



Climate Trends and Projections for WA

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RIAWA Conference 2014

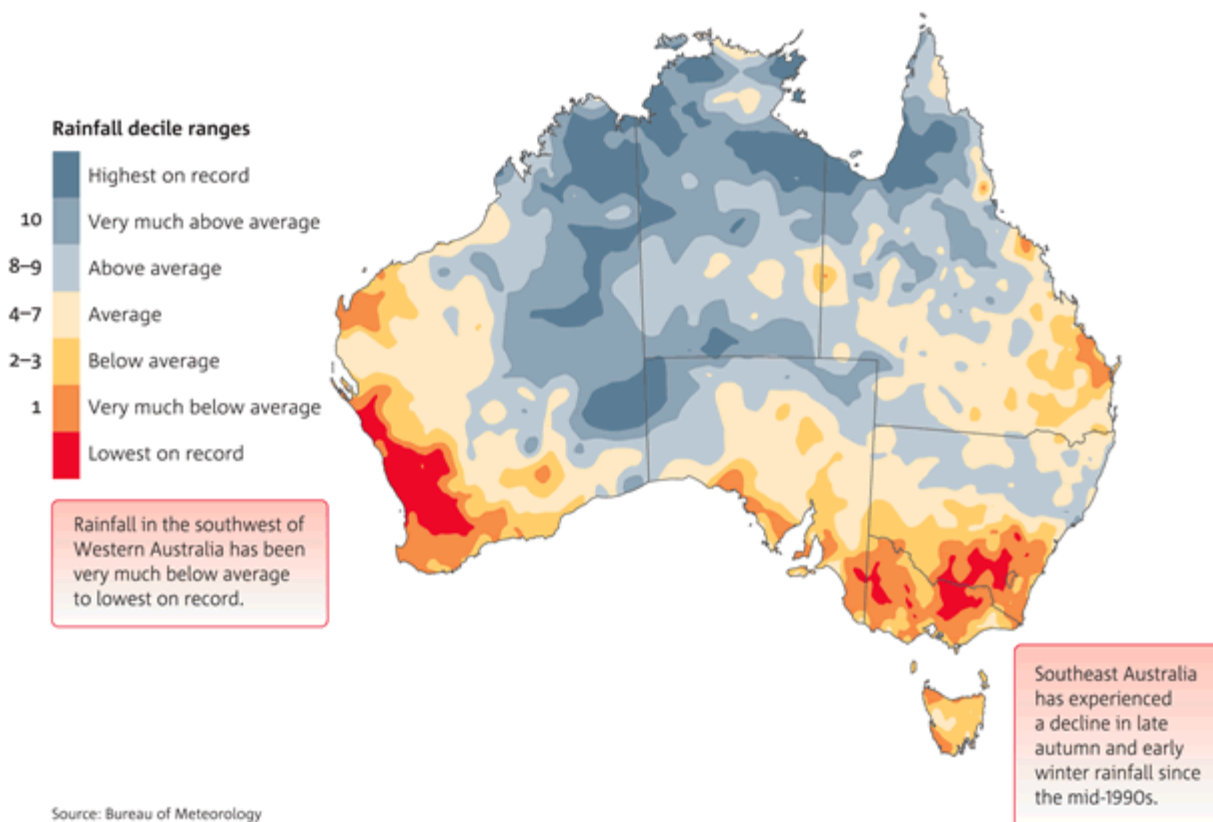


Outline

- Observed rainfall and temperature trends
- Future climate
- Impacts



Rain trends - winter

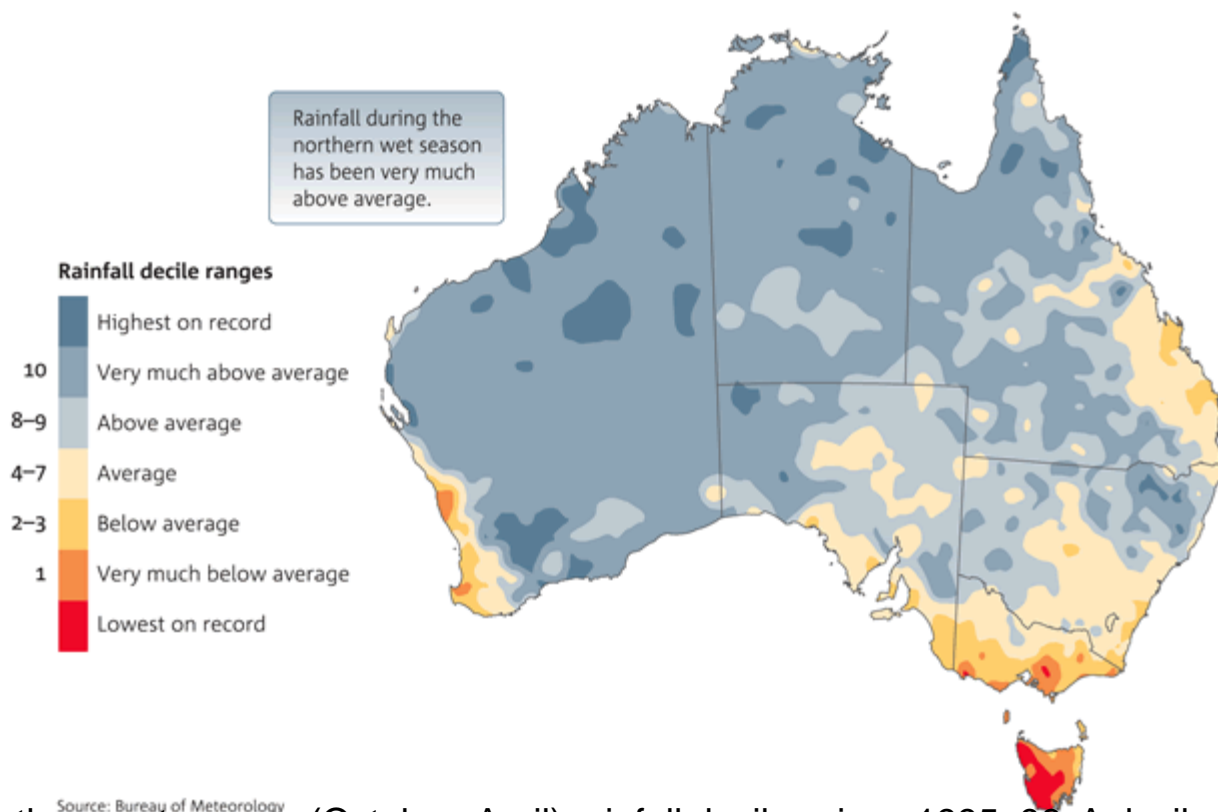


Southern wet season (April–November) rainfall deciles since 1996. A decile map shows the extent that rainfall is above average, average or below average for the specified period, in comparison with the entire rainfall record from 1900. The southern wet season is defined as April to November by the Bureau of Meteorology.

Source: <http://www.bom.gov.au/state-of-the-climate/>



Rain trends - summer



Source: Bureau of Meteorology

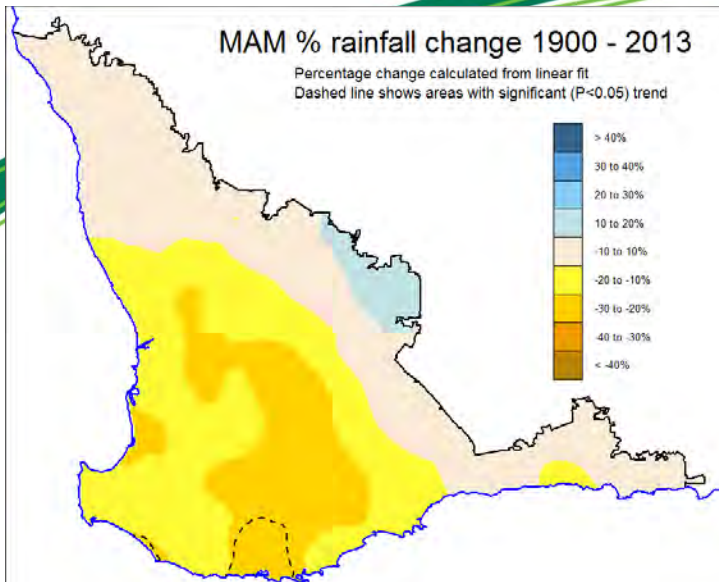
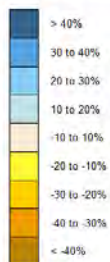
Northern wet season (October–April) rainfall deciles since 1995–96. A decile map shows the extent that rainfall is above average, average or below average for the specified period, in comparison with the entire national rainfall record from 1900. The northern wet season is defined as October to April by the Bureau of Meteorology.

Source: <http://www.bom.gov.au/state-of-the-climate/>



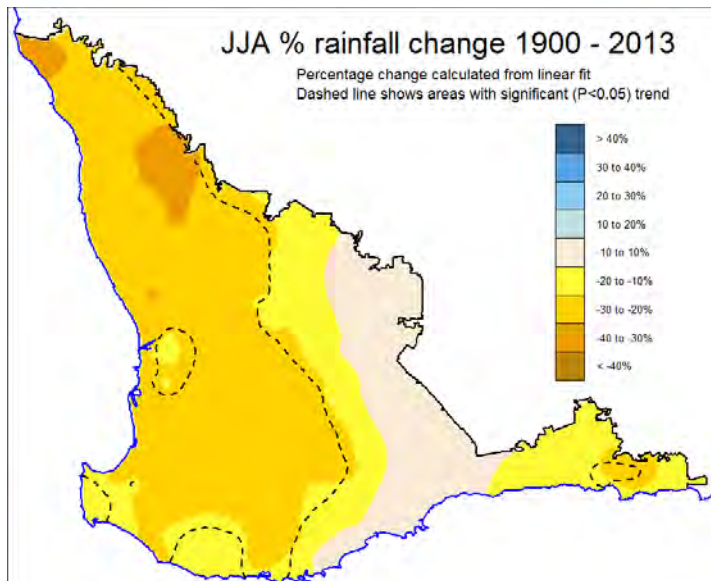
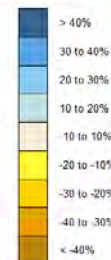
MAM % rainfall change 1900 - 2013

Percentage change calculated from linear fit
Dashed line shows areas with significant ($P < 0.05$) trend



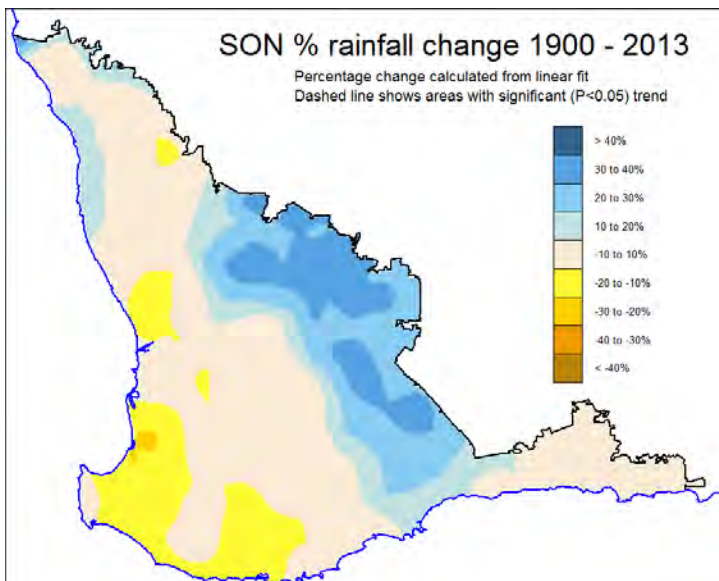
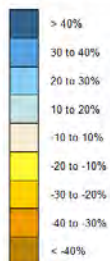
JJA % rainfall change 1900 - 2013

Percentage change calculated from linear fit
Dashed line shows areas with significant ($P < 0.05$) trend



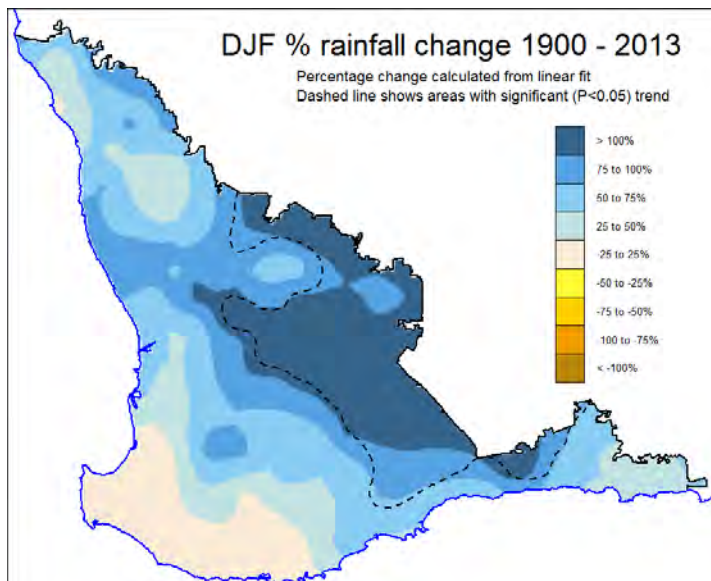
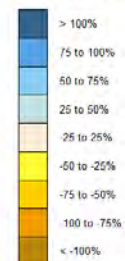
SON % rainfall change 1900 - 2013

Percentage change calculated from linear fit
Dashed line shows areas with significant ($P < 0.05$) trend



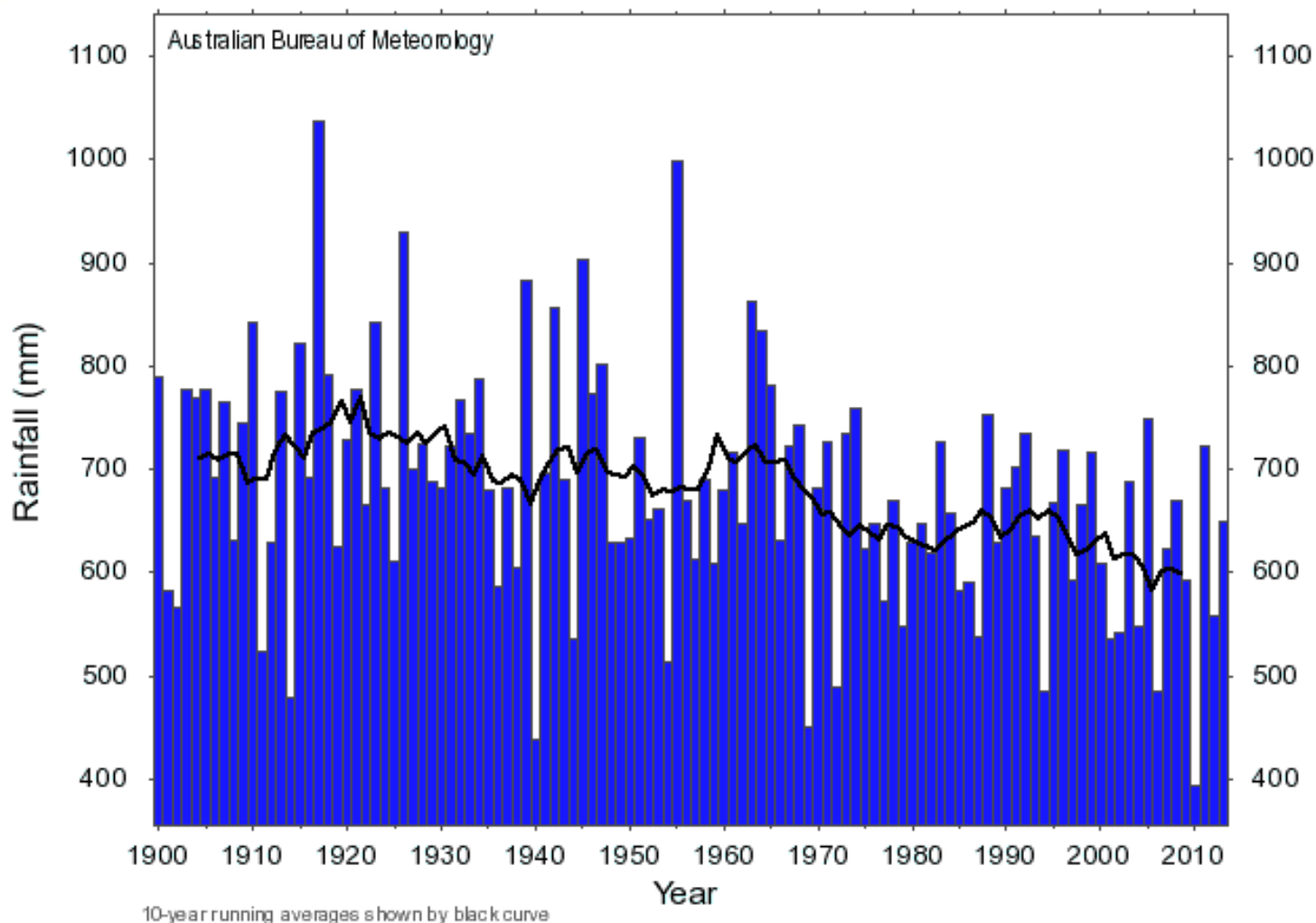
DJF % rainfall change 1900 - 2013

Percentage change calculated from linear fit
Dashed line shows areas with significant ($P < 0.05$) trend





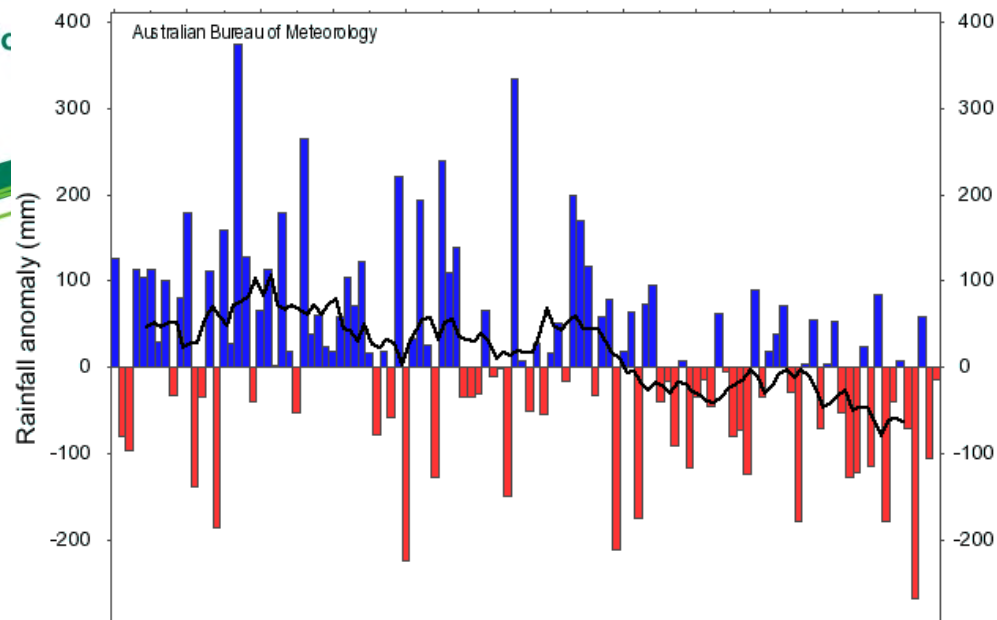
Annual rainfall - Southwestern Australia (1900-2013)



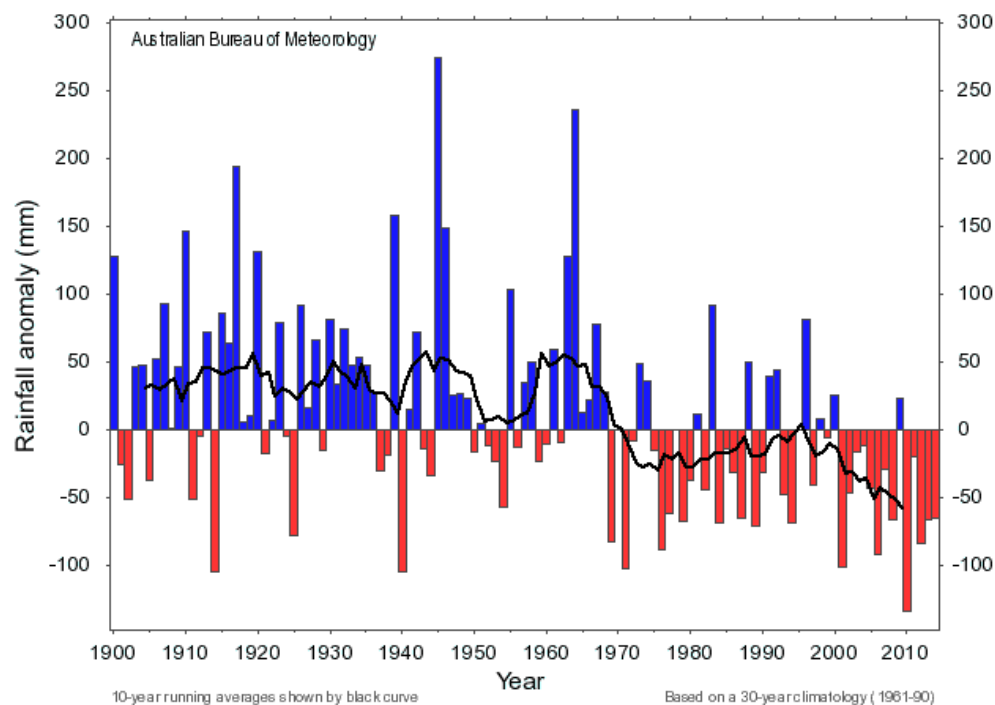
1976-2009 is
90% of 1900-75

2000s are 86%
of 1900-75

Annual rainfall anomaly - Southwestern Australia (1900-2013)

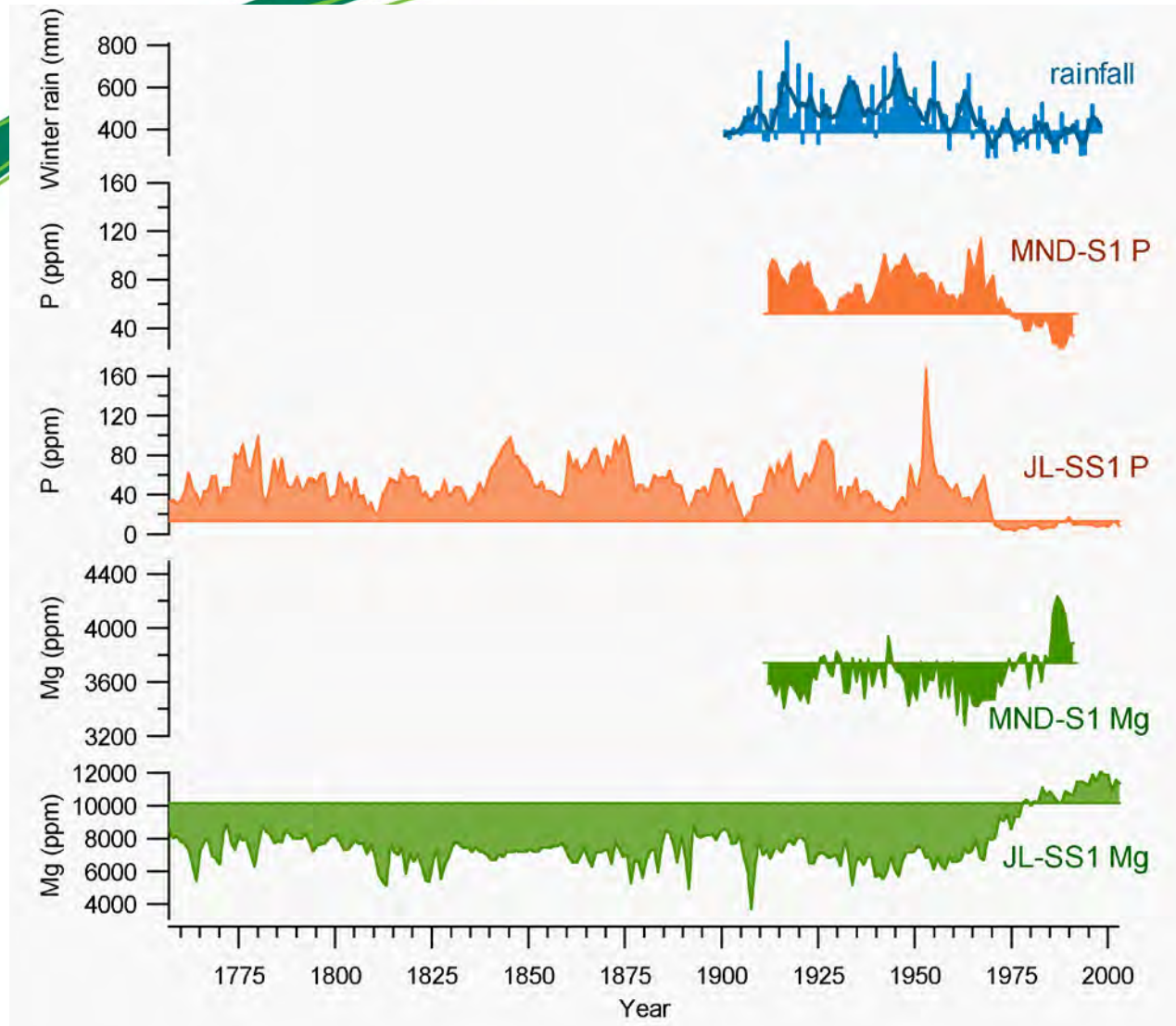


Winter rainfall anomaly - Southwestern Australia (1900-2014)





Paelo-climate



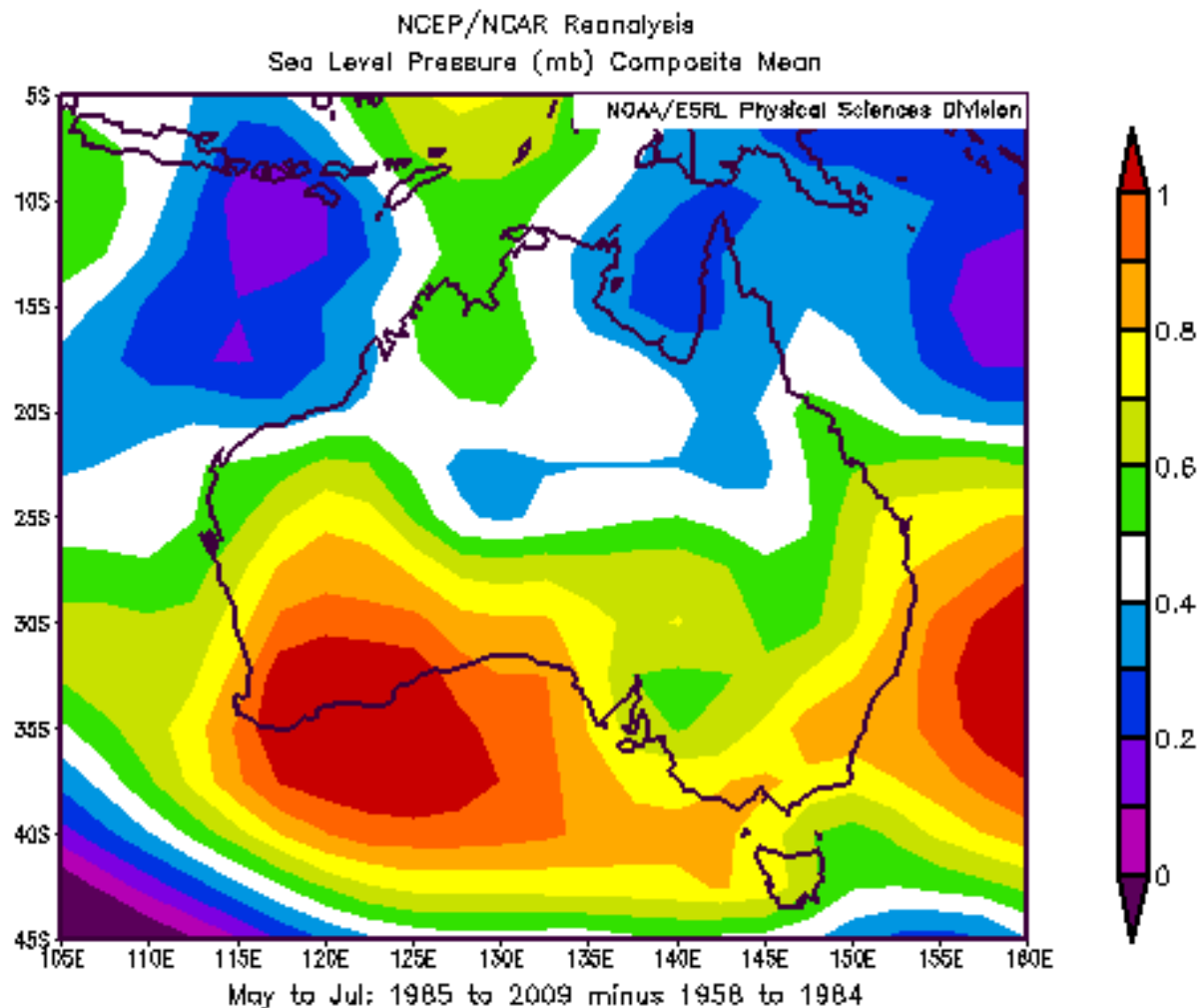
Current rainfall decrease, as recorded by speleothem P, is **well-outside** range of natural rainfall variability of last 200 years

Jewel & Moondyne
Caves near
Margaret River.
Source: IOCI &
Treble



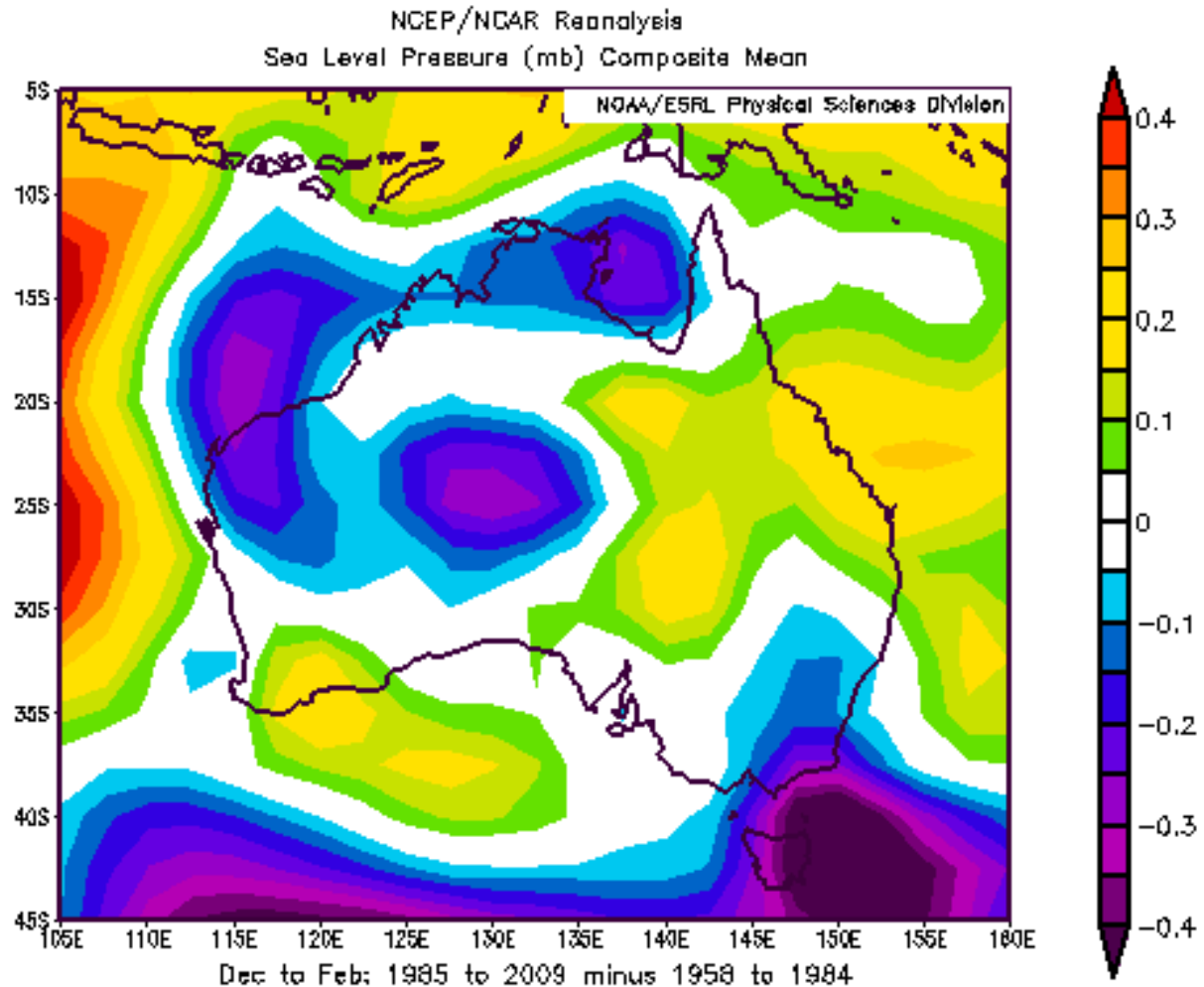
Atmospheric Pressure MJJ

Mean for
1985-2009 vs
1958-1984



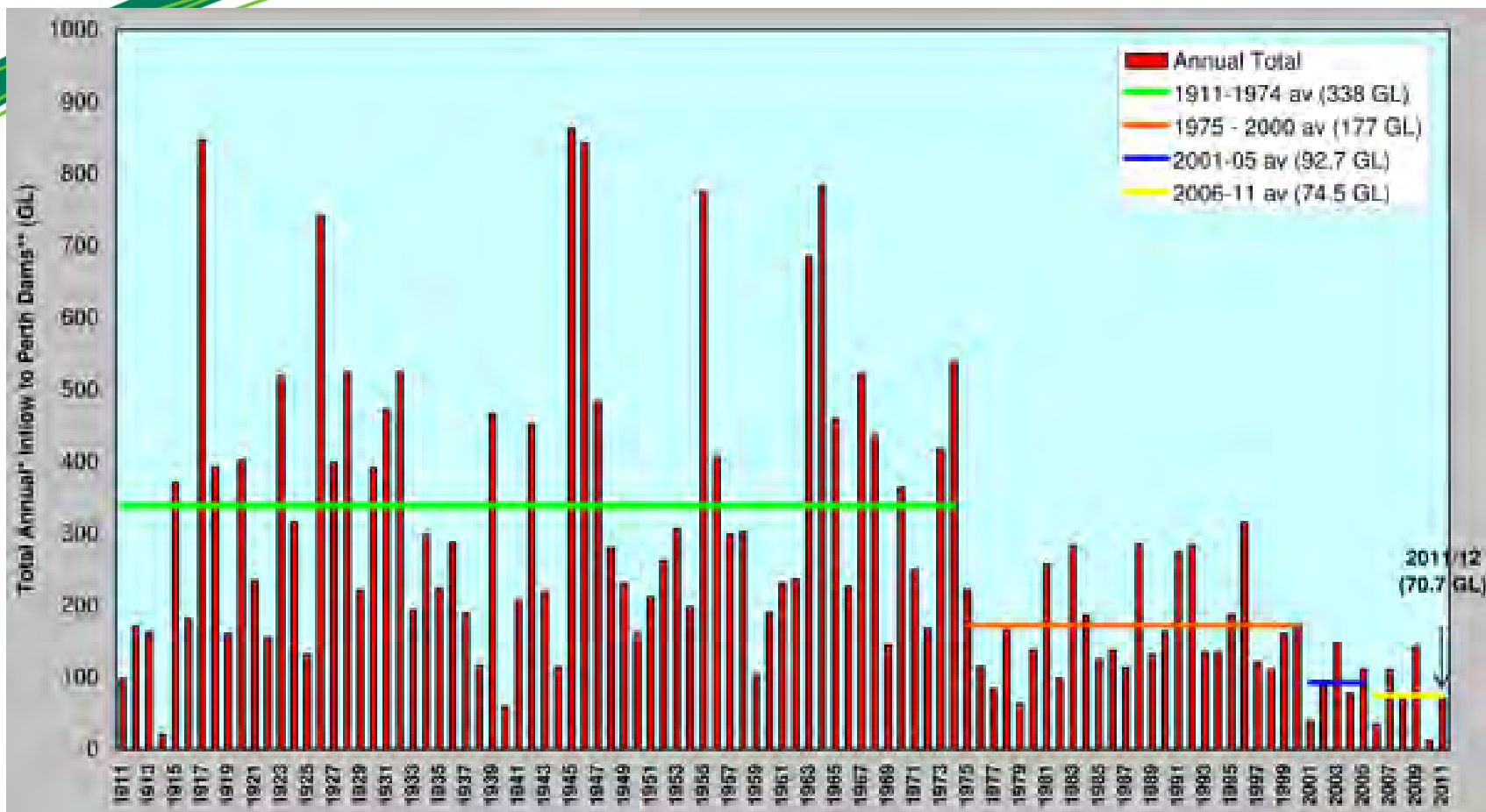


Atmospheric Pressure DJF





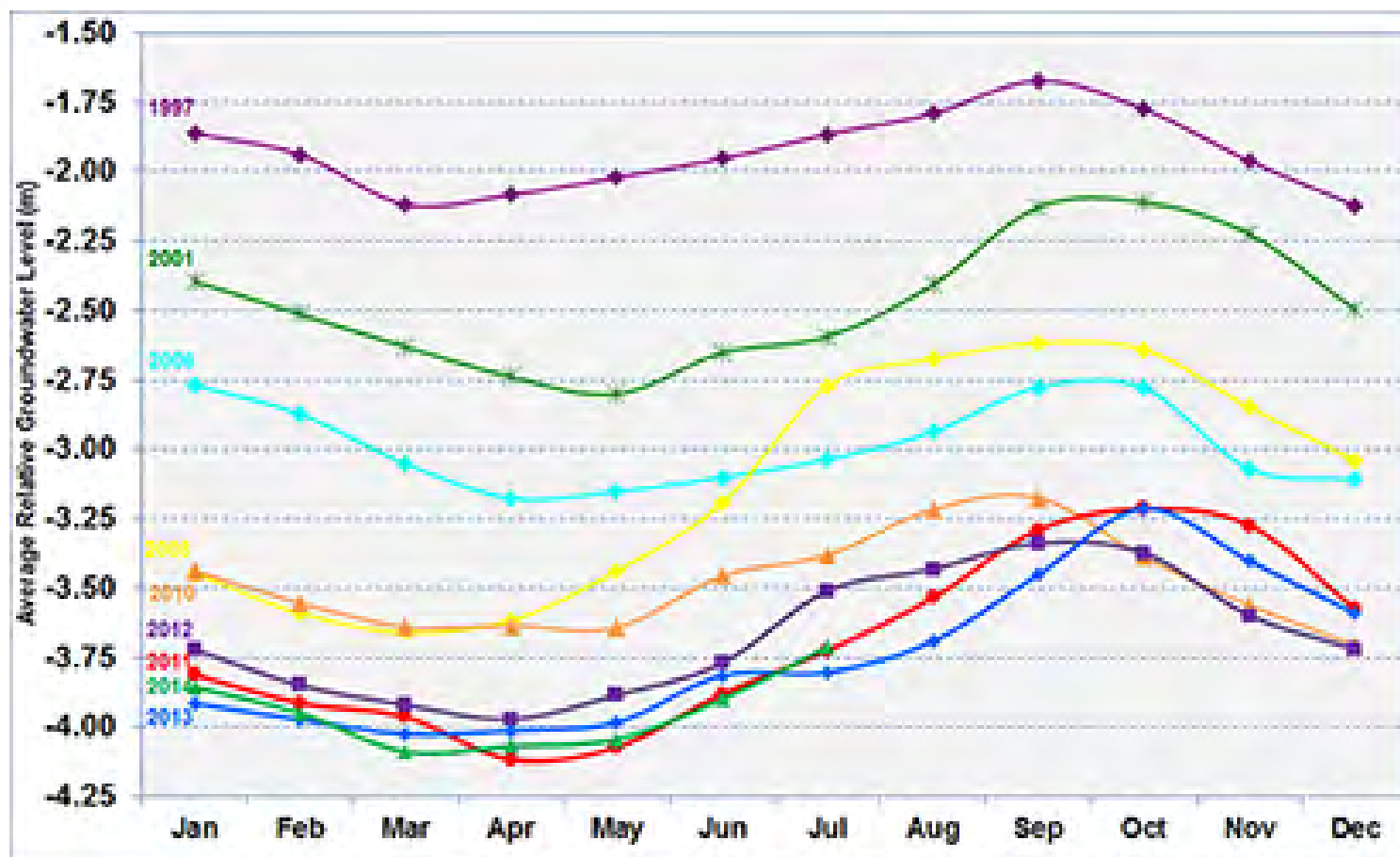
Dam Inflows



Inflow for 2010 was 12 GL, and in 2012 inflow was 18 GL.
Perth's annual budget is almost 400 GL.



Groundwater levels Gnangara Mound

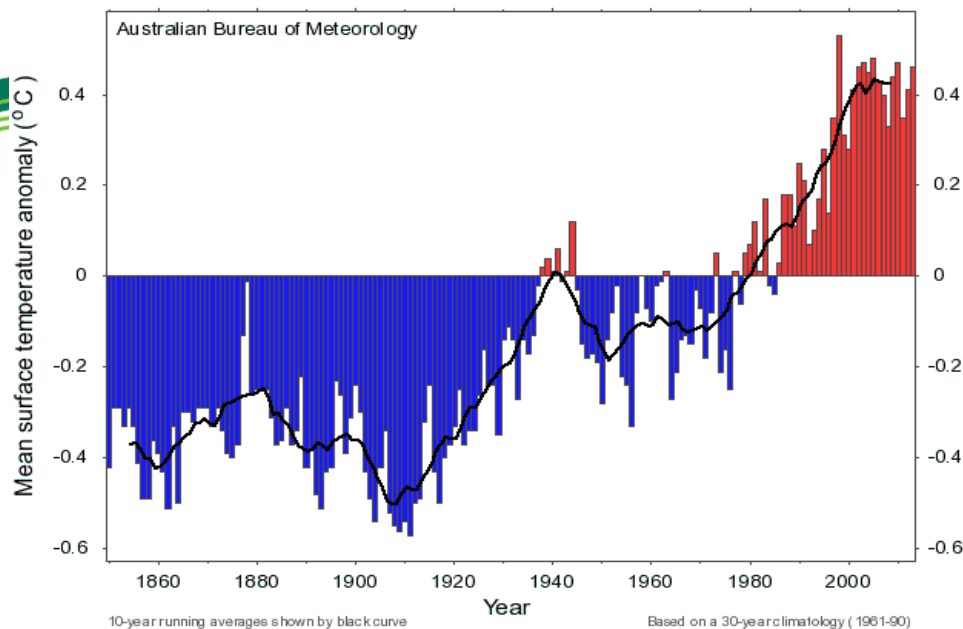


Source: Dept of Water

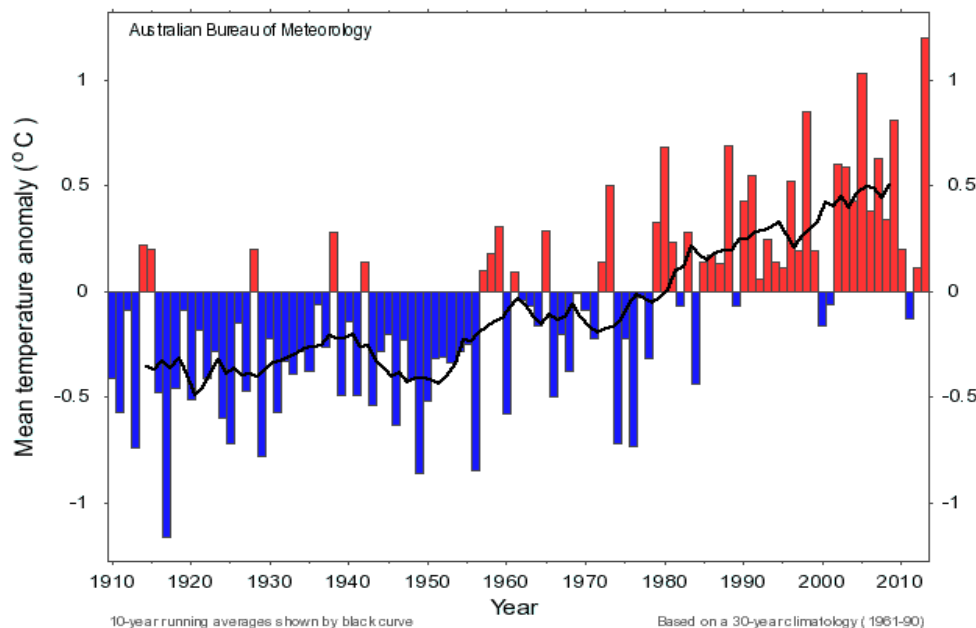


Temperature Trends

Annual mean temperature anomaly - Global (1850-2013)



Annual mean temperature anomaly - Australia (1910-2013)





Ocean heat content

Balmaseda,
Trenberth, and
Källén (2013).

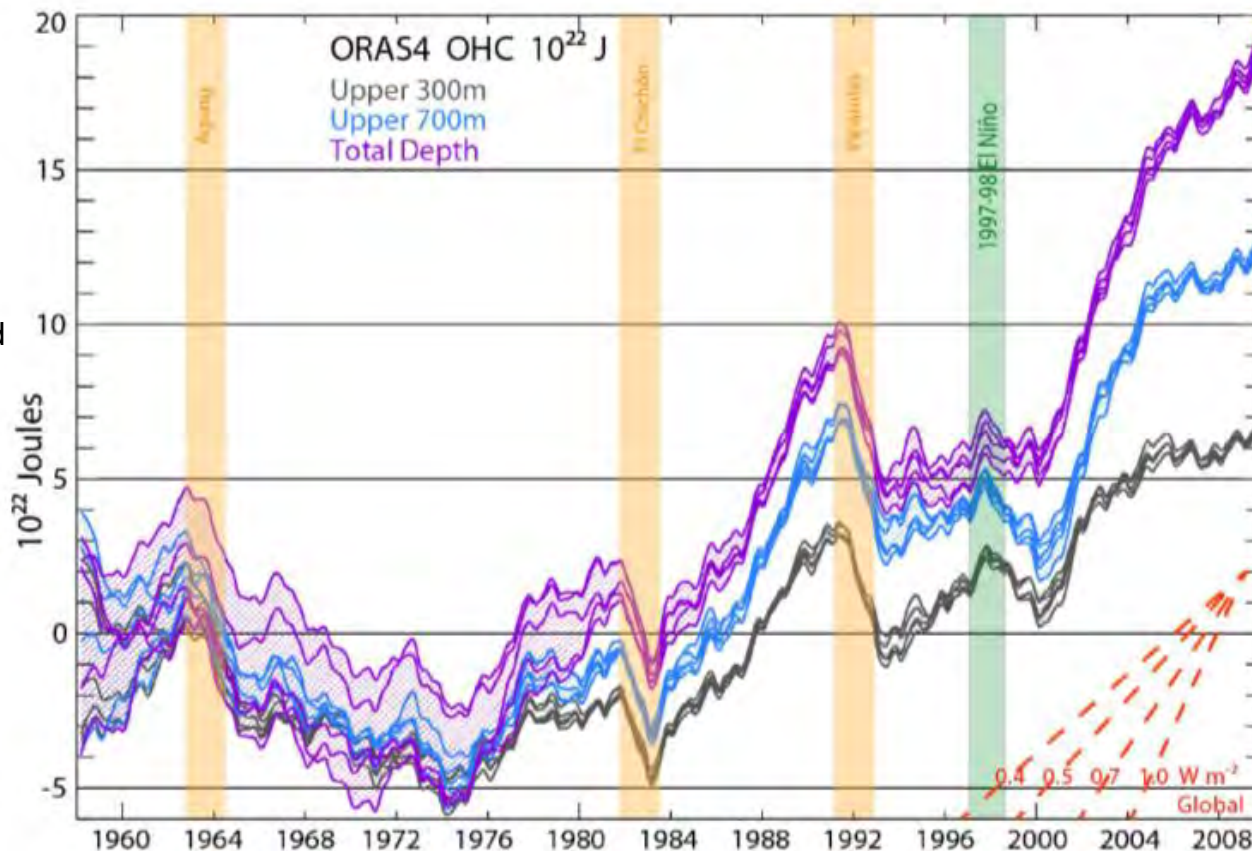


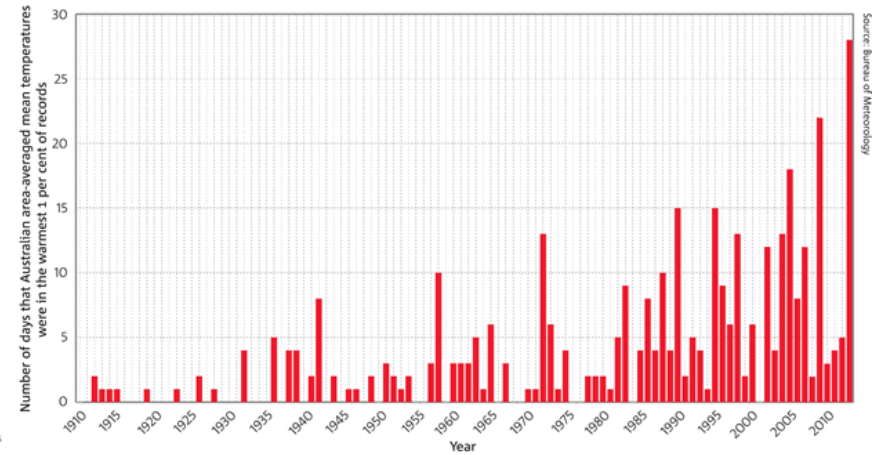
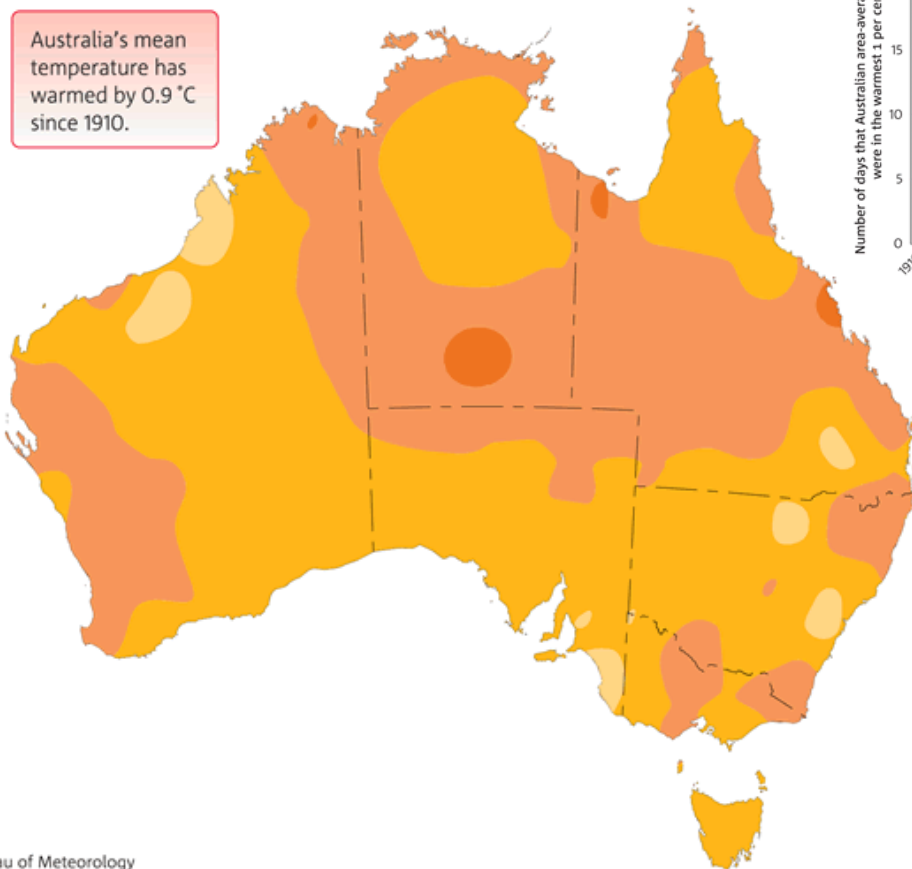
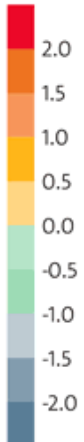
Figure 1: Ocean Heat Content from 0 to 300 meters (grey), 700 m (blue), and total depth (violet) from [ORAS4](#), as represented by its 5 ensemble members. The time series show monthly anomalies smoothed with a 12-month running mean, with respect to the 1958–1965 base period. Hatching extends over the range of the ensemble members and hence the spread gives a measure of the uncertainty as represented by ORAS4 (which does not cover all sources of uncertainty). The vertical colored bars indicate a two year interval following the volcanic eruptions with a 6 month lead (owing to the 12-month running mean), and the 1997–98 El Niño event again with 6 months on either side. On lower right, the linear slope for a set of global heating rates (W/m^2) is given.



Temperature Trends

Australia's mean
temperature has
warmed by 0.9 °C
since 1910.

Temperature
change (°C)

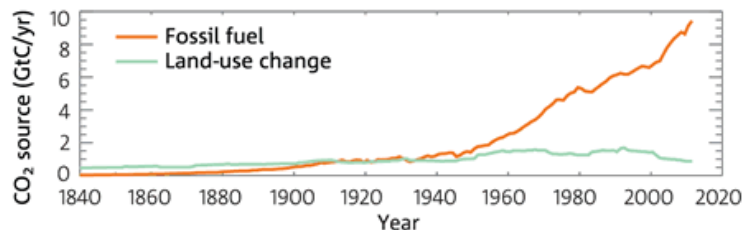


No. days Aust average temperature
is in the top 1%



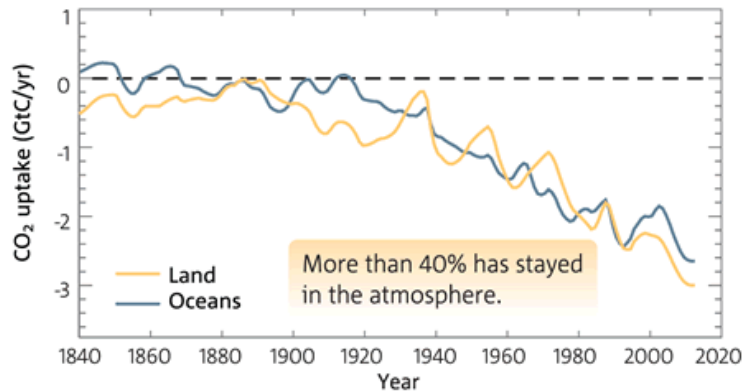
Emissions

Sources of increased atmospheric carbon dioxide concentrations



CO₂ emissions continue to rise and are mainly from fossil fuel burning.

Sinks of carbon dioxide

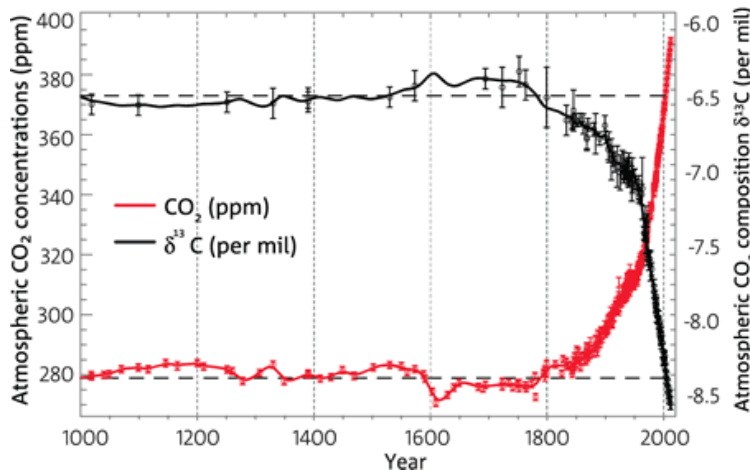


About 30% of anthropogenic CO₂ emissions since the industrial revolution has been taken up by the ocean.

About 30% has been taken up by land vegetation.

More than 40% has stayed in the atmosphere.

Concentration and isotopic composition of atmospheric carbon dioxide



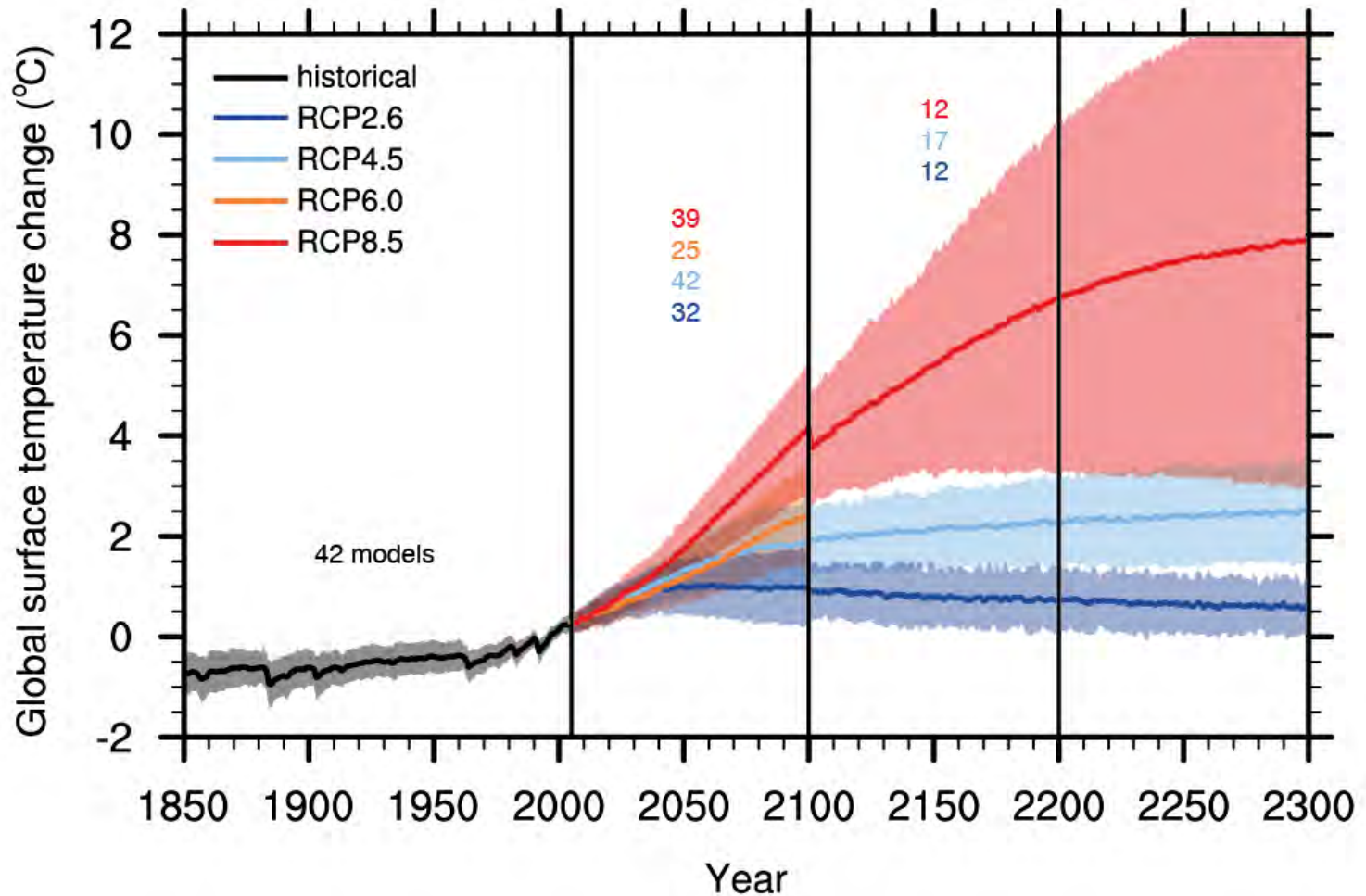
The decrease in the ratio of the carbon-13 isotope ($\delta^{13}\text{C}$) that accompanies increasing CO₂ trends show that the sources are fossil fuel and land-use change.



Projections



Temperature projections

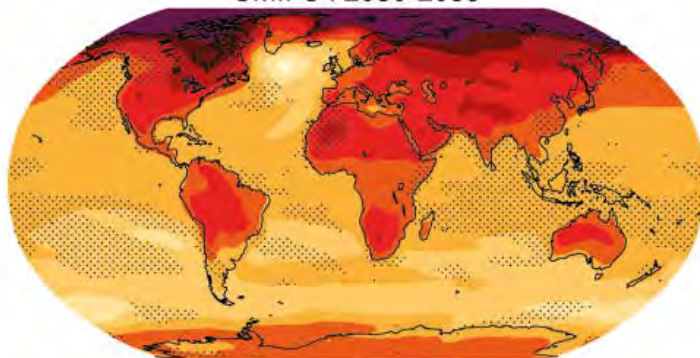




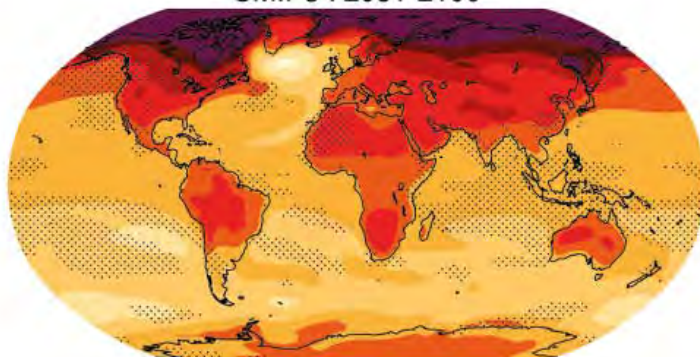
Temperature and rain sensitivity

temperature scaled by global T ($^{\circ}\text{C}$ per $^{\circ}\text{C}$)

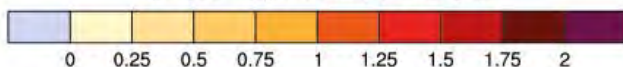
CMIP3 : 2080-2099



CMIP5 : 2081-2100

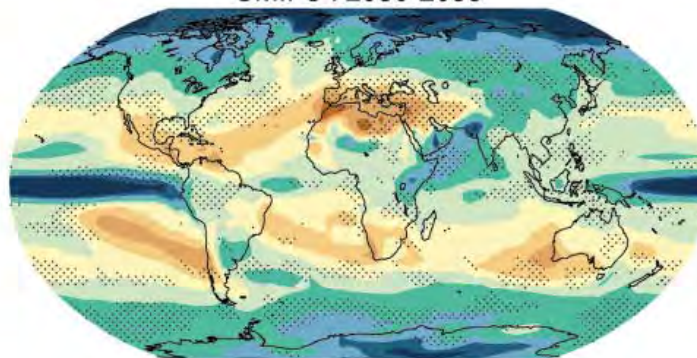


($^{\circ}\text{C}$ per $^{\circ}\text{C}$ global mean change)

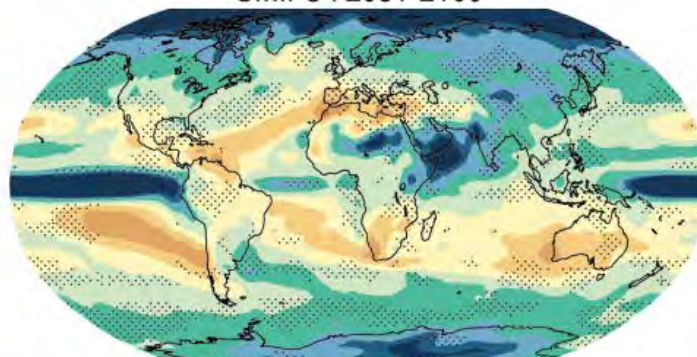


precipitation scaled by global T (% per $^{\circ}\text{C}$)

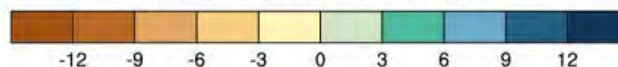
CMIP3 : 2080-2099



CMIP5 : 2081-2100

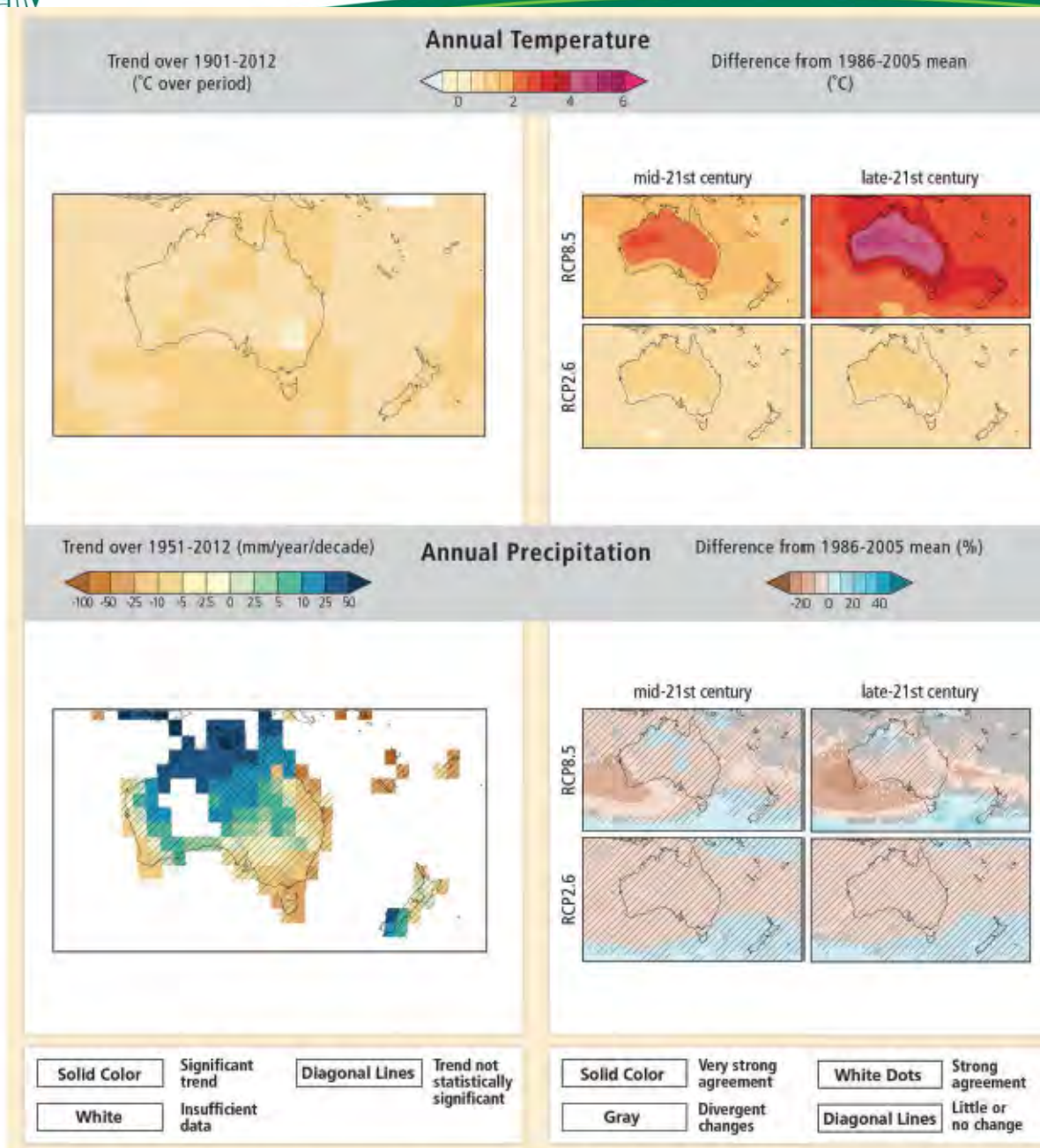


(% per $^{\circ}\text{C}$ global mean change)





Australian projections





Greenhouse 88 Climate Projections

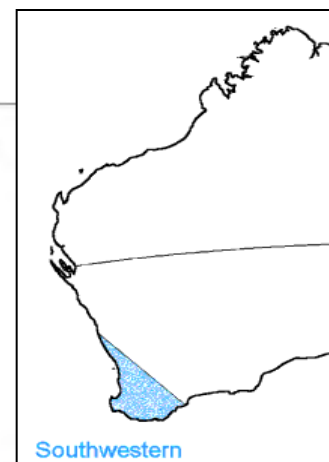
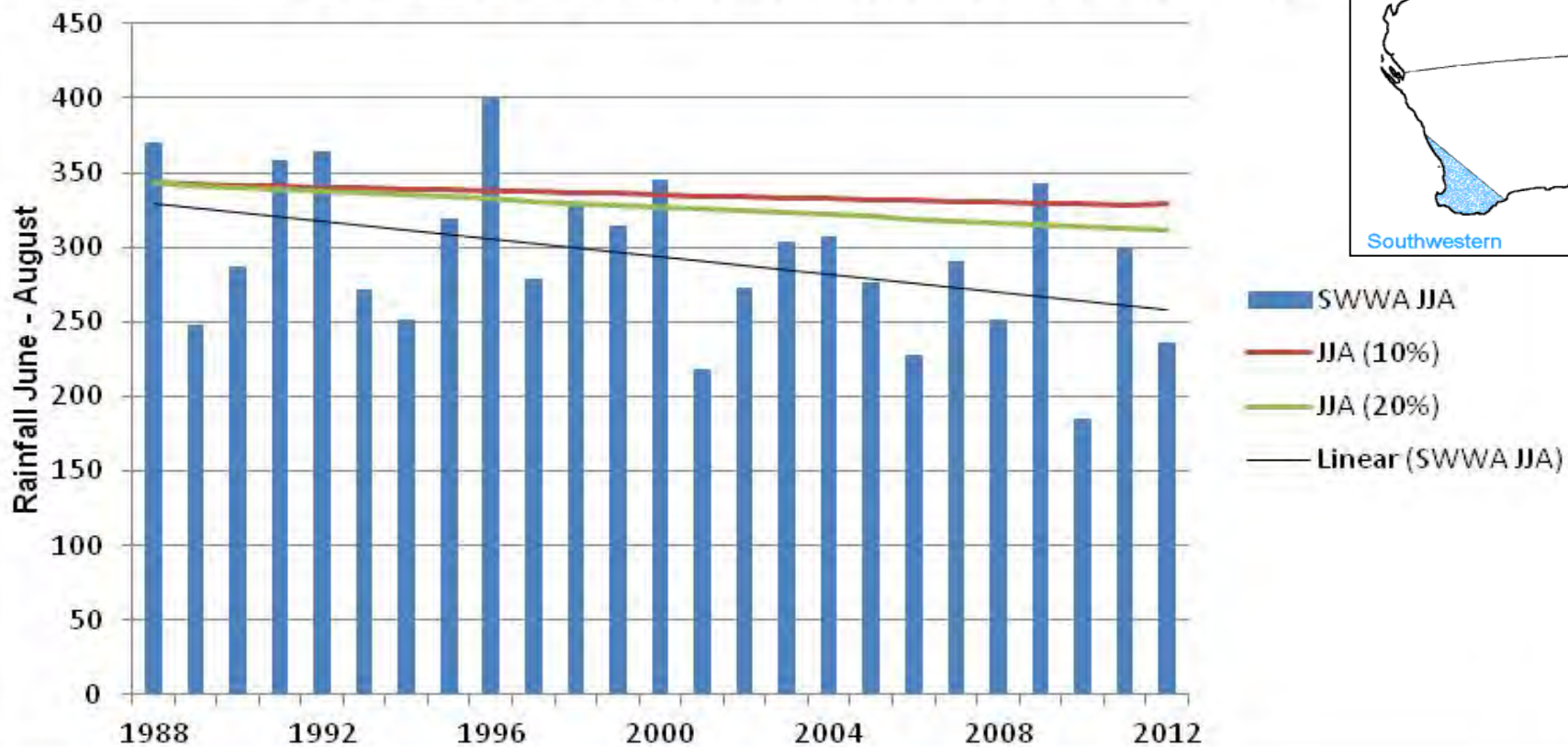
Most likely scenario at 2040:

- Southward shift in winter rainfall systems
- Decreased winter (JJA) rain between 10% and 20%.
- Increased summer rain (up to 40%).
- Winter temperature rise by 1.8 to 2.1 °C
- Summer up by 1.2 – 1.5 °C



Winter Rainfall Changes 1988-2012

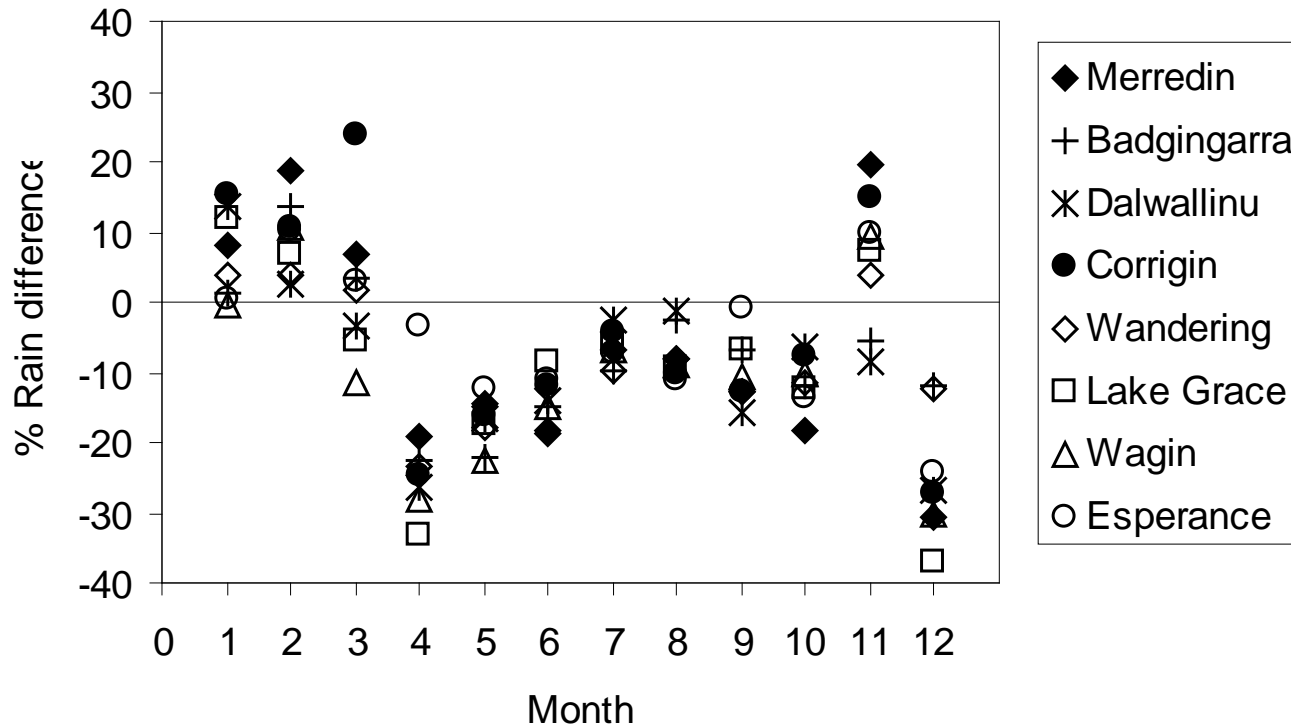
Rainfall over the South West - Actual vs Projected Trend





Future (2035-2064) rainfall vs current (1976-2005)

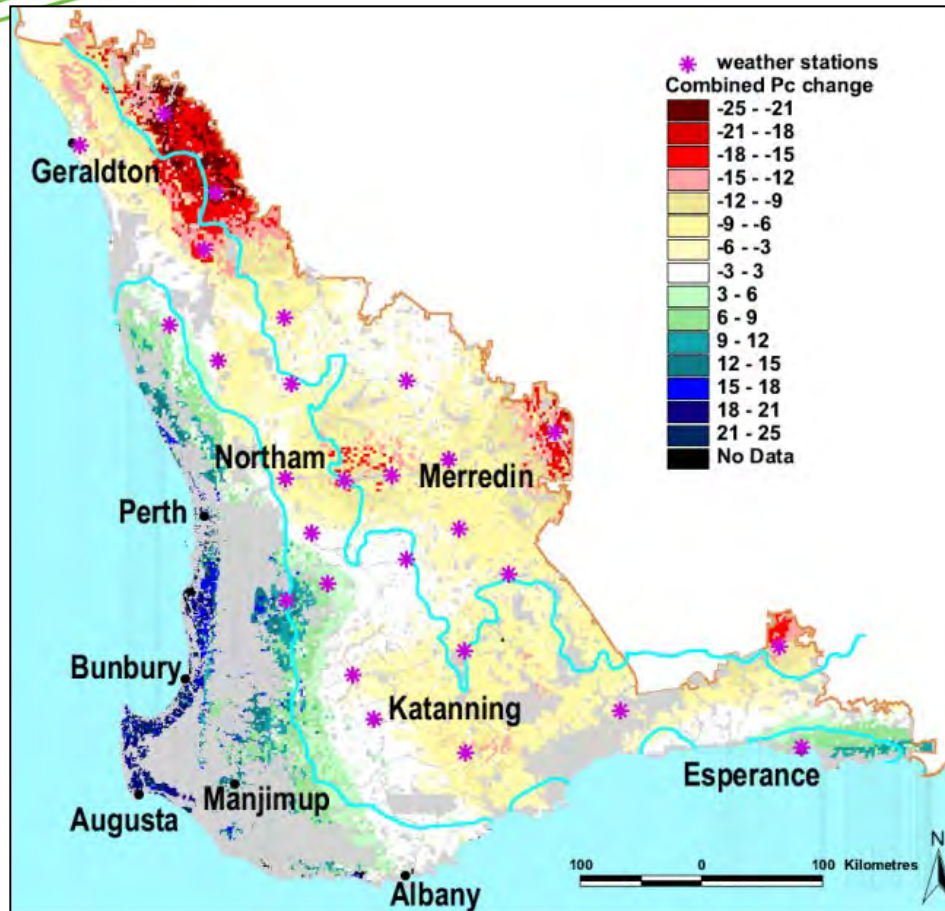
CCAM,
downscaled



More summer rain but less growing season rain. Greater rainfall decrease in autumn, may mean later sowing opportunities

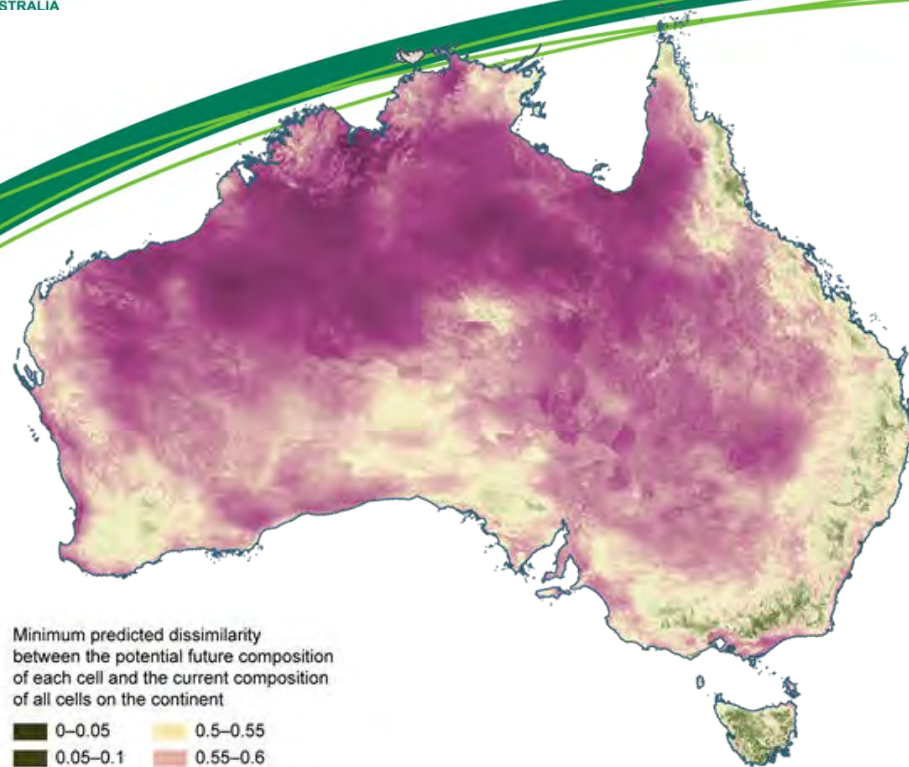


Future Wheat Yields



Combined yield change, adjusted for the proportion of sand, clay or duplex soils. These are 30-year averages for future vs current climate.

Environments



Minimum predicted dissimilarity
between the potential future composition
of each cell and the current composition
of all cells on the continent

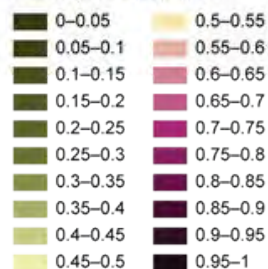


Figure 5.22 Novel biotically scaled environments under 2070 medium-impact scenario, based on generalised dissimilarity modelling of vascular plants.

The colours depict the biotically scaled environmental difference between the future environment at each point and the most similar current environment from anywhere on the continent. Higher values (dark pinks) indicate potential locations of future environments for which no analogue currently exists anywhere on the continent. *State of the Environment. Dept of Environment Australia, 2011*

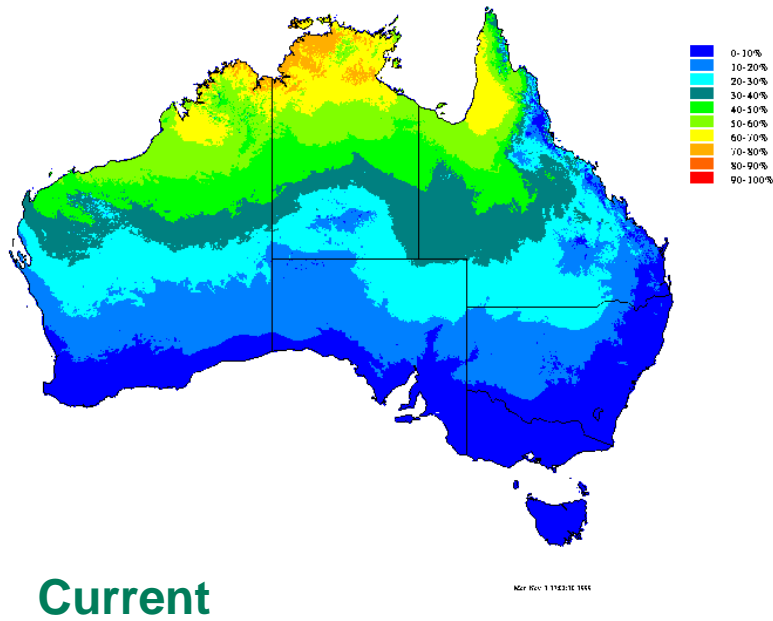


Thank you

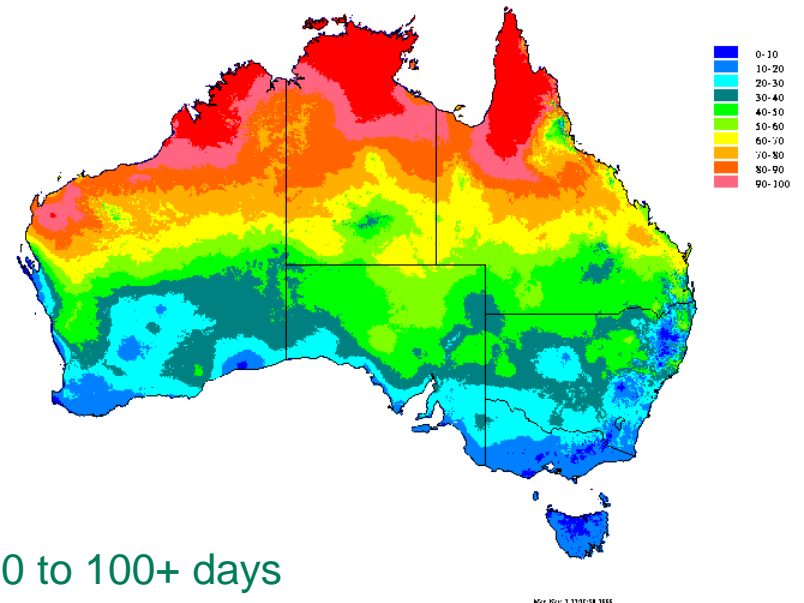
Questions?



Heat Stress



With 2.7 C
warming



Frequency of days with THI >82 changes from 60-70 to 100+ days over Kimberley. Source: M Howden, CSIRO



Existing Climates

These zones are likely to move in future. We cannot assume they are stationary in time.

For many areas, there are already future analogue climates,

