A changing climate – risks and opportunities

Steven Crimp, Mark Howden and many others

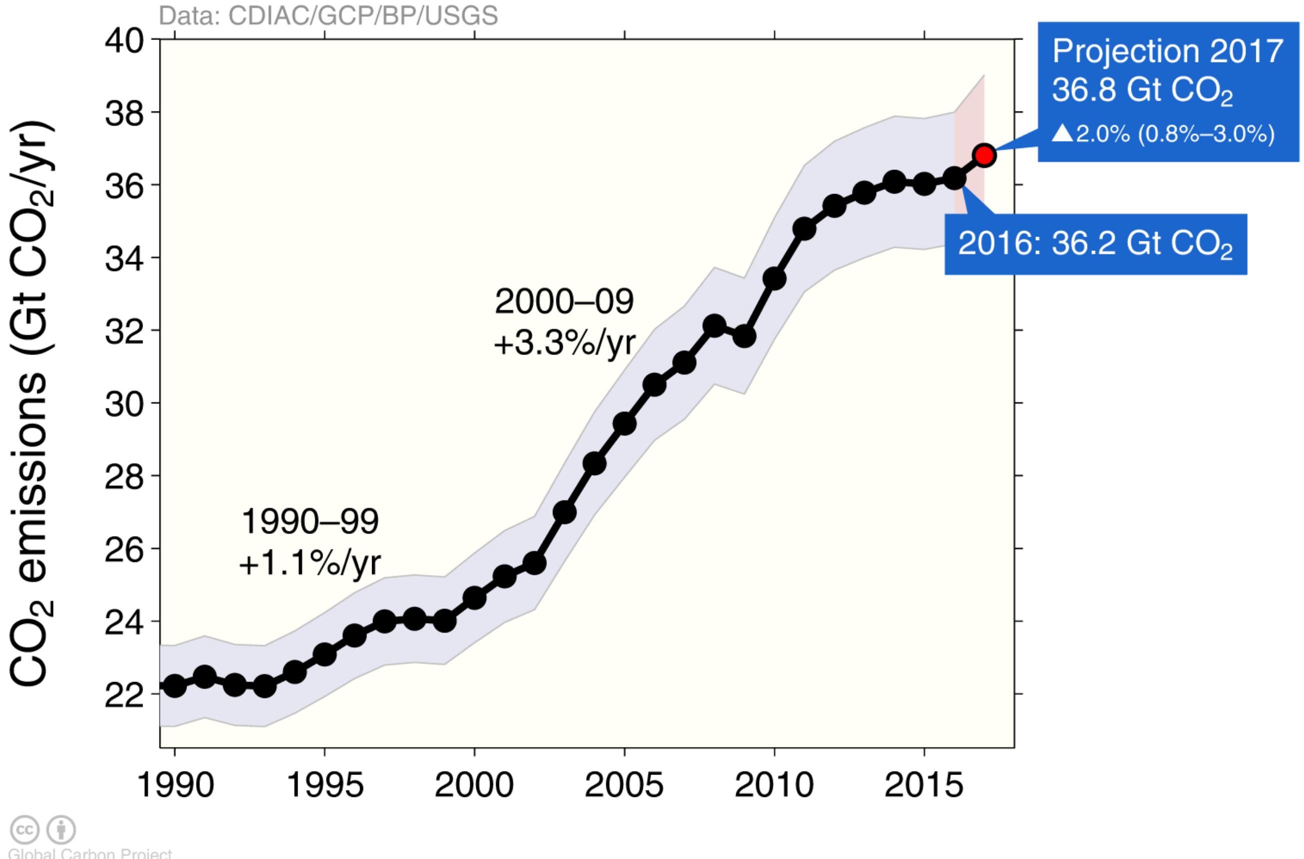
ANU Climate Change Institute

Australian National University

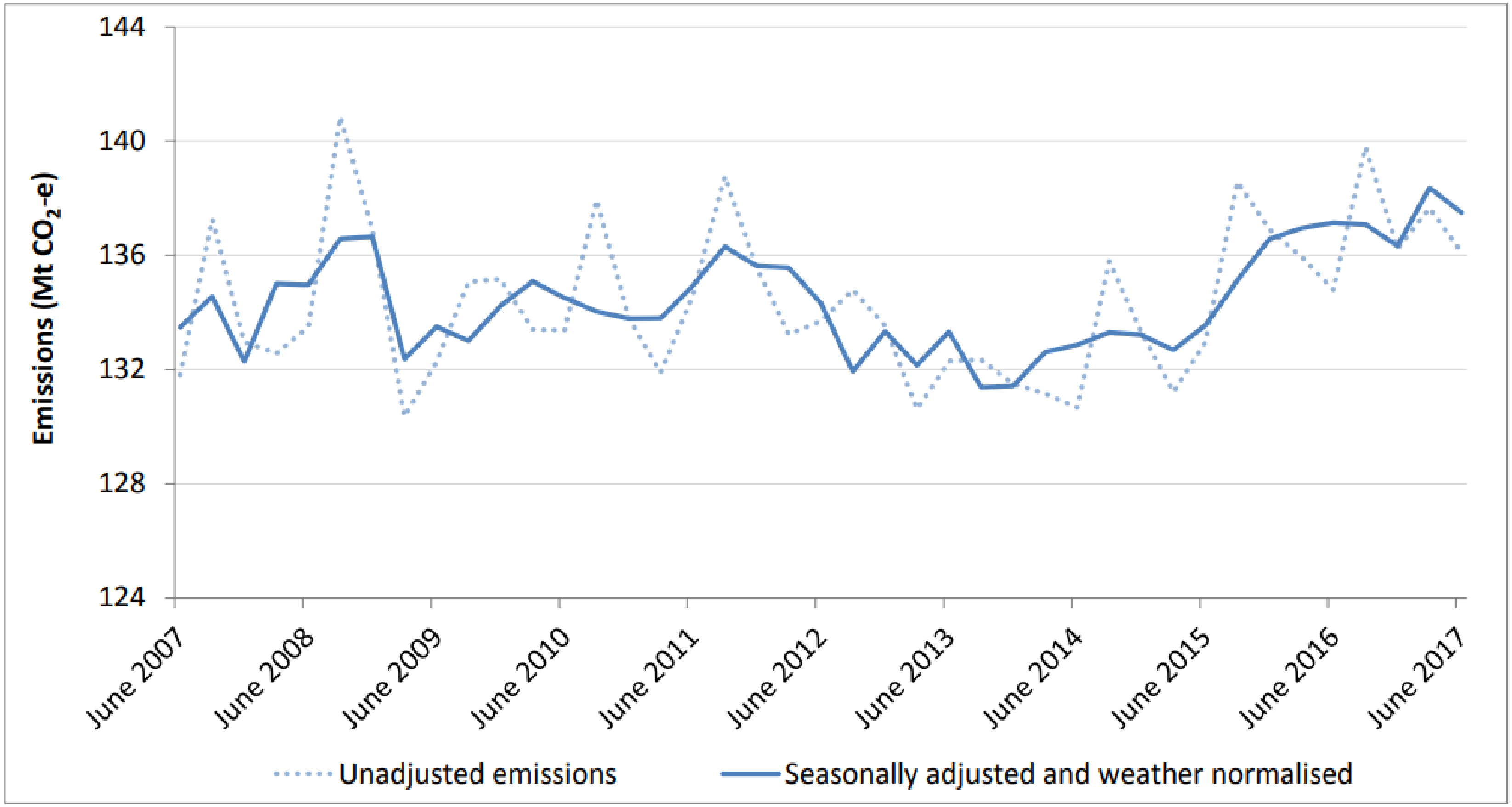
Structure

- Looking backwards – what is changing ?
- Looking forwards – what may change further ?
- Action – what can we do about it ?

CO_2 emission rising again: record levels



Australia's GHG emissions rising



Source: Department of the Environment and Energy

- Australia's emissions rose by 0.7% in 2016-2017.

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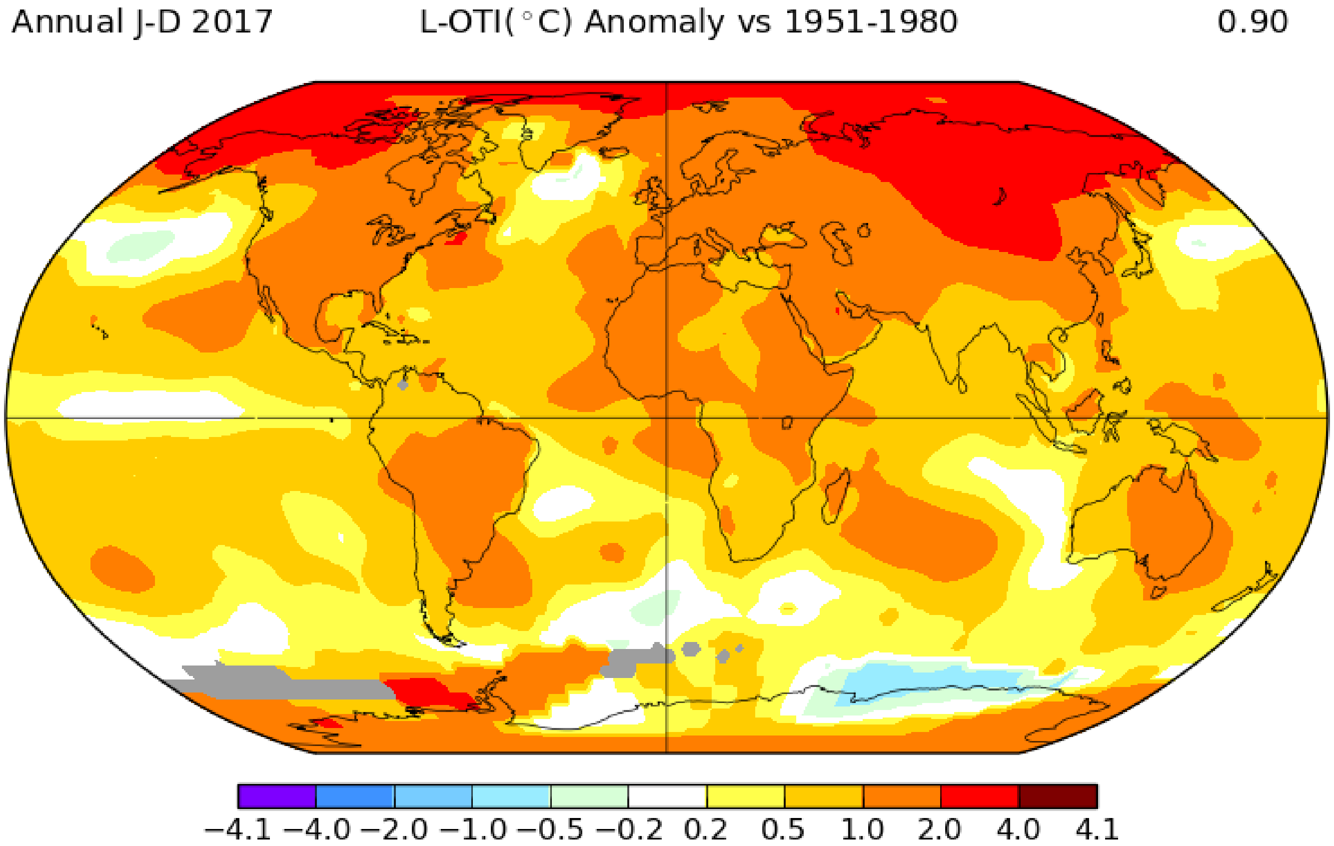
Global Temperatures warming

2017 third warmest year since 1880

Combined land and sea temp .84ºC above average

RANK 1 = WARMEST PERIOD OF RECORD: 1880–2017	YEAR	ANOMALY °C
1	2016	0.94
2	2015	0.90
3	2017	0.84
4	2014	0.74
5	2010	0.70
6	2013	0.67
7	2005	0.66
8	2009	0.64
9	1998	0.63
10	2012	0.62

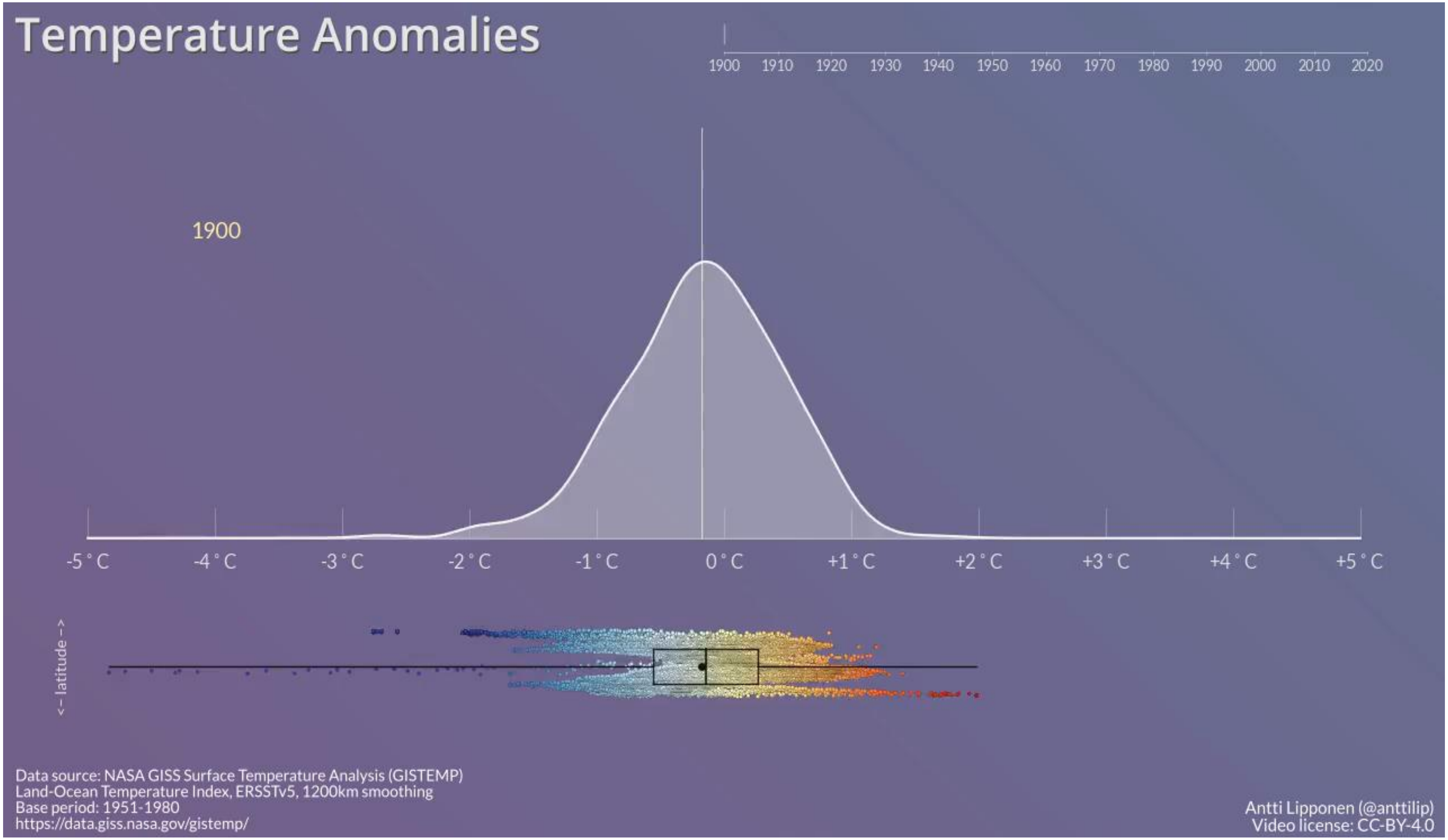
High temps almost everywhere



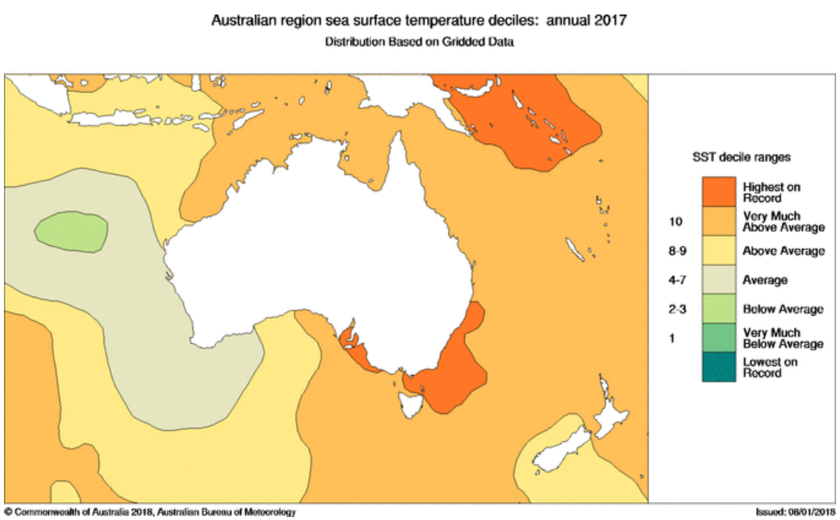
NASA 2018

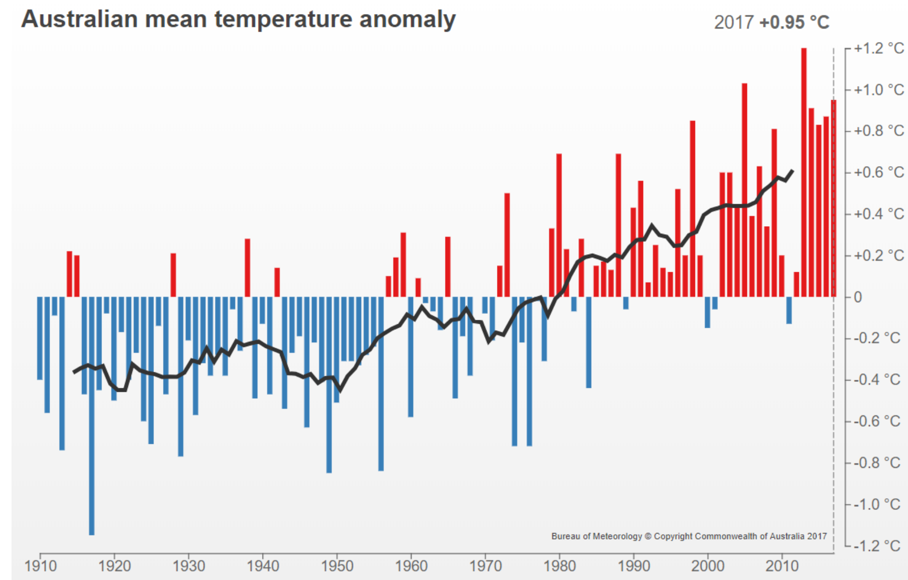
Global temperatures keep rising

Temperature distributions changing



Australia was warm too



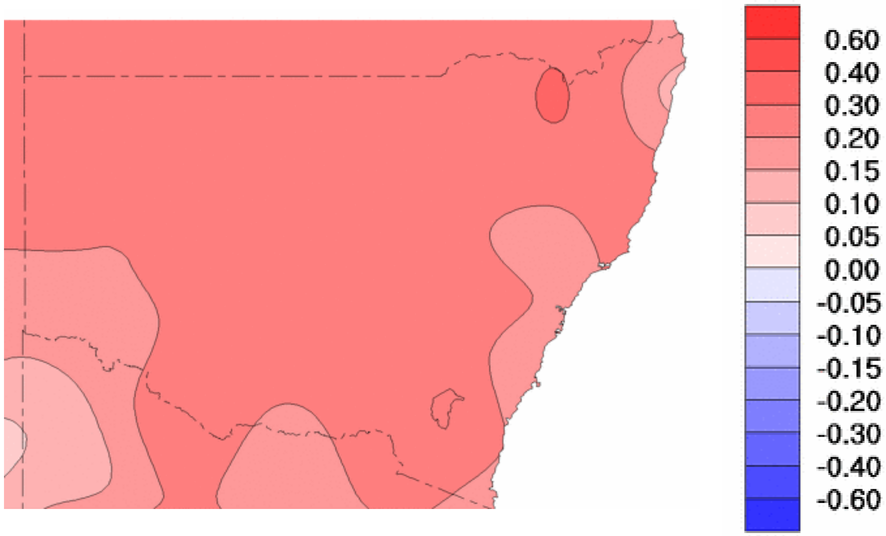


- Sea surface temperature .49ºC above (1961-1990) average
- Above average SST in Australia observed every year since 1994

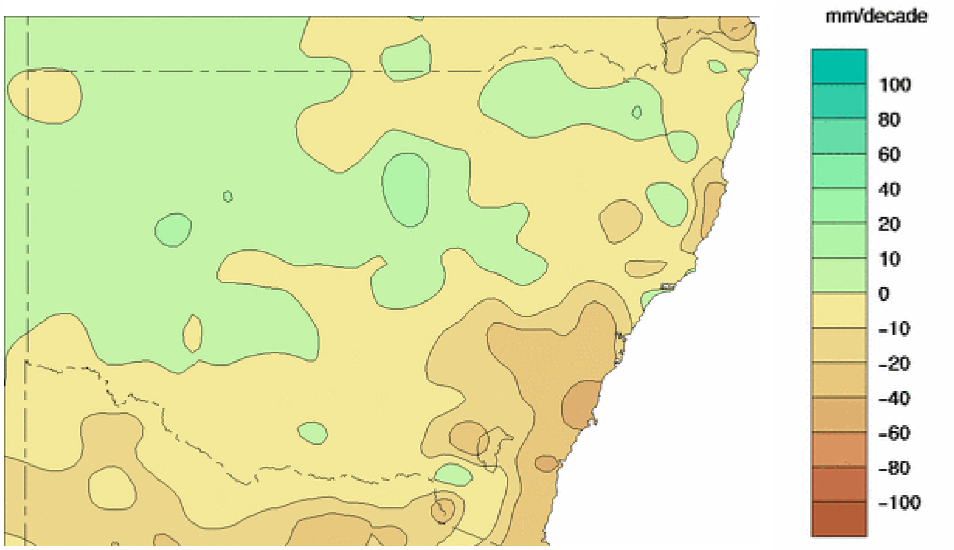
- 2017 atmospheric temperatures at +0.95ºC above the long–term mean
- Third warmest on record.

BoM 2018

NSW getting warmer and drier in the SE



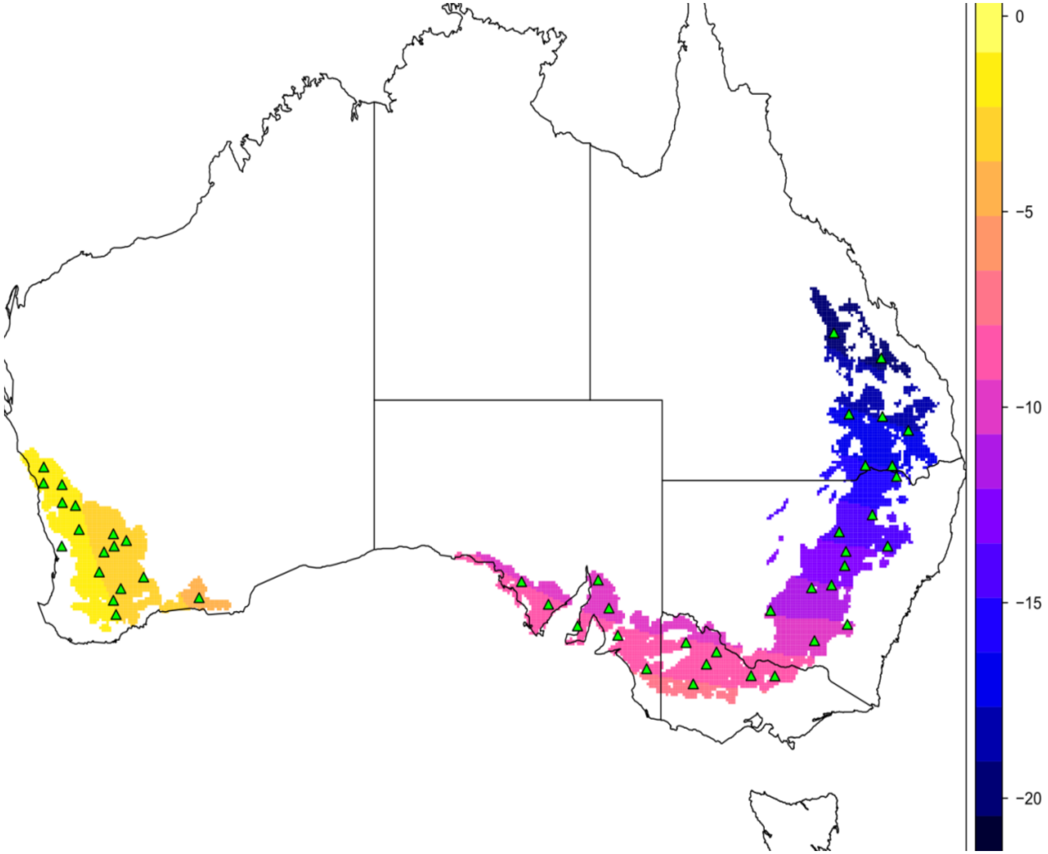
- Mean temperatures are warming across NSW by 0.1 to 0.2 degrees per decade (≈ 0.6 to 1.1^{o}C warmer since 1960)
- Maximum temperatures warming more rapidly than minimum temperatures.



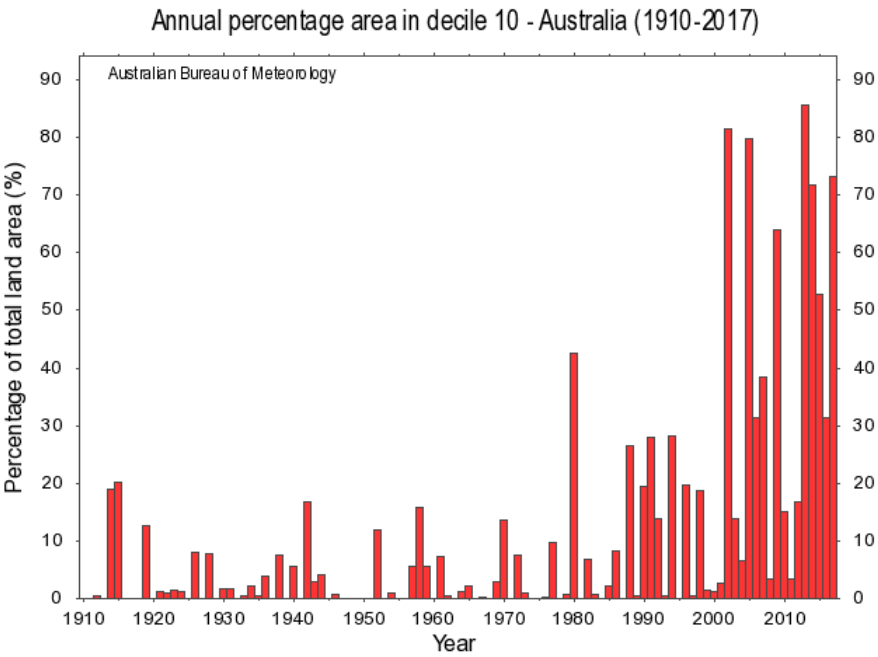
- Annual rainfall has been increasing by approximately 10mm per decade in the NW (i.e. 58mm) and declining by as much as 30mm per decade in the SE (i.e. 174mm).
- Largest declines in Autumn and Spring.

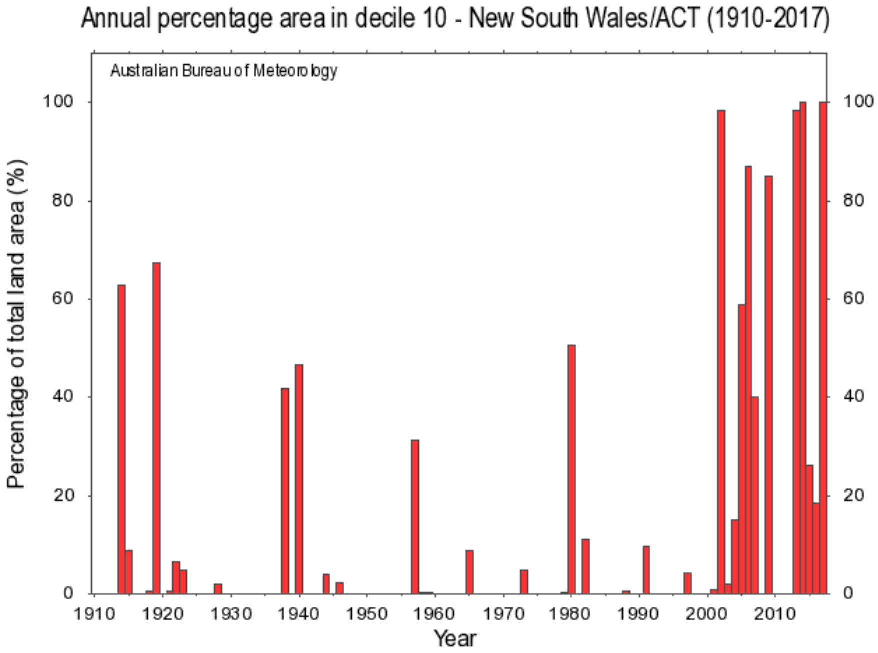
Heat stress occurring earlier

- 2000-2009 vs 1960-1969
- First ‘hot’ day (Tmax > 35ºC)
  - 3 weeks earlier in north
  - 1 week earlier in south
  - Gunning 10 days earlier



Extremes almost everywhere





Rainfall zones 'moving south'

- Rainfall declining in the south
- Increasing in the north

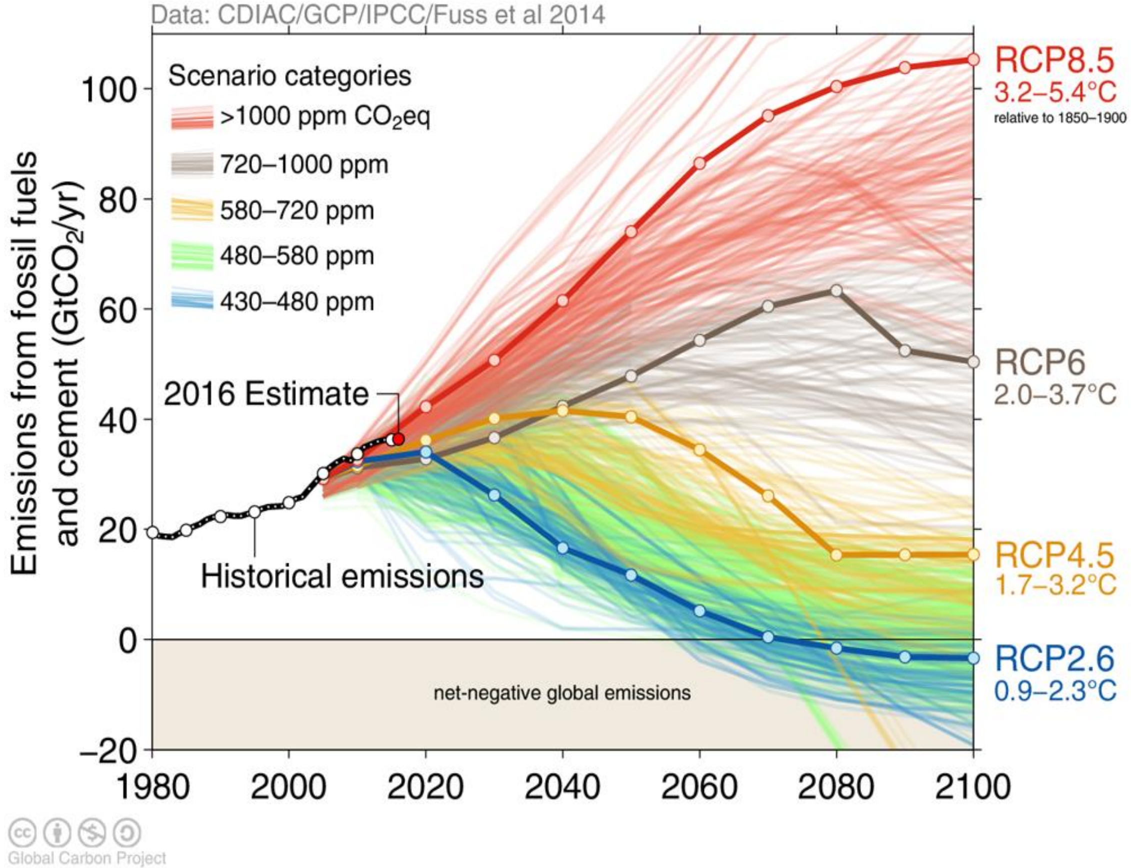
Stephens et al. 2016, BoM 2016

Many other observed changes

- Heat stress
- Storm severity
- Extreme fires (Fire Danger Index, season)
- Animal and plant distribution
- Pest and disease spread
- Natural resource impacts
- etc, etc

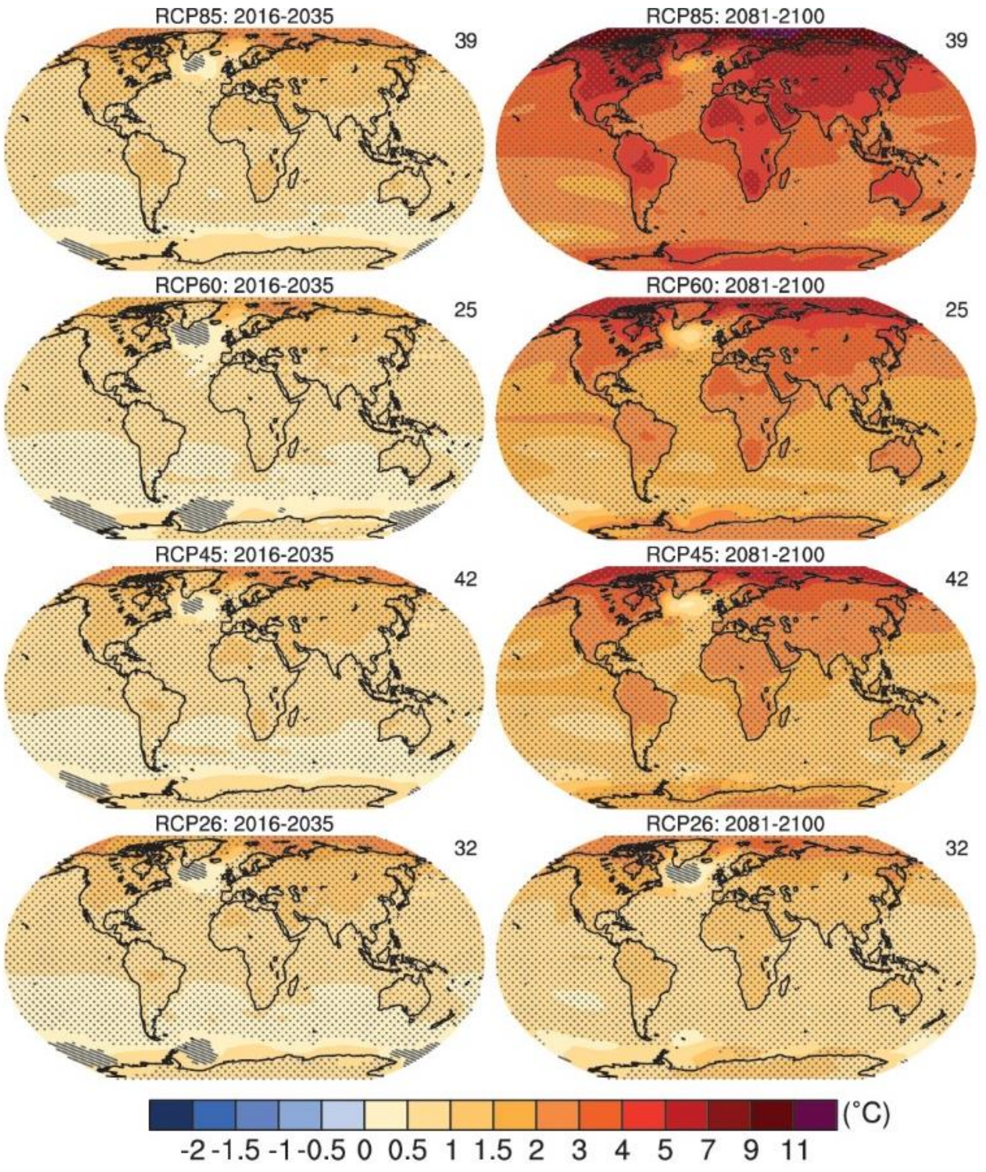
Future climate based on scenarios

- Future warming driven by GHG emission trajectories - Representative Concentration Pathways (RCPs).
- At present we are on track with the most extreme of the RCPs i.e. RCP 8.5.
- Potentially commits us to between 3°C and 5°C of warming if not diverted.



Temperature projections

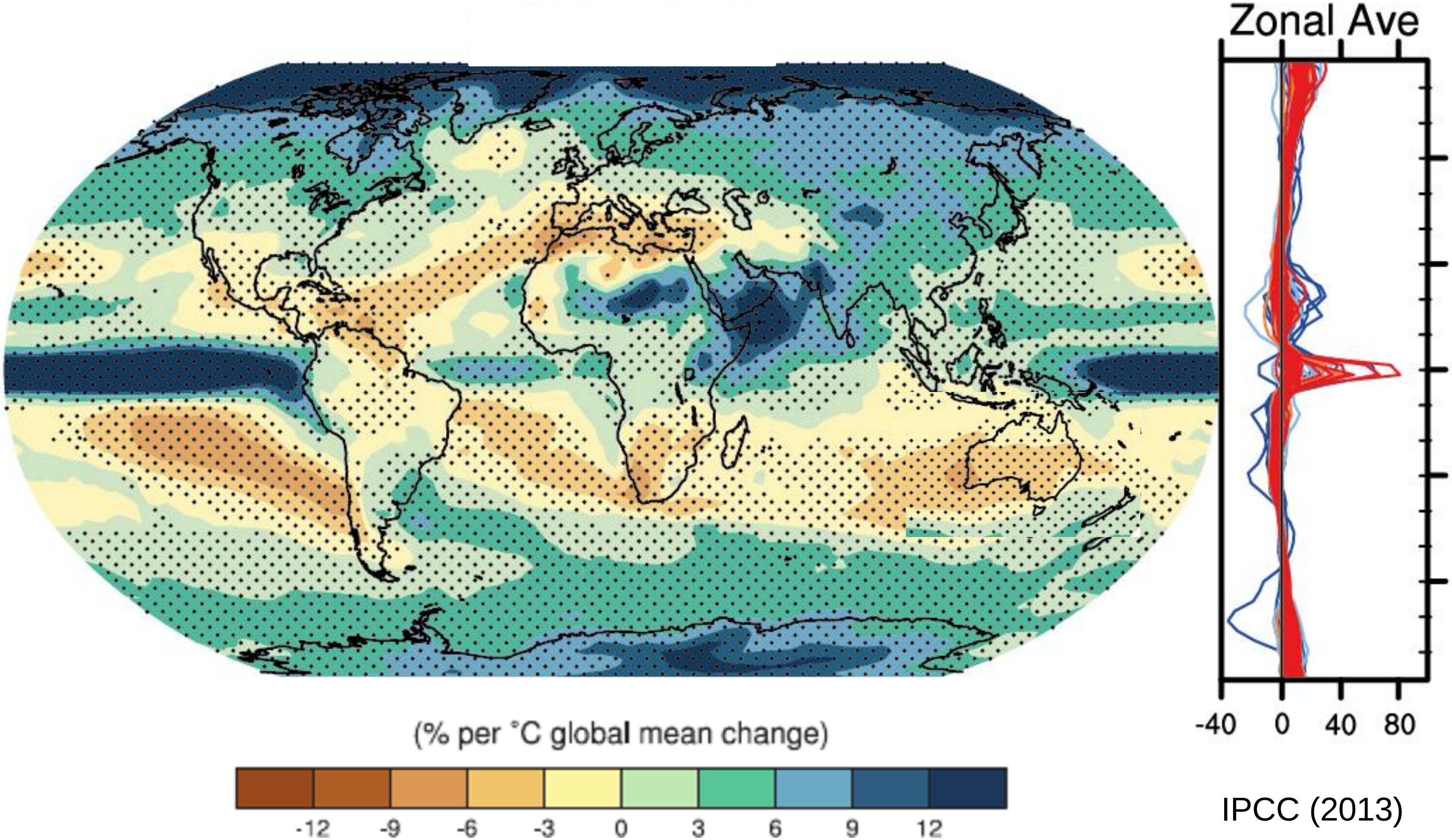
Consensus patterns of warming for mean temperatures using the range of RCPs.



IPCC (2013)

Precipitation change

Precipitation scaled by global T (% per °C)



IPCC (2013)

What are the risks and impacts of climate change in Australia? 1-2°C

Mental and physical health costs rise with more extreme events, including bushfire and drought, with people in rural and lower socio-economic areas most vulnerable.

Increased **demand for aid and disaster response** as rising sea levels displace citizens of low-lying small Pacific Island states.

Around 2,00 more **heat-related deaths** a year, on average.

Yields of some crops, such as wheat increase for a time, but **nutritional quality declines.**

By 2020, in southeastern Australia, **very extreme bushfires occur twice as often and the risk of catastrophic fire events has doubled.** The cost of managing fires and fire risk is rising.

Across southern Australia precipitation continues to decline, while downpours become heavier. In southwest Western Australia winter rainfall declines up to 15% more.

Massive coral bleaching events now occur regularly worldwide. The Great Barrier Reef suffers extensive degradation, losing more than 50% of its coral.

Around 267,000 Australians now exposed to risks associated with long-term sea level rise. There is increasing risk of damage to coastal settlements from storm surges and erosion.

Tourism on the Great Barrier Reef and skiing in alpine areas declines as the attractiveness of these areas is degraded.

Areas with 30 days of annual average **snow cover declines** by 14 to 54%.

Future scenarios - Tmax

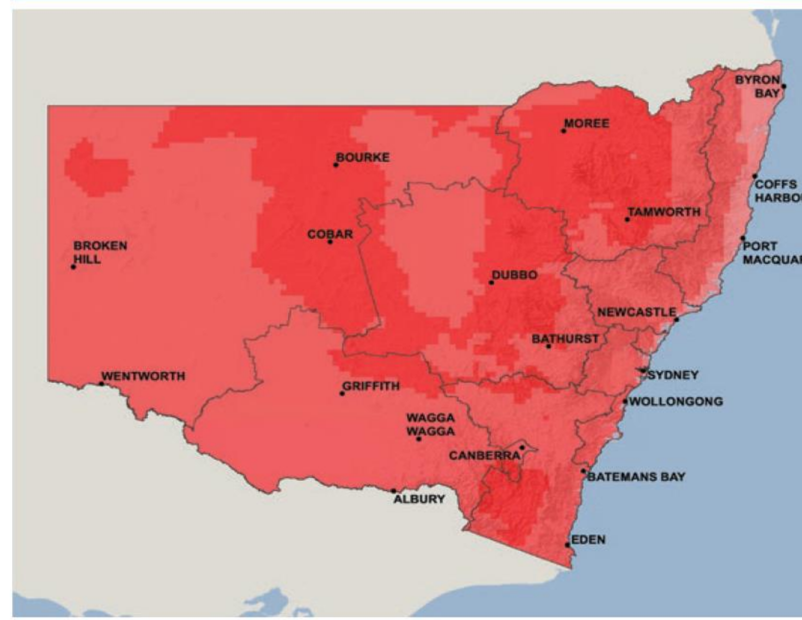
Near future change in maximum temperature

- Consensus projections from NARCliM suggest maximum temperatures by 2030 will be up to 1.5°C warmer.

Change in annual average temperature (°C)

- 2.5 – 3.0
- 2.0 – 2.5
- 1.5 – 2.0
- 1.0 – 1.5
- 0.5 – 1.0
- 0.0 – 0.5

Far future change in maximum temperature



- By 2050 maximum temperatures could be up to 3°C warmer.

Future scenarios - Tmin

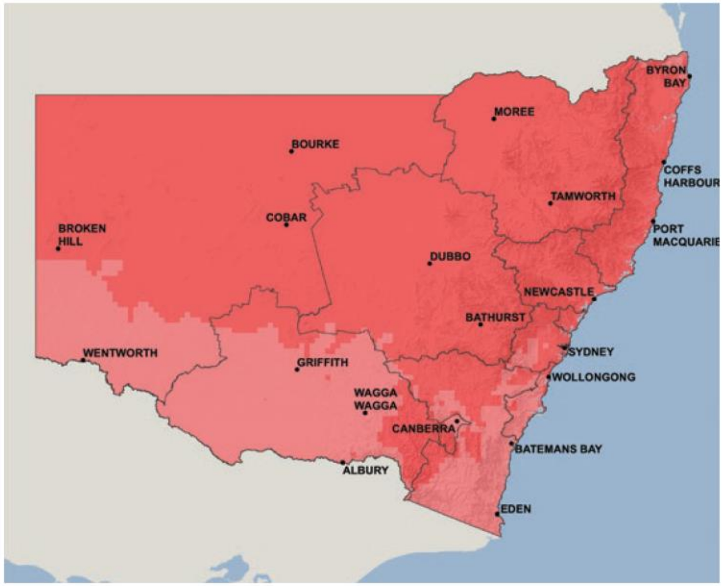
Near future change in minimum temperature

- In terms of minimum temperatures warming of up to 1°C by 2030.

Change in annual average temperature (°C)

- 2.5 – 3.0
- 2.0 – 2.5
- 1.5 – 2.0
- 1.0 – 1.5
- 0.5 – 1.0
- 0.0 – 0.5

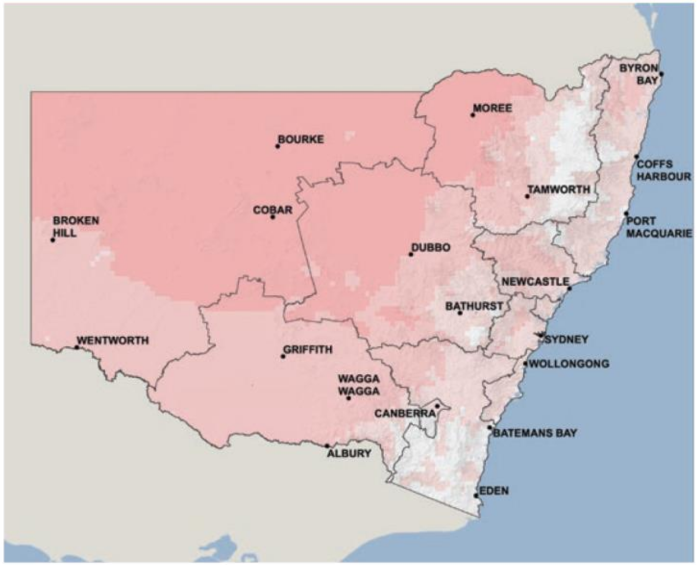
Far future change in minimum temperature



- By 2050 minimum temperatures could be up to 2.5°C warmer.

Future scenarios - Days over 35^{o}C

Near future change in days per year above 35°C

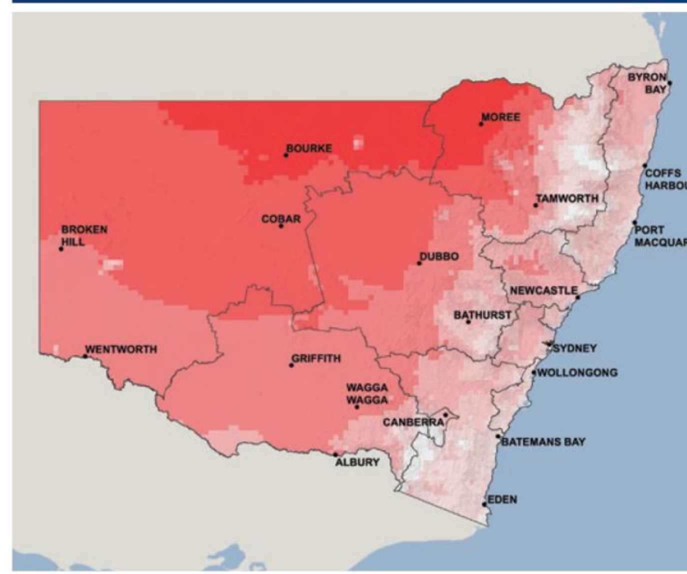


- By 2030 the number of days above 35^{o}C will increase by 5 from 43 (current) to 48.

Change in annual average number of days with temperatures greater than 35°C

- >40
- 30 – 40
- 20 – 30
- 10 – 20
- 5 – 10
- 1 – 5
- 0 – 1

Far future change in days per year above 35°C



- By 2050 the number of days above 35^{o}C will increase by 10 from 43 (current) to 53.

Future scenarios - broad scale

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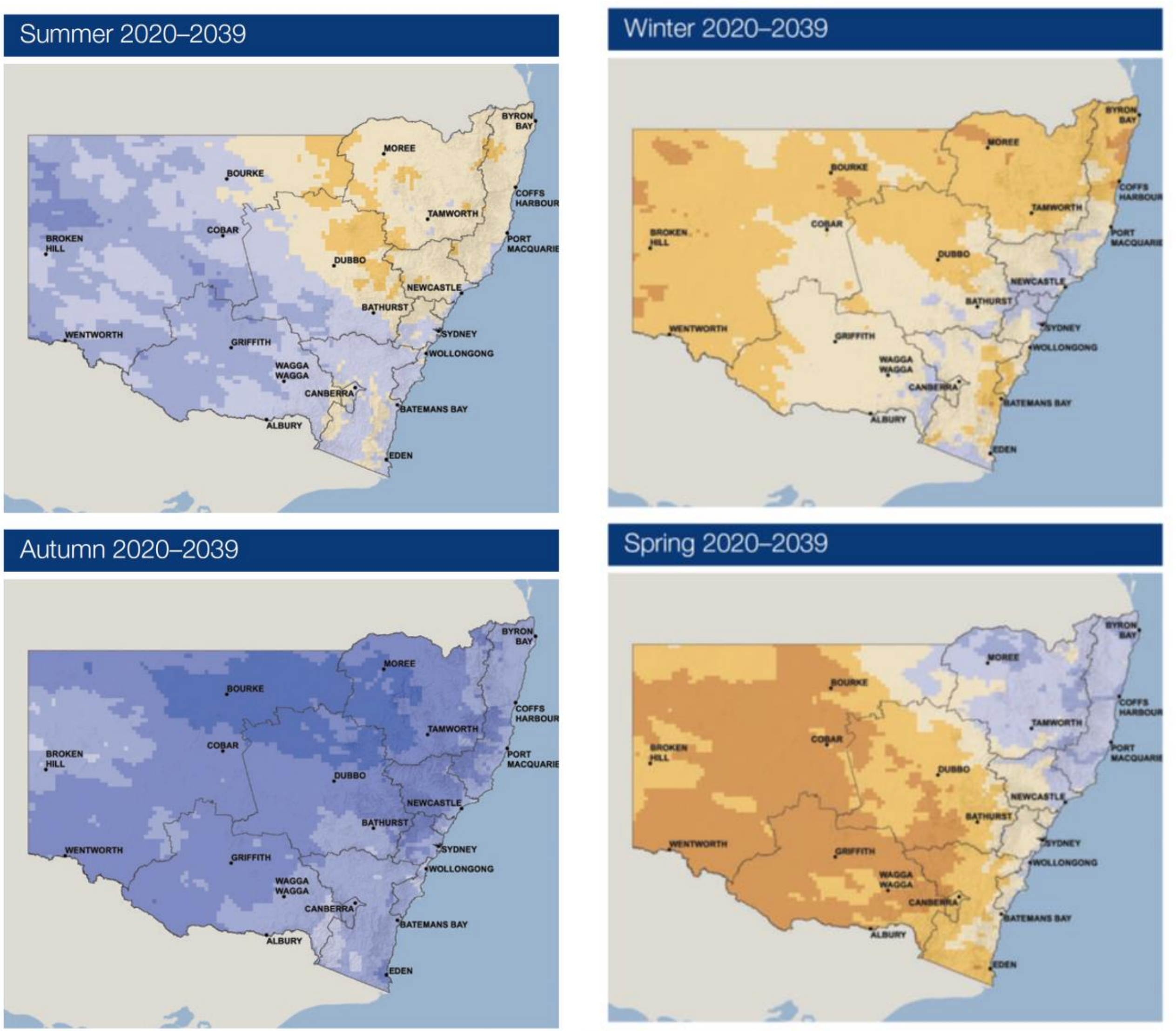
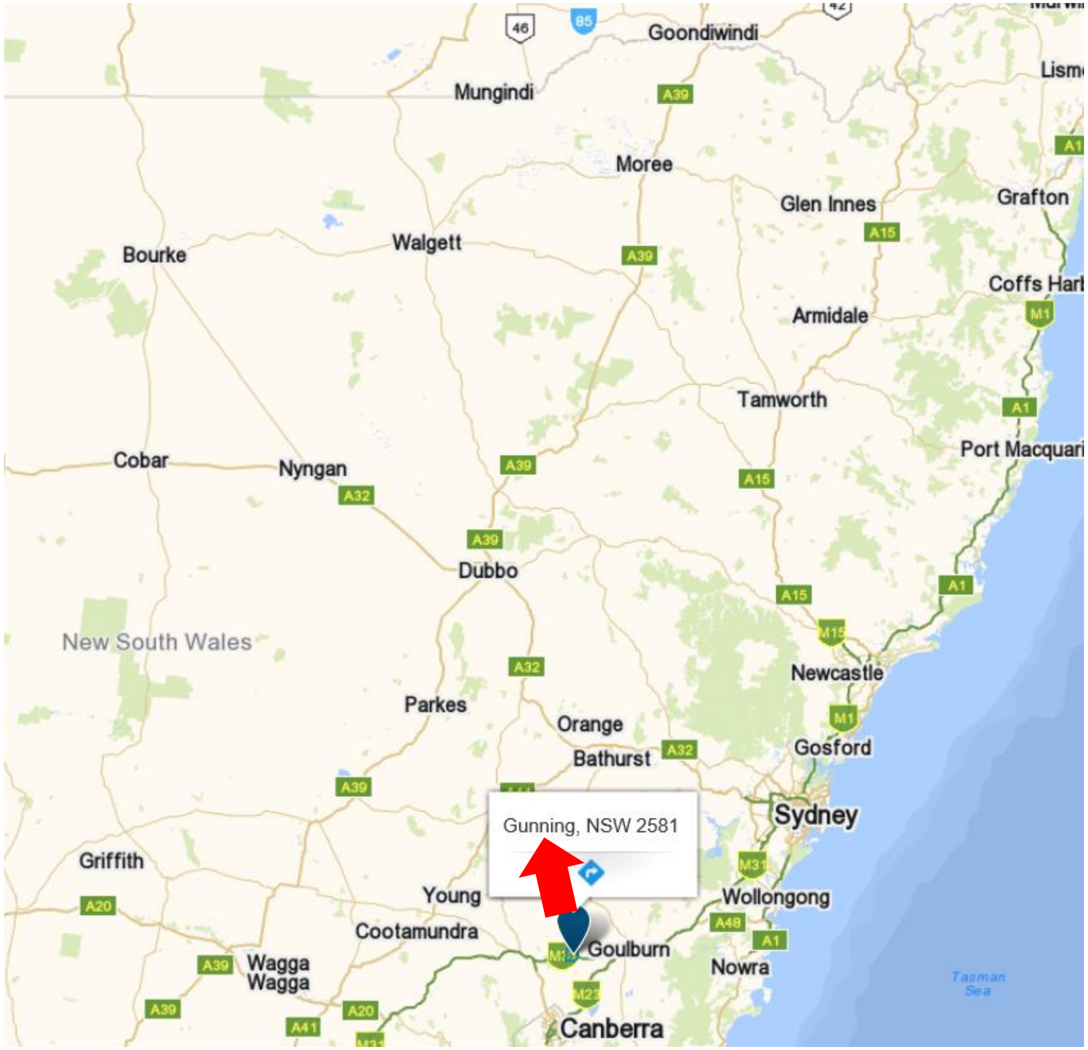


Change in average rainfall (%)

- > 30
- 20 – 30
- 10 – 20
- 5 – 10
- 0 – 5
- -5 – 0
- -10 – -5
- -20 – -10
- <-20

- Annual rainfall is expected to decline around the Gunning region by up to 8% by 2030 and 17% by 2050.
- Most of the declines will be in Winter and Spring.

Future analogues

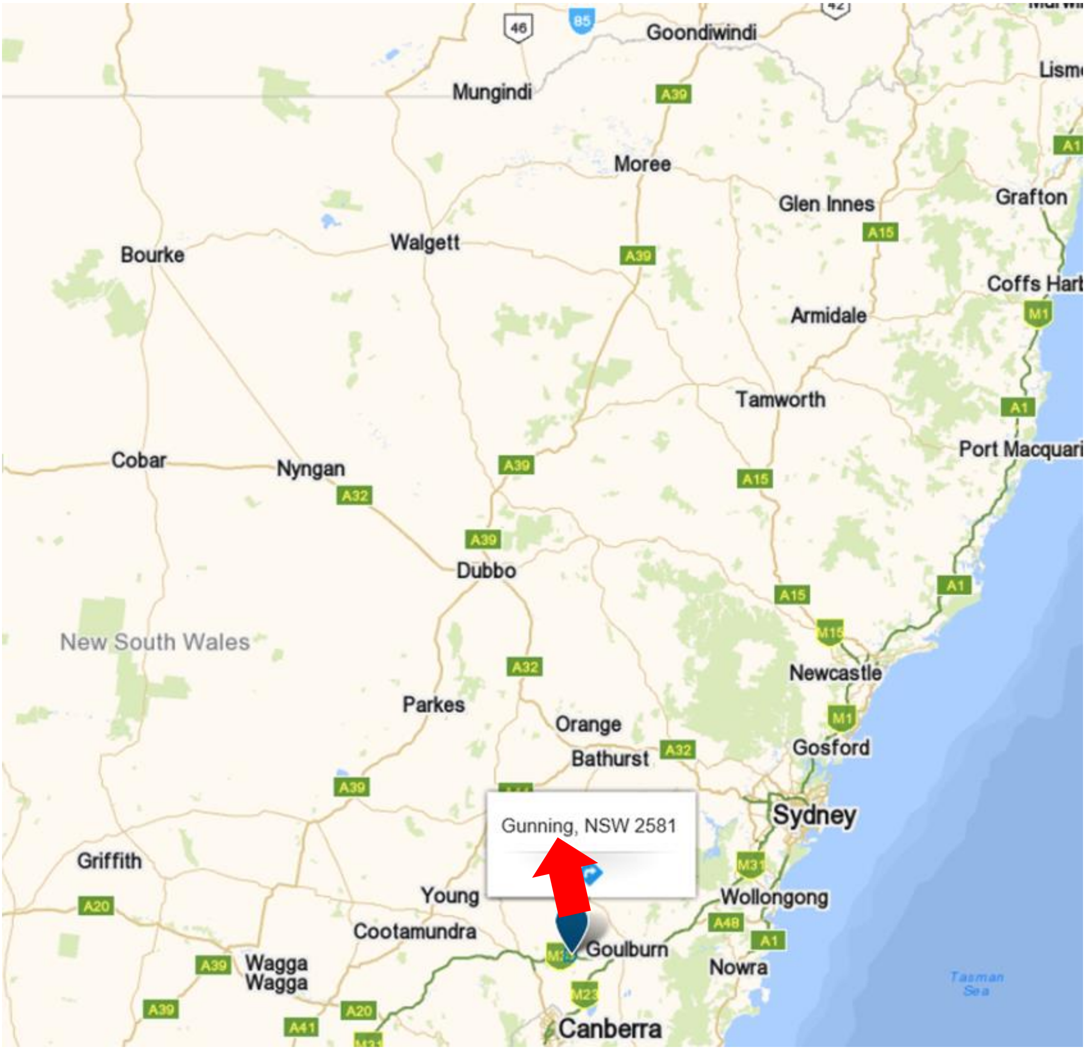


Gunning 2030

Analogue towns that currently experience 1.5^{o}C warmer average conditions and 8% less annual rainfall.

- Gilgandra,
- Condobolin,
- Dubbo,
- Parkes,
- Forbes,

Future analogues



Gunning 2050

Analogue towns that currently experience 2.5°C warmer average conditions and 12% less annual rainfall.

- Nyngan
- Coonamble
- Gunnedah
- Moree

How do we adapt well ?

- Huge diversity of options
  - on farm and off farm
  - technical and managerial
  - tactical and strategic
  - incremental to transformational
  - institutional
  - value chain
  - etc.,

- All require some change in knowledge as well as action

- Highly contextual - values

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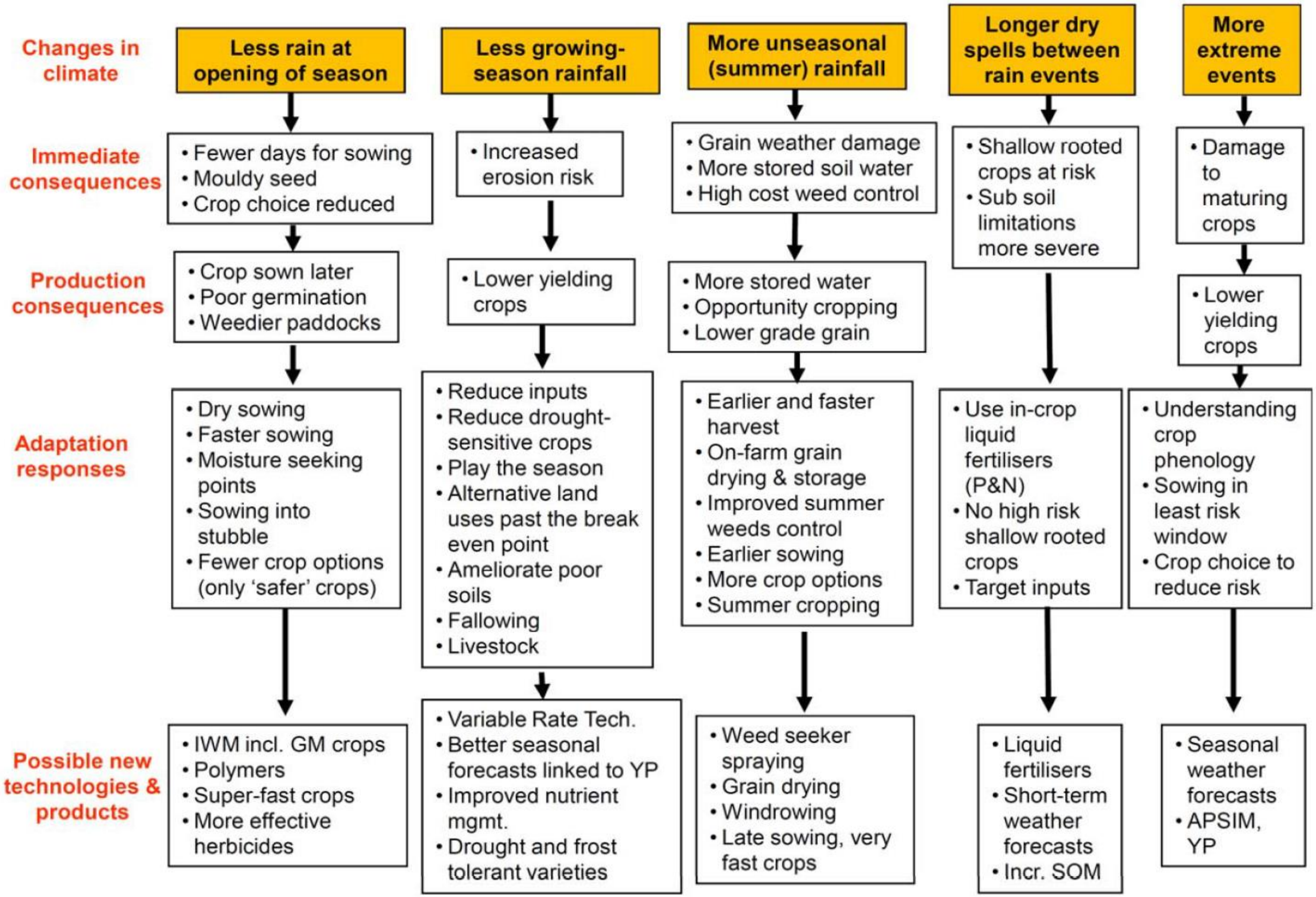
CC adaptations from farmers



van Rees in Crimp et al. 2012

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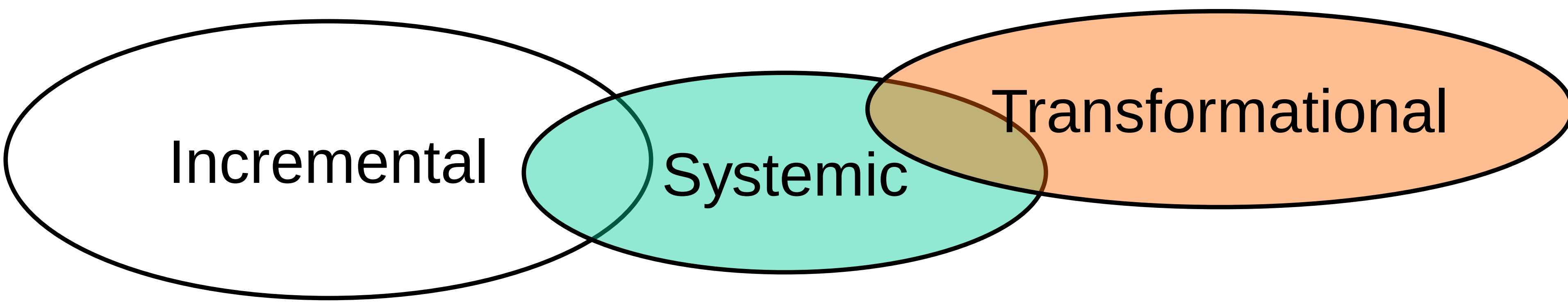
Climate adaptation: a journey from agronomy to strategic business management

2007	2011	2014	2016
• no cultivation, no-till and stubble retention • guidance systems • press wheels for water harvesting • inter-row sowing • opportunity cropping • less canola and pulses • hay • soil testing for N and water • sowing by the calendar not on moisture (dry sowing)	• containment areas for livestock • low P rates and N only just in time • postpone machinery purchases • no burning of stubbles • shorter season and heat tolerant varieties • variable sowing rate • improve sheep production	• canola only on soil moisture • bought and leased more light (sandy) country • concentrate on marketing (futures and foreign exchange rates) • decrease debt • off-farm income • reduce costs • improve harvest efficiency	• simplify all operations • larger paddocks – easier management • improve labour efficiency • improve financial management • requirement for more information and knowledge

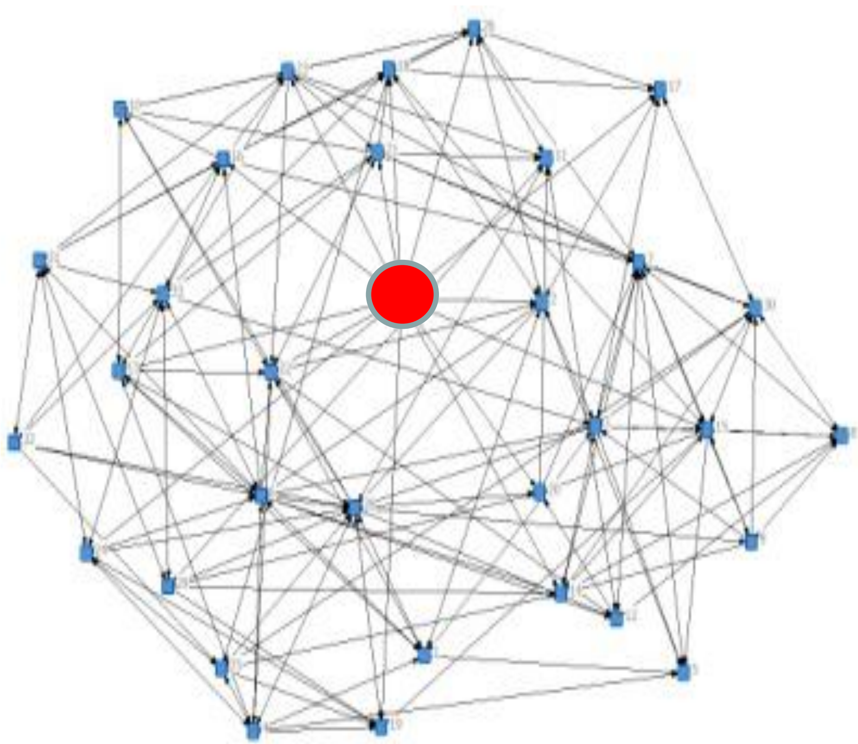
Comprehensiveness: more than incremental

- Focus on existing systems only may result in maladaptation
  - and in missed opportunities
- Need to consider more systemic and transformational adaptations
  - increasingly so as changes continue

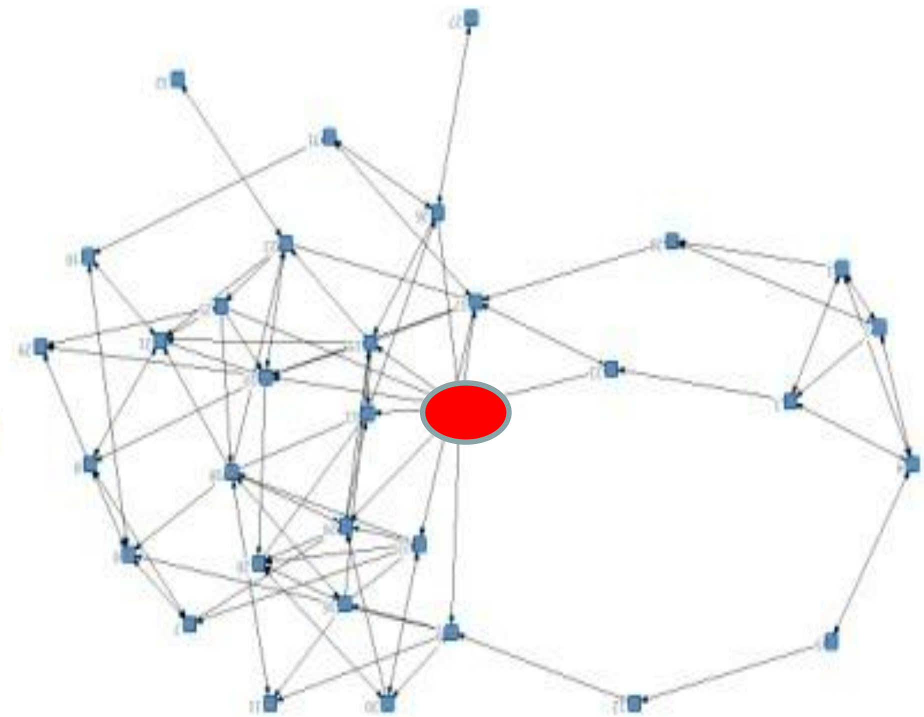


Howden et al. (2010), Park et al. (2012), Rickards and Howden (2012)

Social support networks

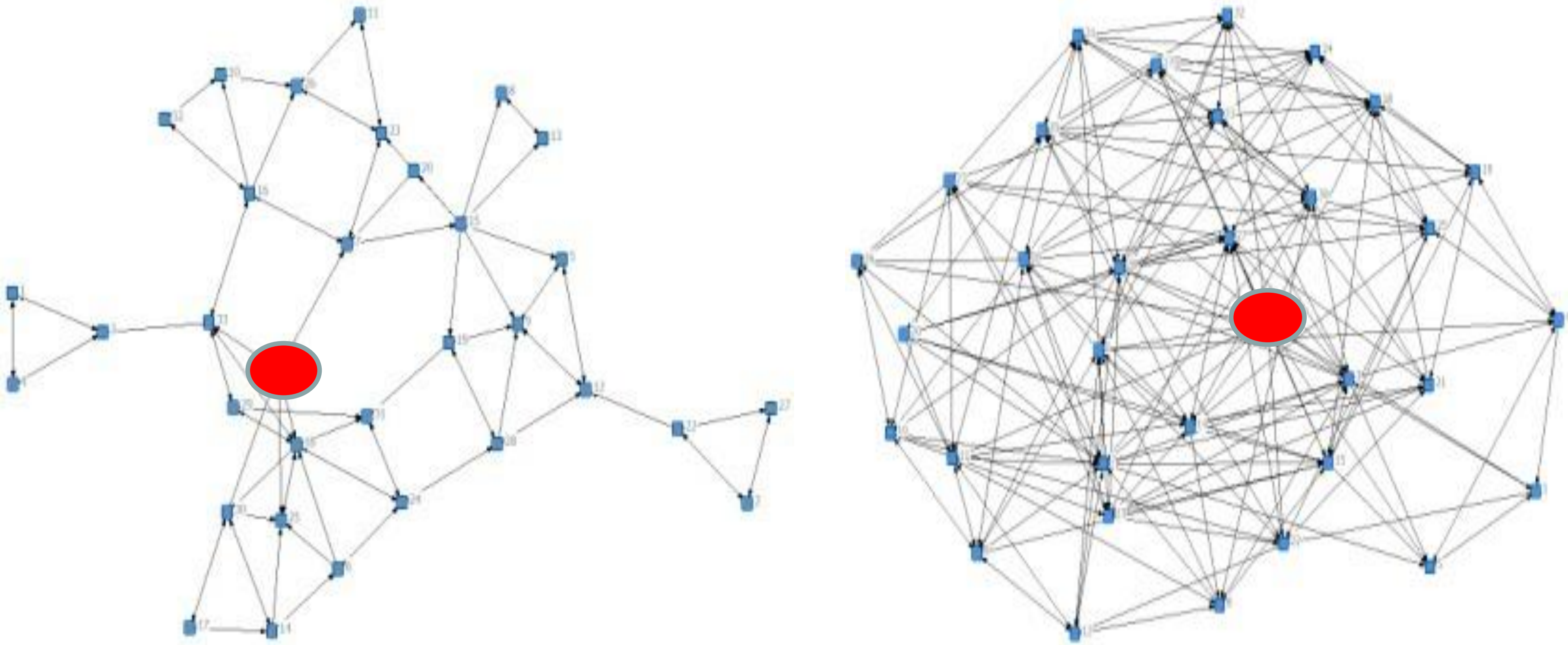


A. Incremental adaptor



B. Transformational adaptor

Information networks



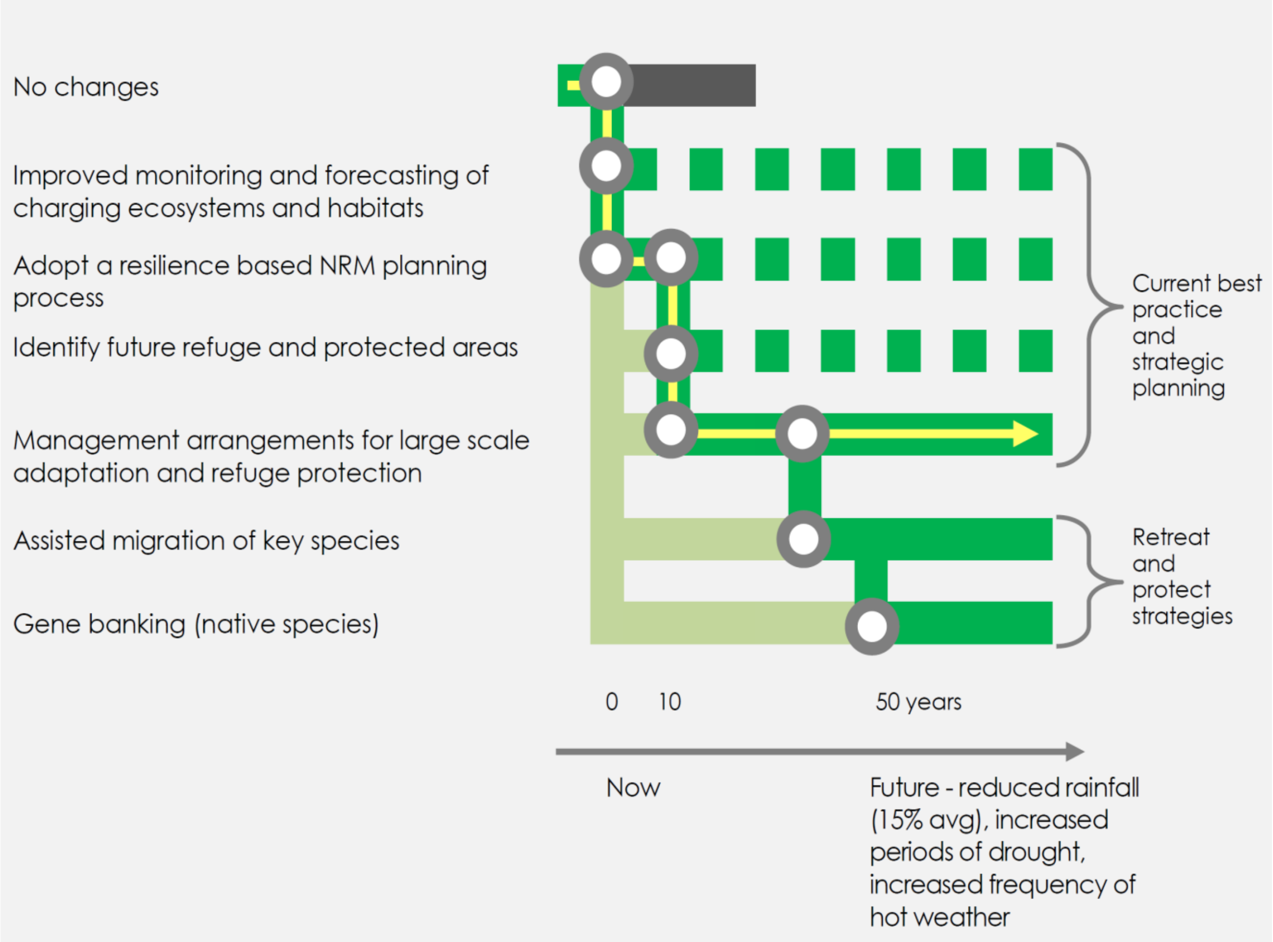
A. Incremental adaptor

B. Transformational adaptor

Dowd et al. (2014)

Using Adaptive pathways thinking

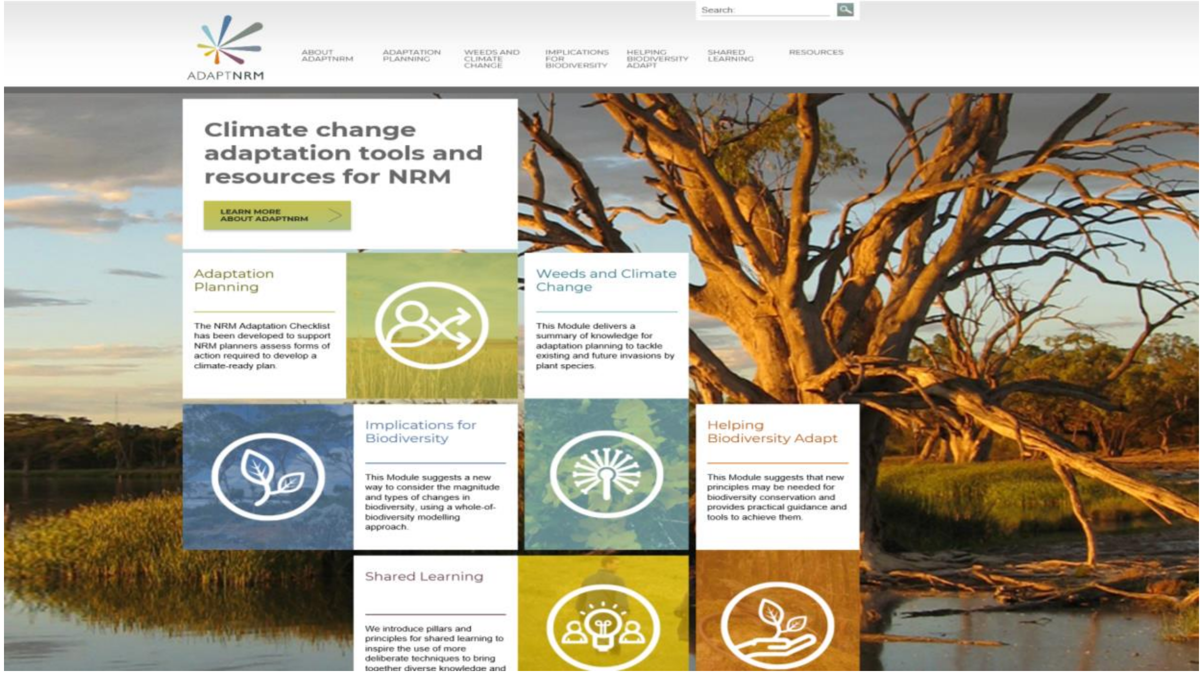
How can ecological communities that are currently threatened be protected as species distributions change in response to warmer and drier conditions?



Summary

- Climate changes already happening
- More change is in store
- A range of ways to respond
- Positive, strategic and timely climate-smart choices in a fast-changing world are required.

Number of tools exist to help NRM



A number of tools exist that provide insights into how to think about adaptation:

- AdaptNRM - http://adaptnrm.csiro.au/
- SouthWest Climate Change portal (VIC) - http://www.swclimatechange.com.au/

Thank you

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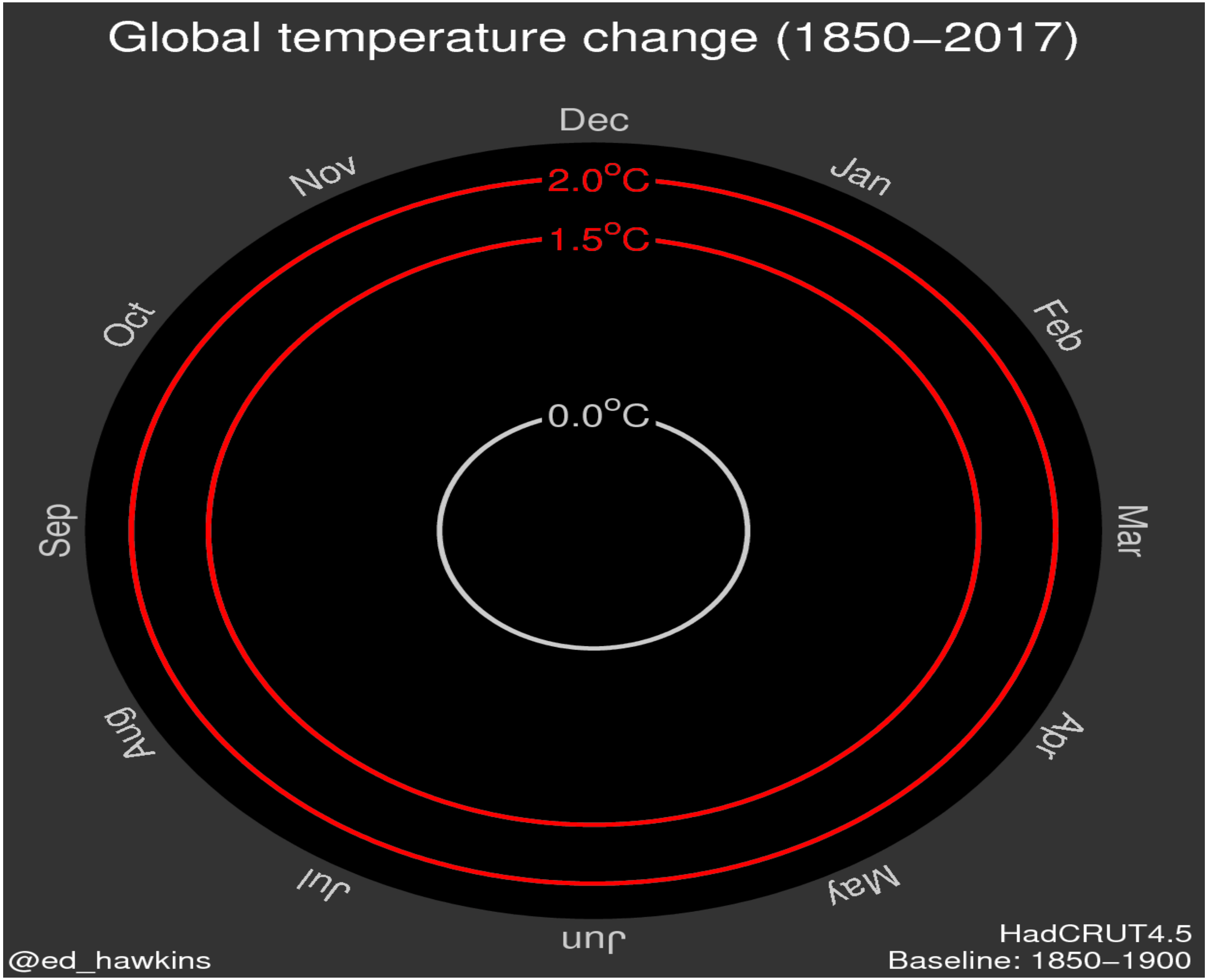
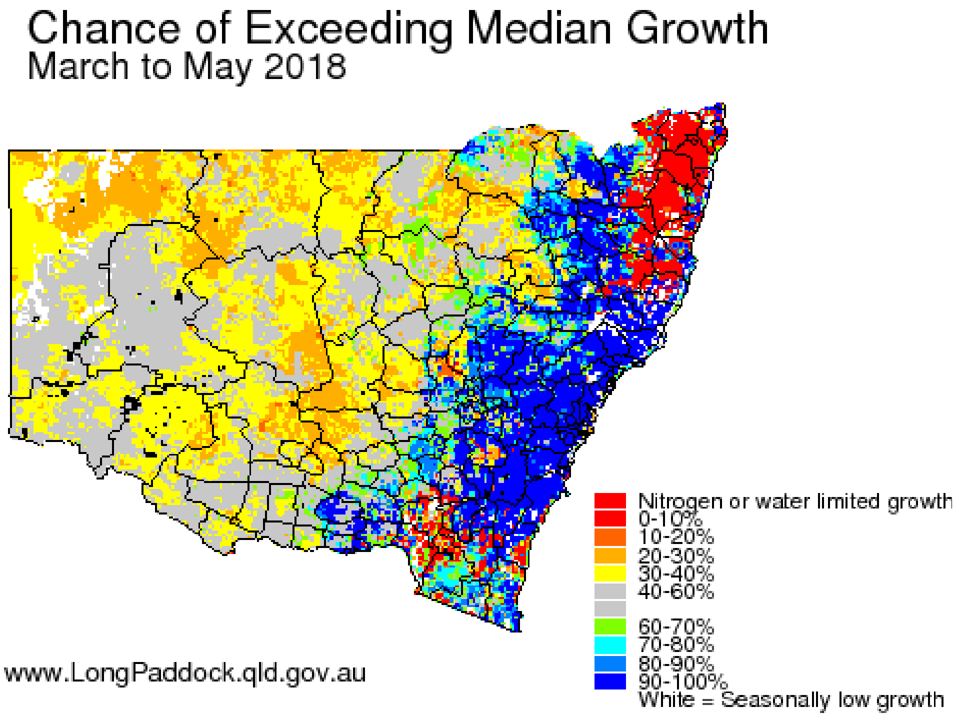
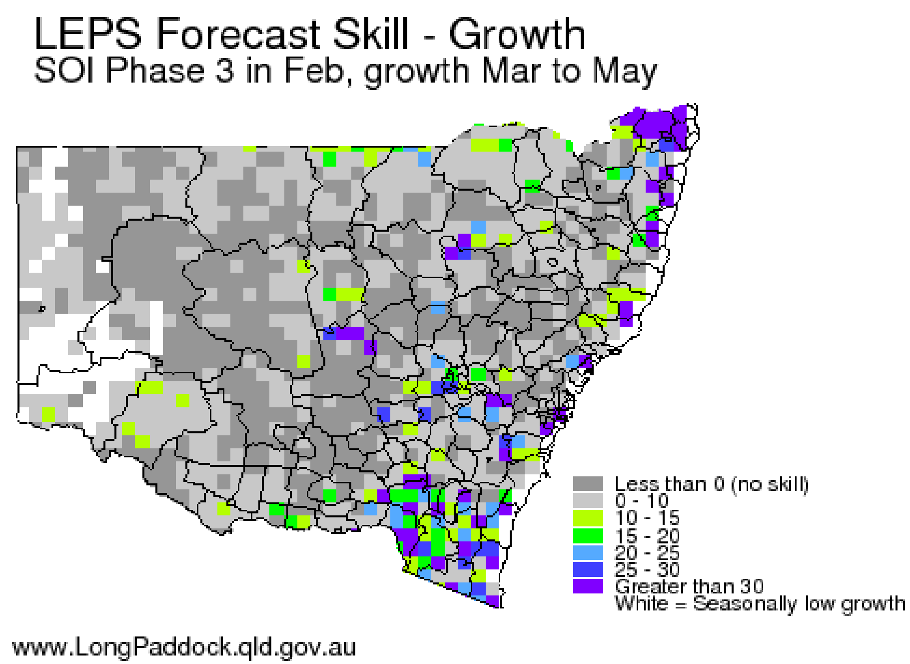
Global temperatures keep rising

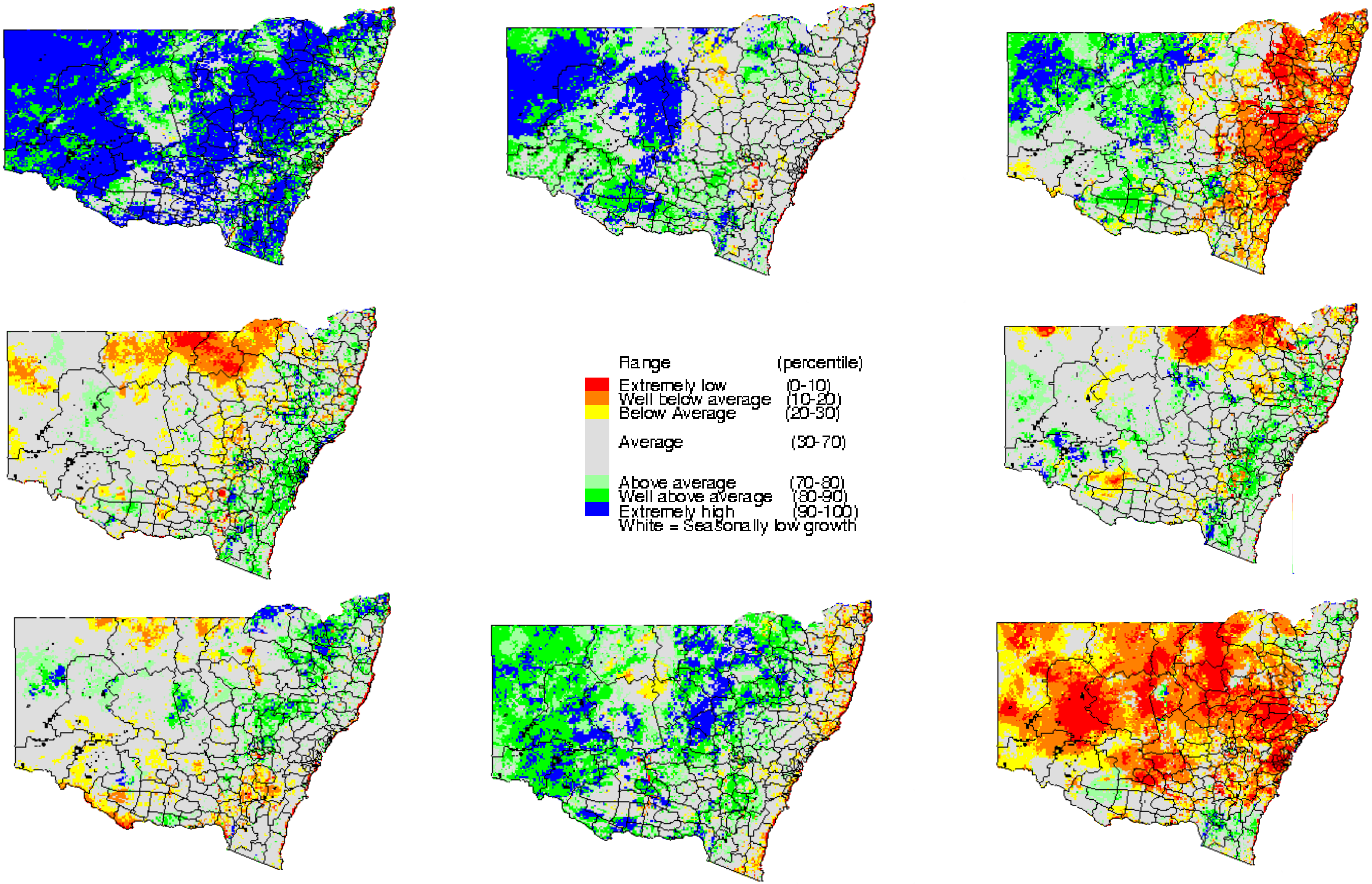


March to May pasture production





2017 pasture production low



What are the risks and impacts of climate change in Australia?

+3°C

Heat-related deaths in Australia rise 400%, **cold-related deaths** fall by 40%. In Sydney, the number of people over 65 years who die from heat-related illness rises more than 700% by 2050.

Extreme heat and reduced water availability combine with other threats to drive severe declines in many wildlife populations, causing extinctions around the country.

A more acidic ocean impairs reproduction and development of many marine organisms disrupting food chains.

Massive and widespread loss of species. More than 50% of Eucalypt habitat likely to be lost Australia-wide.

In the southwest Western Australia, **winter rainfall drops** up to 45%. **Wheat production in some areas falls** 26%.

Around the world, **hundreds of millions of people face displacement**, with the great low-lying megacities of Asia especially vulnerable. Regional and global security comes under added pressure.

Damage to developing countries rises above $1,000 billion annually, straining aid budgets.

Dangerous water shortages now commonplace in urban and rural areas. The average long-term stream flow into Melbourne's water catchments drops as much 35%.

There are as many as **870,000 new cases bacterial gastroenteritis** by 2100, as rising heat triggers a rising risk of food-borne illness.

Most of the Great Barrier Reef has suffered a catastrophic loss of coral, with massive coral bleaching every year, and widespread loss of marine life, economic values, and cultural heritage.

$226 billion in infrastructure is exposed to a 1.1 metre rise in sea level. Long-term sea level rise of 6.4 metres or more is now locked in, placing well over 1,000,000 Australians at risk.

In 2050 the number of **extreme fire-weather days rises** in southern and eastern Australia by 100% to 300%.

Areas with 30 days of annual average **snow cover declines** by 30 to 100%.

By 2100, **irrigated agriculture in the Murray-Darling Basin has declined** by up to 90%. Across southern Australia, cropping has become unviable at the dry margins.

www.climateinstitute.org.au