Rainfall in a changing climate

2015 Stormwater Victoria Conference

Karl Braganza

Bureau of Meteorology Climate Monitoring Manager

Australian Government
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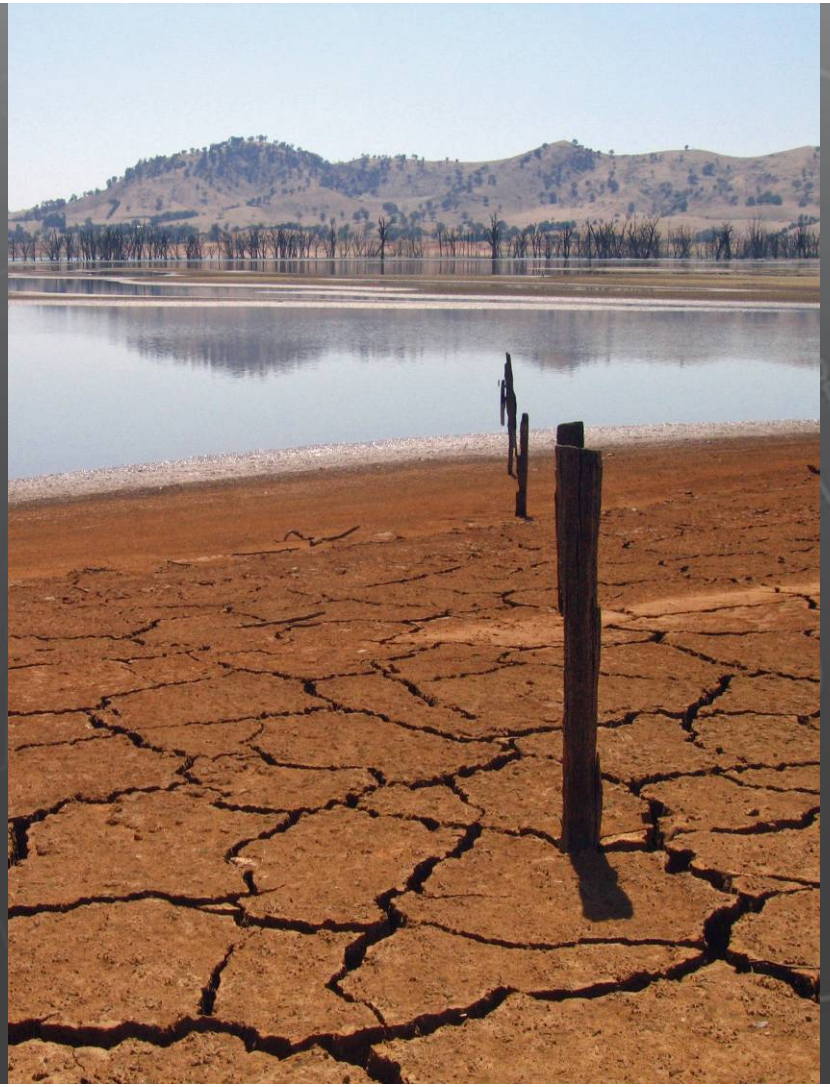
Natural variability:
El Niño and La Niña



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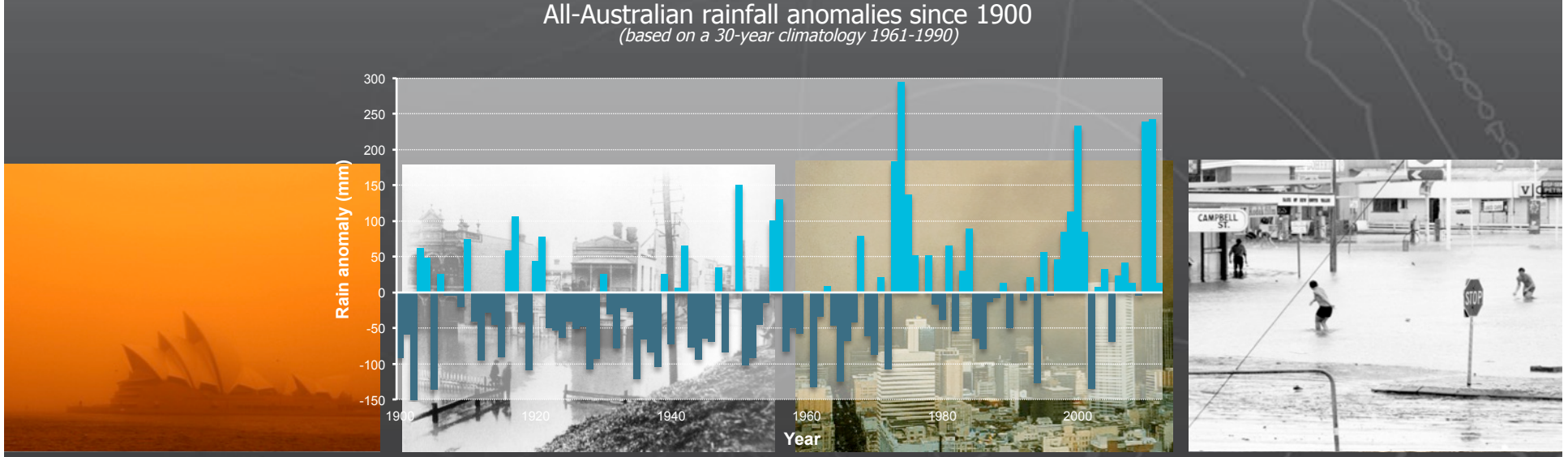
‘…of droughts and flooding rains’



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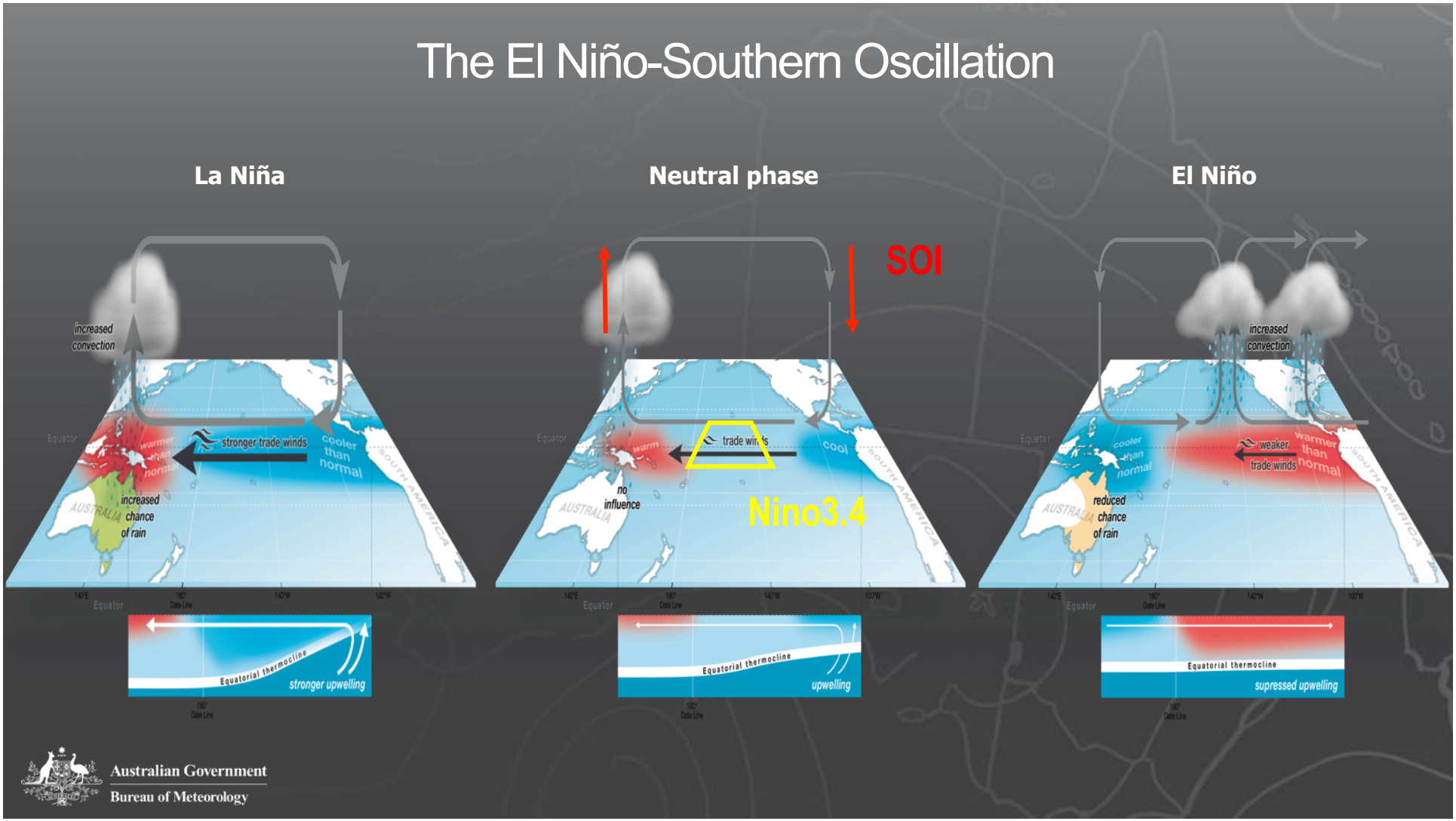
The El Niño-Southern Oscillation



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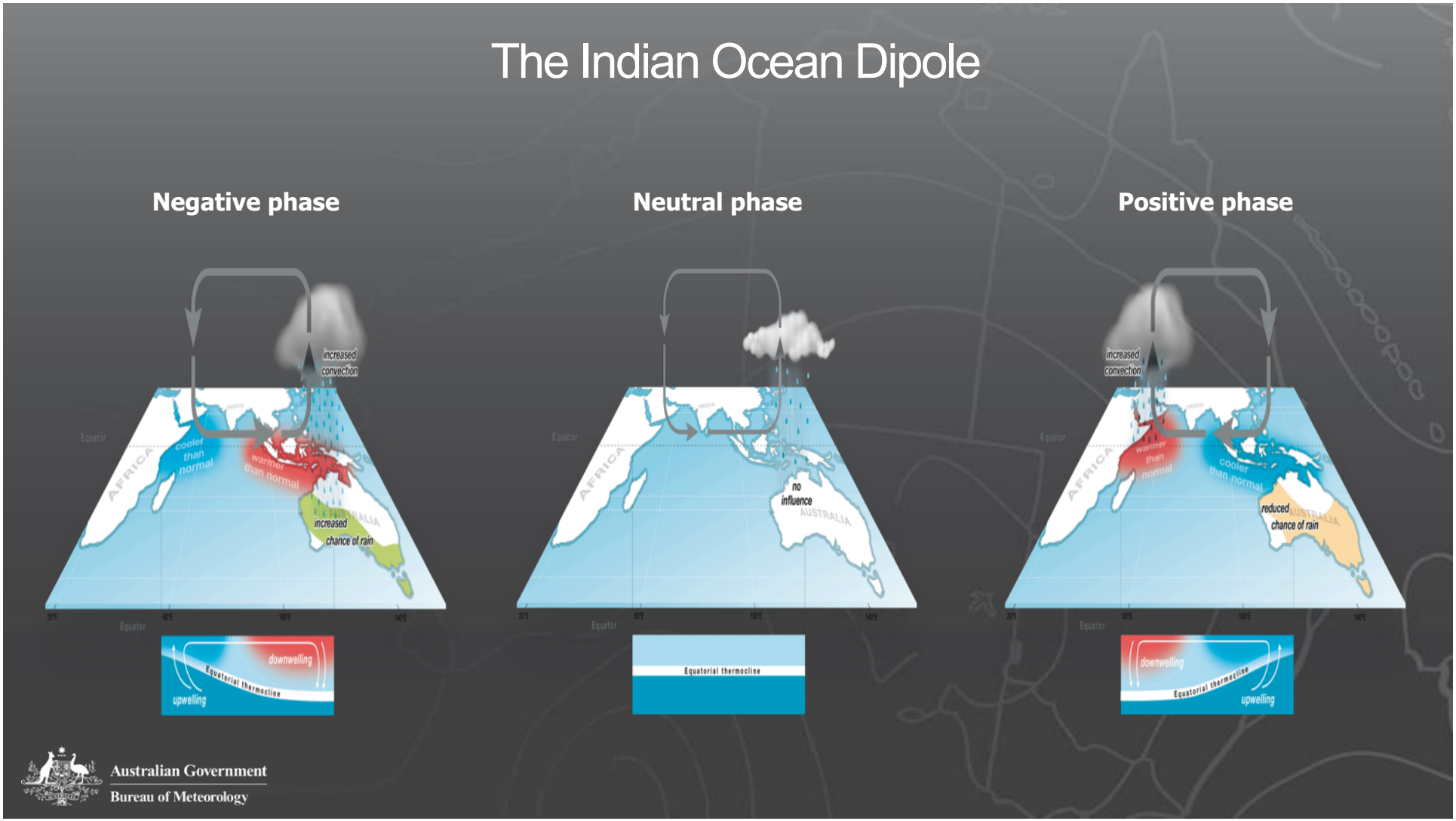
The Indian Ocean Dipole



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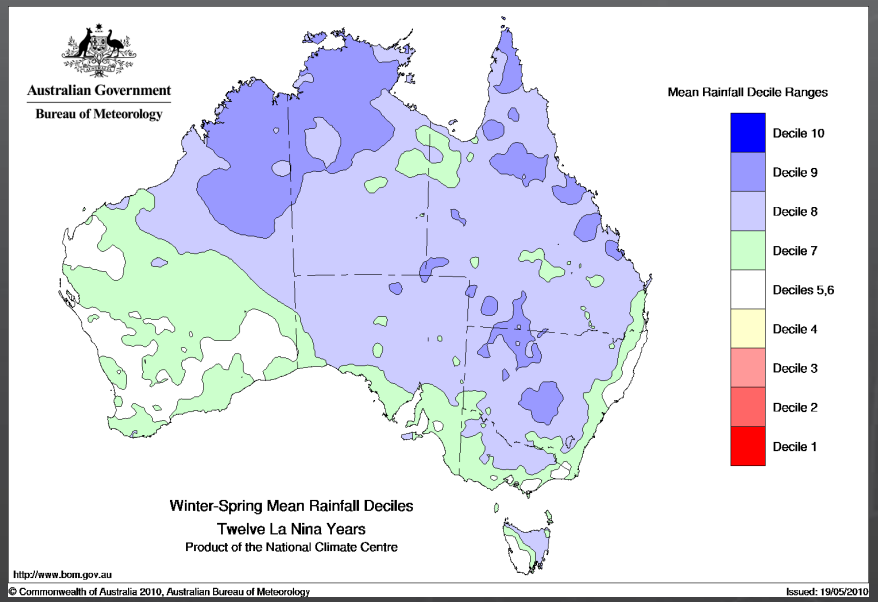
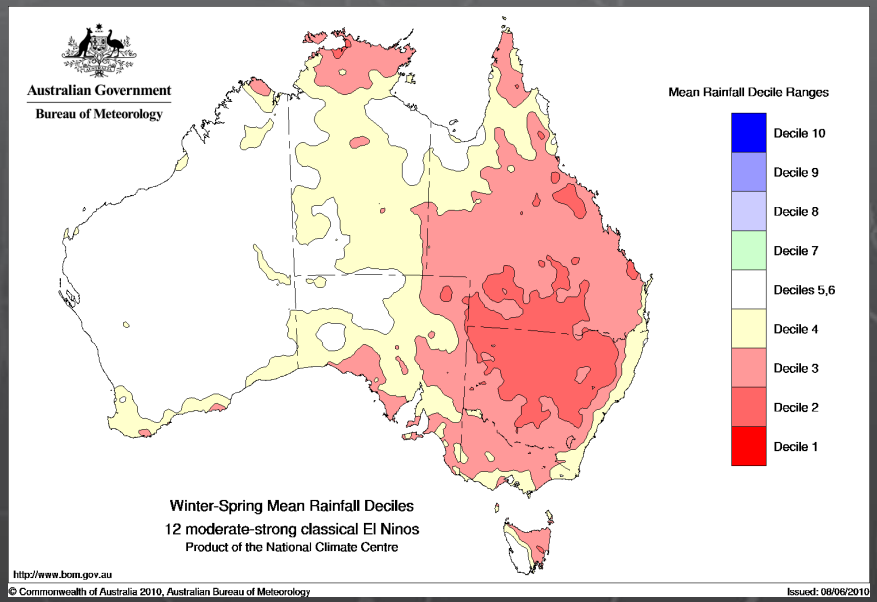
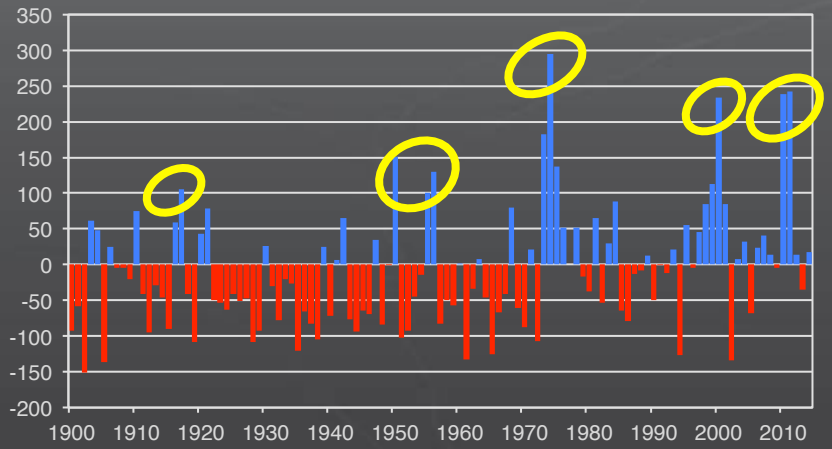
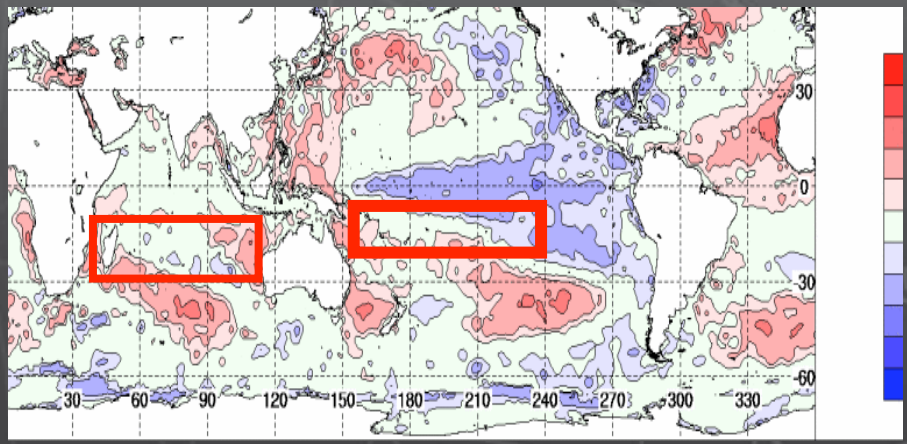
Composite impact of El Niño and La Niña events on Australian rainfall



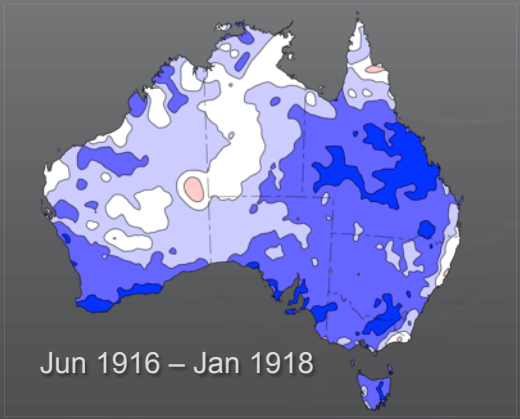


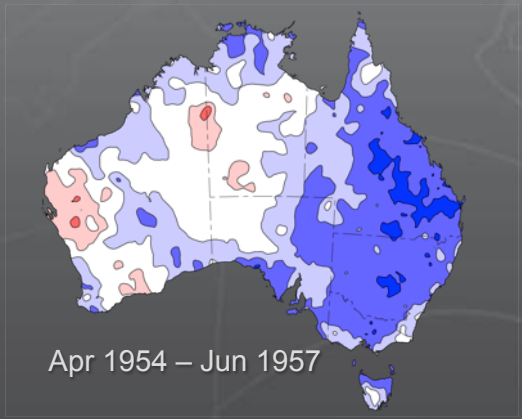
La Niña events and Australian rainfall

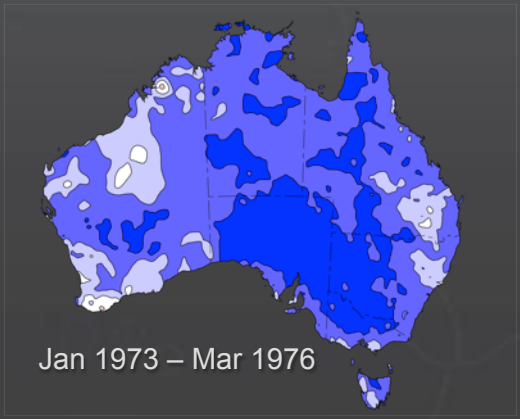


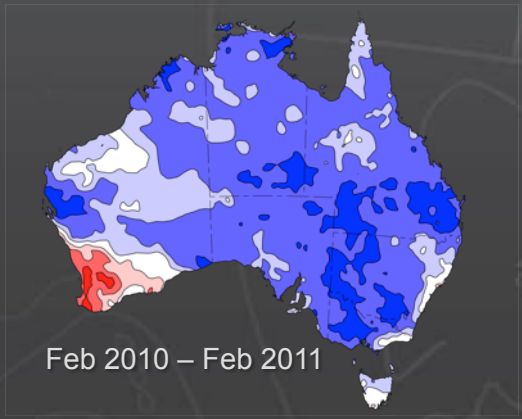


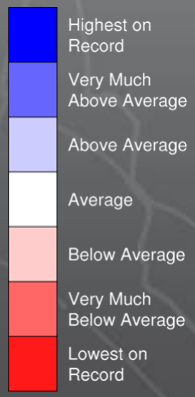
La Niña events and Australian rainfall











All significant La Niña events result in widespread above-average rainfall in Australia.

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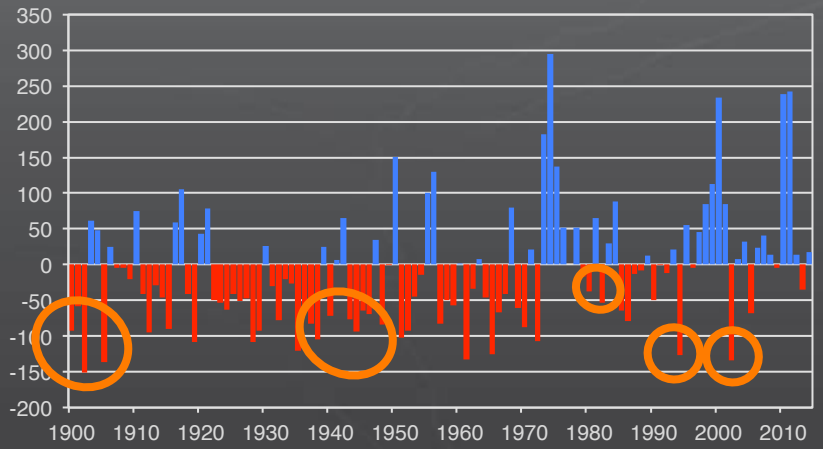
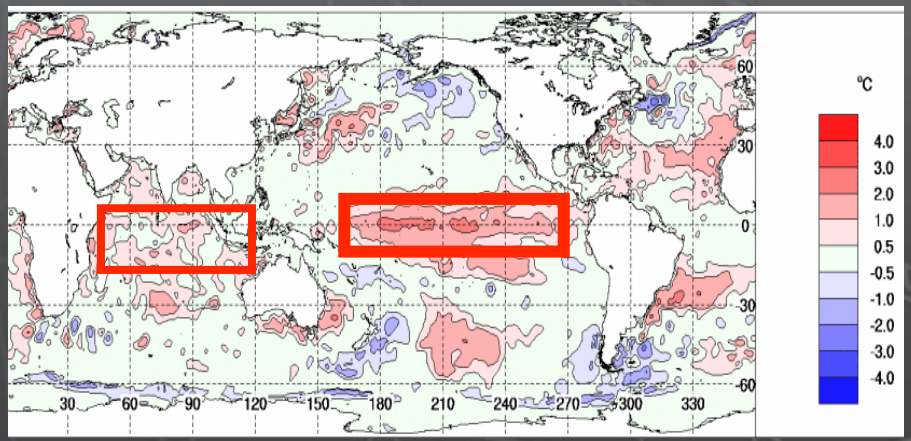
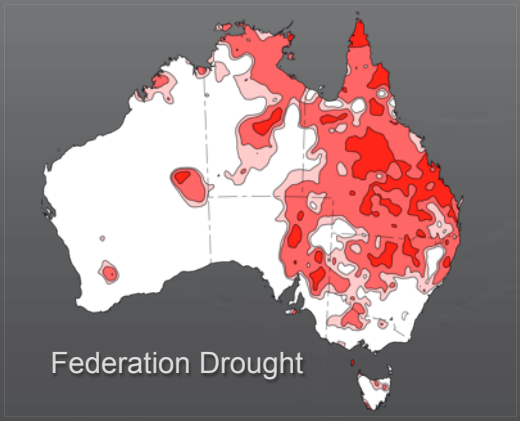
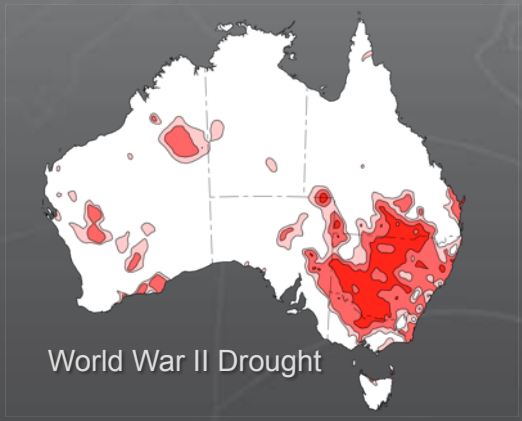
El Niño events and Australian rainfall

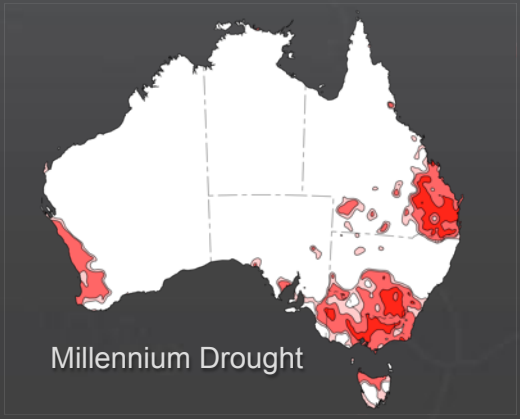


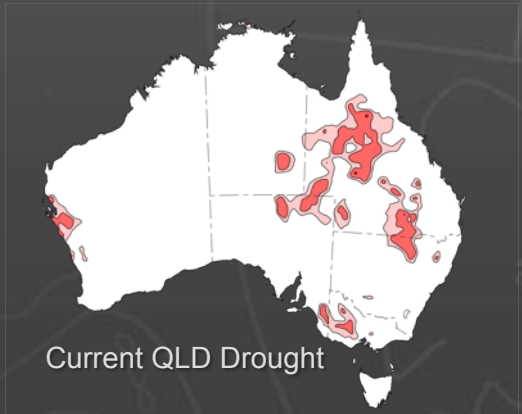


Major Australian droughts









Drought in Australia varies from event to event. Drought is spatially heterogeneous and varies significantly in its seasonal characteristics.

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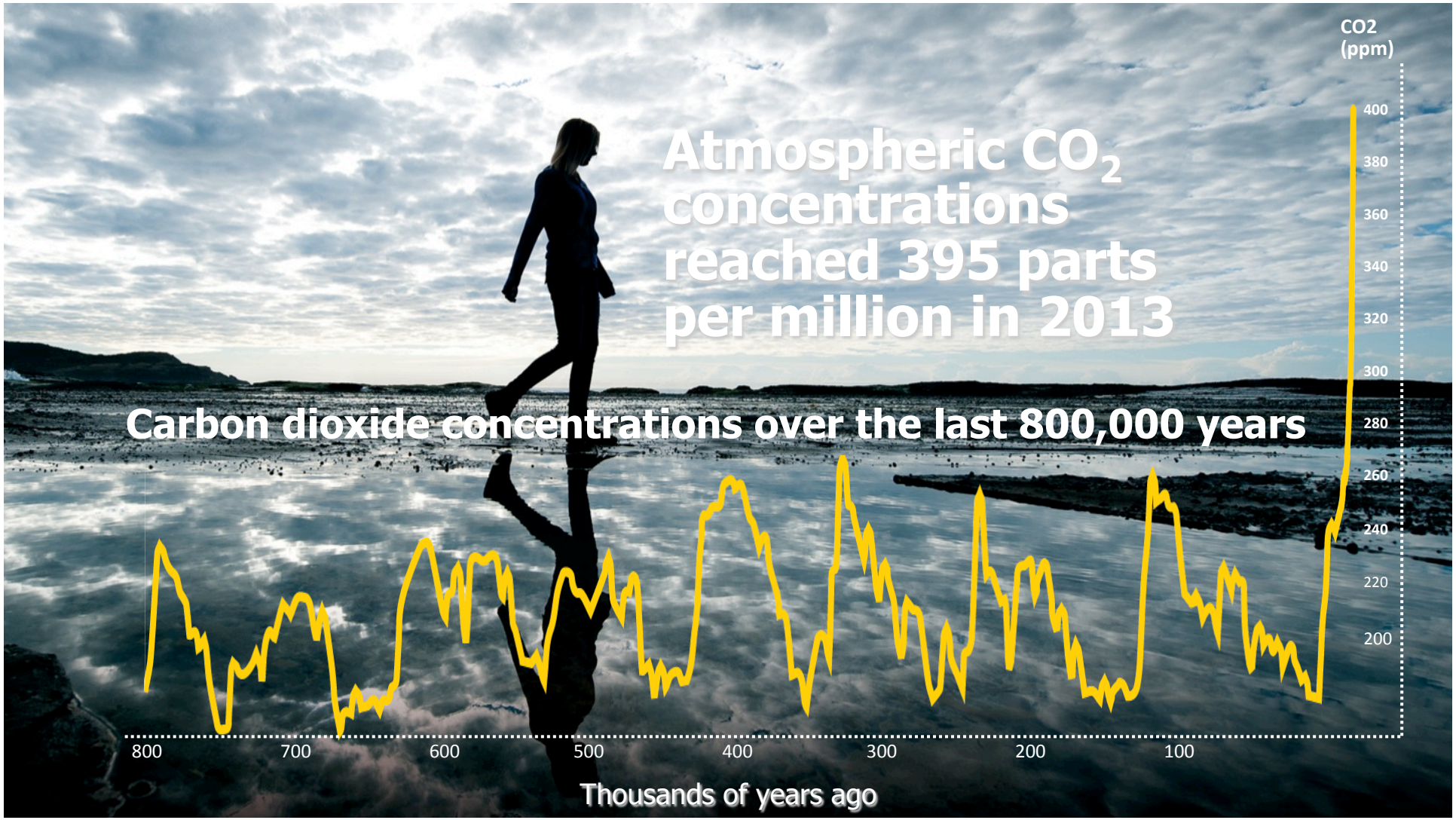
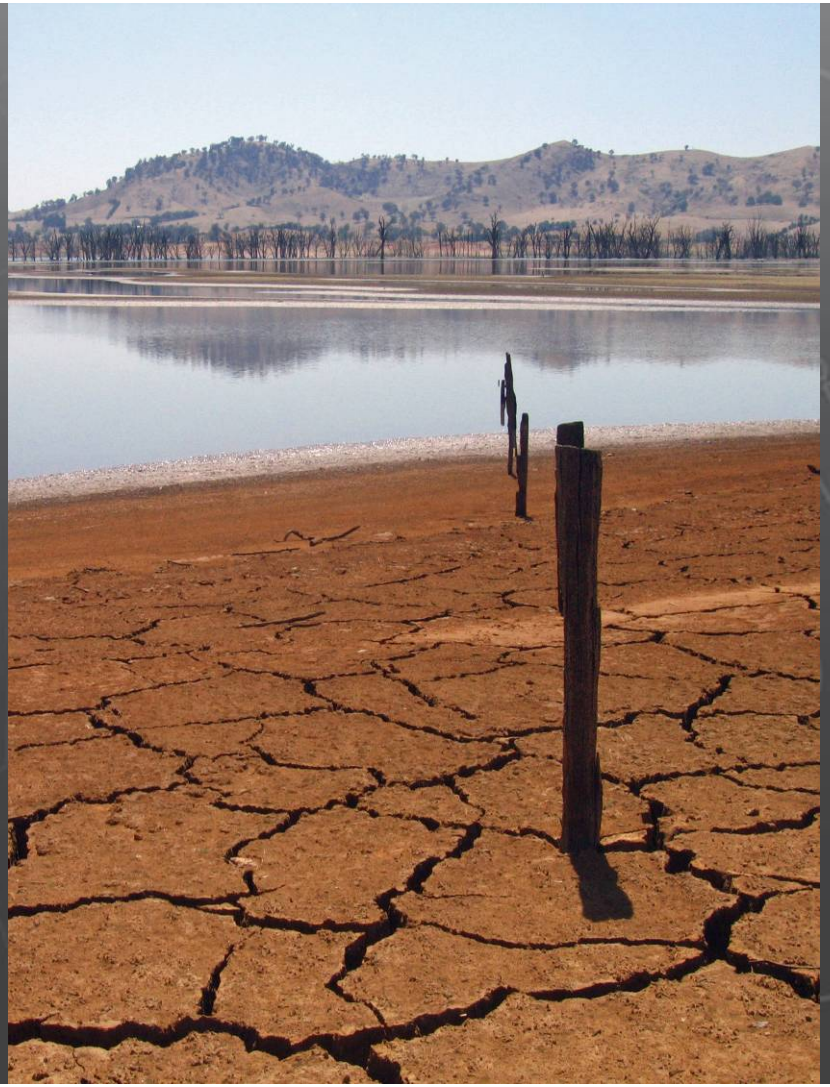

Atmospheric CO_2 concentrations reached 395 parts per million in 2013
Carbon dioxide concentrations over the last 800,000 years
CO2 (ppm)
400
380
360
340
320
300
280
260
240
220
200
800
700
600
500
400
300
200
100
Thousands of years ago

Long-term rainfall changes



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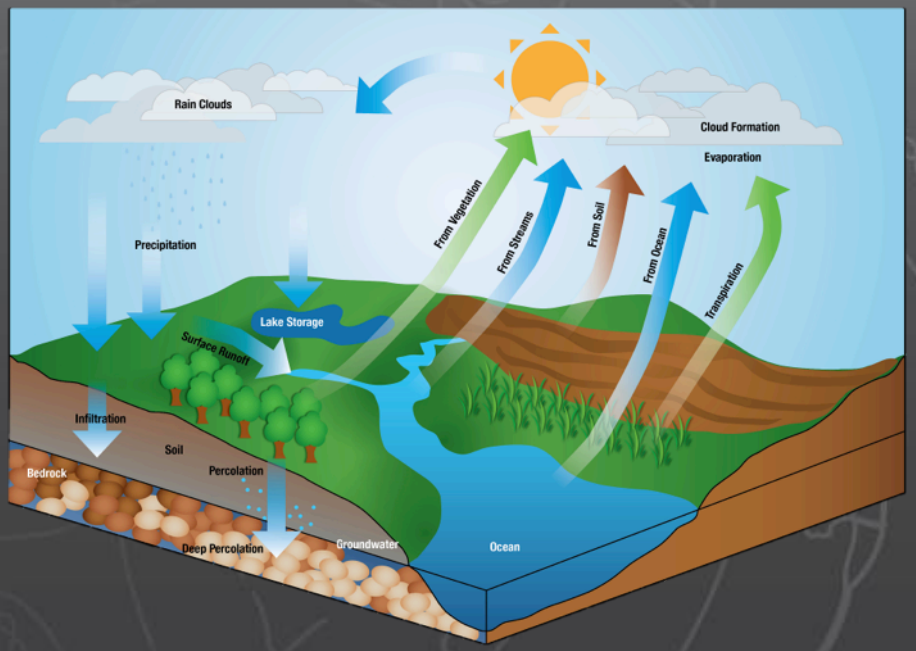
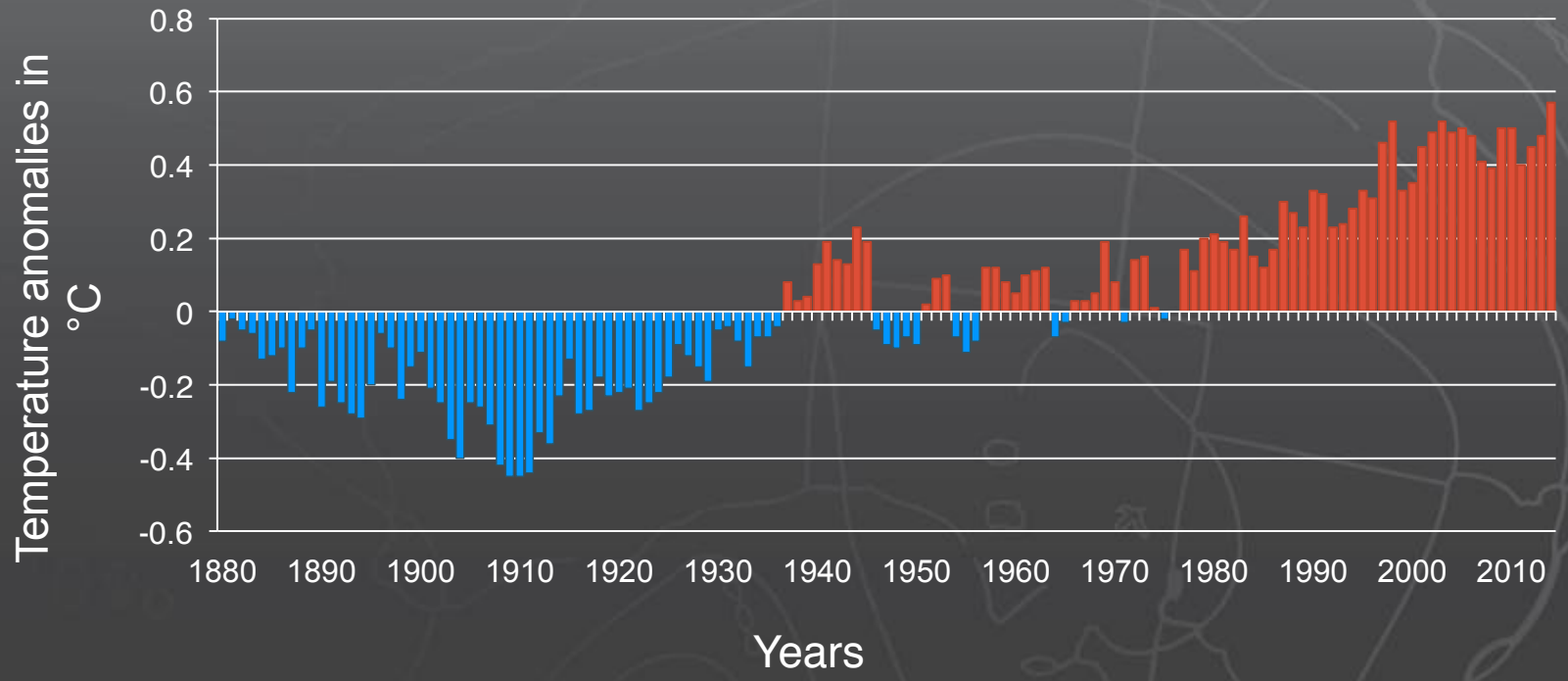
Intensification of the hydrological cycle

- 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



Global annual sea surface temperature anomalies



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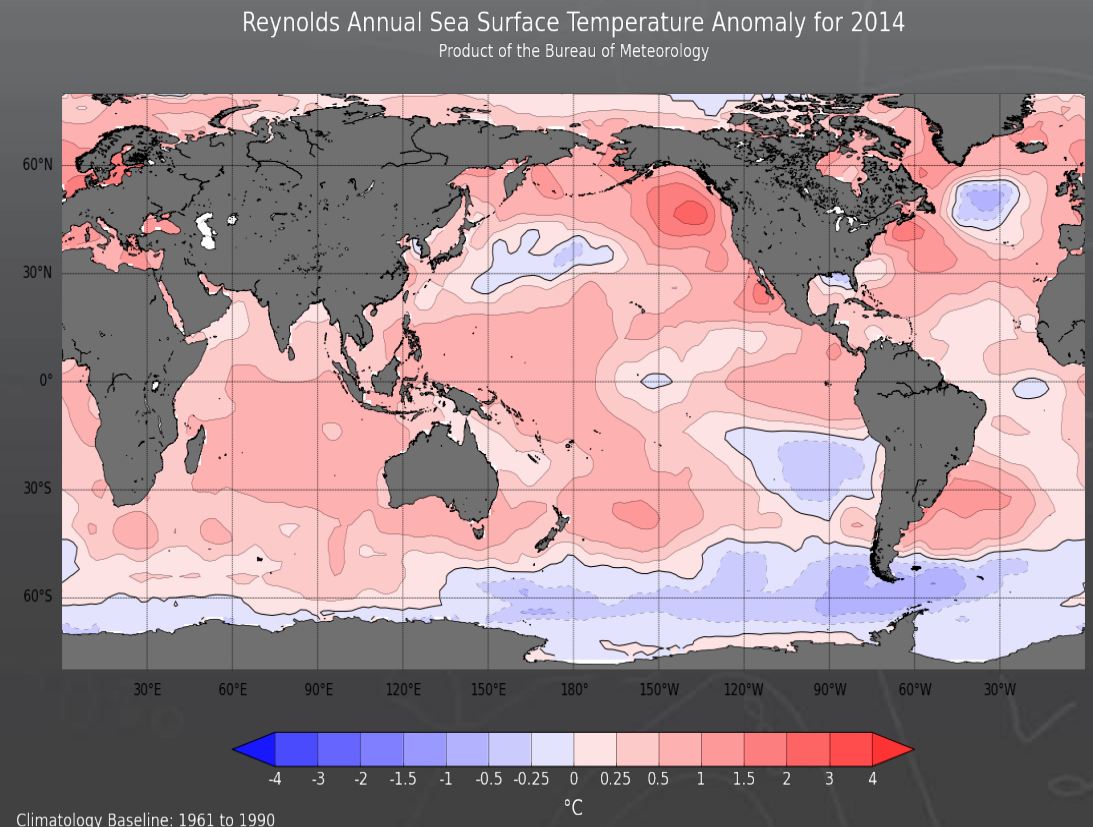
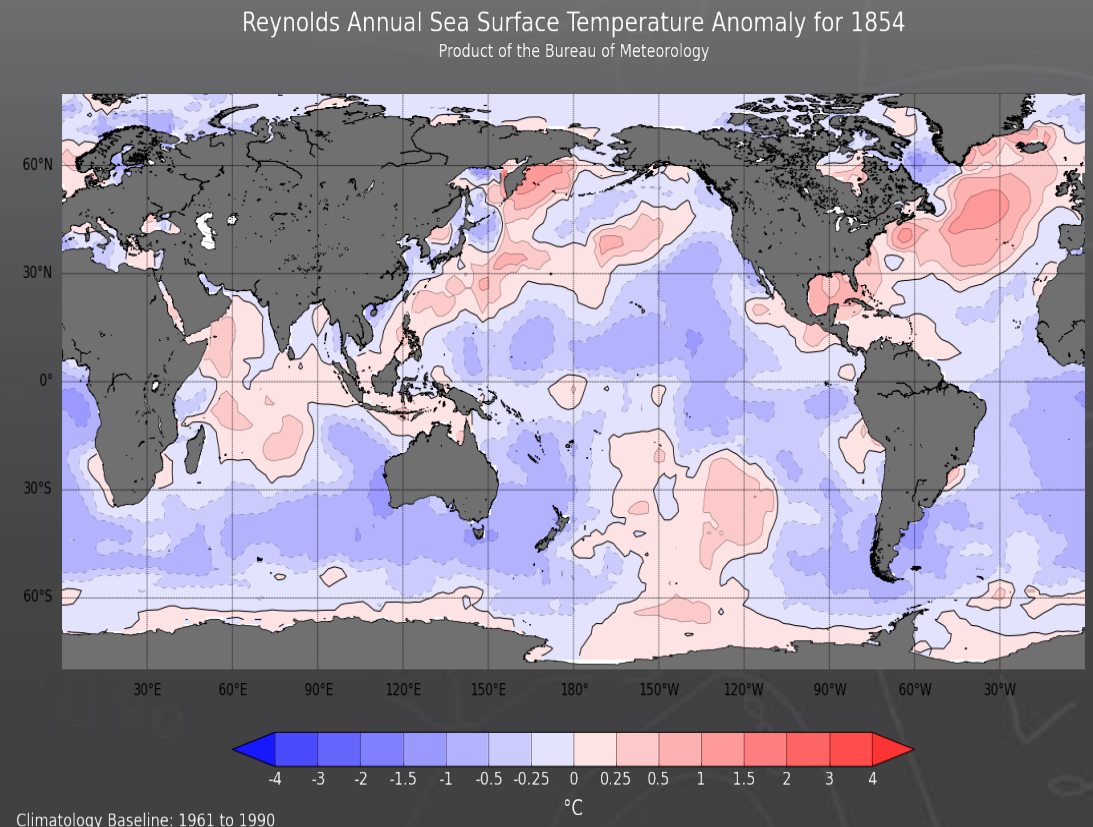
Global sea surface temperature



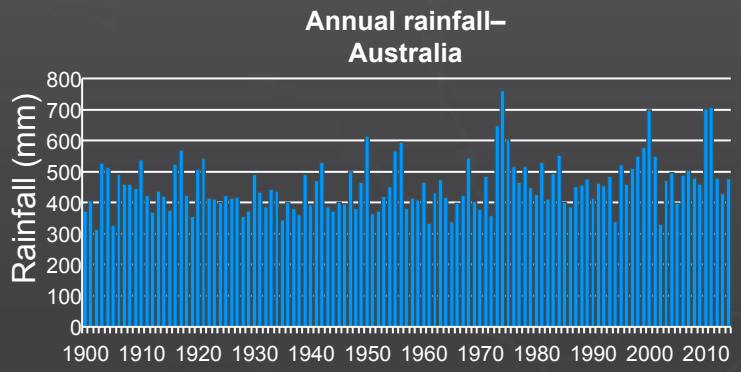
- 2014 sea surface temperatures — relative to the 1961-1990 average

Global sea surface temperature

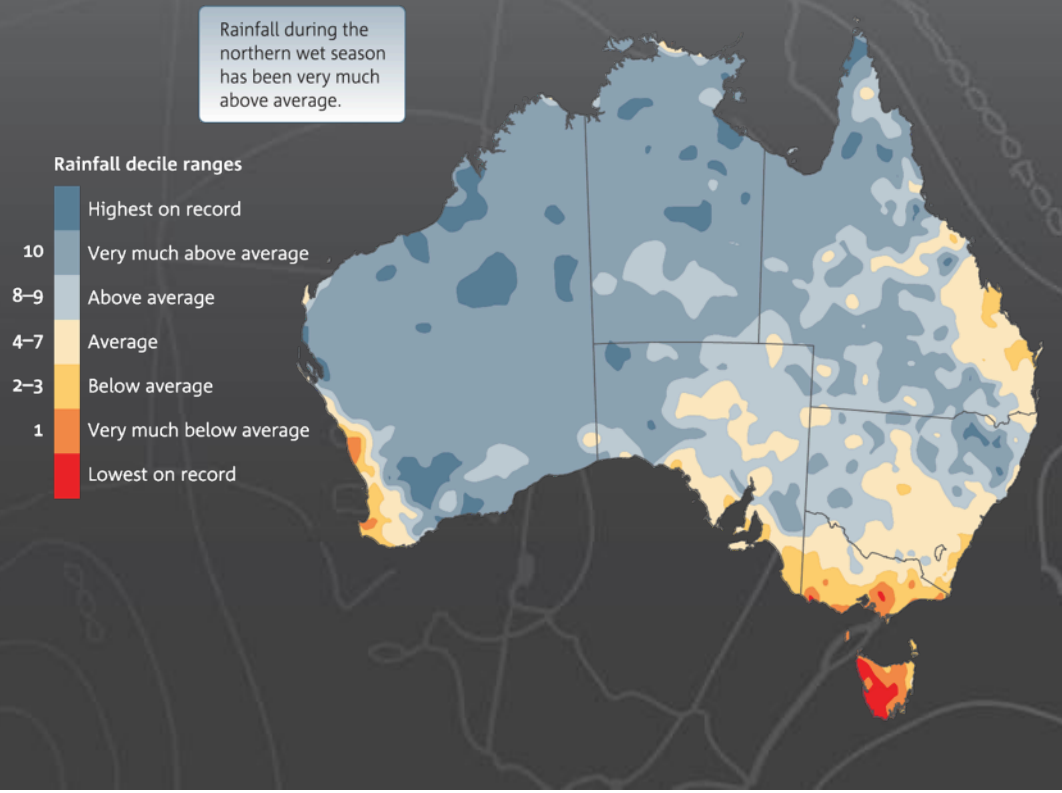


- 1854 sea surface temperatures — relative to the 1961-1990 average

Increased rainfall?



Northern wet season (Oct-Apr) rainfall deciles since 1995-96



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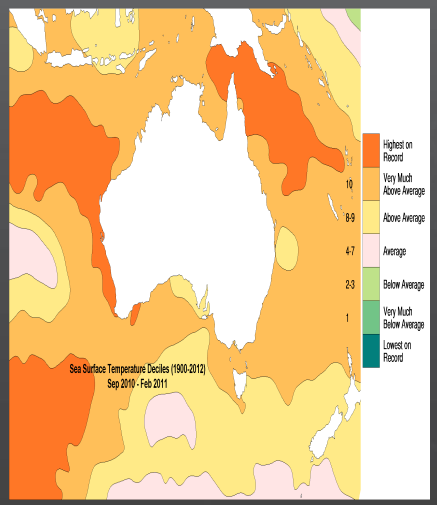
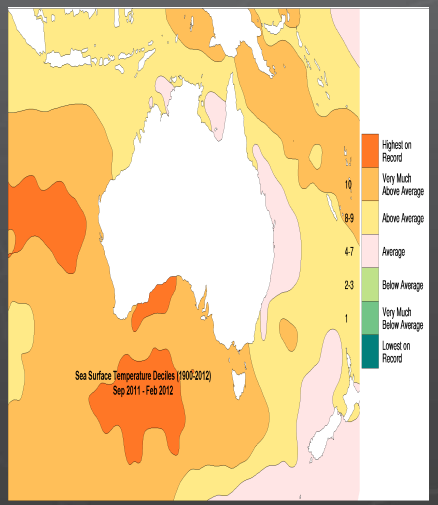
Twin La Niñas of 2010 to 2012 and record Australian rainfall



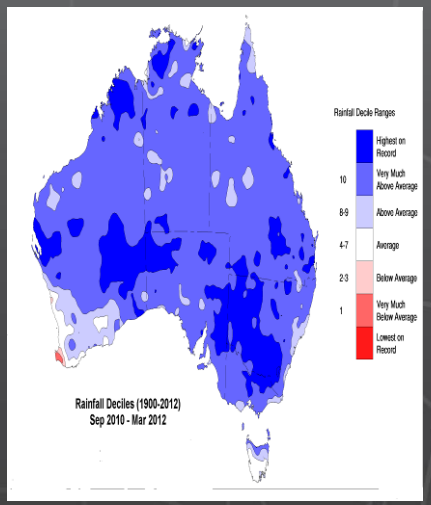
Australian sea surface temperature deciles for spring and summer

2010–2011



Australian sea surface temperature deciles for spring and summer

2011–2012



Australian Spring and Summer Rainfall deciles

2010–2012

Sea surface temperatures have been the highest on record around Australia for the past three years

The warmest surface temperatures during 2010 and 2011 were in regions that drive Australian rainfall

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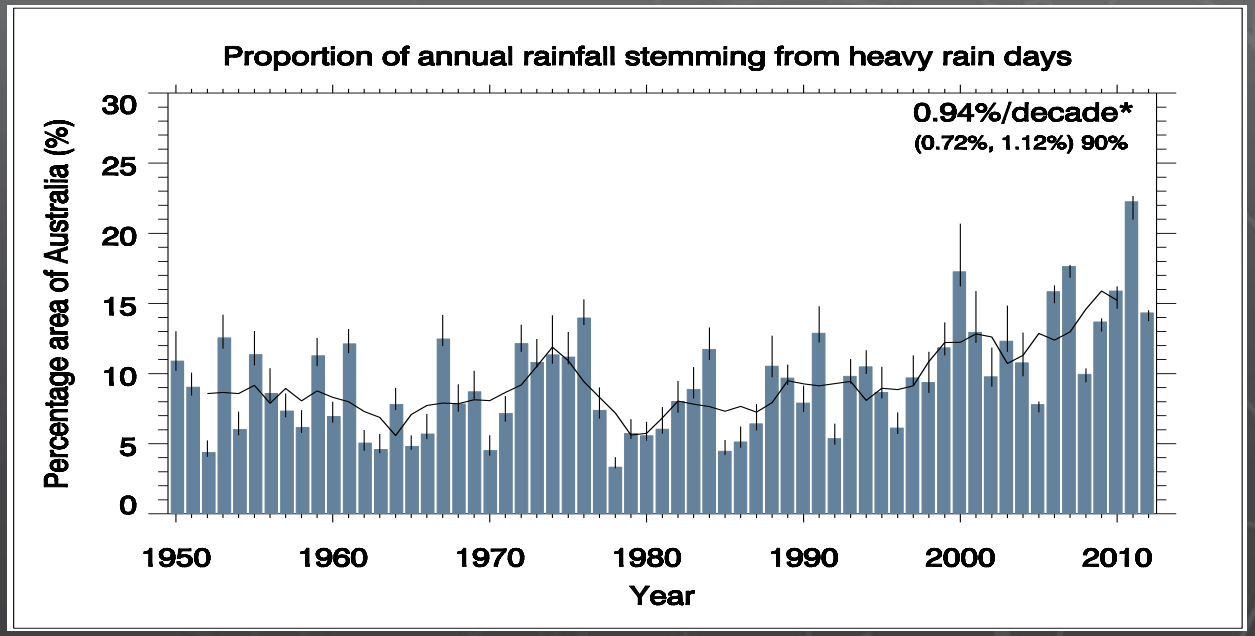
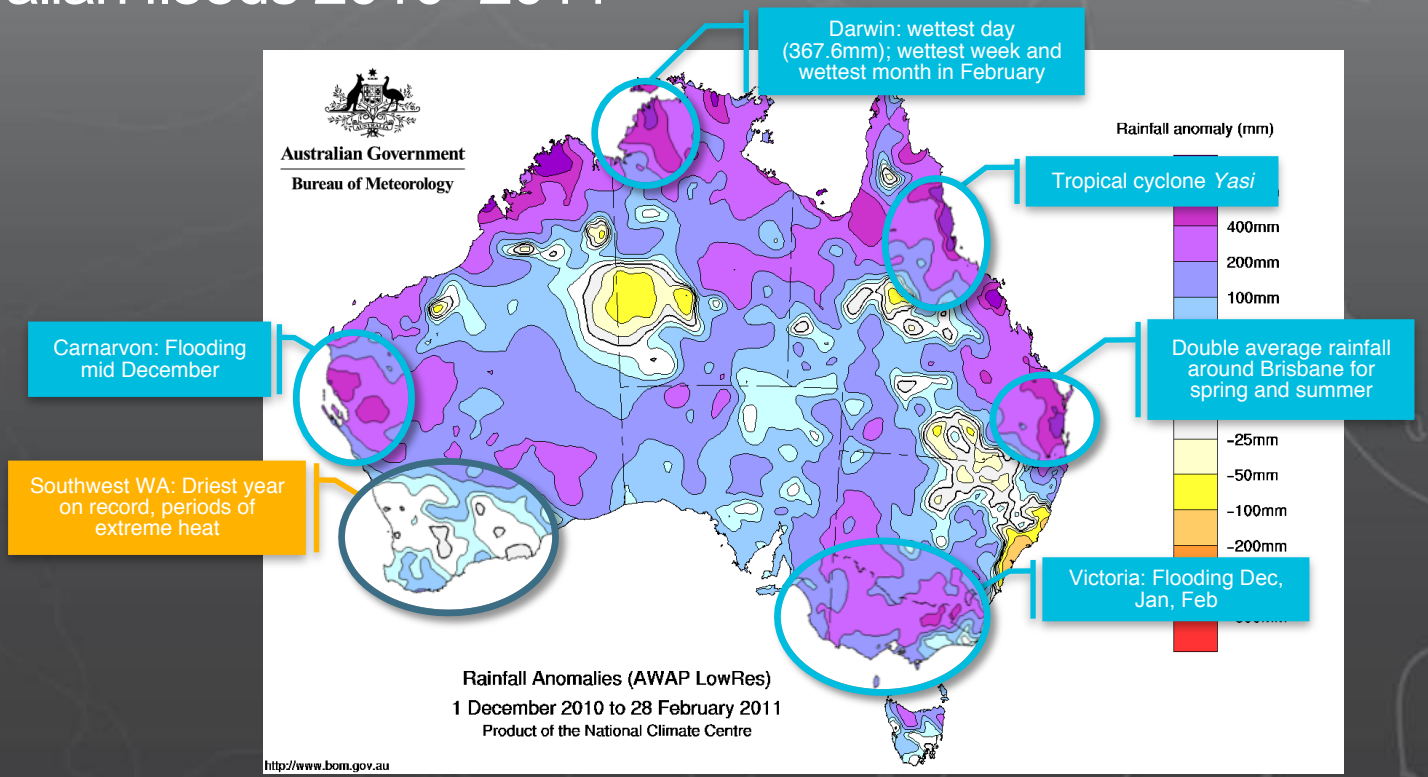
Intensification of the hydrological cycle



Gallant, A. J. E. and D. J. Karoly, 2013

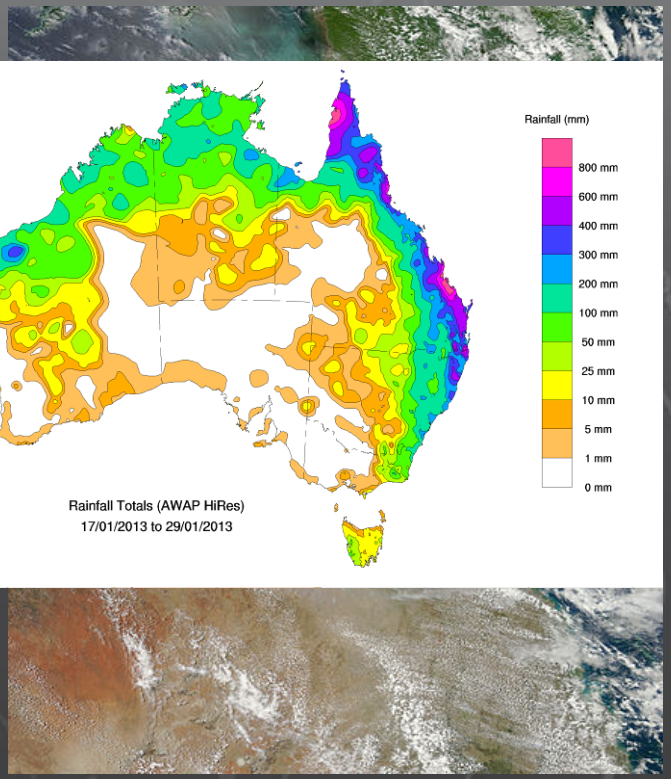
Record Australian floods 2010–2011

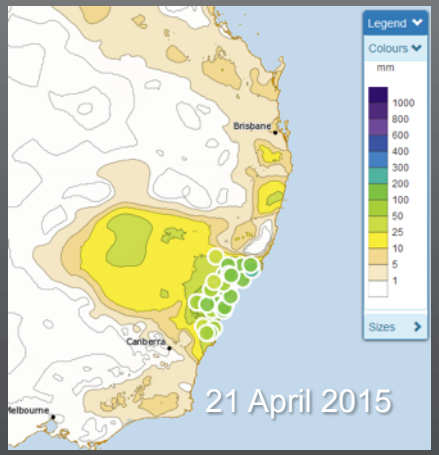
- Record warm ocean temperatures
- Record rainfall and humidity
- Record extreme rainfall
- Major flooding across northern and eastern Australia
- Large and powerful tropical cyclone

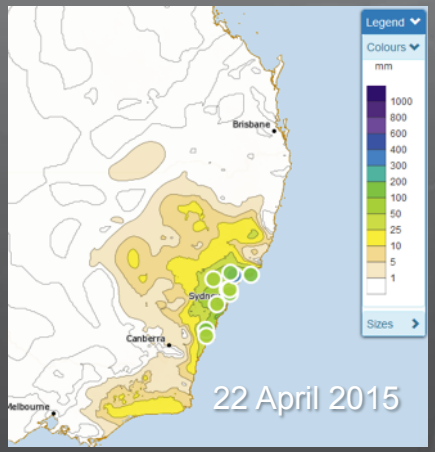


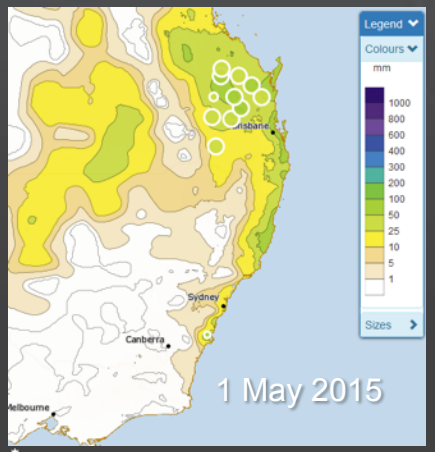
Tropical cyclone Oswald

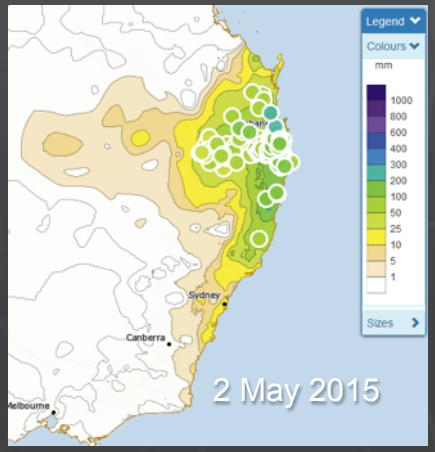
- Tropical low developed in the Gulf of Carpentaria from 17 January
- Made landfall as a Cat 1 storm on 21 January near Kowanyama (western Cape York Peninsula)
- Torrential rain followed the ex-cyclone south over following days, peaking at Tully with ~1000 mm for the event, 632 mm in 48 hours
- Extensive flooding along coastal rivers, with 6 recorded deaths











Recent high intensity East Coast Low events

April 2015 highest rainfall totals:

- 535.0 mm (month) at Maitland Belmore Bridge (Hunter River) in NSW
- 307.5 mm at Maitland Belmore Bridge (Hunter River) on the 22nd

May 2015 highest rainfall totals (month-to-date):

- 366 mm at Morayfield Alert in QLD
- 323 mm at Bowra Sugarloaf in NSW

Stations with white circle outlines are daily rainfall records for that month

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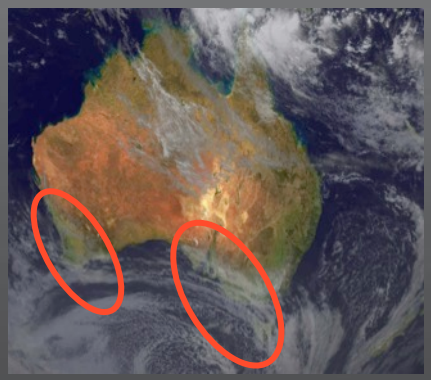
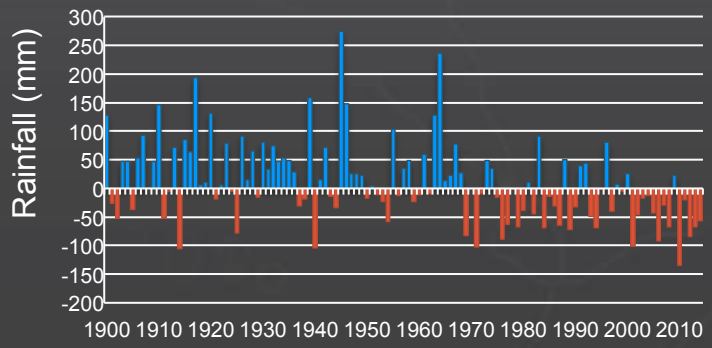
Drying across the south

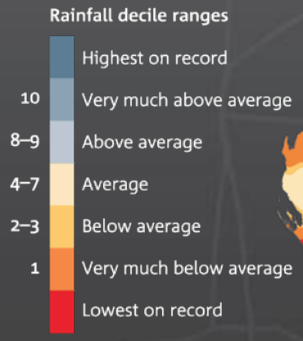


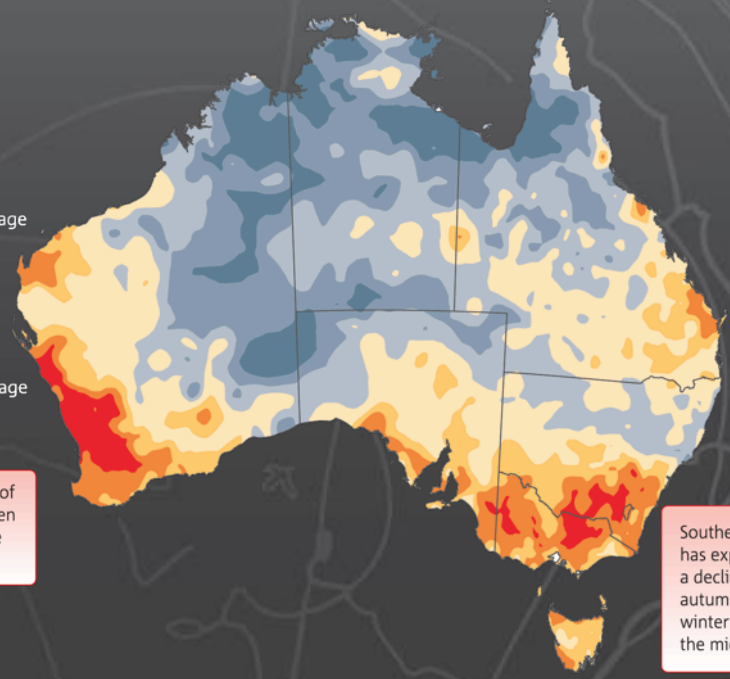
Winter rainfall anomaly–Southwestern Australia



Rainfall in the southwest of Western Australia has been very much below average to lowest on record.

Southern wet season (Apr-Nov) rainfall deciles since 1996





Southeast Australia has experienced a decline in late autumn and early winter rainfall since the mid-1990s.

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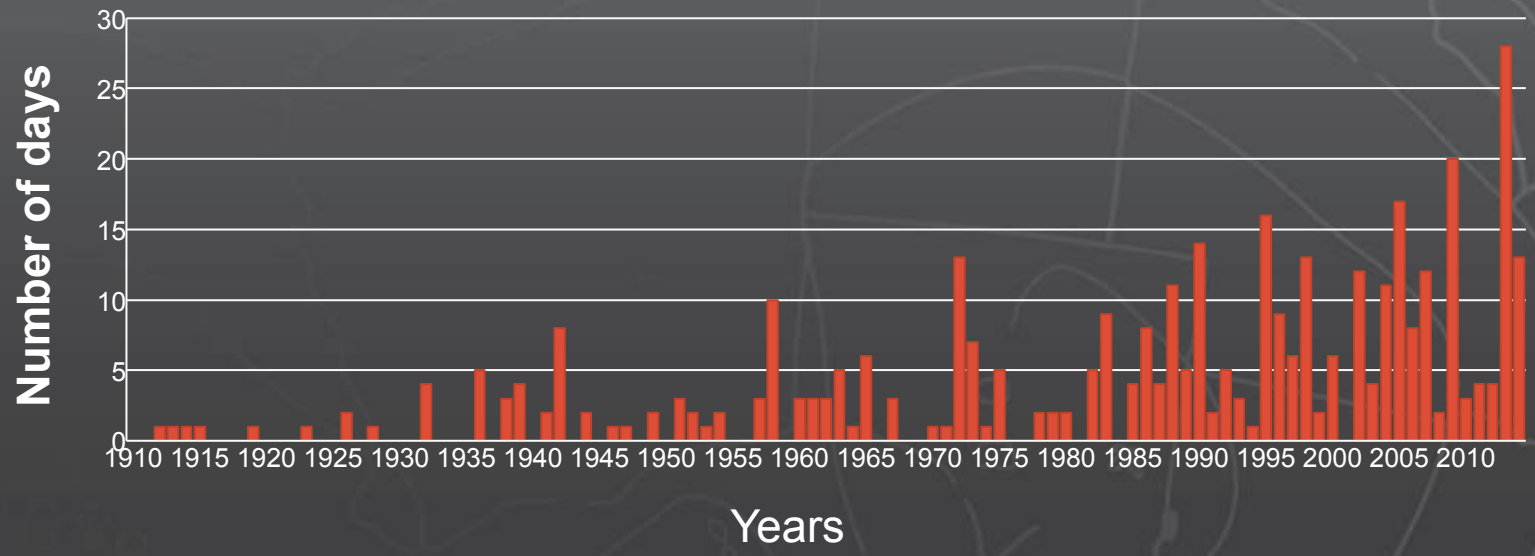
Number of days that Australian temperatures were in the warmest 1% of records



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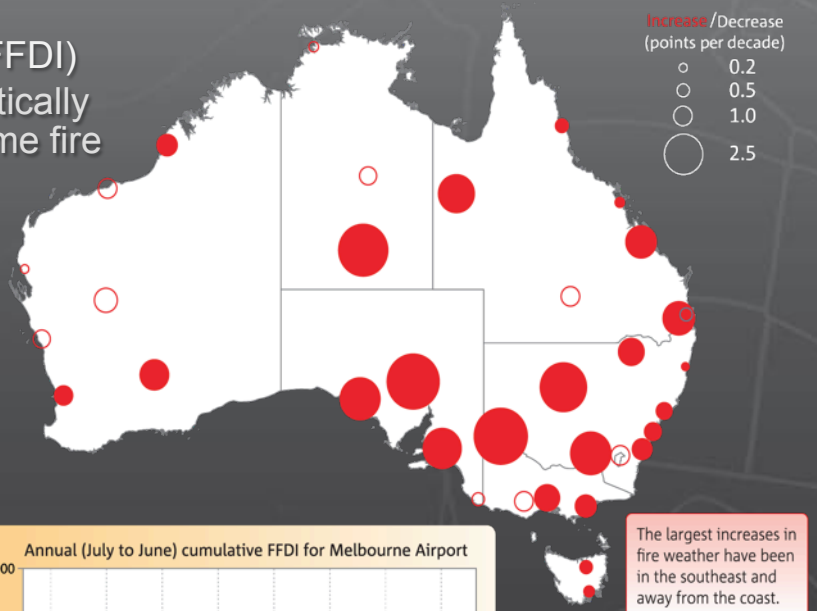
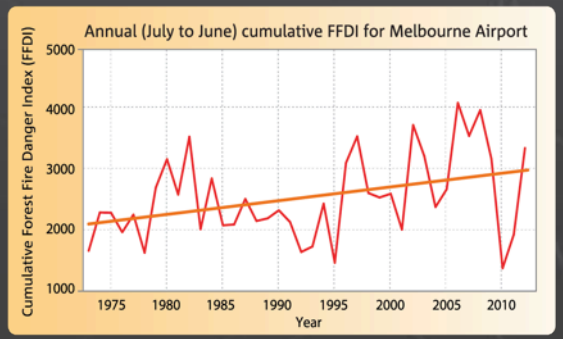
An increase in fire weather

Forest Fire Danger Index (FFDI)
Solid circles represent statistically significant increases in extreme fire weather days



Forest Fire Danger Index at Melbourne Airport since 1963



Annual cumulative FFDI increased with statistical significance at 16 of 38 climate reference sites from 1973–2010

Extreme fire-weather days have become more extreme at 24 of the 38 locations since the 1970s

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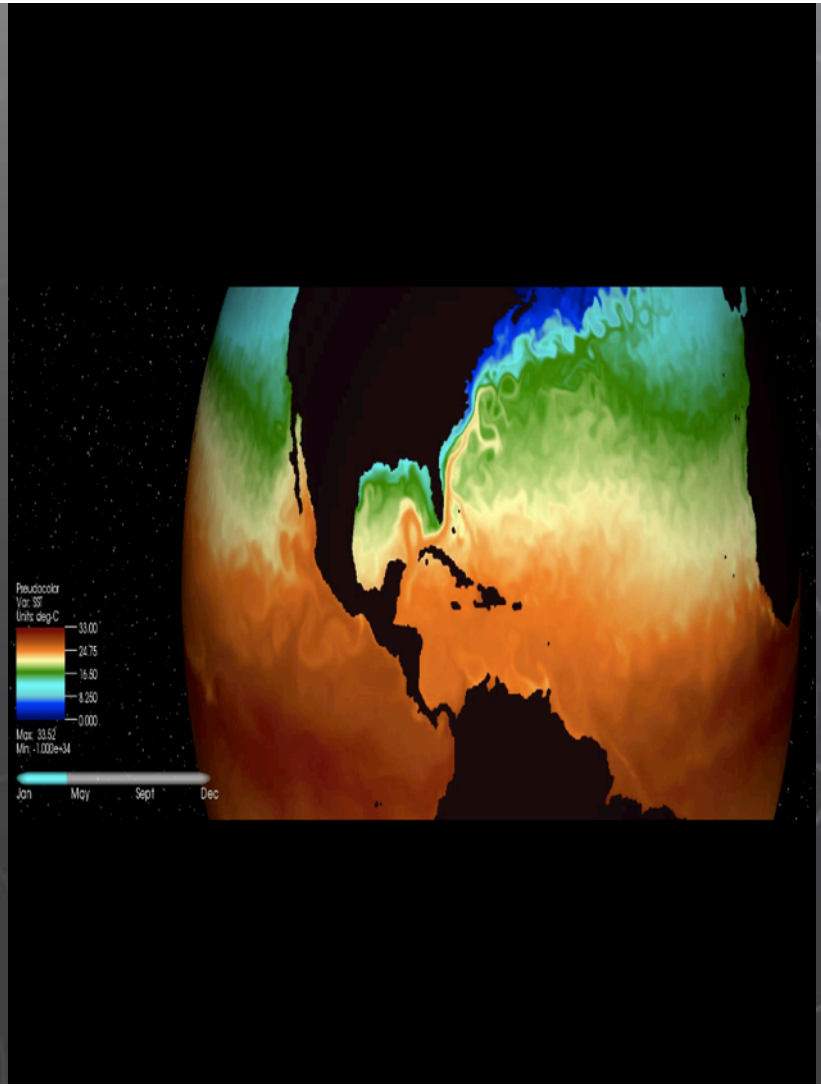
Black Saturday heatwave and bushfires

- Record heatwave across southeastern Australia
- Severe and prolonged drought
- Record daytime maximum temperatures
- Record night-time minimum temperatures
- Prolonged drought (record breaking in some aspects)
- Record fire danger Black Saturday:
  173 deaths, 414 serious injuries, total cost of ~$5 billion
- 374 deaths from extreme heat

Future projections



Explaining uncertainty, lessons from medicine: diagnosis versus prognosis

Diagnosis: is the identification of the nature and cause of a certain phenomenon. In climate science, this is called attribution.

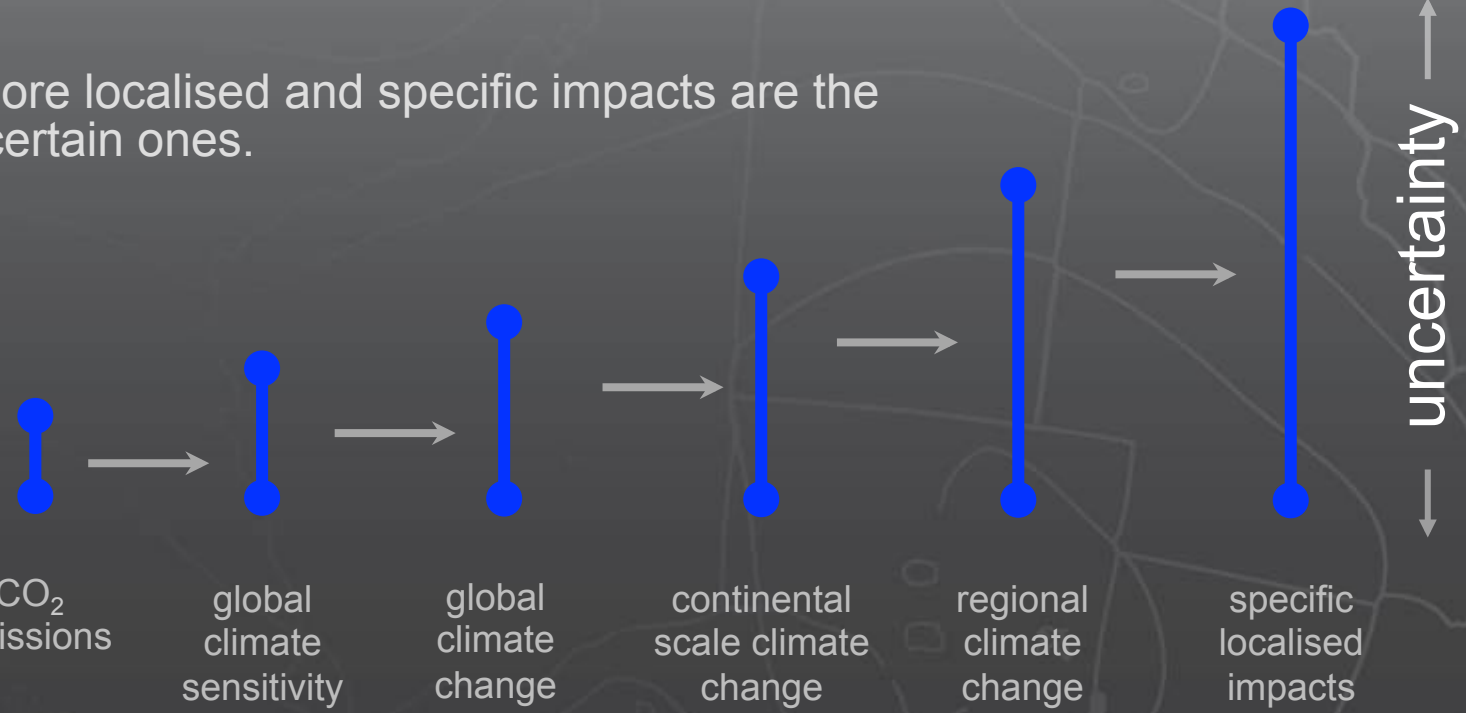
Prognosis: the likely outcome of one's current standing. In climate science, this is a climate projection or future climate scenario.

Prognoses can be very accurate when applied to large populations. **It is much harder to translate this into a prognosis for an individual patient.**

Prognoses with ill-defined timelines, intermittent crises, or sudden, unpredictable crises are common in medicine.

The physical uncertainty cascade

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



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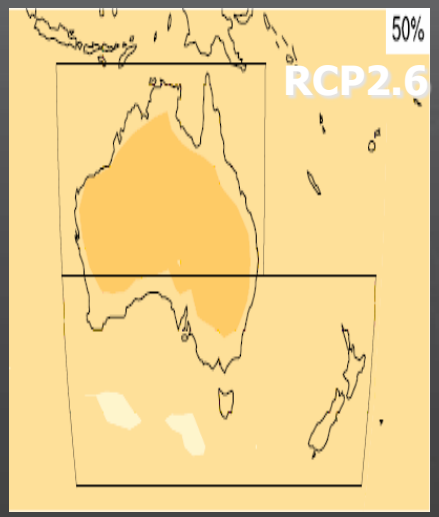
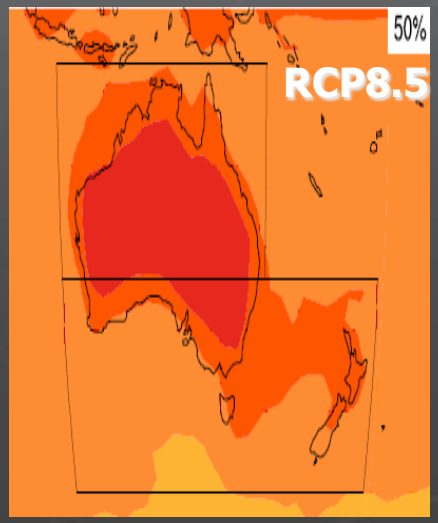
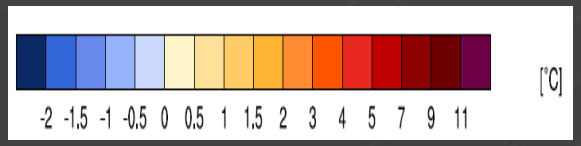
Australian climate projections for 2100

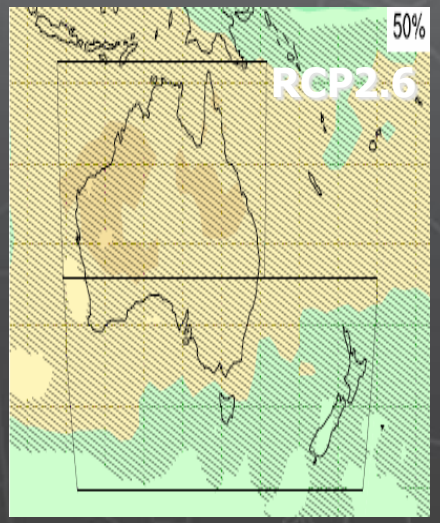
temperature

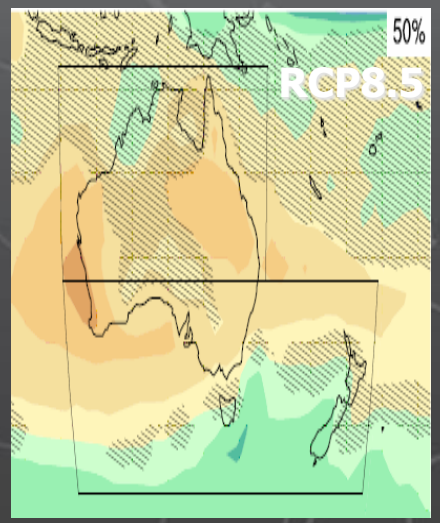


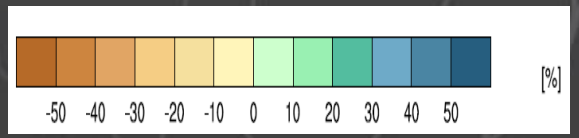




rainfall







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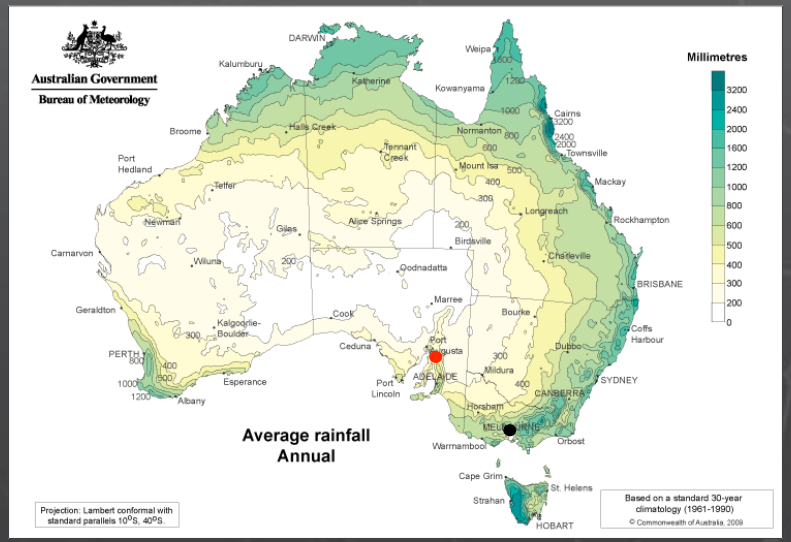
Potential change in climate zones

Clare, South Australia

Climatological rainfall map based on around 2 degrees of warming and more than 20% drier

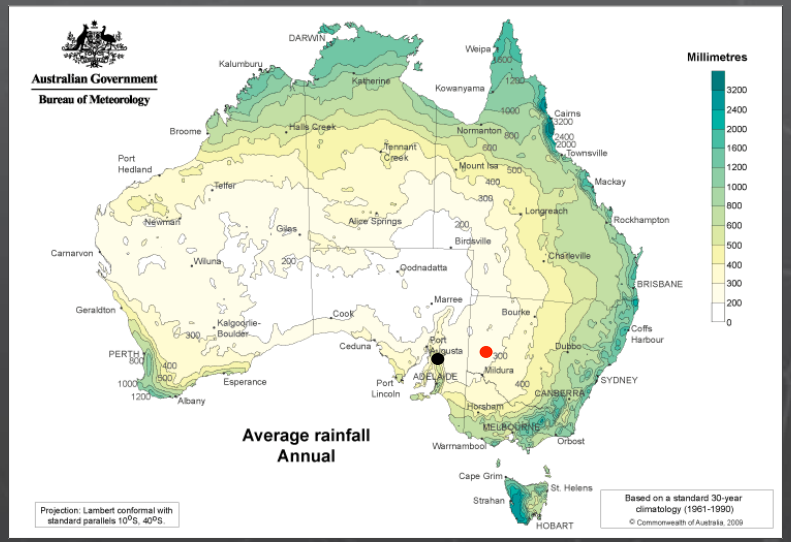


Yarra Valley, Victoria

Potential change in climate zones

Central Darling, NSW

Climatological rainfall map based on around 2 degrees of warming and more than 20% drier



Clare, South Australia

Thanks…

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Bureau of Meteorology


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