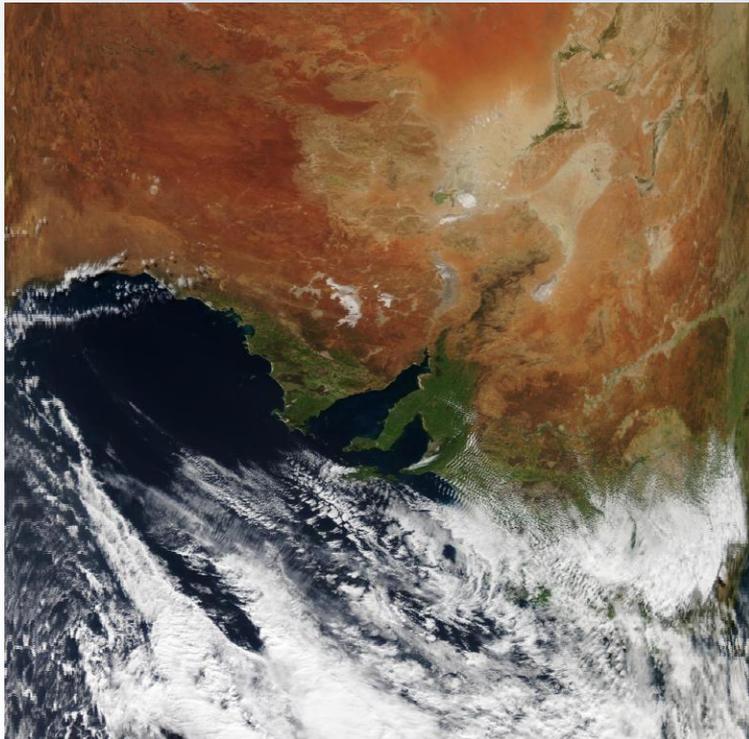




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# Climate change and the Limestone coast wine region



**Darren Ray**

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Centre

Bureau of Meteorology

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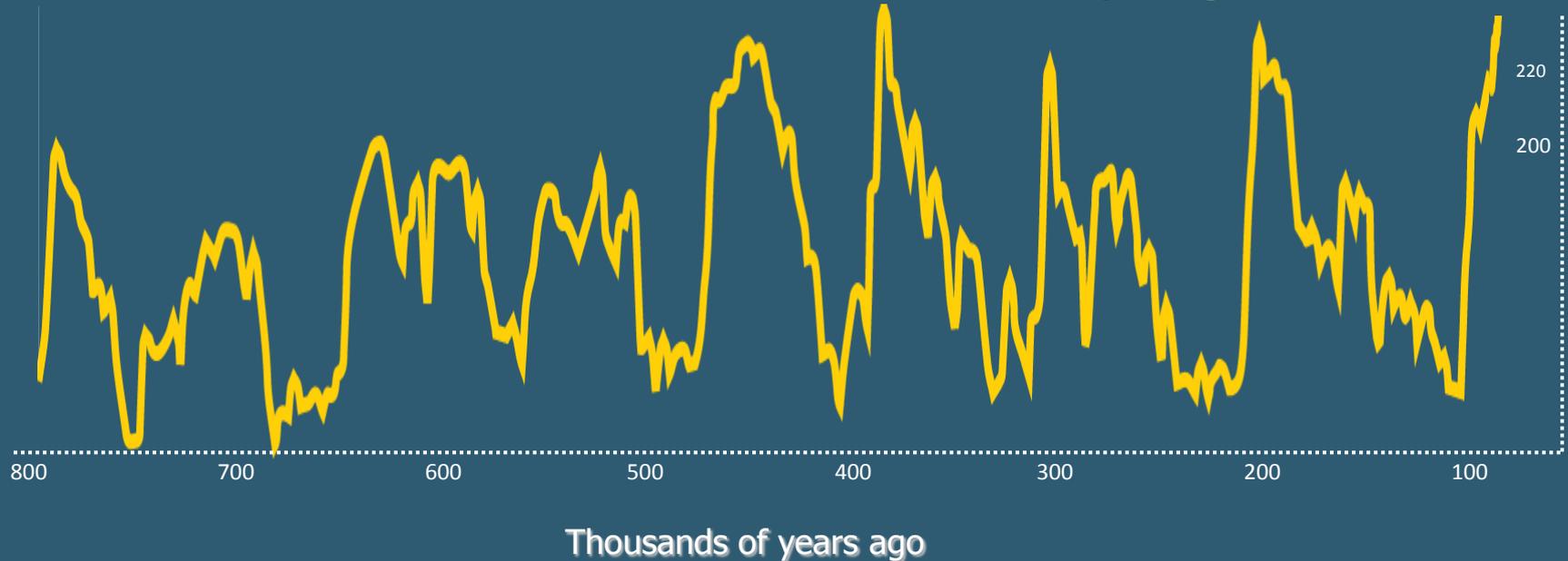
# Outline

- Climate change science
- Observed trends and changes impacting viticulture  
– globally to locally
- Sources of information about climate change
- Forecasting information for climate change adaptation

**Atmospheric CO<sub>2</sub> concentrations reached 400 parts per million in 2013**

**We have put a large pulse of greenhouse gases into the atmosphere over a short period**

**Carbon dioxide concentrations over the last 800,000 years**





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# What are those higher levels of greenhouse gases doing?

Less heat is being measured escaping to space by satellites



More heat is being measured coming back to the surface...  
2.3 watts/square metre

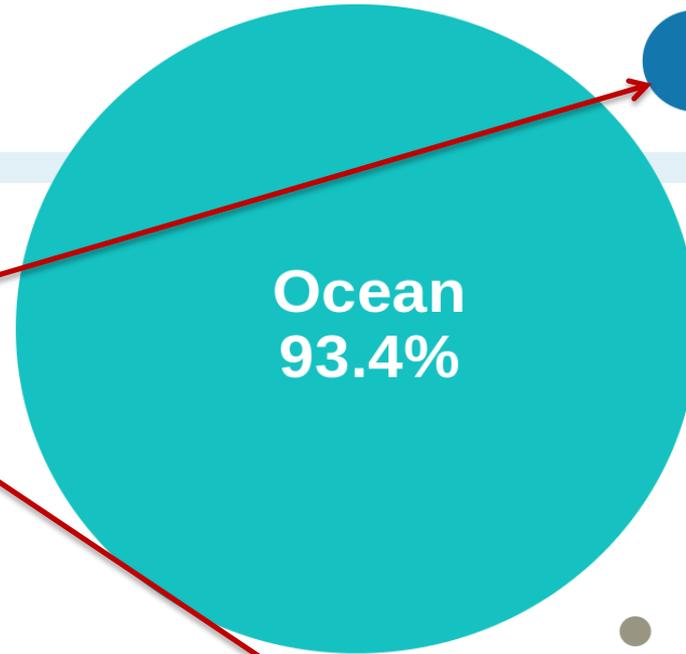


The amount of extra heat being trapped in the Earth climate system is equivalent to 4 Hiroshima bombs per second



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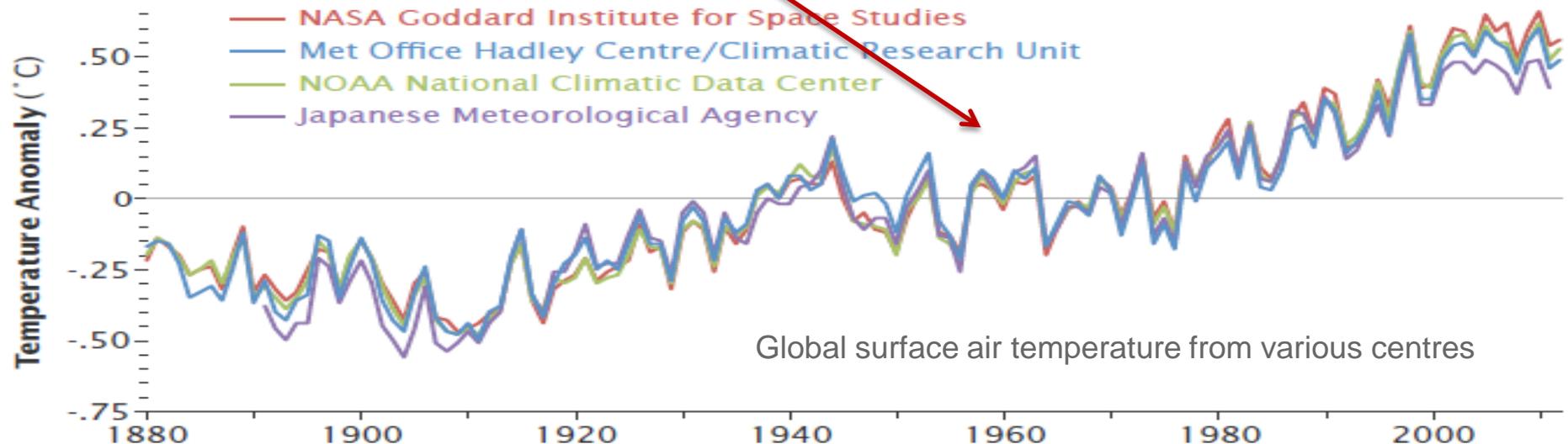
# Where is global warming going?



- Atmosphere 2.3%
- Continents 2.1%
- Glaciers/ice caps 0.9%
- Arctic sea ice 0.8%
- Greenland Ice Sheet 0.2%
- Antarctic Ice Sheet 0.2%

The amount of trapped heat that ends up being measured in surface air temperature

2014 is very likely to be the new hottest year on record globally

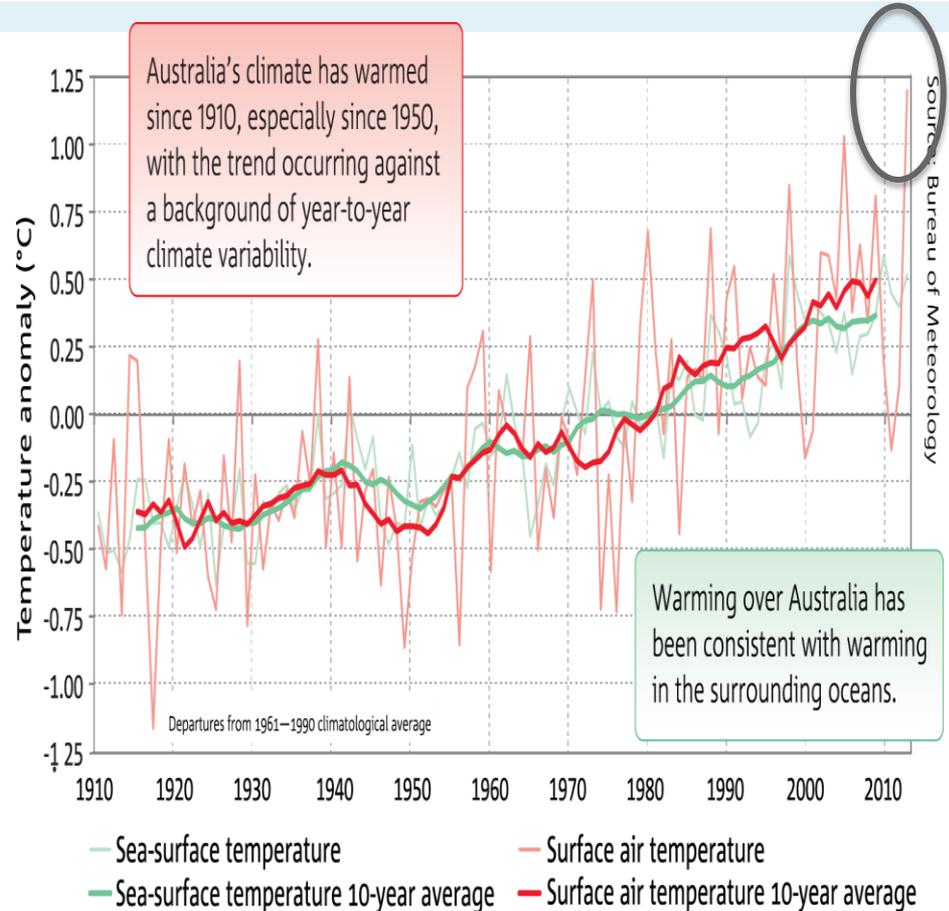
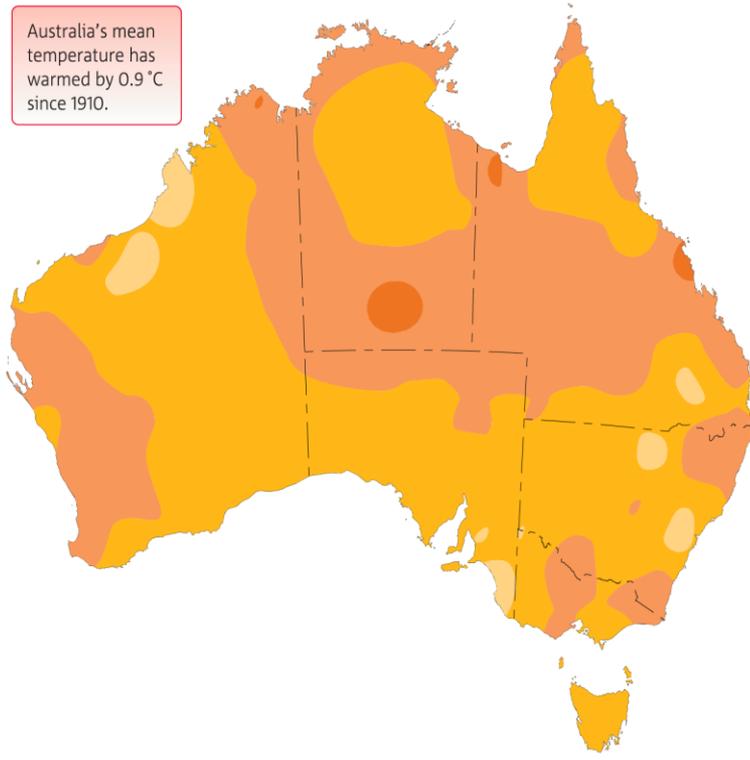
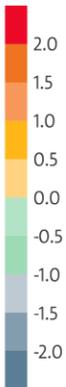




# Australia is warming, on land and in the oceans

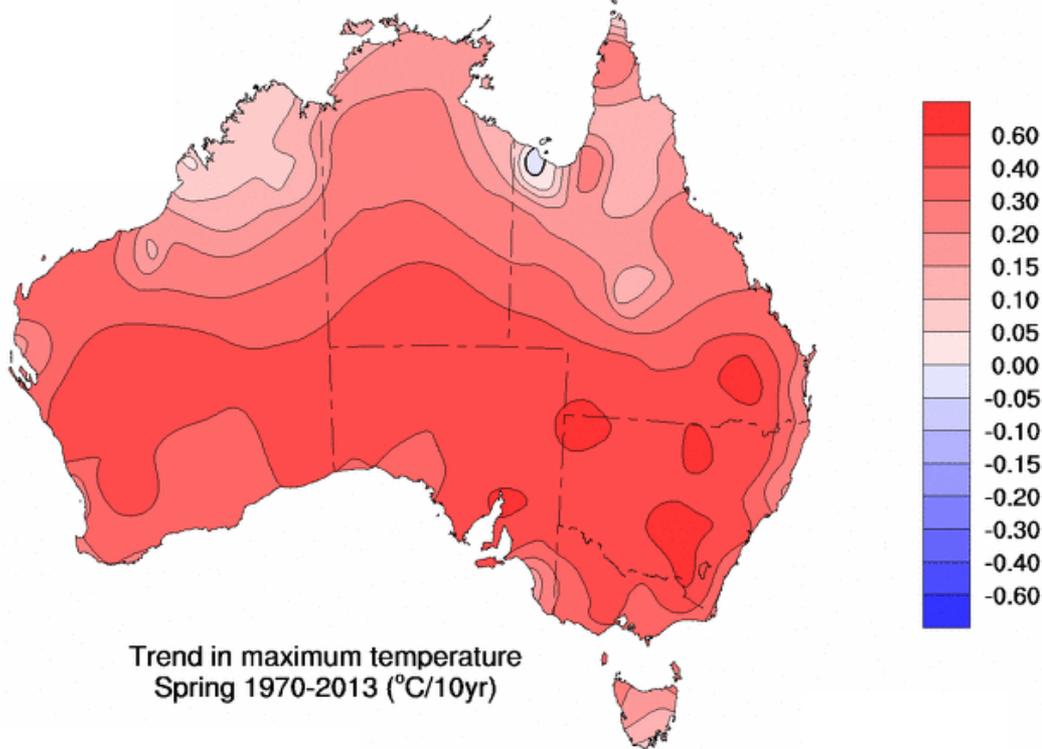
Australia's mean temperature has warmed by 0.9 °C since 1910.

Temperature change (°C)



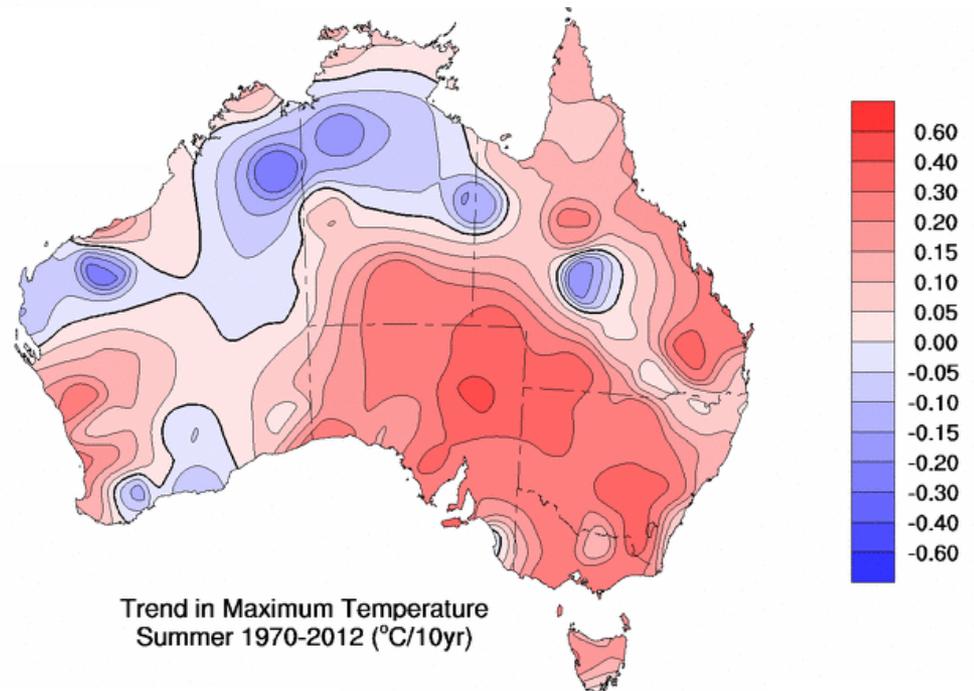
2013 was hottest year on record for Australia and South Australia

# Climate trends and changes

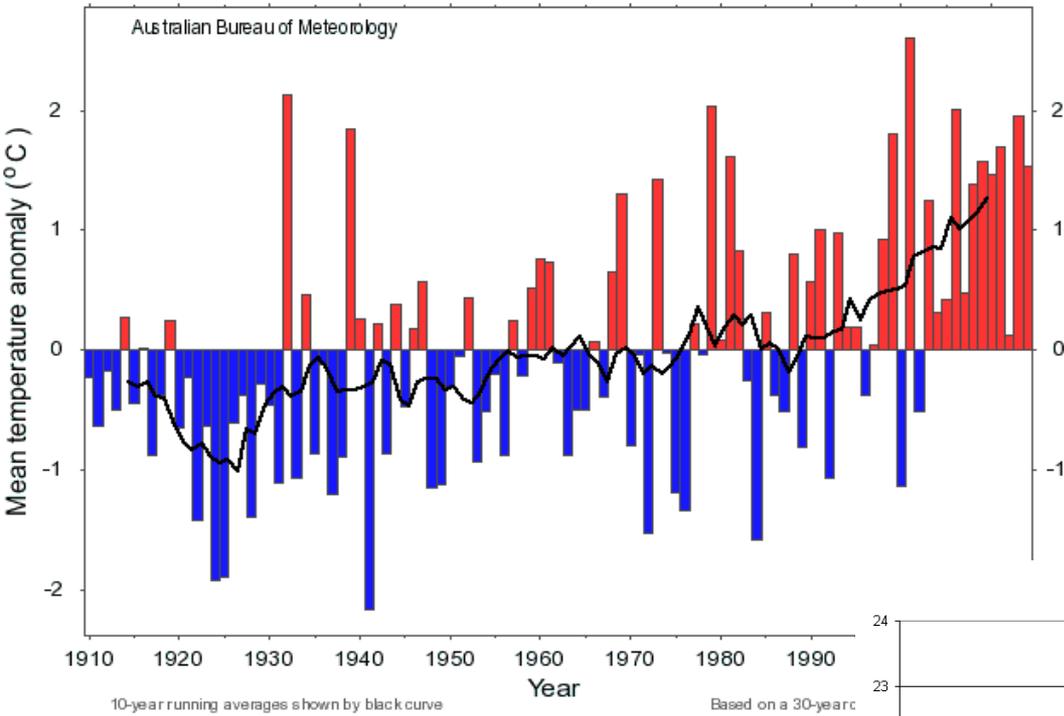


Warming by ~ 1.0C,  
particularly at night and in  
spring

Earlier bud burst and  
flowering resulting in  
earlier harvests in late  
summer

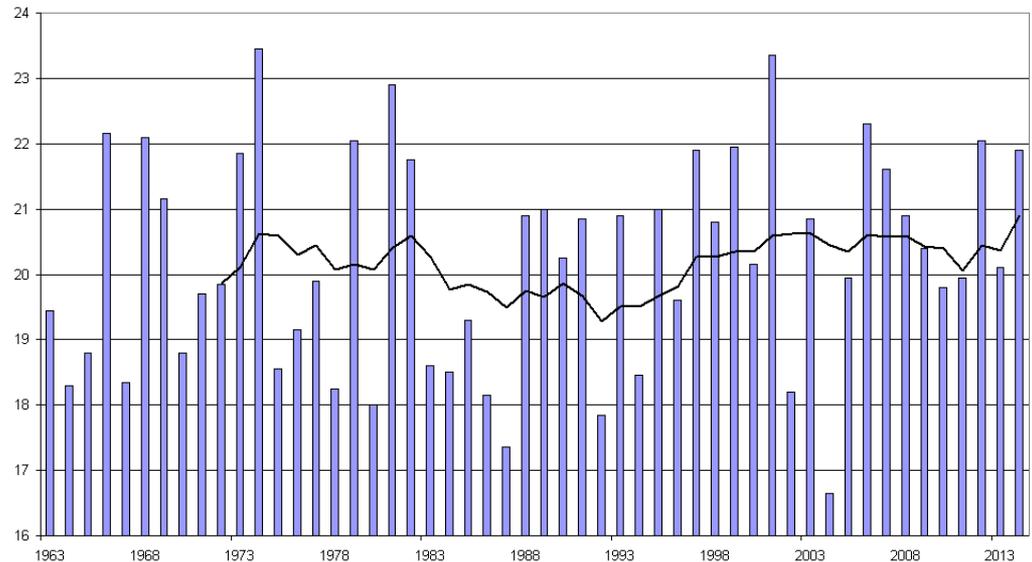


January mean temperature anomaly - Southern Australia (1910-2014)



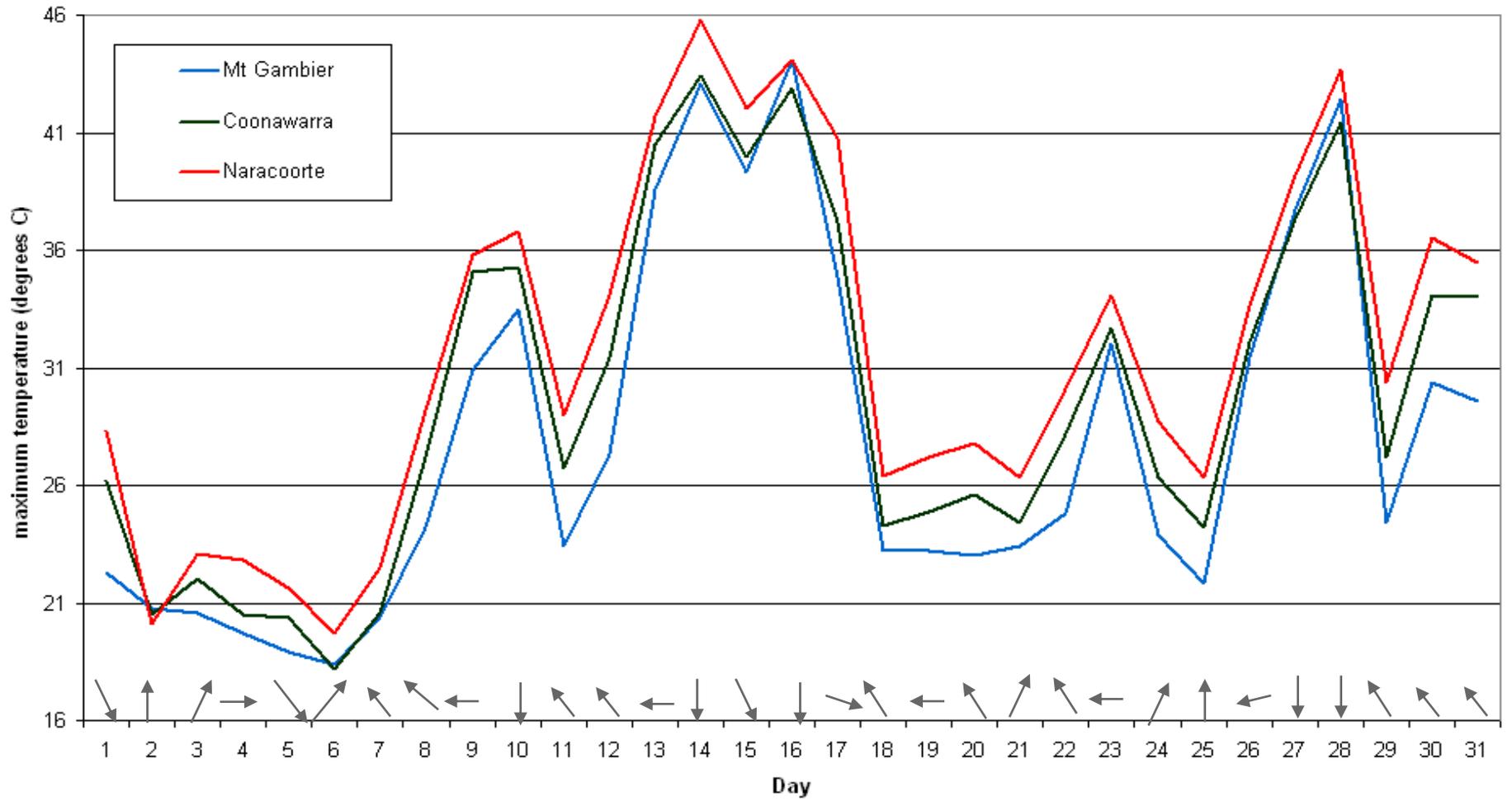
# Mean January Temperature

Mean January Temperature- Naracoorte

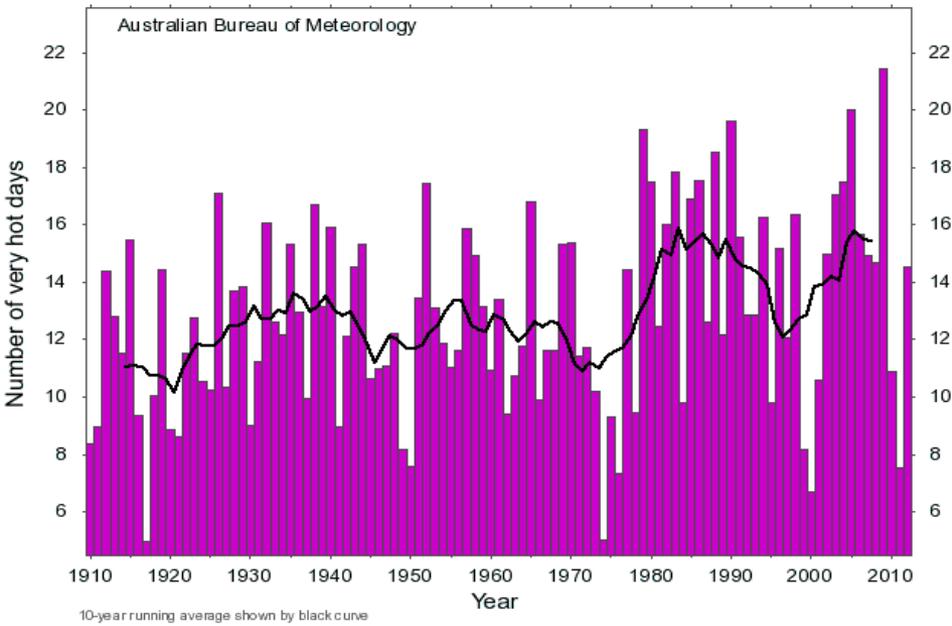




January 2014 daily maximum temperatures



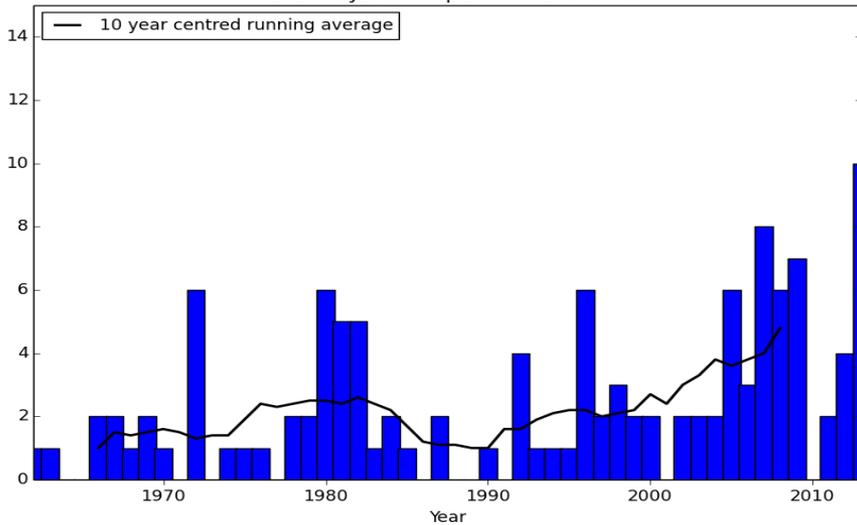
Average number of very hot days (1910-2012)



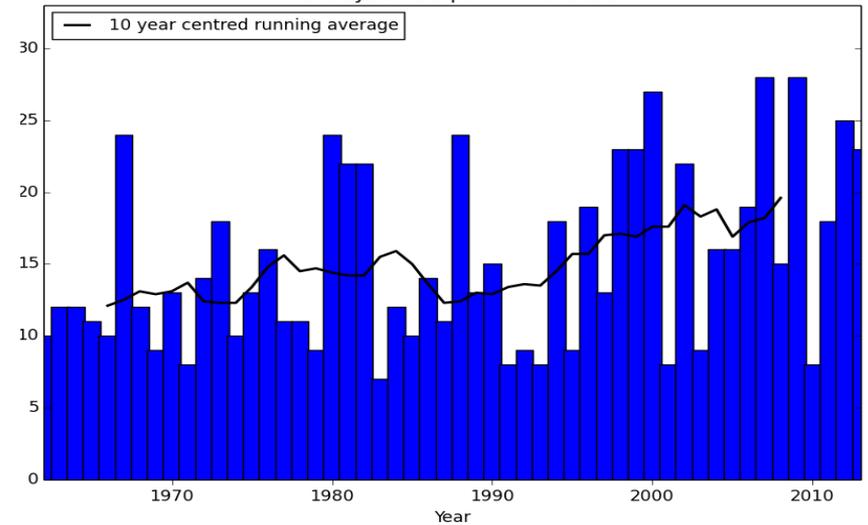
# Australian extreme temperatures

About a 2-3 x increase in extreme days

No. of days >40C per FY: Naracoorte



No. of days >35C per FY: Naracoorte



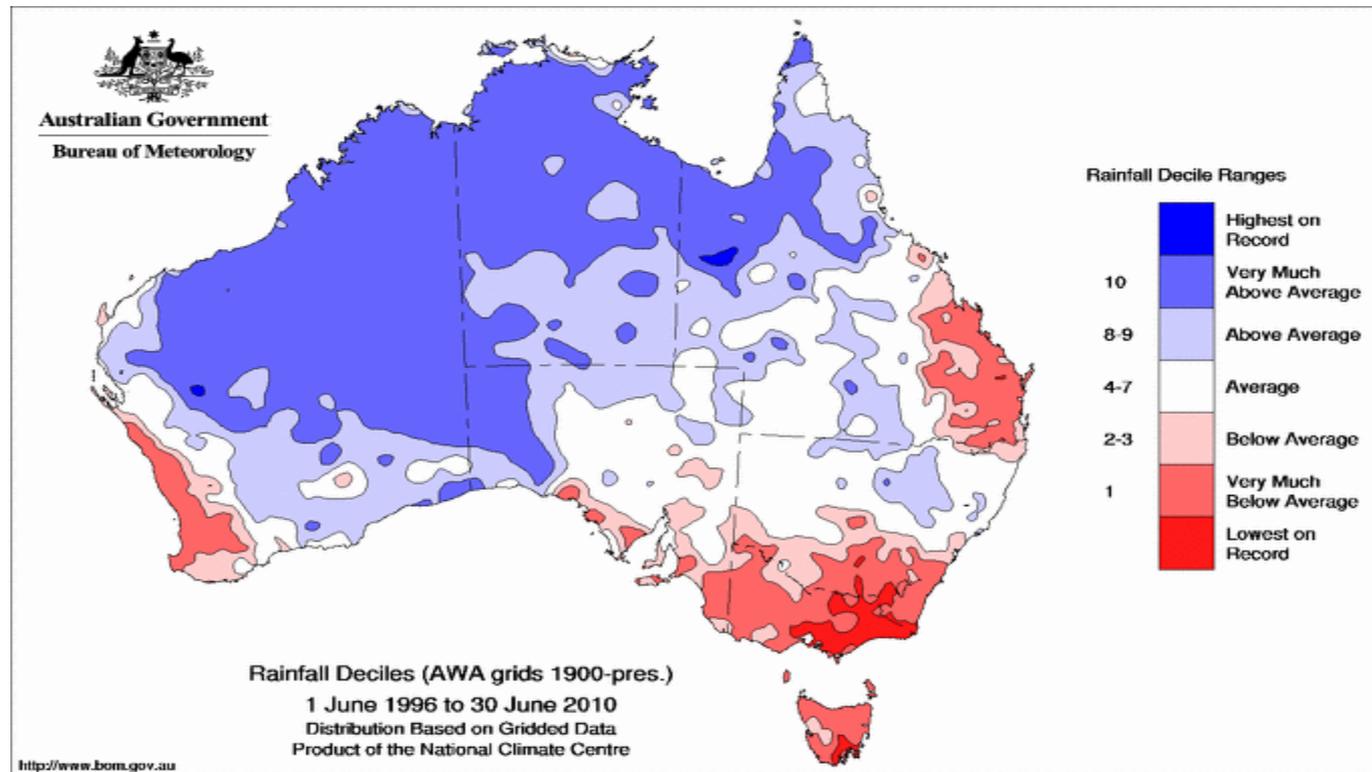


Australian Government

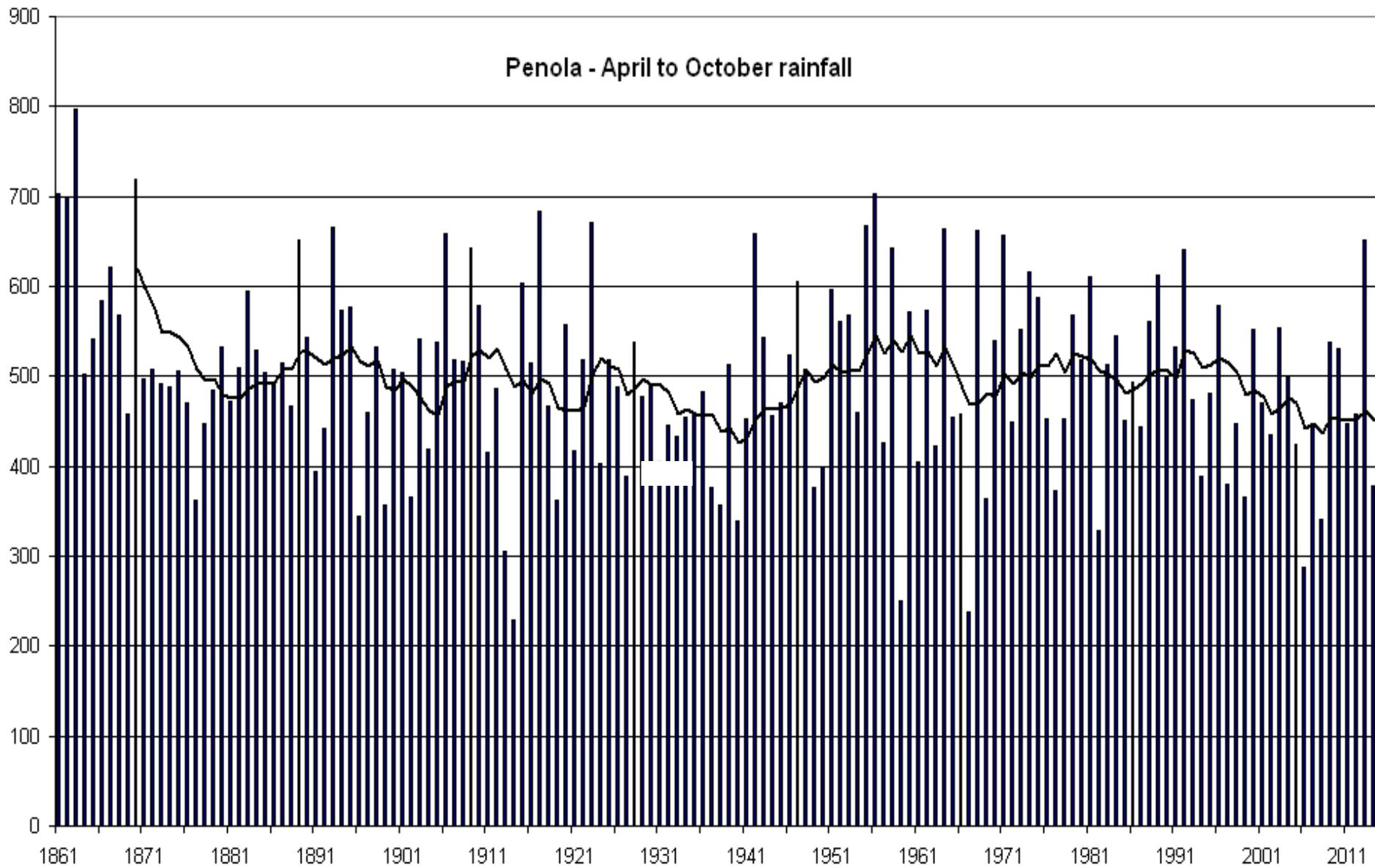
Bureau of Meteorology

# Changes in weather patterns

Decreased April  
to October  
rainfall

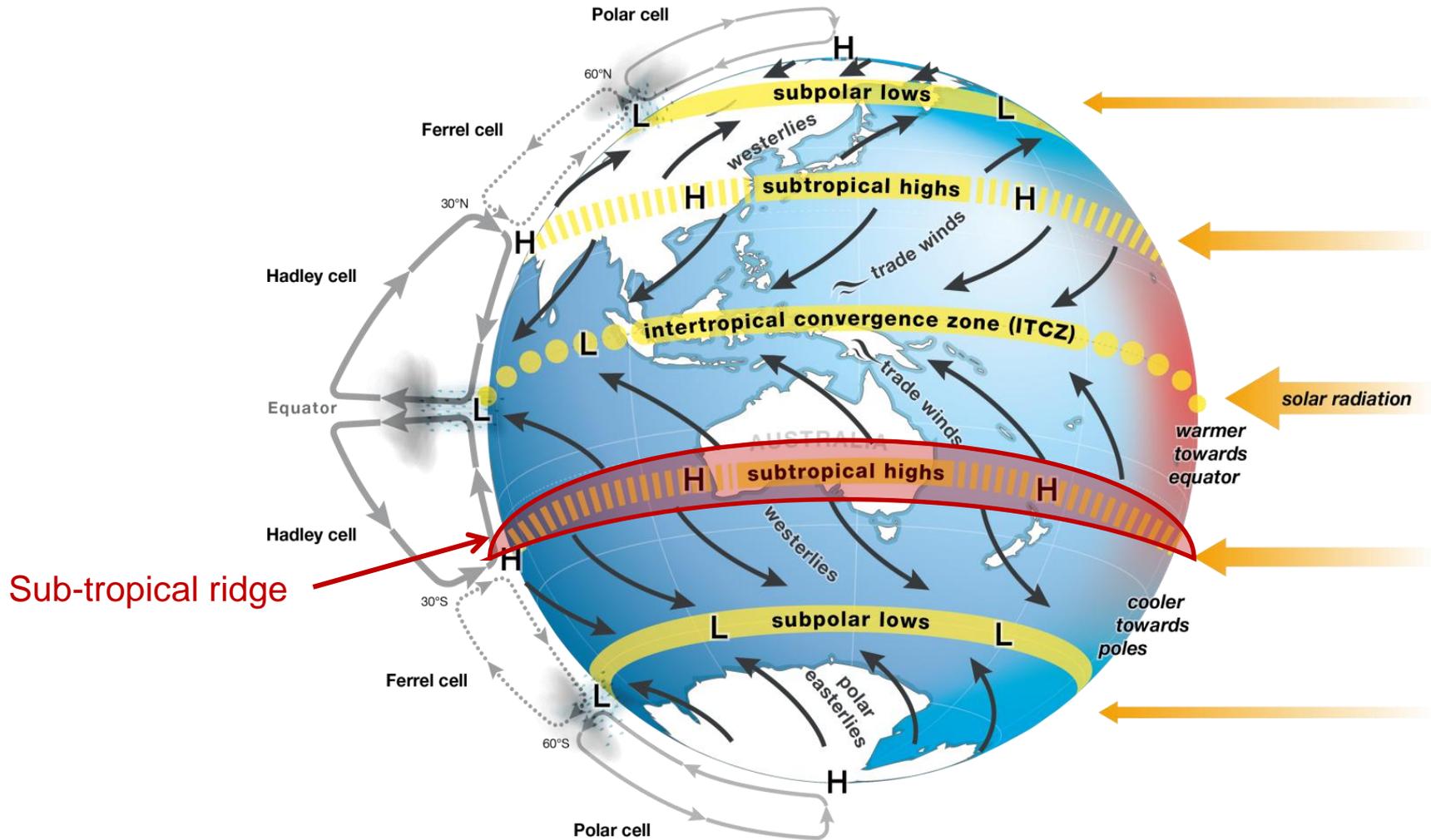


Penola - April to October rainfall



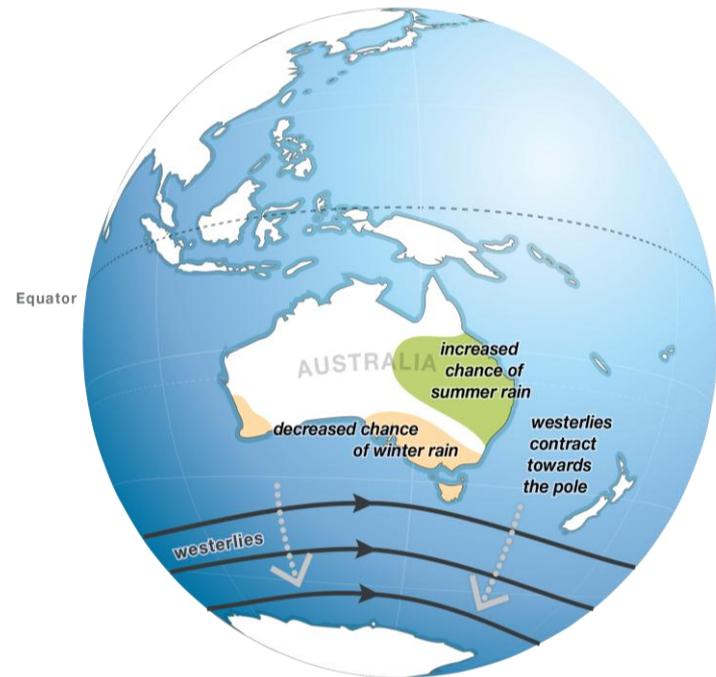
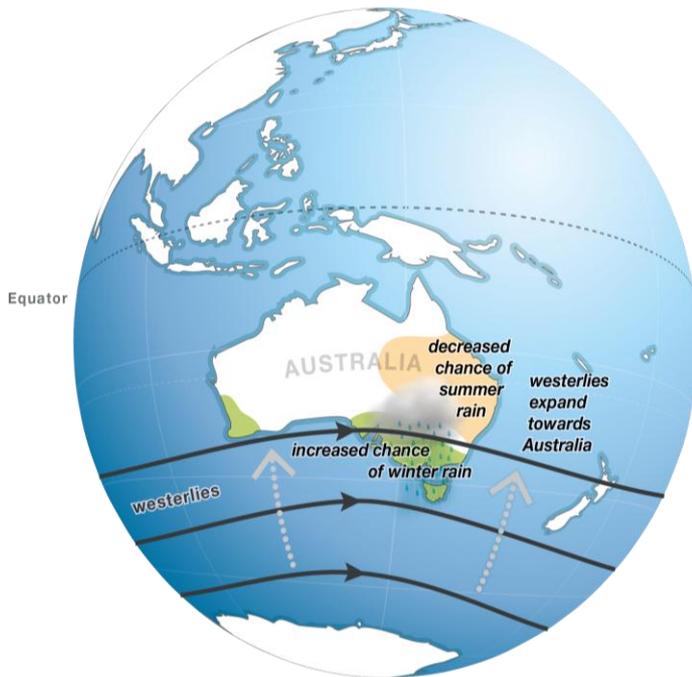


# Changes in weather patterns





# Southern Annular Mode

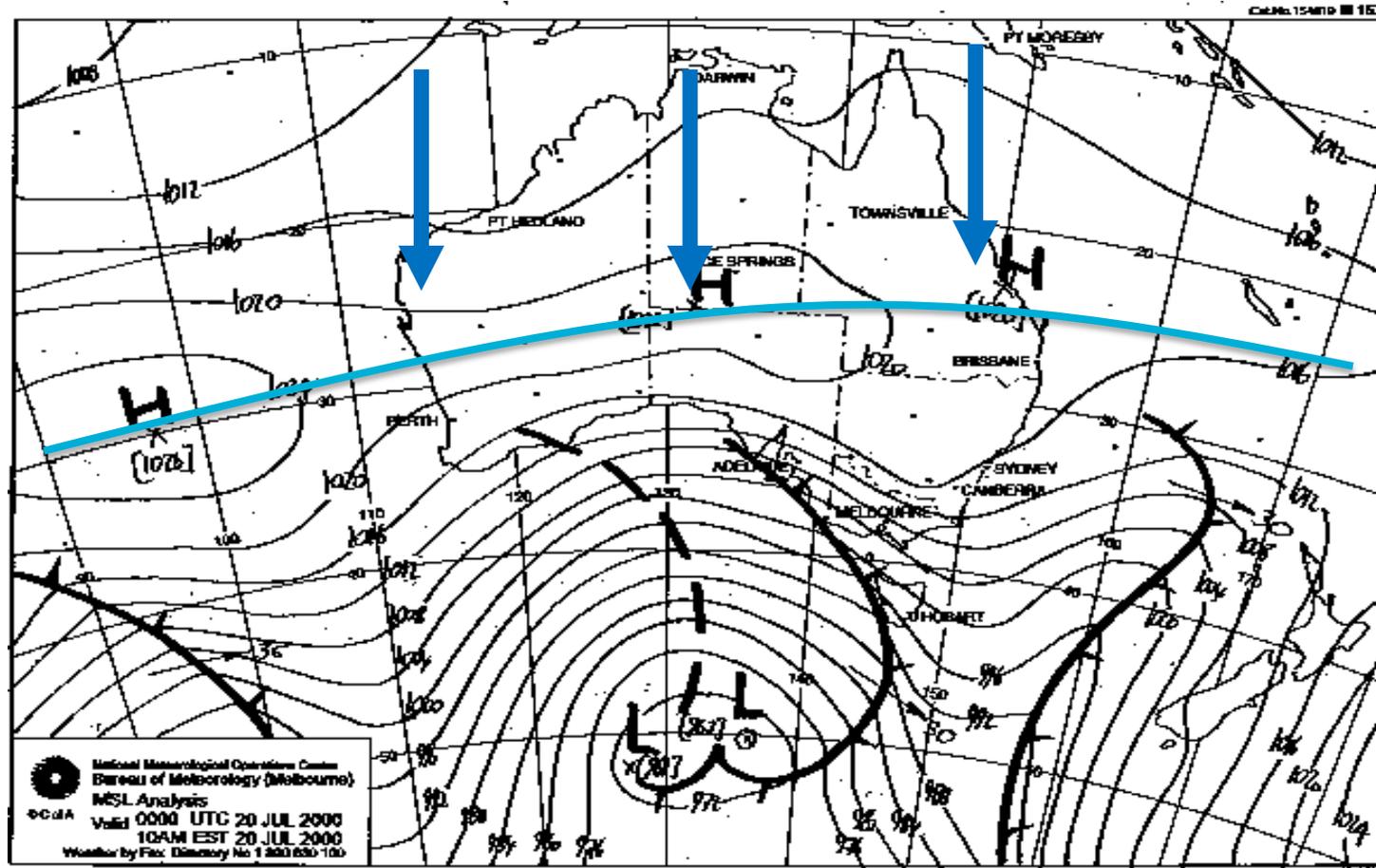


A measure of how contracted the westerly winds are around Antarctica



# Changes in weather patterns

Not from natural  
variability  
Strong April-June  
drying trend



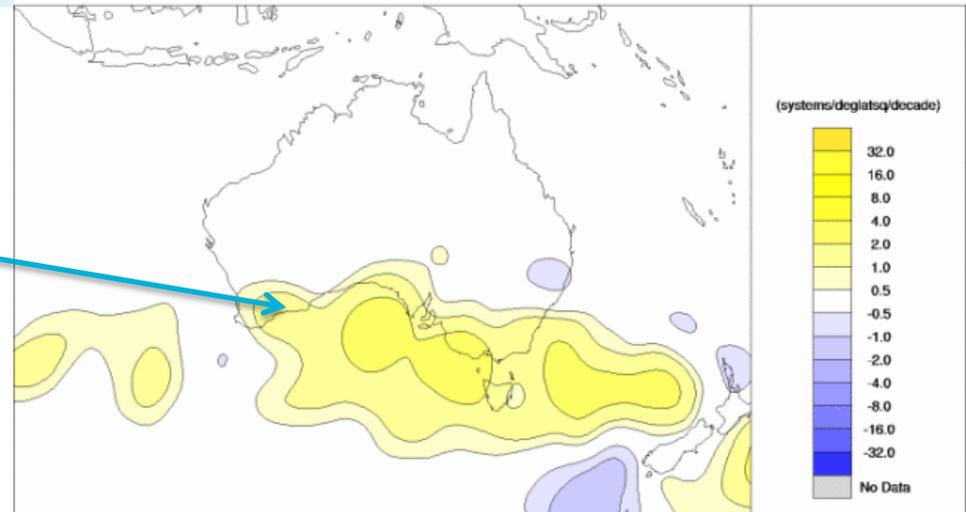


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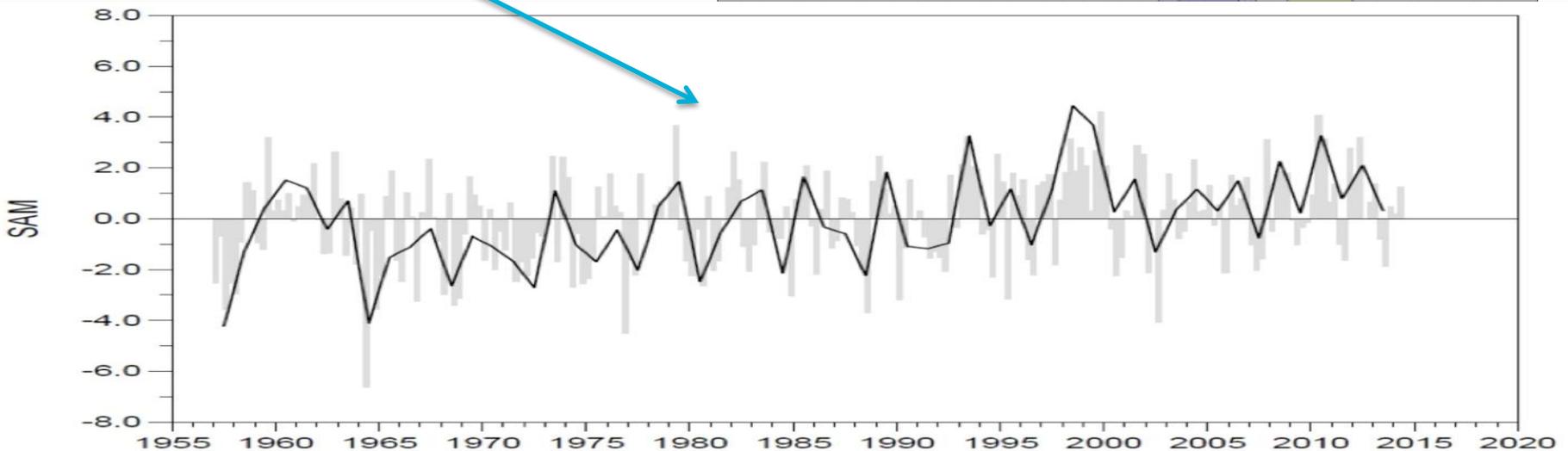
# Changes in weather patterns

Trend in Autumn Anti-Cyclone Density 1970-2009



Stronger sub-tropical ridge  
over southern Australia

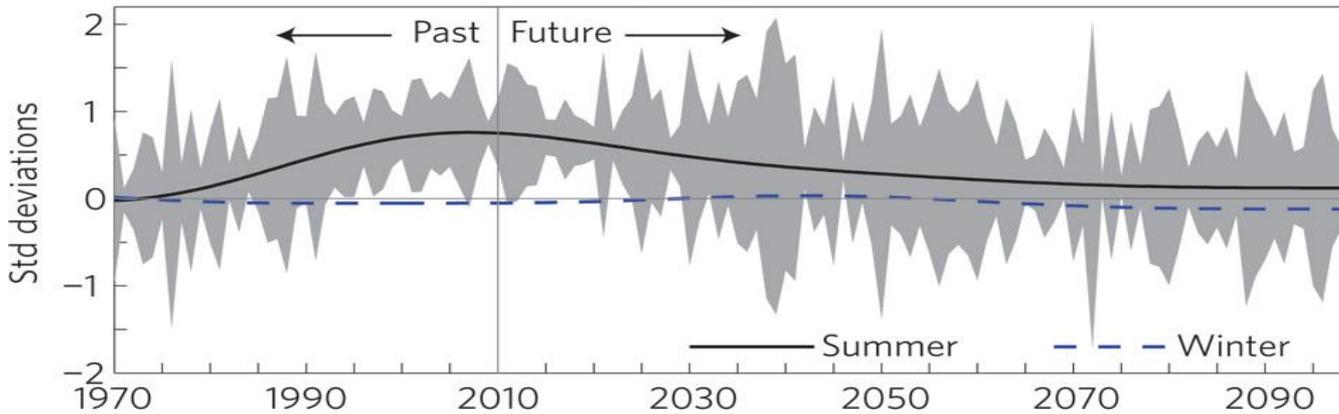
and SAM is trending upwards



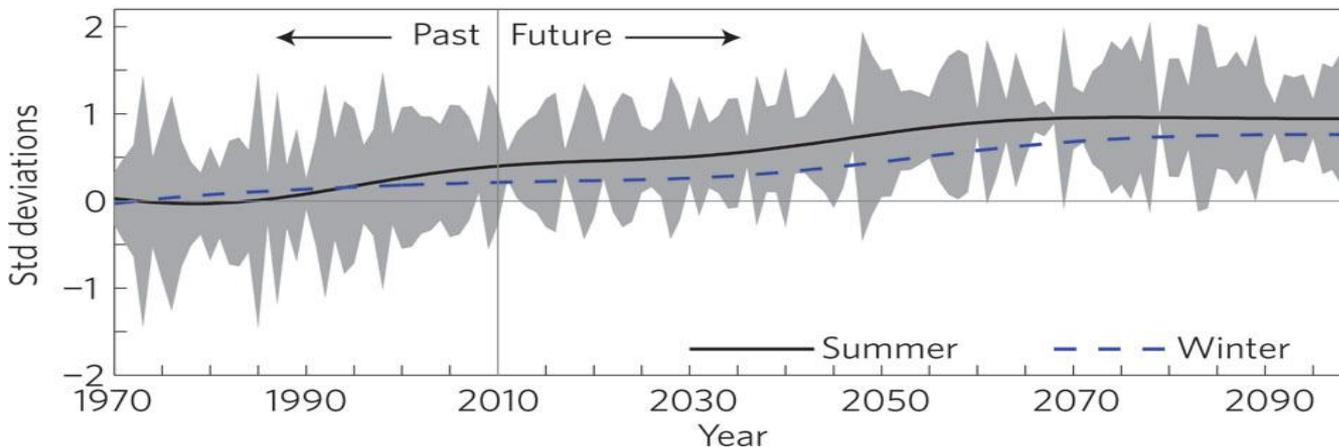


# SAM observations and projections

Ozone-depleting substances



Greenhouse gases



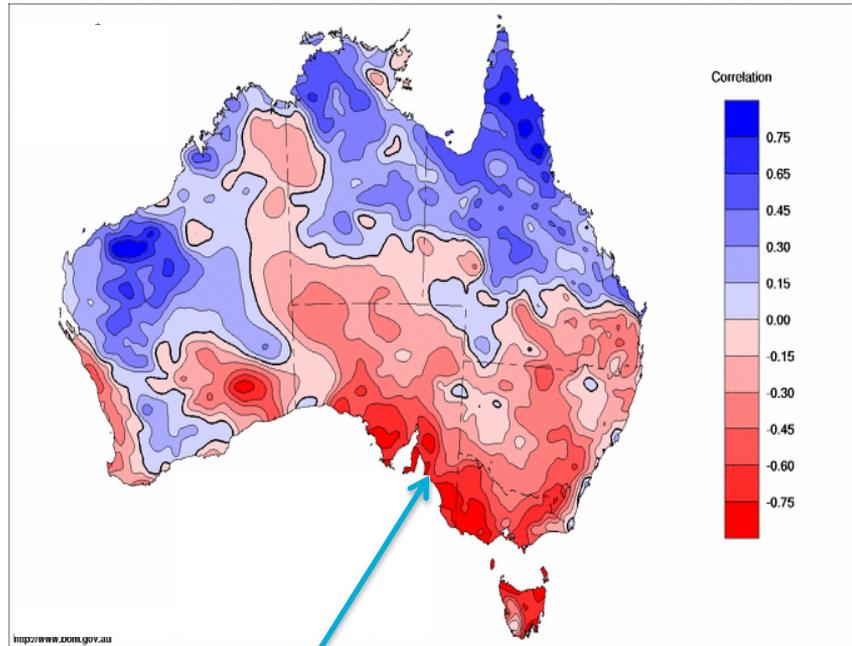
Has implications for SE coast weather patterns and rainfall

Impacts Antarctic sea ice



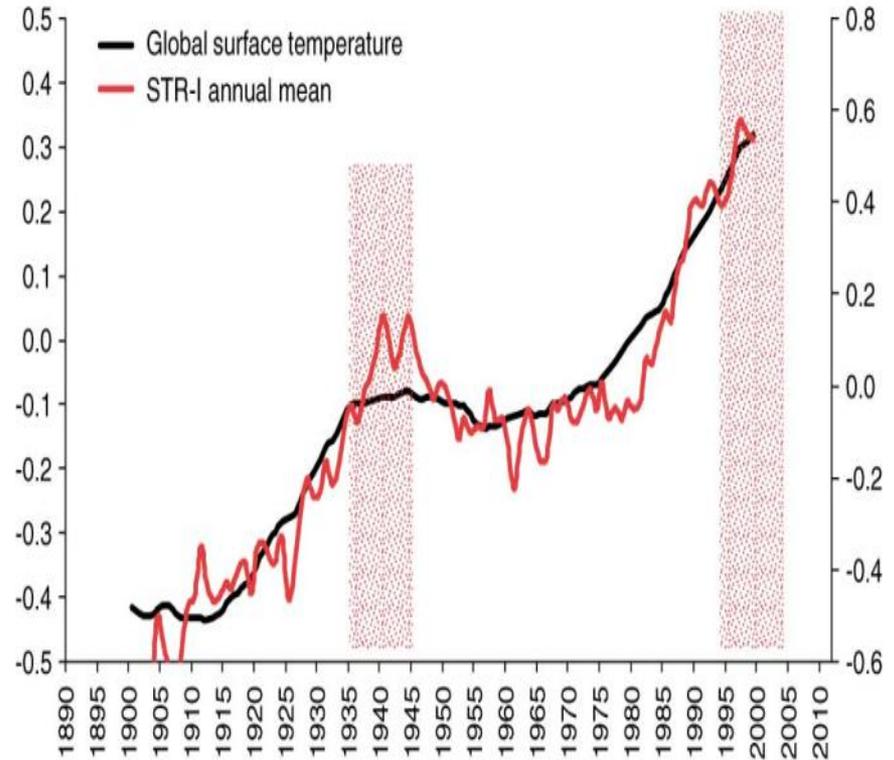
# Changes in weather circulation patterns

The strength of high pressure weather patterns is strongly related to April to October rainfall



Correlation between rainfall and sub-tropical ridge intensity

and to global temperature...

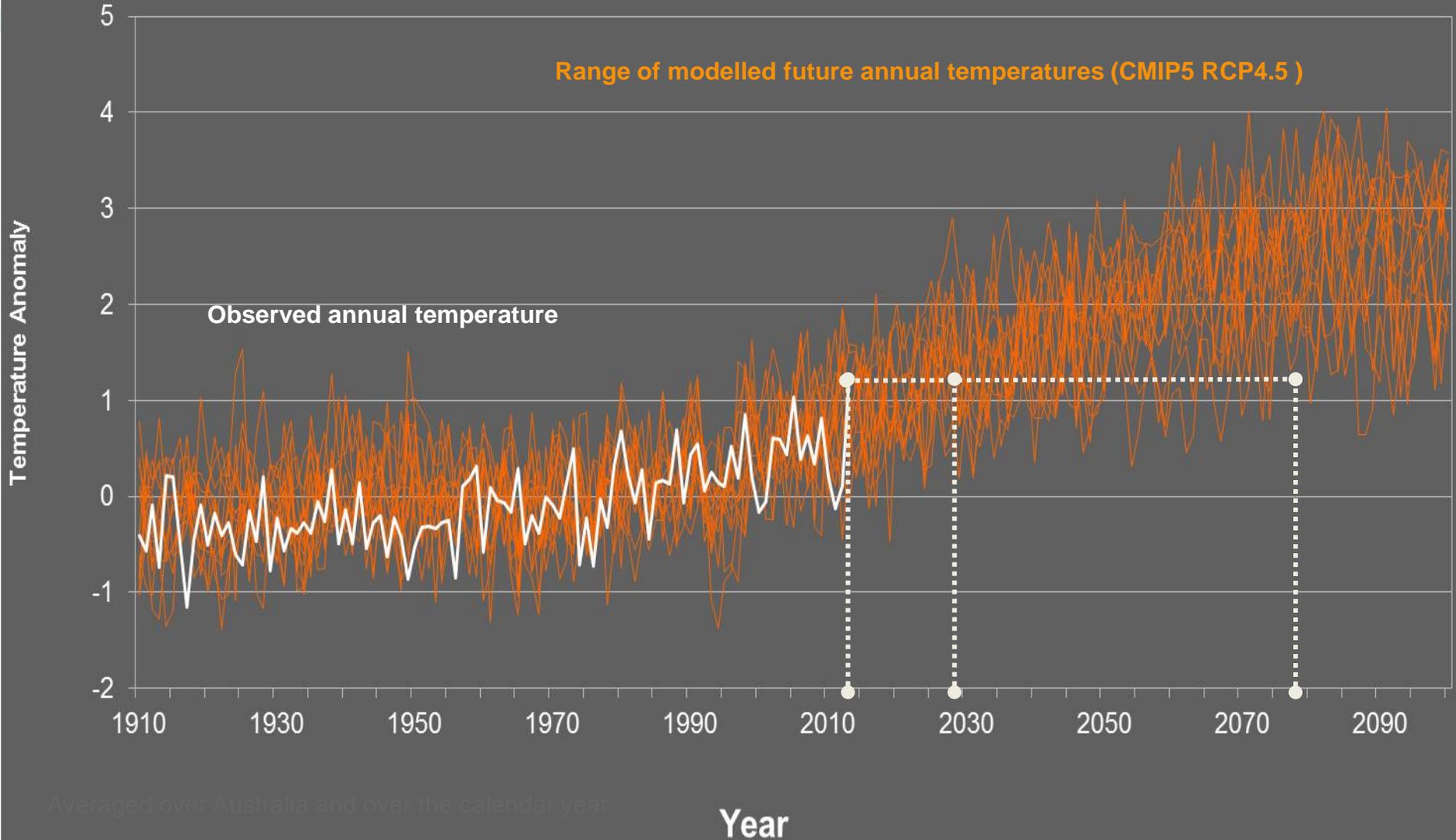




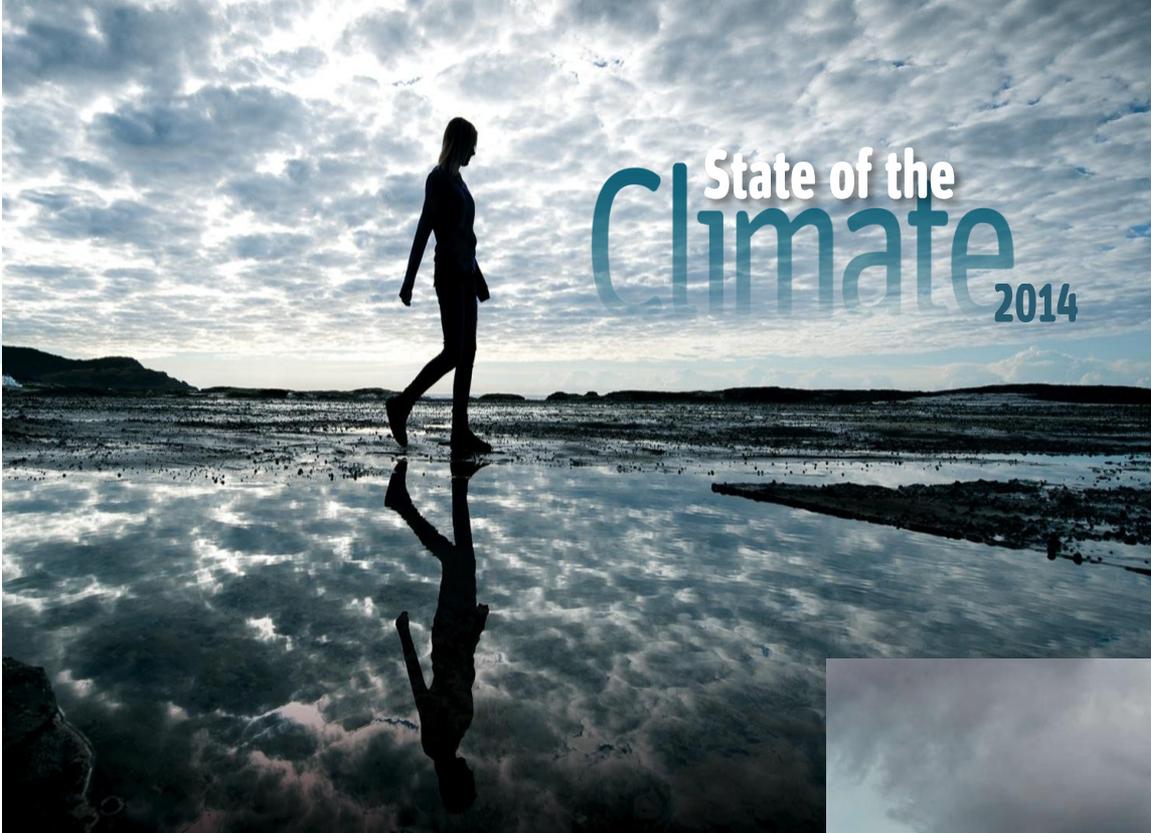
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# Australia's future is very likely to be hotter

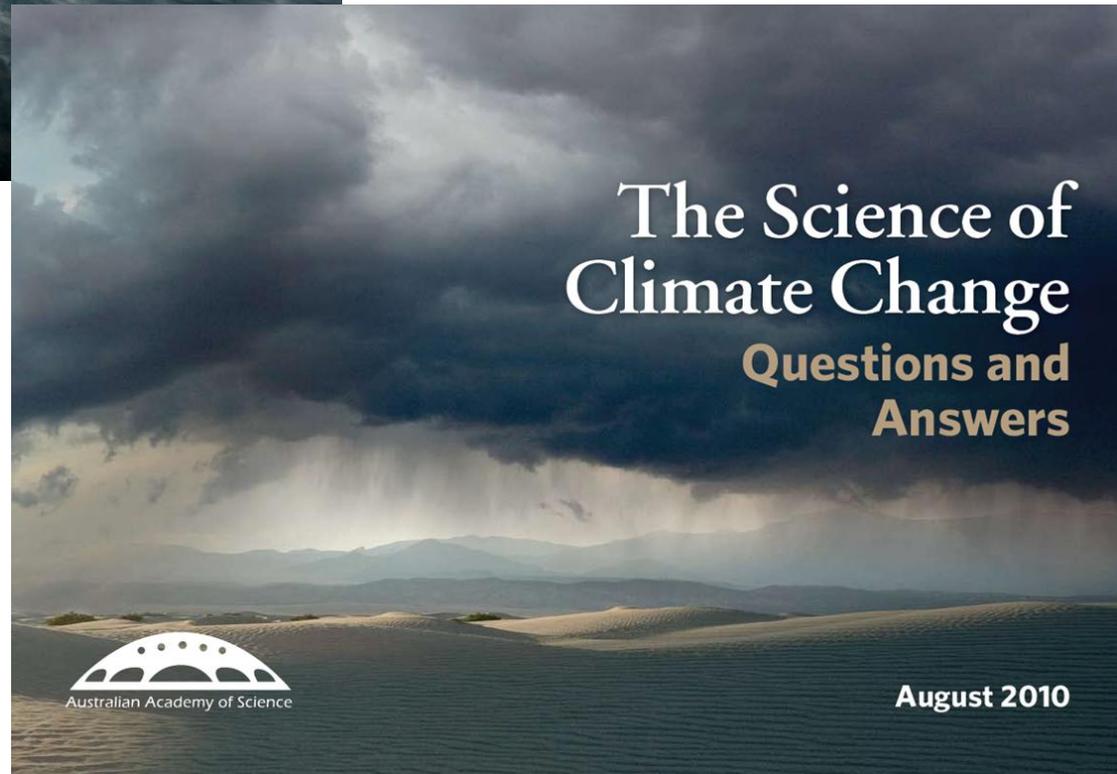


Averaged over Australia and over the calendar year



## Useful reports

Australian Academy of Science climate change science update (August 2010)



## The Science of Climate Change

### Questions and Answers

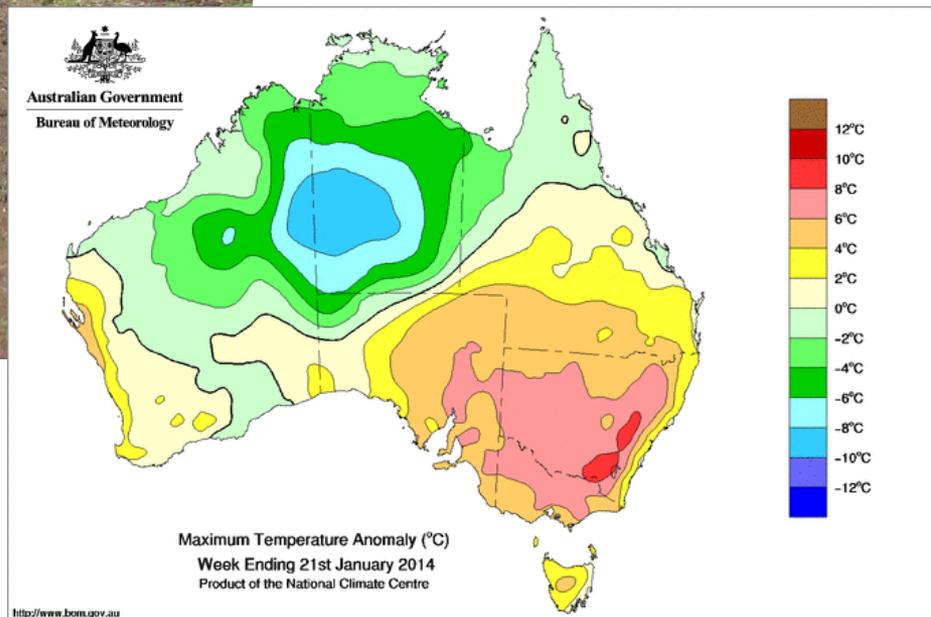


August 2010



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# Forecast information for climate change adaptation





Australian Government  
Bureau of Meteorology

# BoM Next Generation Forecasting system

- 7 day forecasts across all of SA on a 6km grid

- Now available through MetEye

- MetEye - your eye on the environment, bringing BoM observations and forecasts together in one place.

[www.bom.gov.au](http://www.bom.gov.au)

The screenshot shows the Bureau of Meteorology website interface. At the top, there is a navigation bar with links for HOME, ABOUT, CONTACTS, and a search box. Below this is a yellow banner for "Warnings current" with links for NSW, VIC, QLD, WA, SA, TAS, ACT, and NT. The main content area features a satellite map of Australia with regional labels (NT, QLD, WA, SA, NSW, ACT, VIC, TAS). To the right of the map is a sidebar with links for "Rain radars", "Satellite images", "Weather maps", and "MetEye". A red arrow points from the "MetEye" link to the "a world of indigenous weather knowledge" advertisement. Below the map is a section for "Weather for Wednesday 17 July" with a dropdown for "City observations" and a "Help using this page" link. The weather table below shows current and maximum temperatures for various cities along with brief weather conditions.

City	Now	max	Conditions
Sydney	19.7°	22°	Possible afternoon shower.
Melbourne	14.8°	18°	Cloudy.
Brisbane	20.7°	22°	A few showers.
Perth	11.6°	15°	Few showers easing.
Adelaide	17.0°	19°	Late rain.
Hobart	13.3°	14°	Cloudy.
Canberra	14.0°	17°	Shower or two clearing.
Darwin	28.6°	32°	Sunny, dry.



Australian Government  
Bureau of Meteorology

# MetEye

The screenshot shows the MetEye website interface. At the top, there is a navigation bar with links for HOME, ABOUT, CONTACTS, and a search box. Below this, the page title is "MetEye - your eye on the environment™". A yellow banner displays "View the current warnings for Australia". A search bar prompts the user to "Start typing, then select from list (town, city, postcode or lat/lon)".

The main content area is divided into several sections:

- LATEST WEATHER:** Shows "Current Temp, Rain, Wind ...".
- FORECASTS:** Includes "Rainfall Forecasts" and "Temperature Forecasts".
- 3-hourly:** Radio buttons for "Air temperature", "Feels like", "Daily maximum", and "Overnight minimum".
- Overlay:** A checkbox for "Latest rain radar".
- Other sections:** Storms, Snow, Fog, Frost; Humidity Forecasts; Wind Forecasts; Waves Forecasts.

The central feature is a weather map of Australia. A popup window titled "Forecast for 37.15°S, 140.6°E" provides a detailed forecast for a specific location. The popup includes a table with the following data:

	Fri. 7 Nov	Sat. 8 Nov	Sun. 9 Nov	Mon. 10 Nov	Tue. 11 Nov	Wed. 12 Nov	Thu. 13 Nov
Max (°C)	36	25	23	23	28	31	28
Min (°C)	-	16	6	5	5	9	11
Chance of rain (%)	-	60	5	10	5	10	50
Rainfall range (mm)	-	0.4 to 2	0	0	0	0	0.2 to 3

The popup also includes a "Save location" button, a "See text views for location" link, and a "Detail" button for each day. The map itself shows a temperature gradient from blue (cooler) to red (warmer), with a legend on the right indicating temperature ranges in °C. The map also shows various cities and geographical features across Australia.

The Next Generation forecasting system allows more information out 7 days ahead for a point or as maps/grids

Key features:

GIS enabled data

Zoom/pan

Multiple forecast element overlay & marine (waves)

Includes observations, radar, satellite overlays

Potential to add profiles such as Agriculture profile



# Evapotranspiration (Eto) data for irrigation

- Daily past Eto figures derived from BoM weather stations
- On our 'Agriculture' page from the BoM homepage
- 7 day forecast Eto is in development

The screenshot shows the Bureau of Meteorology website interface for 'Recent Evapotranspiration' data. The page title is 'Recent Evapotranspiration' and the location is 'Mount Gambier Aero - November 2014 daily calculations'. The page includes a navigation menu on the left, a main content area with a table of daily calculations, and a 'Monthly Archive' section. The table provides detailed data for each day of the month, including evaporation, rain, temperature, and humidity. The 'Totals' row shows a total evaporation of 37.3 mm and a total rain of 5.2 mm for the month.

Date	Evapotranspiration (mm) 0000-2400	Rain (mm) 0900-0900	Pan Evaporation (mm) 0900-0900	Max Temp	Min Temp	Max Rel Hum (%)	Min Rel Hum (%)	Average 10m Wind Speed (m/sec)	Solar Radiation (MJ/sq m)
31/10/2014	9.6	0.0	3.4	33.2	8.3	95	10	7.15	23.01
01/11/2014	3.6	3.8	10.2	14.4	8.9	95	43	8.75	18.98
02/11/2014	3.4	1.4	4.8	17.0	8.1	91	39	4.33	14.60
03/11/2014	5.6	0.0	3.6	24.7	3.4	99	18	3.83	23.87
04/11/2014	5.6	0.0	7.4	22.3	11.0	82	21	6.28	16.03
05/11/2014	4.5	0.0	4.0	19.1	5.2	91	35	3.98	26.52
06/11/2014	5.0	0.0	5.2	23.9	4.8	95	33	3.18	26.36
Totals:	37.3	5.2	38.6						

Monthly Archive

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	<a href="#">Jan</a>	<a href="#">Feb</a>	<a href="#">Mar</a>	<a href="#">Apr</a>	<a href="#">May</a>	<a href="#">Jun</a>	<a href="#">Jul</a>	<a href="#">Aug</a>	<a href="#">Sep</a>	<a href="#">Oct</a>	<a href="#">Nov</a>	<a href="#">Dec</a>
2010	<a href="#">Jan</a>	<a href="#">Feb</a>	<a href="#">Mar</a>	<a href="#">Apr</a>	<a href="#">May</a>	<a href="#">Jun</a>	<a href="#">Jul</a>	<a href="#">Aug</a>	<a href="#">Sep</a>	<a href="#">Oct</a>	<a href="#">Nov</a>	<a href="#">Dec</a>
2011	<a href="#">Jan</a>	<a href="#">Feb</a>	<a href="#">Mar</a>	<a href="#">Apr</a>	<a href="#">May</a>	<a href="#">Jun</a>	<a href="#">Jul</a>	<a href="#">Aug</a>	<a href="#">Sep</a>	<a href="#">Oct</a>	<a href="#">Nov</a>	<a href="#">Dec</a>
2012	<a href="#">Jan</a>	<a href="#">Feb</a>	<a href="#">Mar</a>	<a href="#">Apr</a>	<a href="#">May</a>	<a href="#">Jun</a>	<a href="#">Jul</a>	<a href="#">Aug</a>	<a href="#">Sep</a>	<a href="#">Oct</a>	<a href="#">Nov</a>	<a href="#">Dec</a>
2013	<a href="#">Jan</a>	<a href="#">Feb</a>	<a href="#">Mar</a>	<a href="#">Apr</a>	<a href="#">May</a>	<a href="#">Jun</a>	<a href="#">Jul</a>	<a href="#">Aug</a>	<a href="#">Sep</a>	<a href="#">Oct</a>	<a href="#">Nov</a>	<a href="#">Dec</a>
2014	<a href="#">Jan</a>	<a href="#">Feb</a>	<a href="#">Mar</a>	<a href="#">Apr</a>	<a href="#">May</a>	<a href="#">Jun</a>	<a href="#">Jul</a>	<a href="#">Aug</a>	<a href="#">Sep</a>	<a href="#">Oct</a>	<a href="#">Nov</a>	<a href="#">Dec</a>

Product Code: IDCKWCDEA0



# BoM seasonal outlook information has just been re-vamped

- Interactive
- Grid point detail
- Monthly and seasonal outlooks



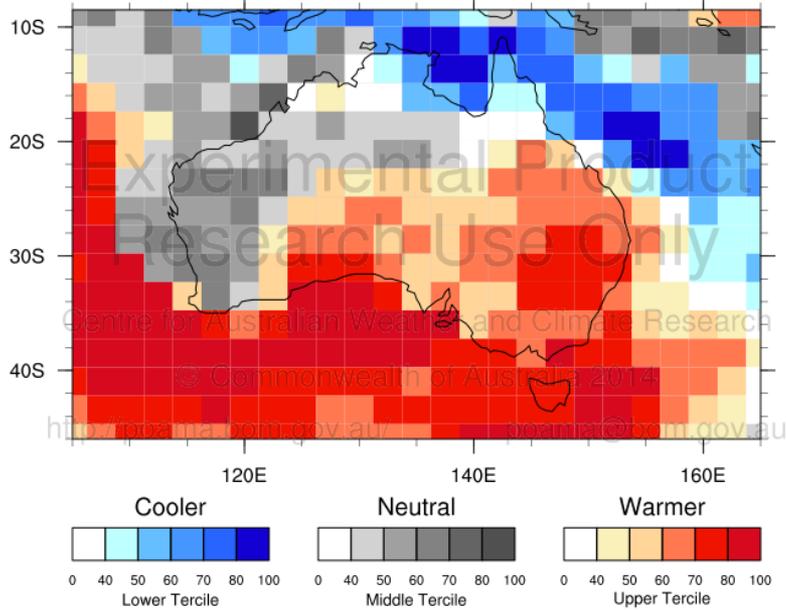


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# POAMA

bridging the gap between the week ahead  
and the season ahead

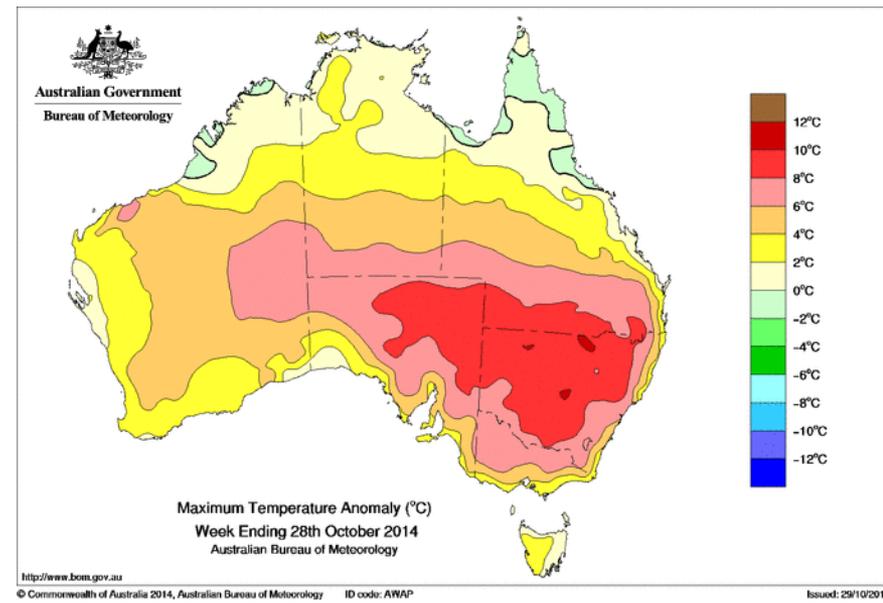
Maximum Temperature Tercile Probabilities  
Region: Australia  
Start Date: 2014-10-09  
Period: (Week) 23/10/2014 to 29/10/2014



Climatology: years from 1981 to 2010 with mmdd = 1011  
Created: 2014-10-10 15:32:31 +0000  
Start Dates (DD/MM): Start Date List  
Resource: wact\_ / week

POAMA gives useful predictions of  
heatwaves 2-6 weeks ahead

## Maximum temperature

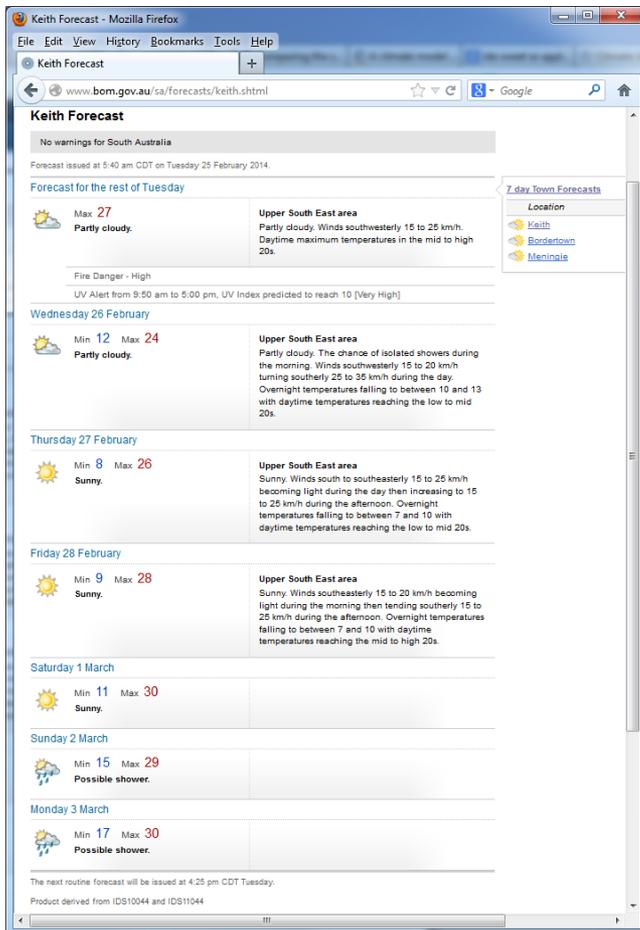


Observed daytime temperature anomaly

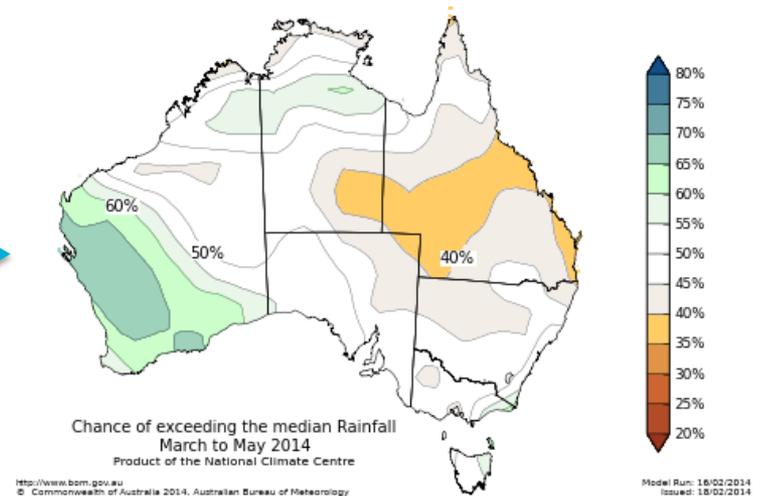


# Providing information across a range of timescales

## 7 day forecasts



## 3 month block seasonal outlook



BoM is moving toward more specific products across a range of timescales



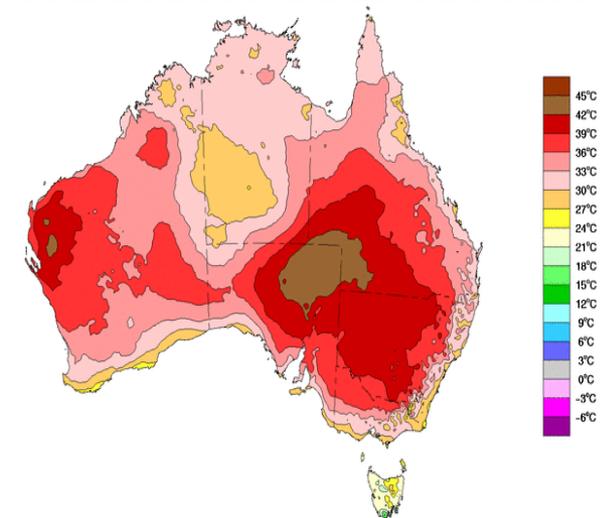
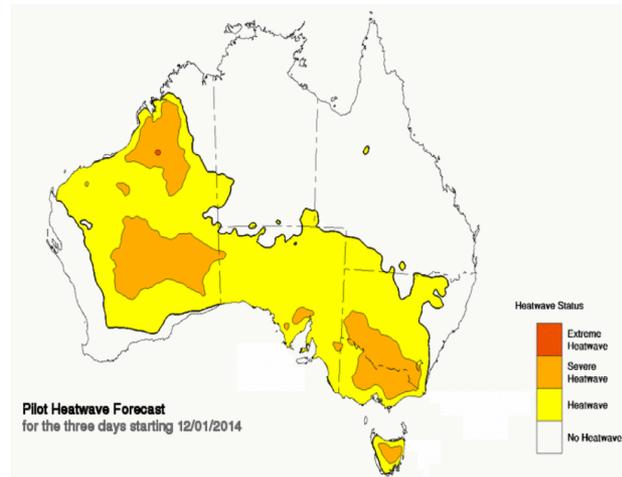
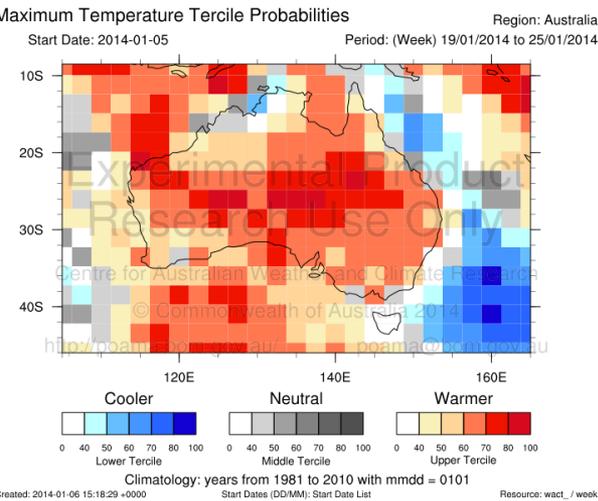
Australian Government  
Bureau of Meteorology

# Predicting extremes – BoM pilot heatwave warning service

POAMA outlook 5<sup>th</sup> January 2014 for third week of January

Pilot heatwave forecast

Observed Temperatures  
Week ending 21 January 2014





Australian Government

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# Summarising...

- There is direct evidence of the impact of increasing ghg's
- Seeing temperature increases globally, nationally and locally, and increased heat extremes
- Weather patterns are changing –MJT? ,
- Improved forecasting across timescales allows climate change adaptation
- Reducing emissions as much as possible is a smart way to go



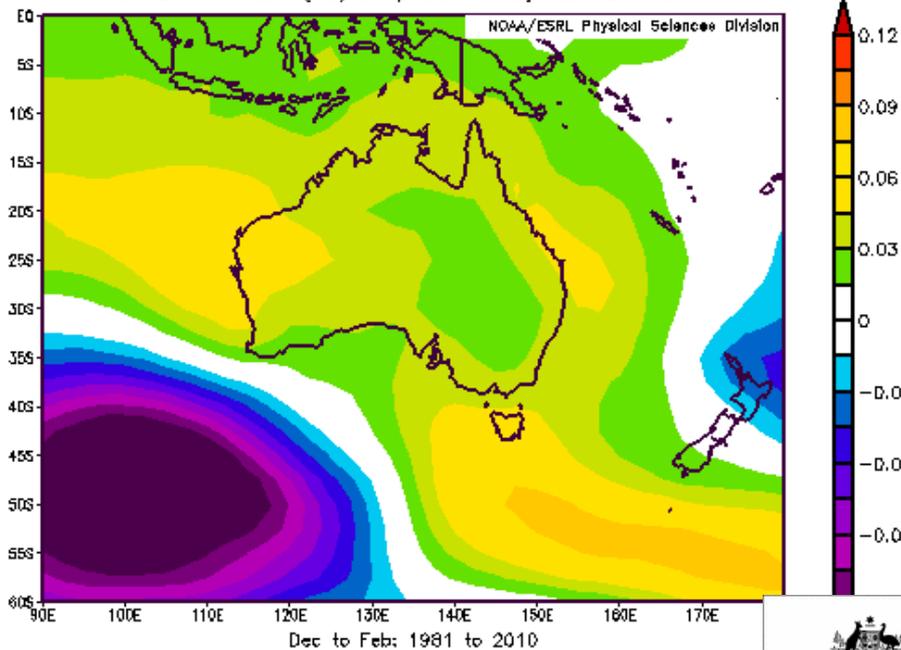
Australian Government

Bureau of Meteorology

# Thank you

[d.ray@bom.gov.au](mailto:d.ray@bom.gov.au)

NCEP/NCAR Reanalysis  
Sea Level Pressure (mb) Composite Anomaly 1981–2010 climo



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