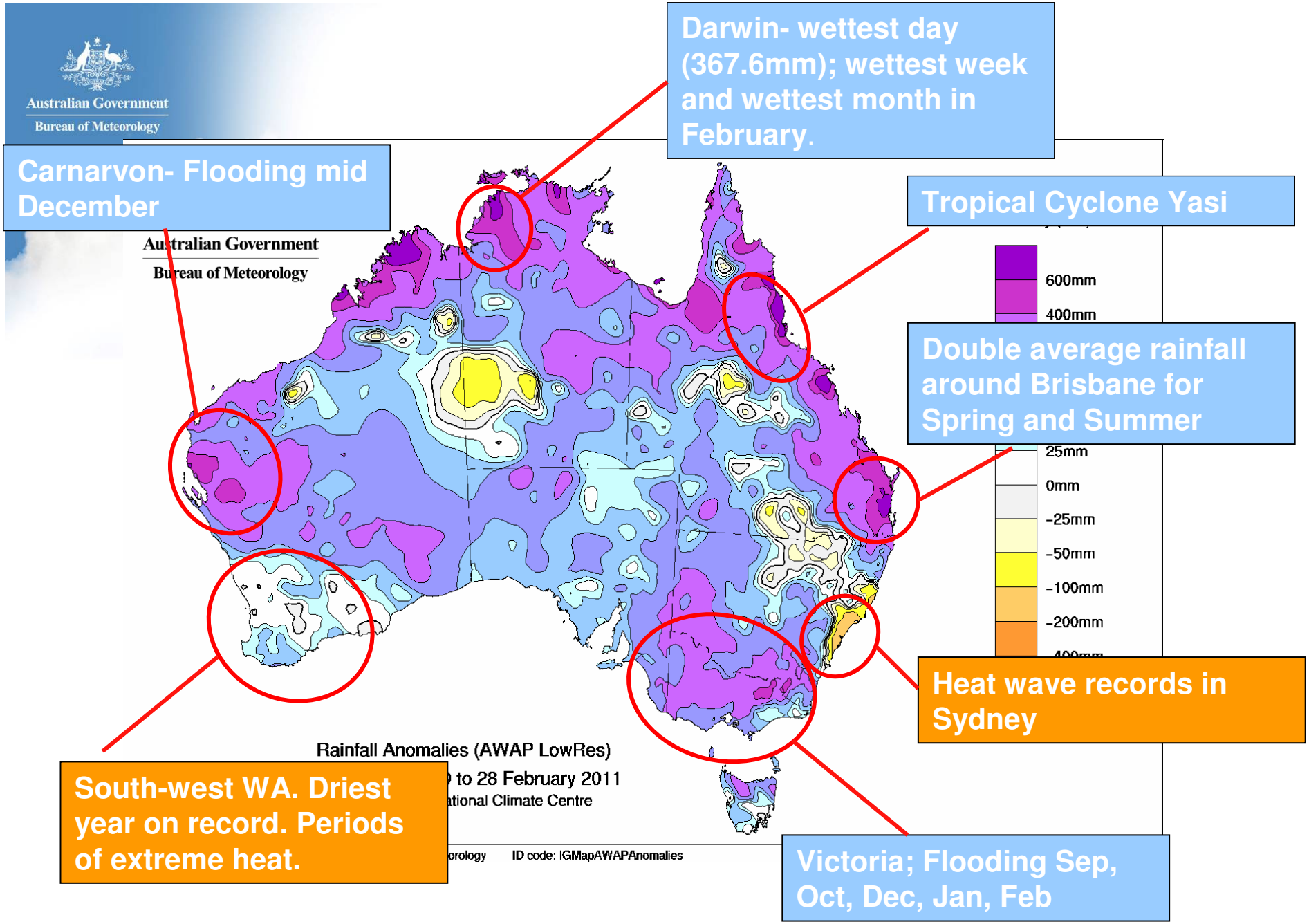
Extreme Weather in 2010/2011





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Darwin- wettest day (367.6mm); wettest week and wettest month in February.
Carnarvon- Flooding mid December
Tropical Cyclone Yasi
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600mm
400mm
Double average rainfall around Brisbane for Spring and Summer
25mm
0mm
-25mm
-50mm
-100mm
-200mm
Heat wave records in Sydney
Rainfall Anomalies (AWAP LowRes)
to 28 February 2011
tional Climate Centre
South-west WA. Driest year on record. Periods of extreme heat.
orology
ID code: IGMapAWAPAnomalies
Victoria; Flooding Sep, Oct, Dec, Jan, Feb

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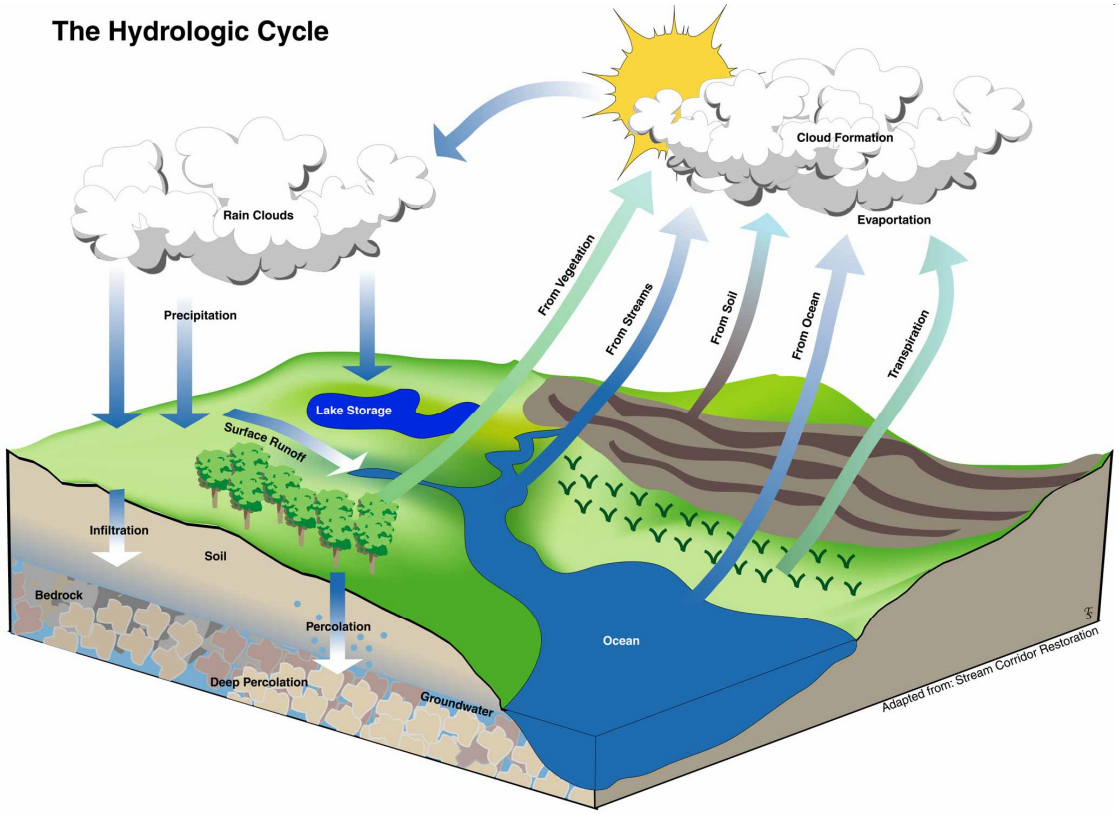
Intensification of the Hydrological Cycle

Globally averaged mean water vapour, evaporation and precipitation are projected to increase.

Rainfall will increase in the Tropics (monsoonal regions).

Rainfall will be more intense (heavy rainfall)

General decreases in rainfall will occur over the subtropics.



Even in areas where average rainfall decreases, rainfall intensity is projected to increase; but there would be longer periods between rainfall events.

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Changes to the Hydrological Cycle

From IPCC Executive Summary 2007:

For a future warmer climate, the current generation of models indicates that **precipitation generally increases in the areas of regional tropical precipitation maxima (such as the monsoon regimes)** *and over the tropical Pacific in particular, with* **general decreases in the subtropics**, *and increases at high latitudes as a consequence of a general intensification of the global hydrological cycle.* **Globally averaged mean water vapour, evaporation and precipitation are projected to increase**.

Intensity of precipitation events is projected to increase, particularly in tropical and high latitude areas *that experience increases in mean precipitation.* **Even in areas where mean precipitation decreases (most subtropical and mid-latitude regions), precipitation intensity is projected to increase but there would be longer periods between rainfall events.** *There is a tendency for drying of the mid-continental areas during summer, indicating a greater risk of droughts in those regions. Precipitation extremes increase more than does the mean in most tropical and mid- and high-latitude areas.*

Sea Surface Temperatures

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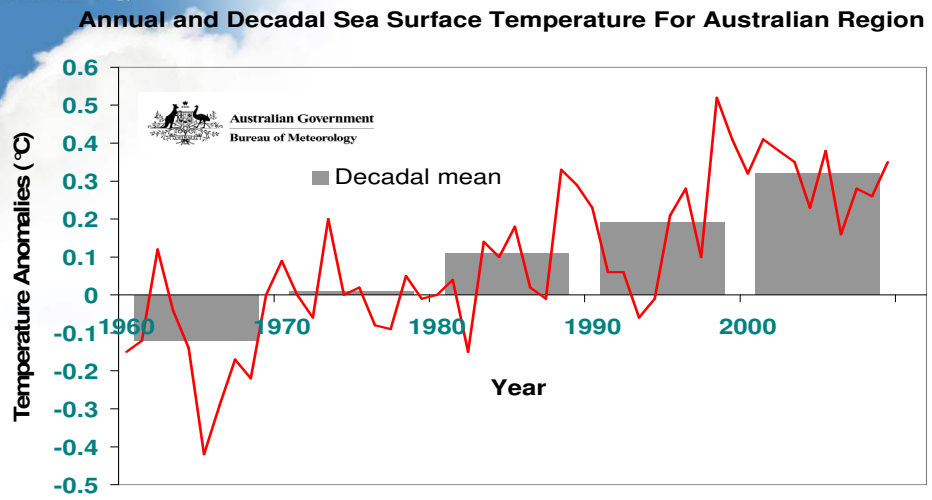

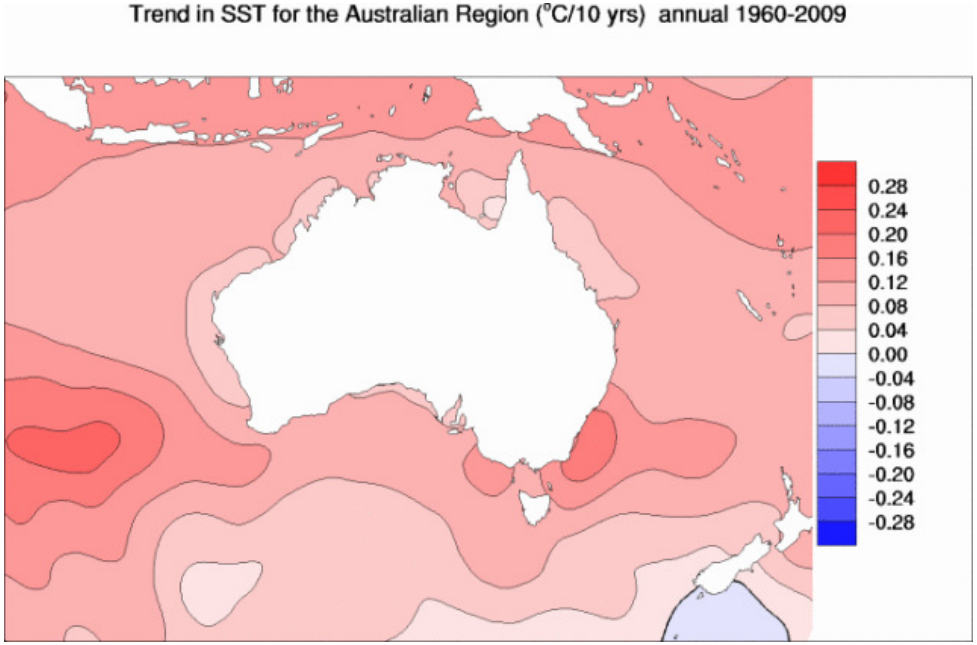

Sea Surface Temperature Increases are consistent with terrestrial warming.

Noting that the instrumentation associated with ocean monitoring is very different to those on the land.

Strongest warming trends are in the Tasman Sea and Indian Ocean

Total warming in these areas has reached up to 1°C

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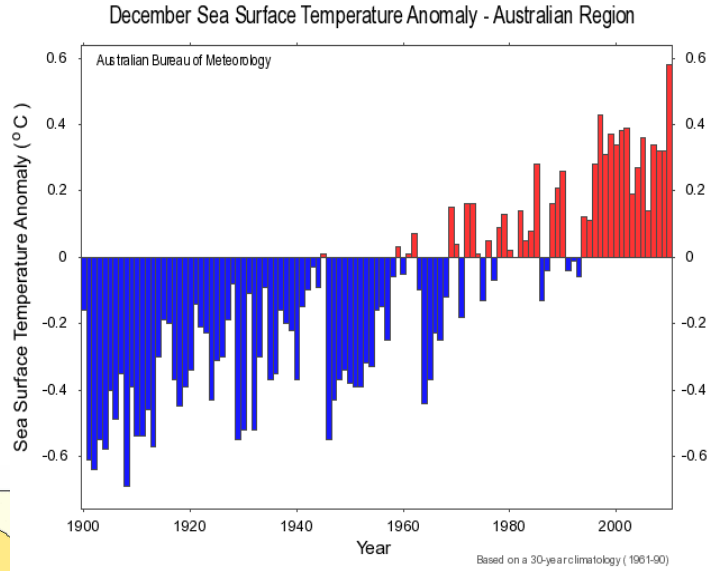
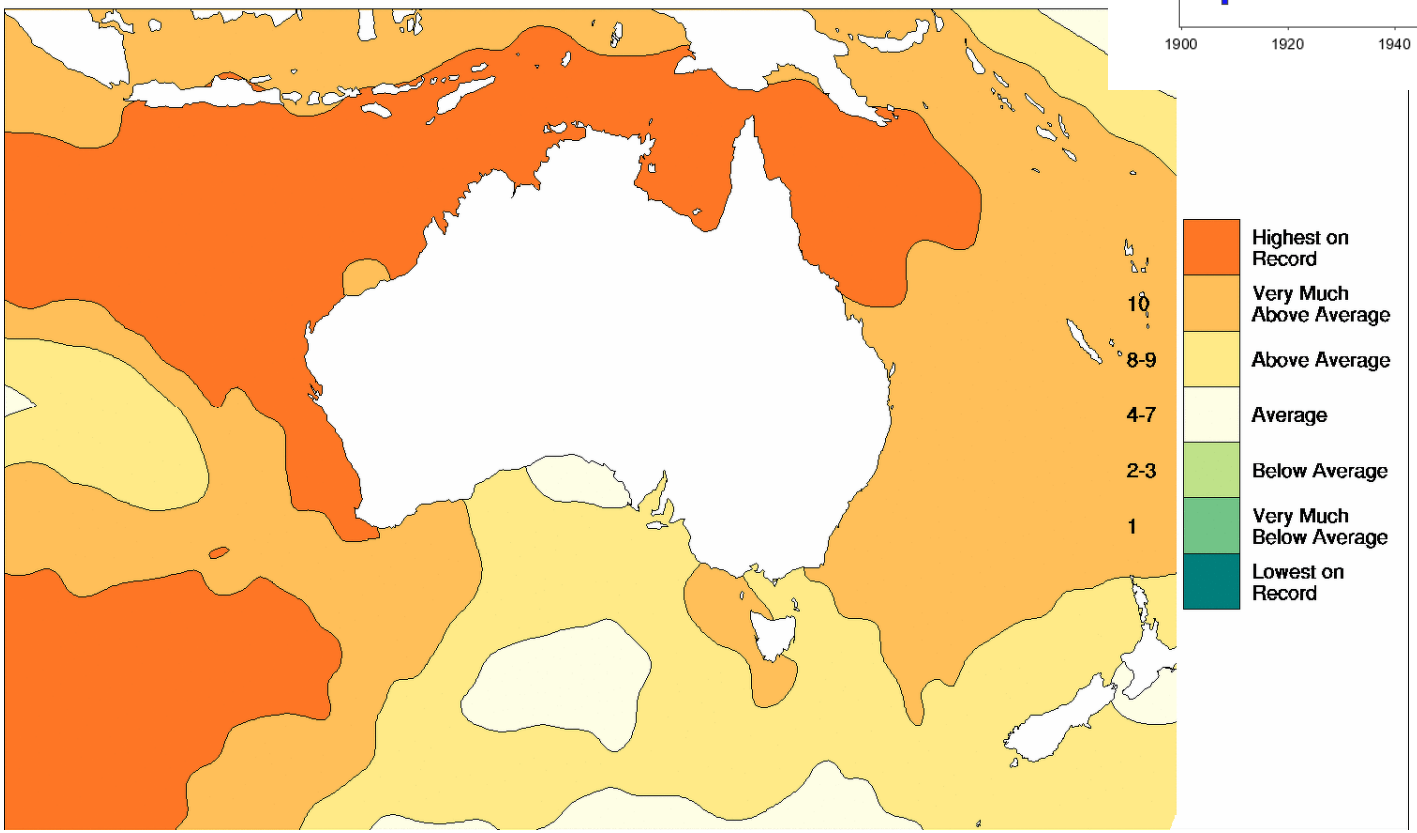
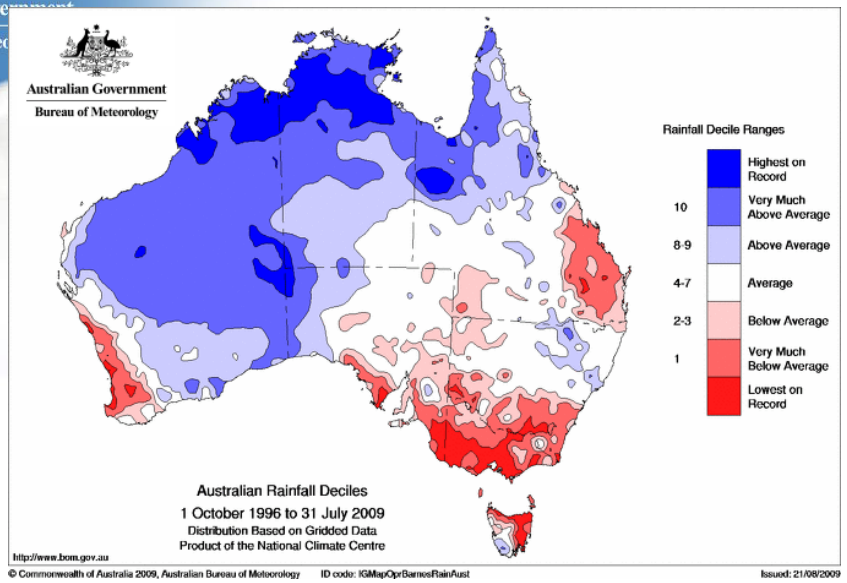
Tropical sea surface temperature was the highest on record for the second half of 2010

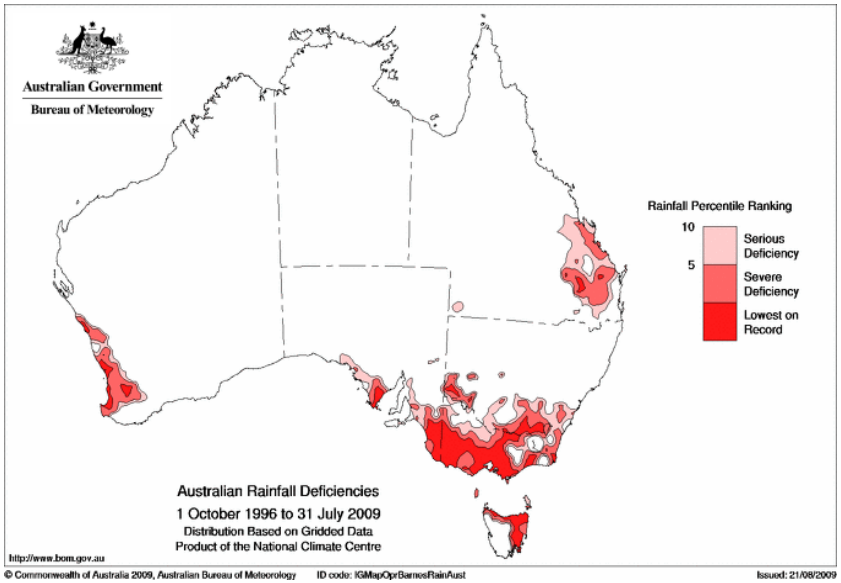


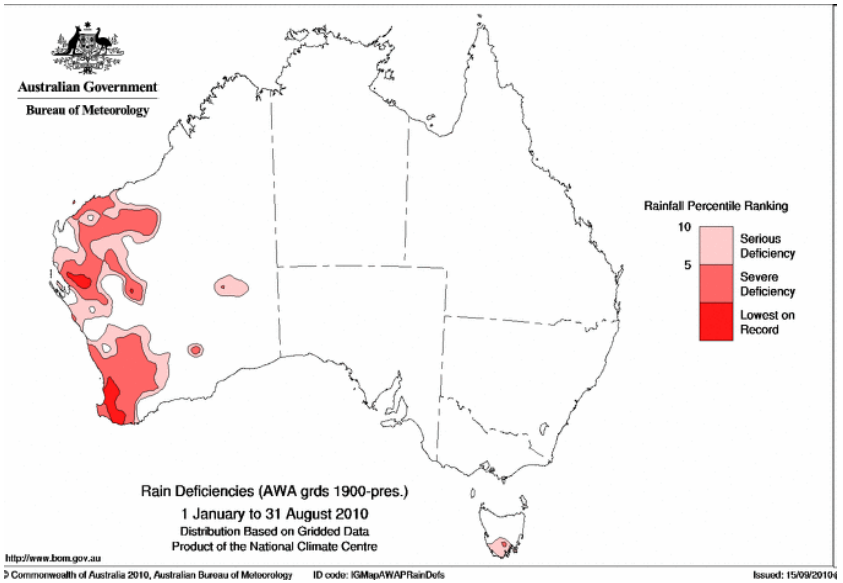


Sep-Dec 2010 Rainfall Deciles.

End of “The Big Dry” ?







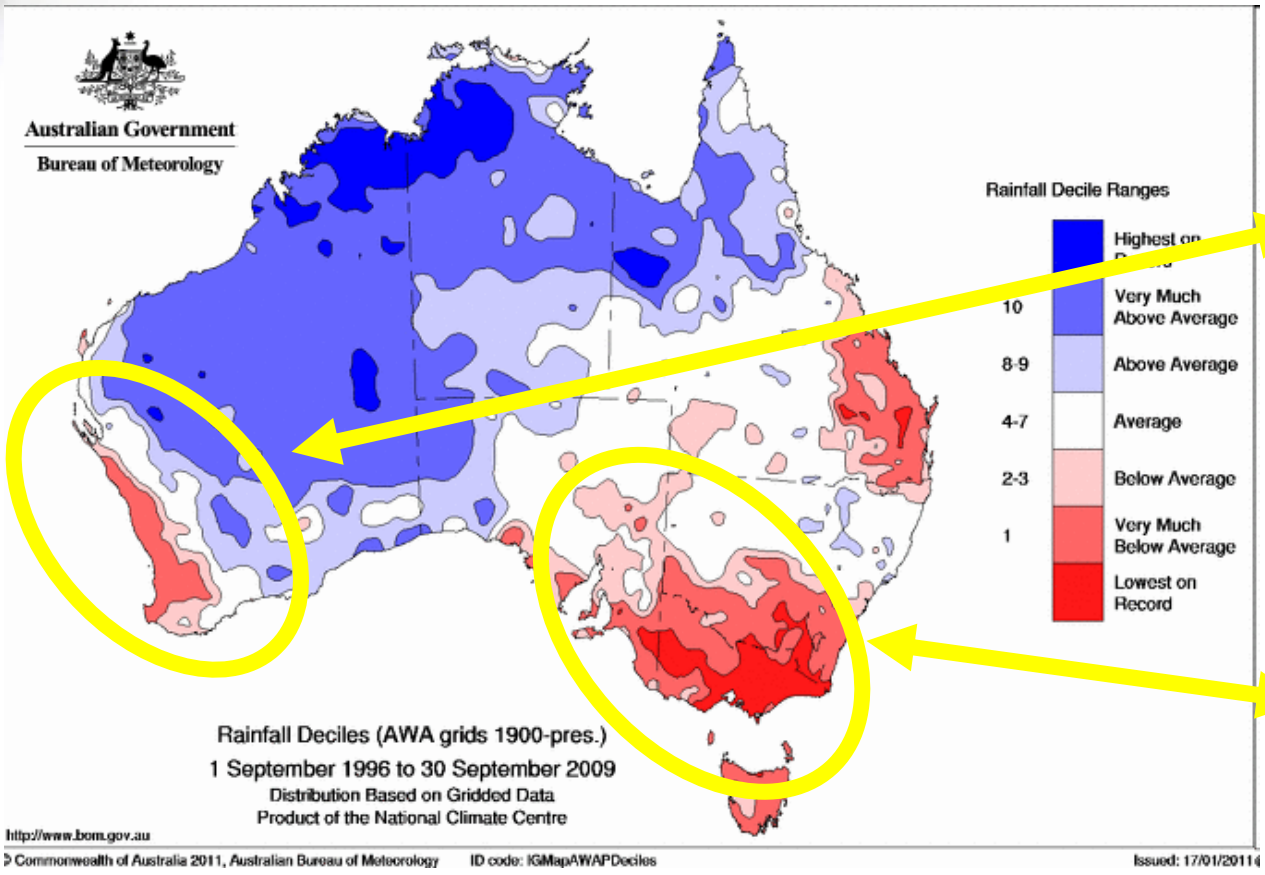
Parts of Australia have recently experienced their worst dry periods on record.

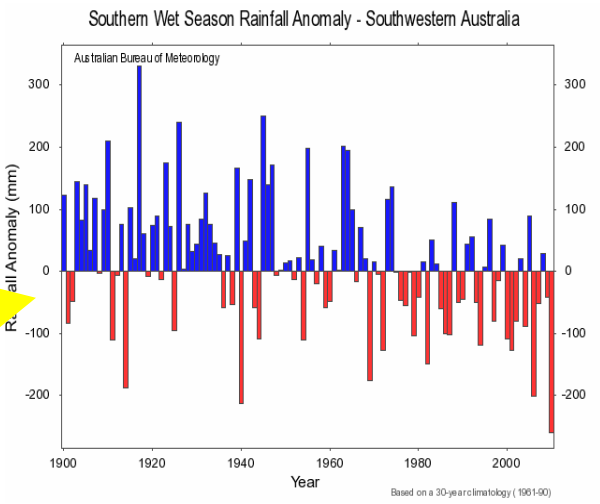
South East Australia; 1996-2010

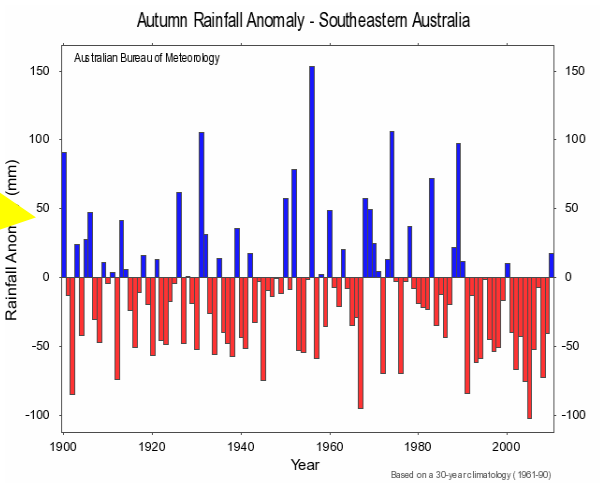
South East Queensland; 1996-2010

South West Western Australia; 1970 - Present

Rainfall Trends are Emerging from the Background Noise







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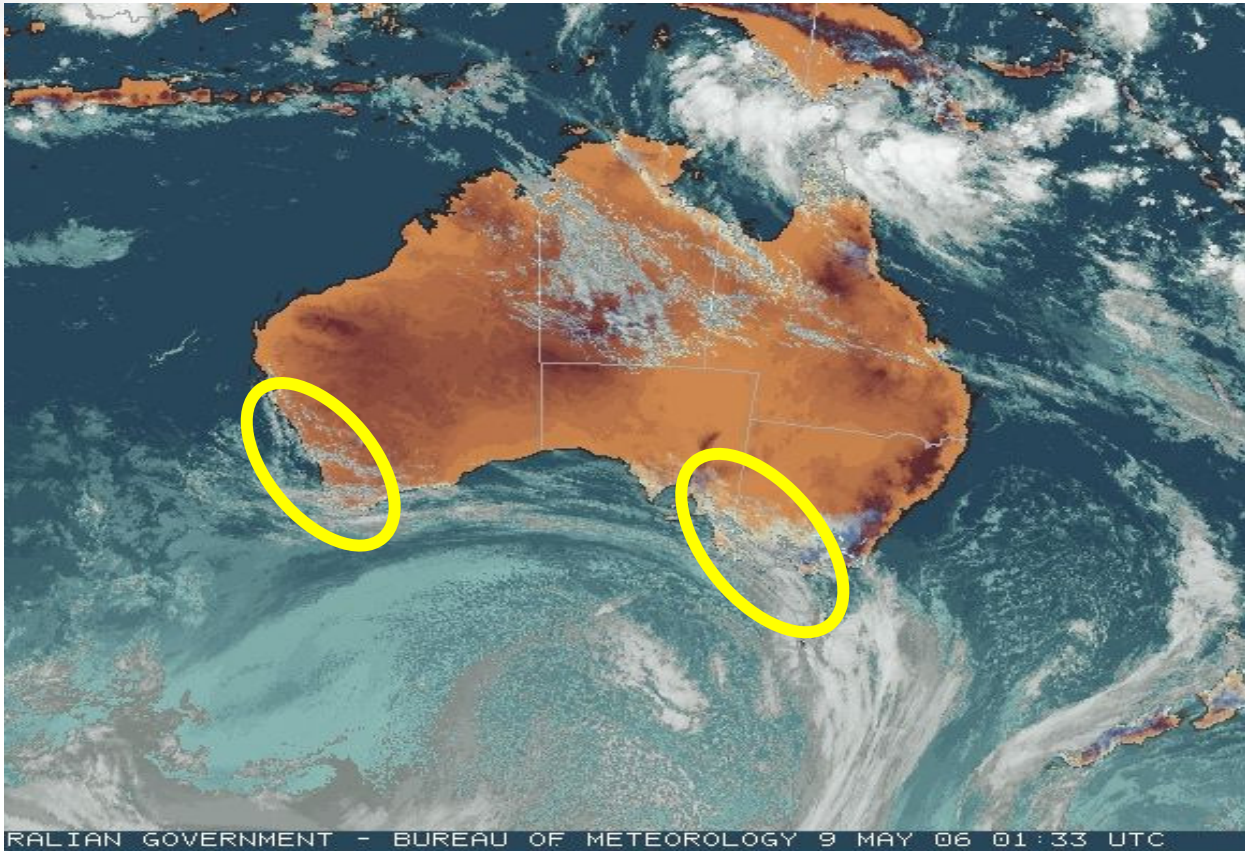
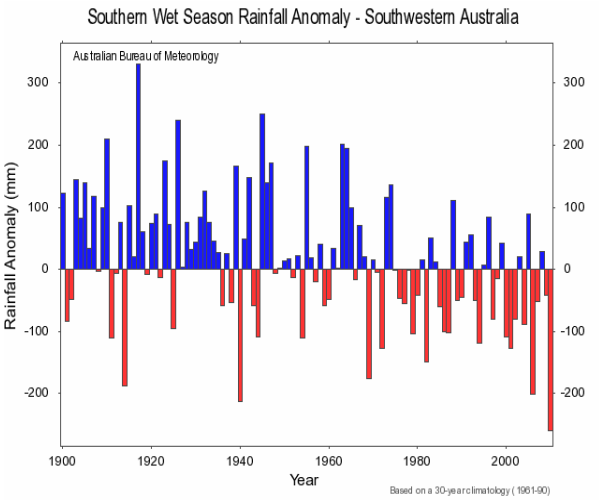
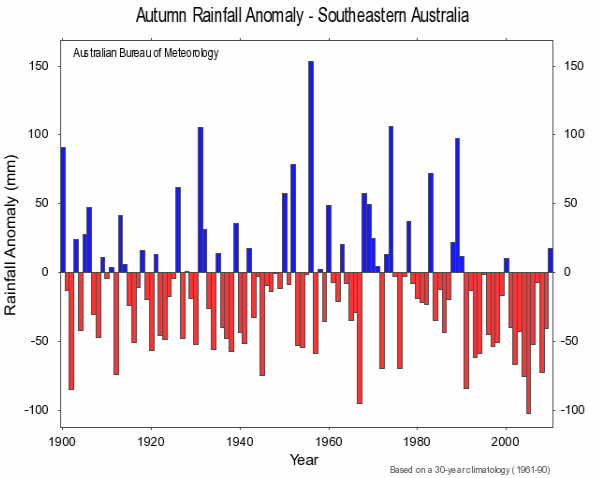
Rainfall Trends are Emerging from the Background Noise







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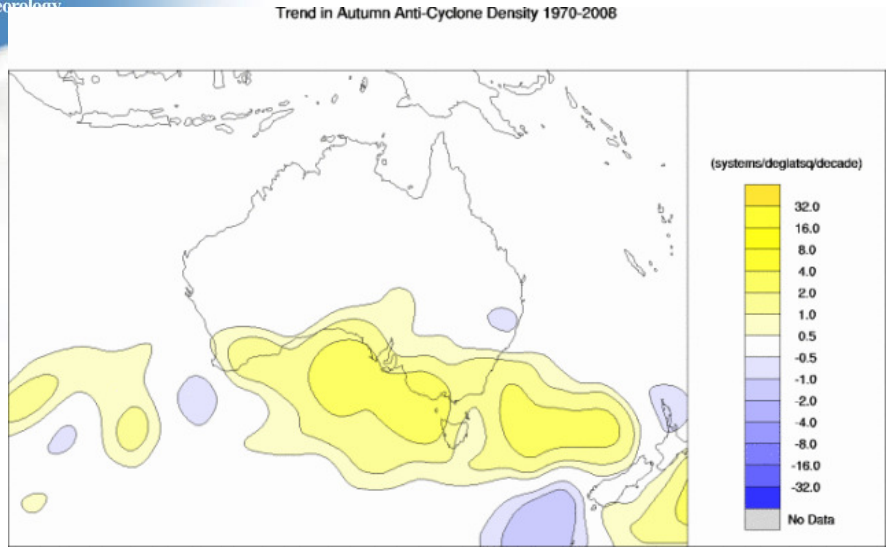
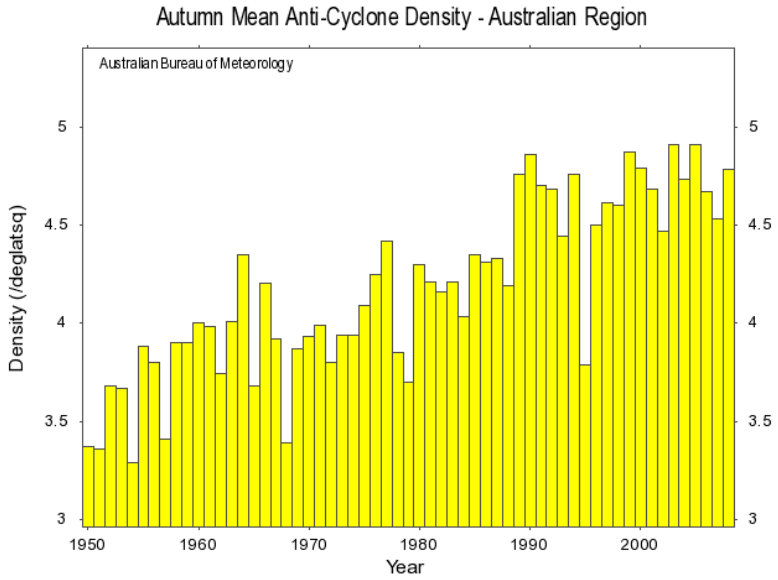
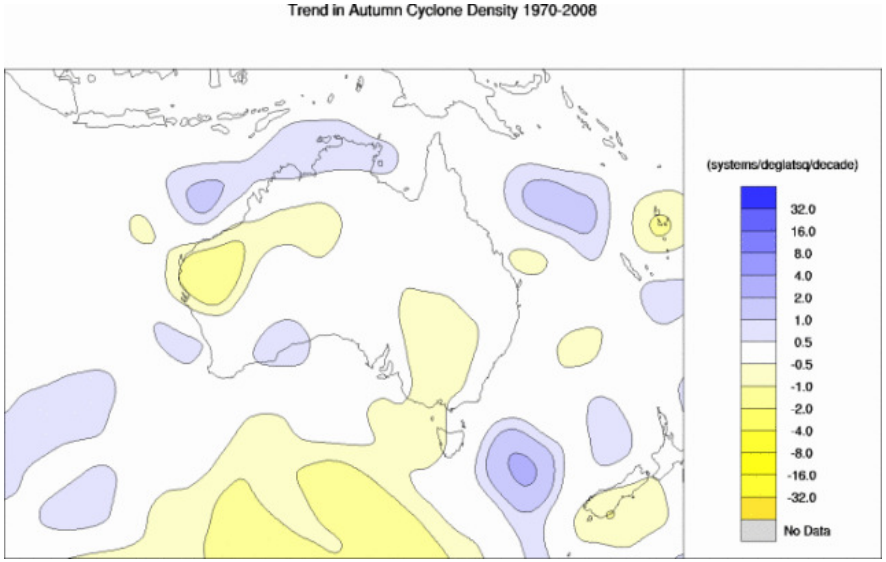
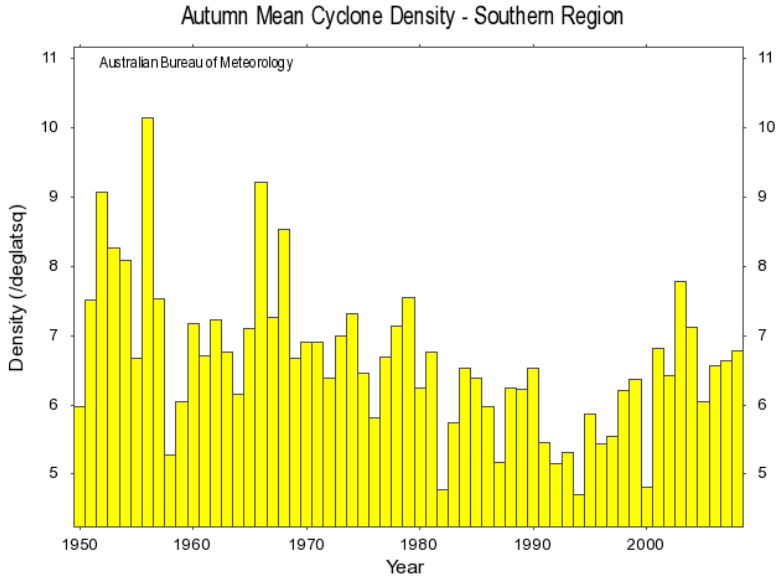
Changes in Rainfall Could be Greenhouse Driven









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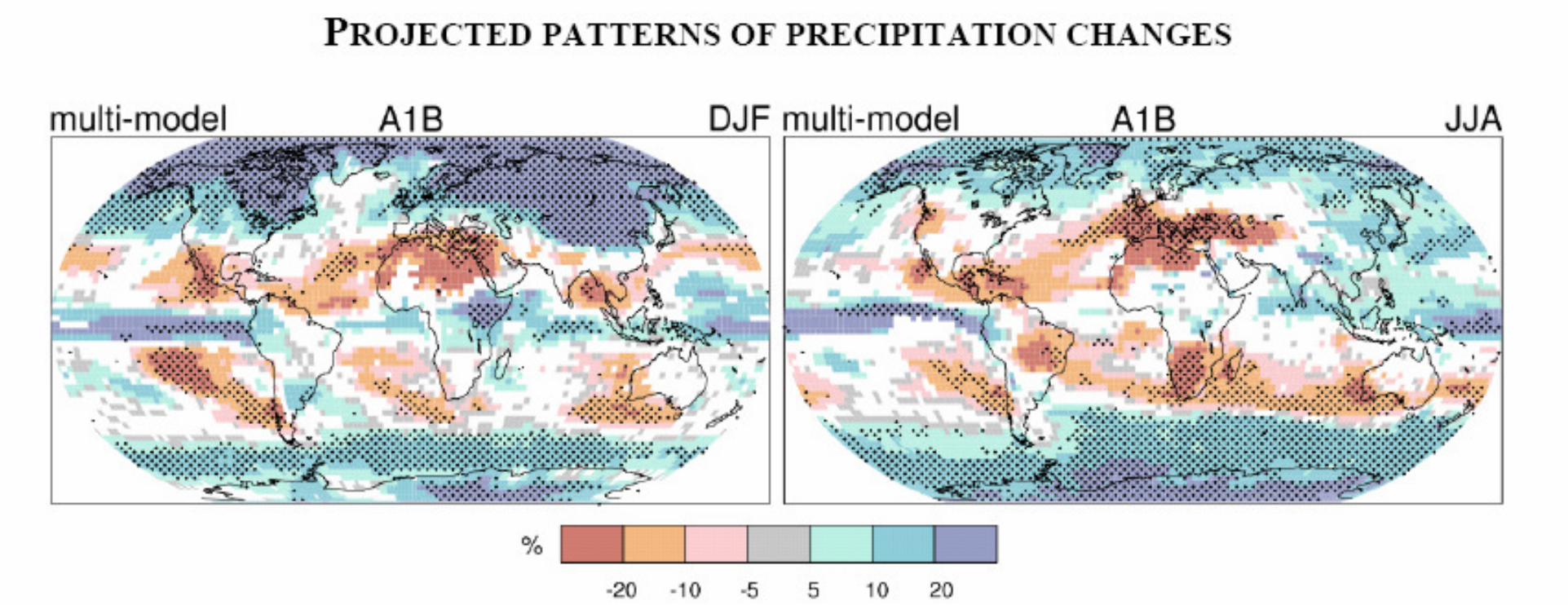
Future Rainfall Changes



Rainfall change for 2090-2099 relative to 1980-1999.

Drying across southern Australia and indeed most subtropical areas

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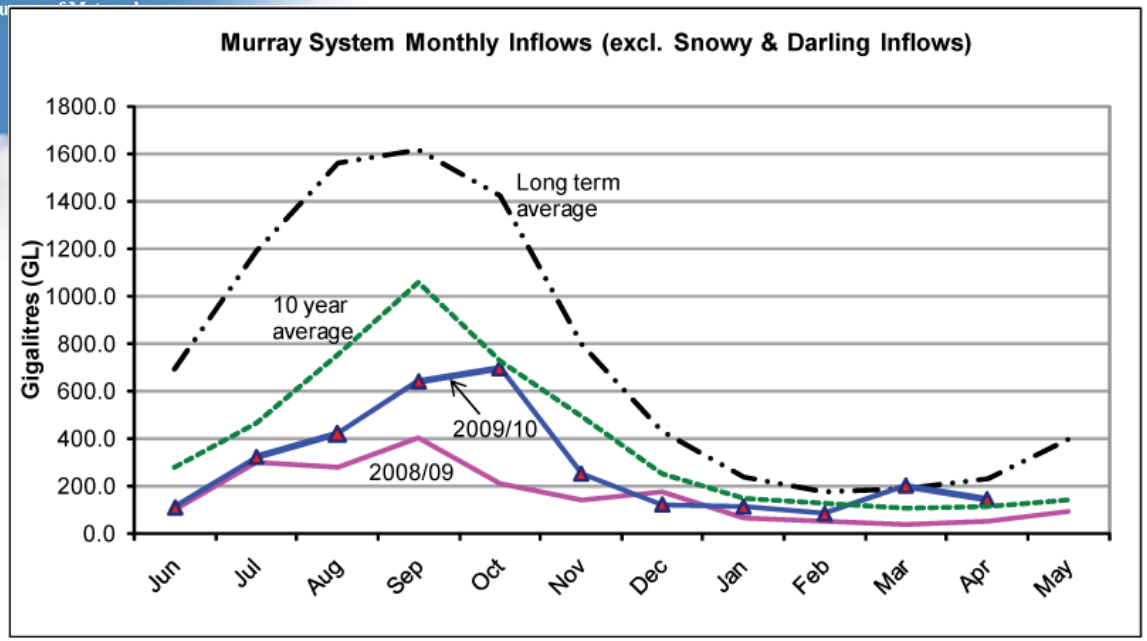
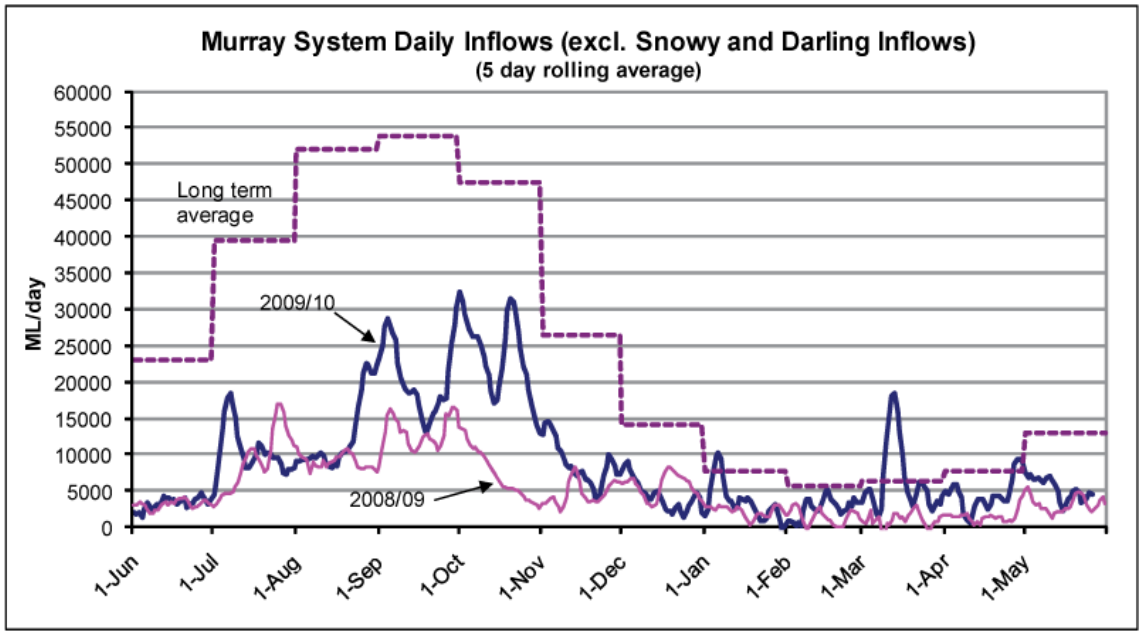
Murray River Inflows





The last 10 years have seen dramatically reduced inflows to the Lower Murray Darling Basin.

This is a function of both reduced rainfall, and the timing of the rainfall decline.

The loss of autumn rainfall has been significant in the lower Basin, since it 'primes' the catchment for runoff during the remaining wet season.

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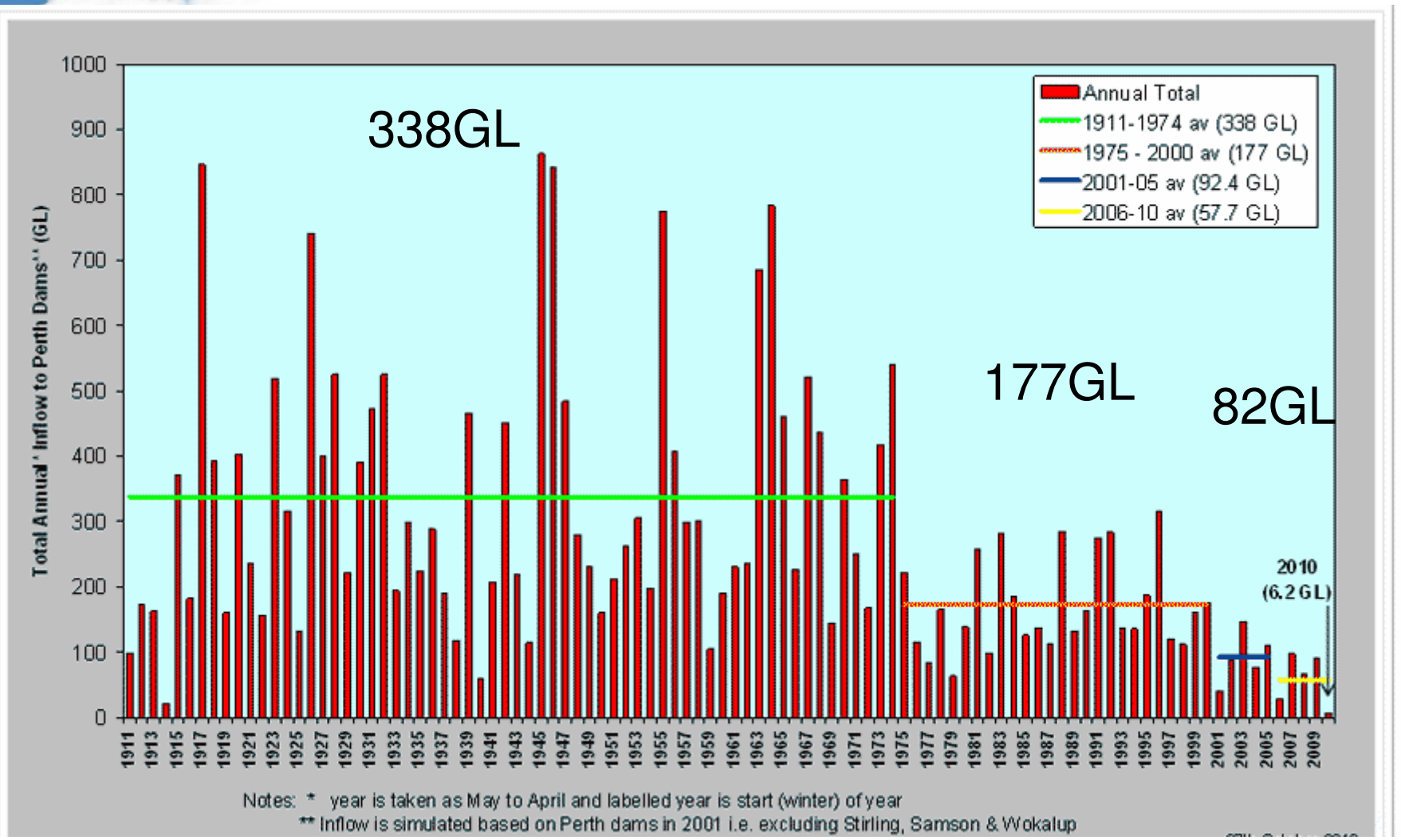
10-20% Reduction in Rainfall Lead to amplified losses in streamflow



Collapse of Perth streamflow as a result of warming and drying

From: http://www.watercorporation.com.au/D/dams_streamflow.cfm

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Prolonged Drought Increases Fire Danger in the Medium Term

Droughts of long duration and exceptional heat can cause persistently dry conditions.

- lessening the effects of seasonal rainfall, fuel remains tinder dry.

- removing natural fire breaks (creeks, soaks, green vegetation) from the environment.

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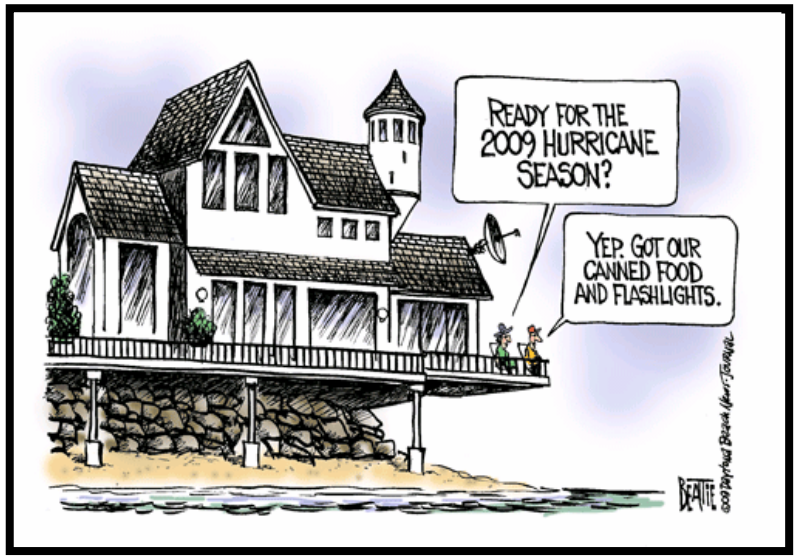
What are the Options?

Mitigation; minimising future climate change

Planned Adaptation; reduce the impact of (or the vulnerability to) climate change

Ad Hoc Adaptation; deal with the consequences as changes occur



http://Goldcoast.com.au

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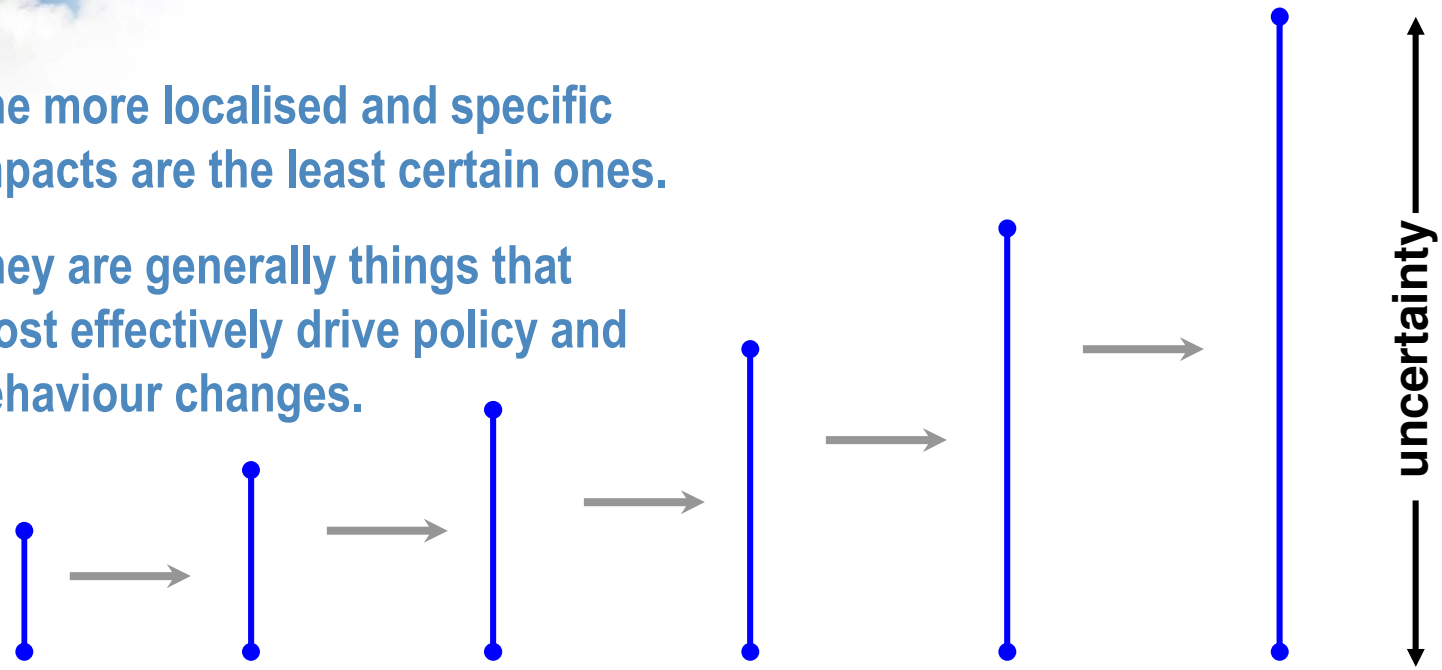
The Uncertainty Cascade

The more localised and specific impacts are the least certain ones.

They are generally things that most effectively drive policy and behaviour changes.



CO_2 emissions

carbon cycle

global climate sensitivity-change

continental scale climate change

regional climate change

specific localised impacts

high certainty | certainty in some metrics | informed guess


The End
Coral Sea
Fitzroy River
Rockhampton
Mackenzie River
clouds
Dawson River
N
20 km