

**Exploring the Risks and Impacts
of Climate Change on Australia:
Physical Climate Changes**
Australian Climate Roundtable
24 February 2020



**AUSTRALIAN
CONSERVATION
FOUNDATION**



**AUSTRALIAN
ENERGY
COUNCIL**



**AUSTRALIAN
ALUMINIUM
COUNCIL LTD**



**Business Council
of Australia**



**Investor Group on
Climate Change**



Topics

Time	Topic
09:00 am	Arrival/Tea and Coffee
09:15 am	Overview and Purpose
09:20 am	Presentation 1: Dr Karl Braganza , Head of Climate Monitoring, National Climate Centre, Bureau of Meteorology.
09:40 am	Questions re: Presentation 1
10:00 am	Presentation 2: Prof. Andy Pitman , Director, ARC Centre of Excellence for Climate Extremes, University of New South Wales.
10:20 am	Questions re: Presentation 2
10:40 am	Break (tea/coffee/cake/networking)
11.10 am	Facilitated discussion: Implications for the Australian Climate Roundtable
12:00 pm	Close

Overview and Purpose



Australian Climate Roundtable

24 February 2020

Dr Karl Braganza
Bureau of Meteorology



Australian Government
Bureau of Meteorology



25 Aug 2018 Sheep on a drought affected farm near the NSW town of Bigga. Source ABC News Franklin Hood

Changes already happening and requiring adaptation



Increased frequency of large-scale heatwaves and record-high temperatures



Longer fire season with more extreme fire danger days



Prolonged high ocean temperatures



Reduced average rainfall and more time spent in drought



An increase in heavy rainfall



Increased frequency of coastal storm surge inundation

occurring now



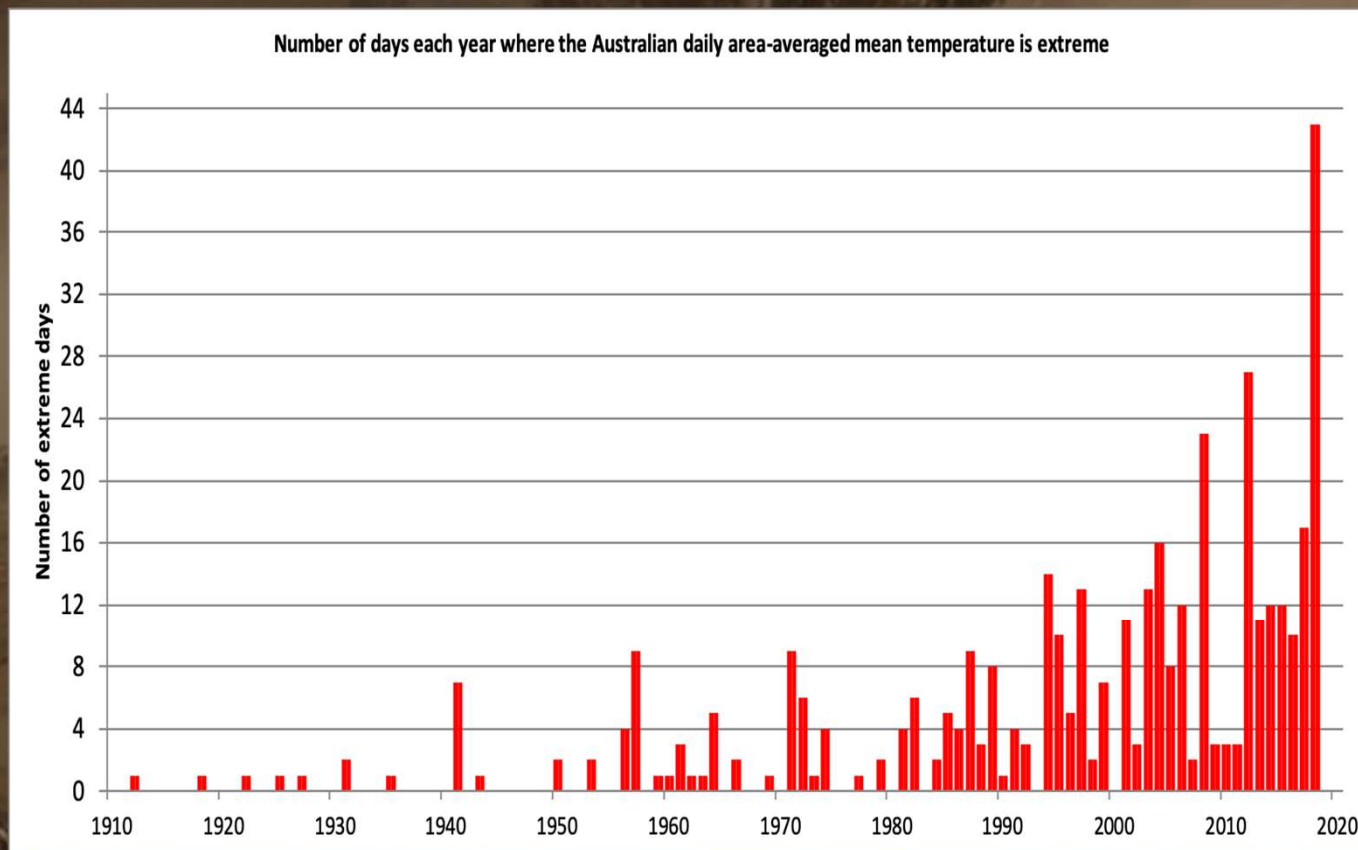
emerging threat



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Changes
already
happening
and requiring
adaptation

Increasing Extreme heat



Frequency count of the national daily temperature (continental average) reaching the 99th percentile (relative to the month) each year



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Black Saturday 2009

- Record-breaking heatwave across southeastern Australia
- Many all-time daily records set

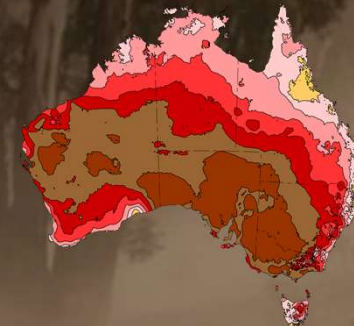
January 2013

- Over 70% of the continent recording temperatures in excess of 42 °C
- Broke every sequential national heat record from 1 day through to 1 month

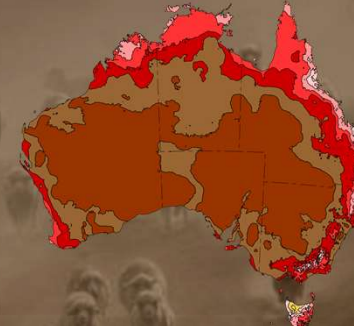
February 2017

- Broke area-averaged records for NSW maximum temperatures

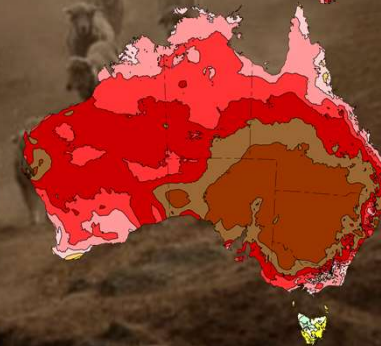
Summer heatwaves



Highest maximum temperature:
27 Jan – 8 Feb 2009



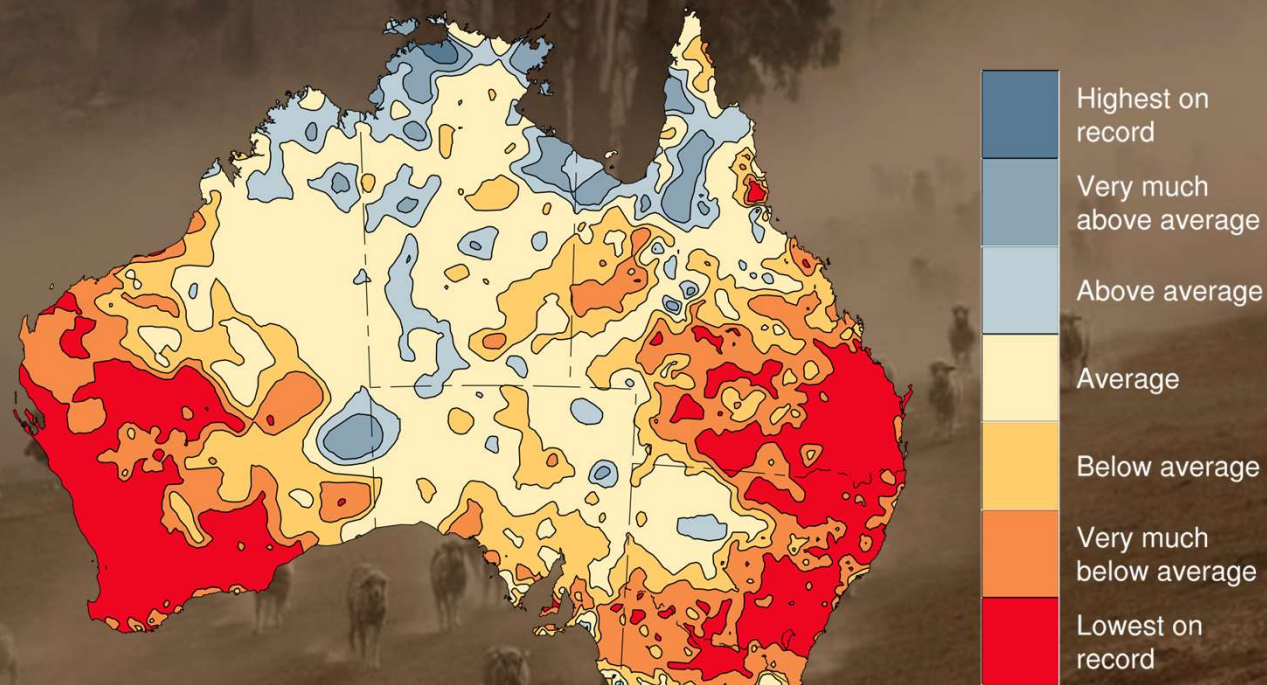
Highest maximum temperature:
First half of Jan 2013



Highest maximum temperature:
31 Jan – 12 Feb 2017

Changes
already
happening
and requiring
adaptation

Drying over southern Australia



April-September
rainfall deciles for the
period 2000-2019
compared with records
since 1900

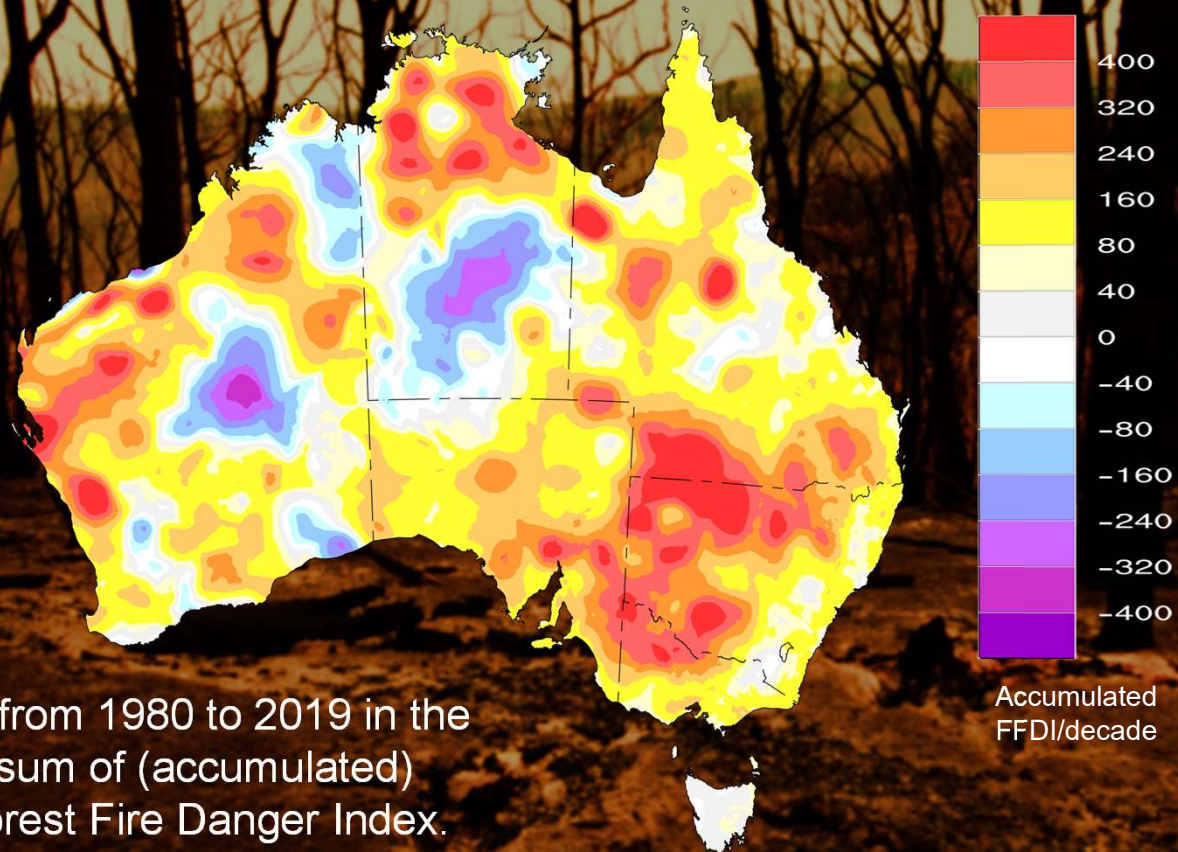


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Changes
already
happening
and requiring
adaptation

Worsening fire seasons

Trends from 1980 to 2019 in the
annual sum of (accumulated)
daily Forest Fire Danger Index.



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Kinglake Fire. Source: CSIRO Science Image, Nick Pitsas, February 25 2009



Bega Valley, NSW
15 August 2018
(Source: ABC)

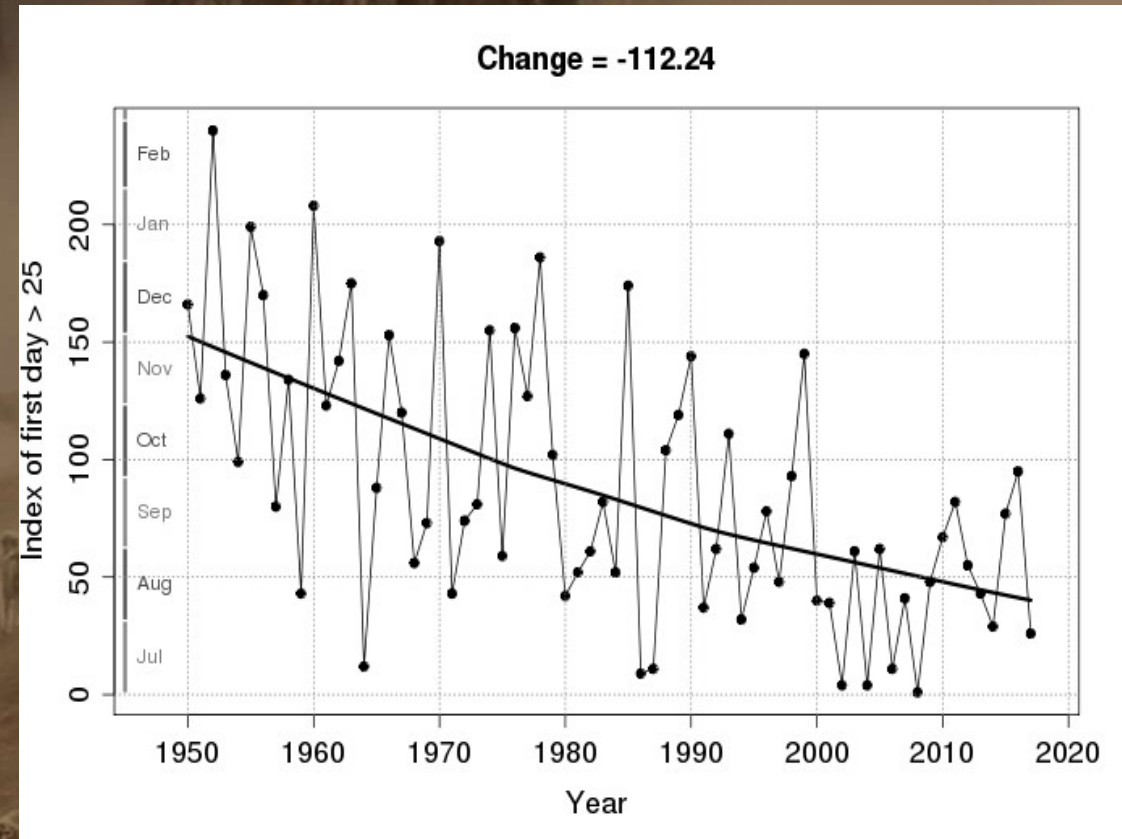


Albany, WA
25 May 2018
(Source: ABC)



Ranch Fire, California
August 2018 (Source: SFGate)

Worsening fire seasons



Earliest day with south-coastal NSW daily FFDI > 25

Record-breaking
heat and fire
weather:
the new normal?



Bushfire plumes from Himawari 8 Japanese
weather satellite; 7:30am on 29 November 2018



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Record-breaking heat and fire weather: the new normal?

Bushfire plumes from Himawari 8 Japanese
weather satellite; 29 January 2019



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Record-breaking heat and fire weather: the new normal?



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Bushfire plumes from Himawari 8 Japanese
weather satellite; 4 January 2020

50 km

Black Saturday 2009

- Record preceding heatwave across southeastern Australia
- Prolonged drought (record breaking in some aspects)
- Record daytime and overnight temperatures
- Record fire danger Black Saturday
- 173 deaths, 414 serious injuries, total cost of ~\$5 billion
- ~500 excess deaths from extreme heat across South Australia and Victoria

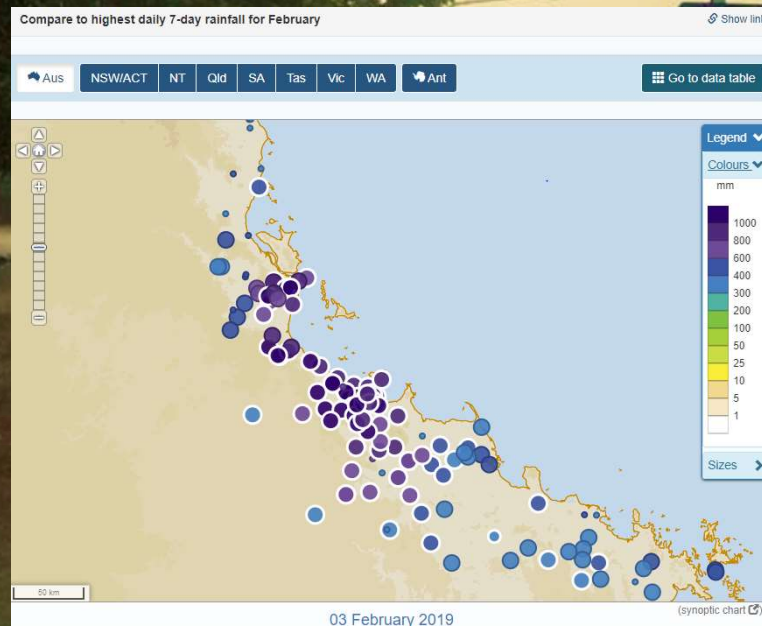
Responses to Royal Commission

- Introduction of heatwave warning services
- Changes to public health policy and heatwave provisions
- Changes to national fire danger rating
- Changes to emergency management responses and advice
- Changes to firefighting techniques
- Changes to management of electricity transmission during extreme conditions
- Proposed changes in land-use planning

Kinglake Fire. Source: CSIRO Science Image, Nick Pitsas, February 25 2009

Changes already happening and requiring adaptation

Record flooding in coastal Queensland



Monsoon low over Queensland, 4 February 2019

Record high multi-day rainfall widespread

Flooding in Townsville ABC News

Future sea level

Inundation from storm tide under a business-as-usual median-estimate sea level rise by 2050

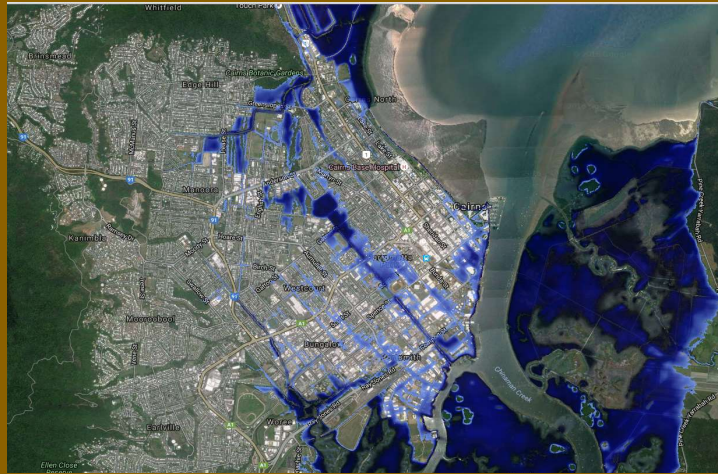
(1-in-100 year storm tide ~2.32 metres)

Inundation from storm tide under a business-as-usual high-estimate sea level rise by 2100

(1-in-100 year storm tide ~3.08 metres)

Data sources: <http://www.climatechangeinaustralia.gov.au/en/> McInnes et al, (2009; 2015)

<http://coastalrisk.com.au/viewer>



Cairns projected storm tide inundation



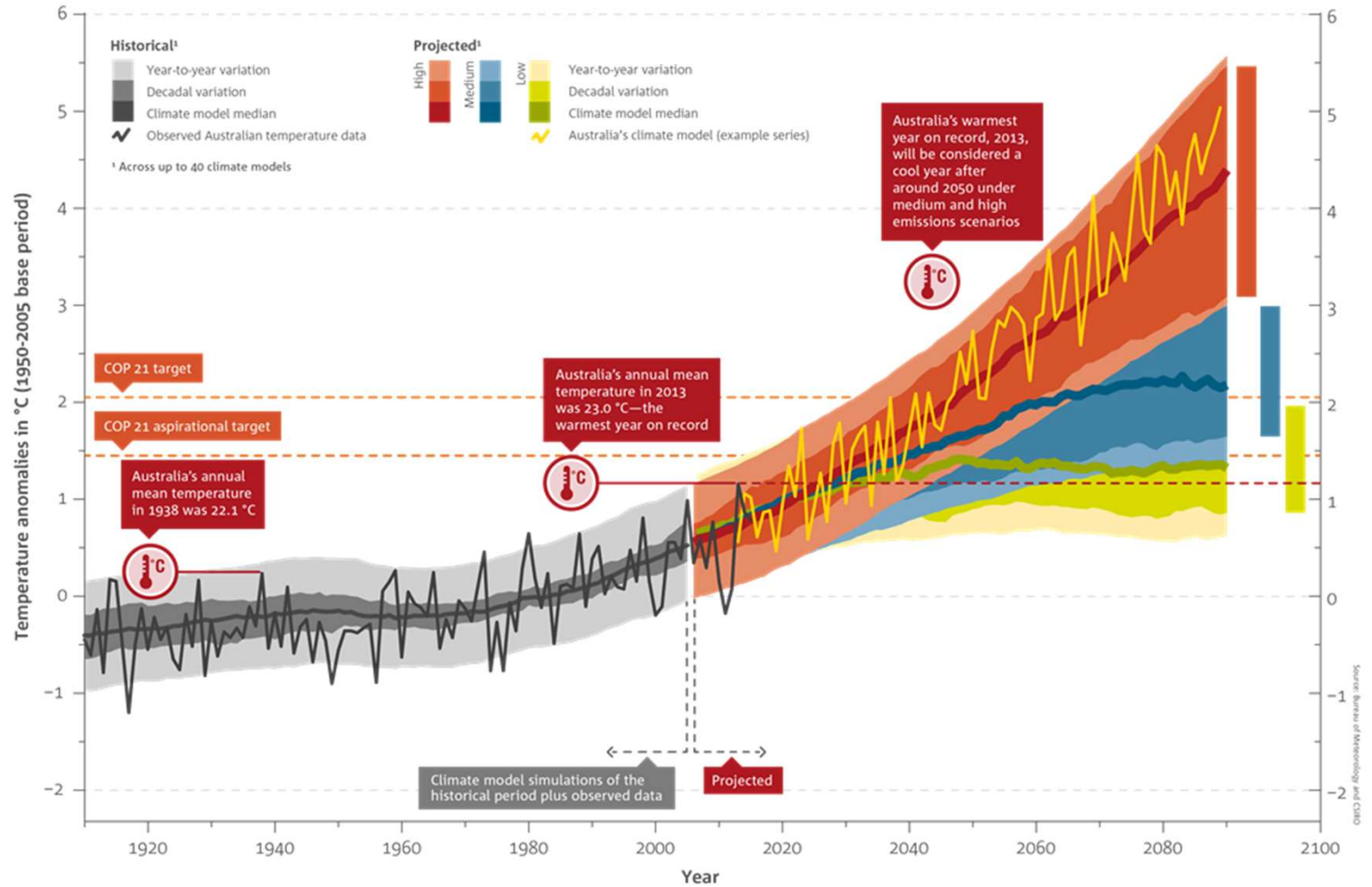
Scenario(s):

Australian average temperature trends from different emissions pathways



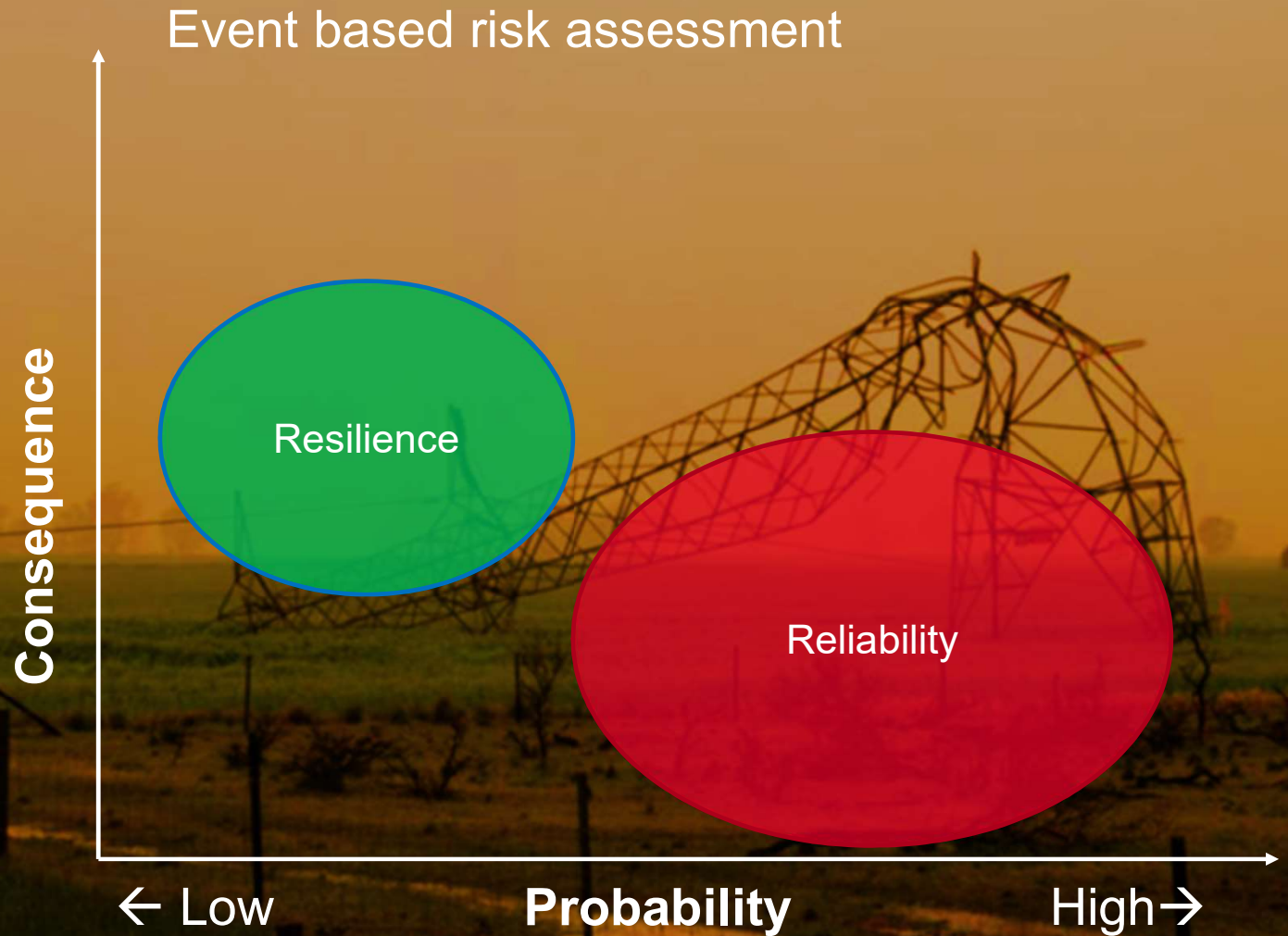
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Australian temperature projections



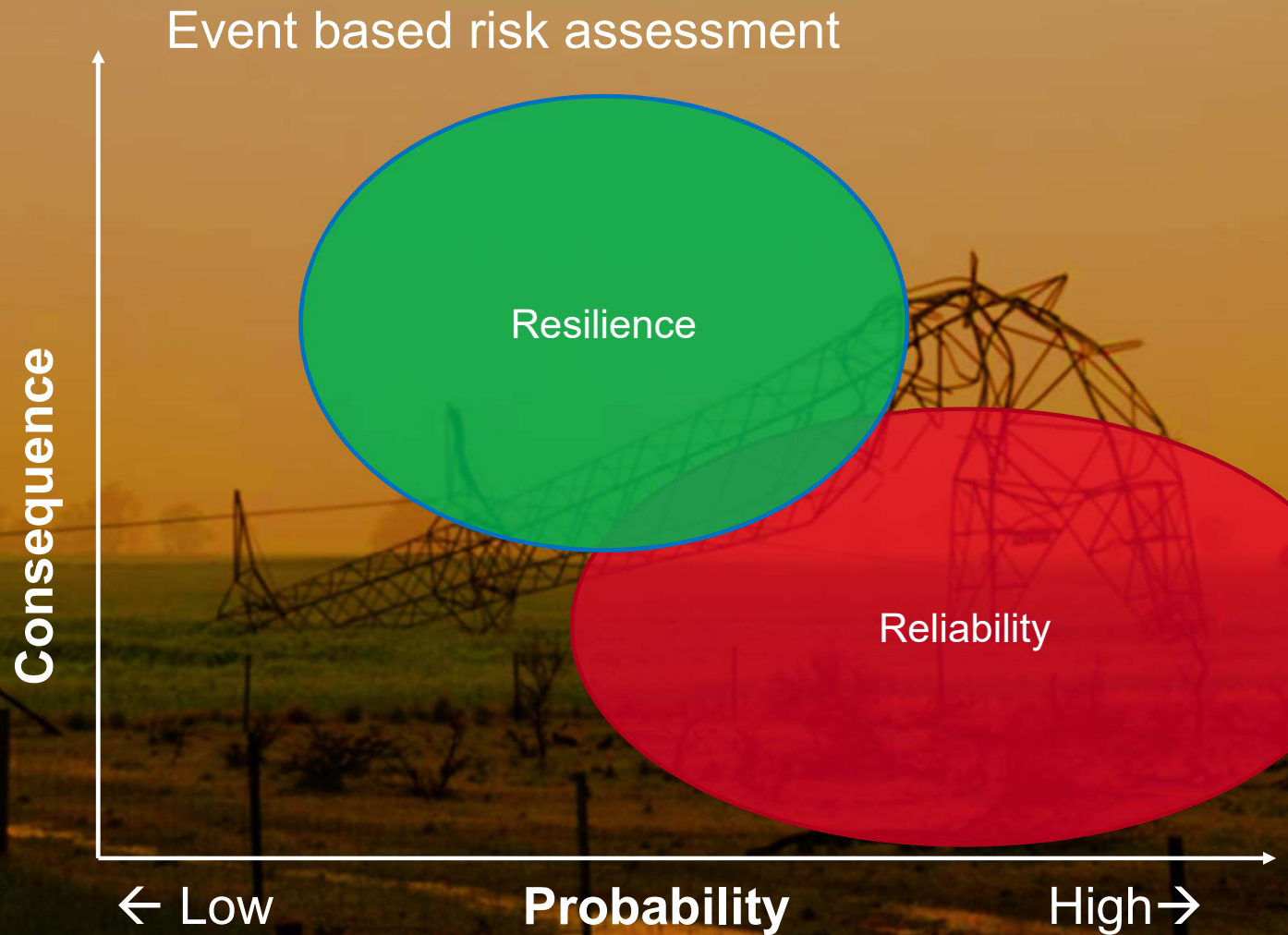
Securing Assets and Utilities

Consequence and Likelihood



Securing Assets and Utilities

Consequence and Likelihood



Securing urban water supply

Lake Hume Millennium Drought 2007 Source Image: Wikipedia



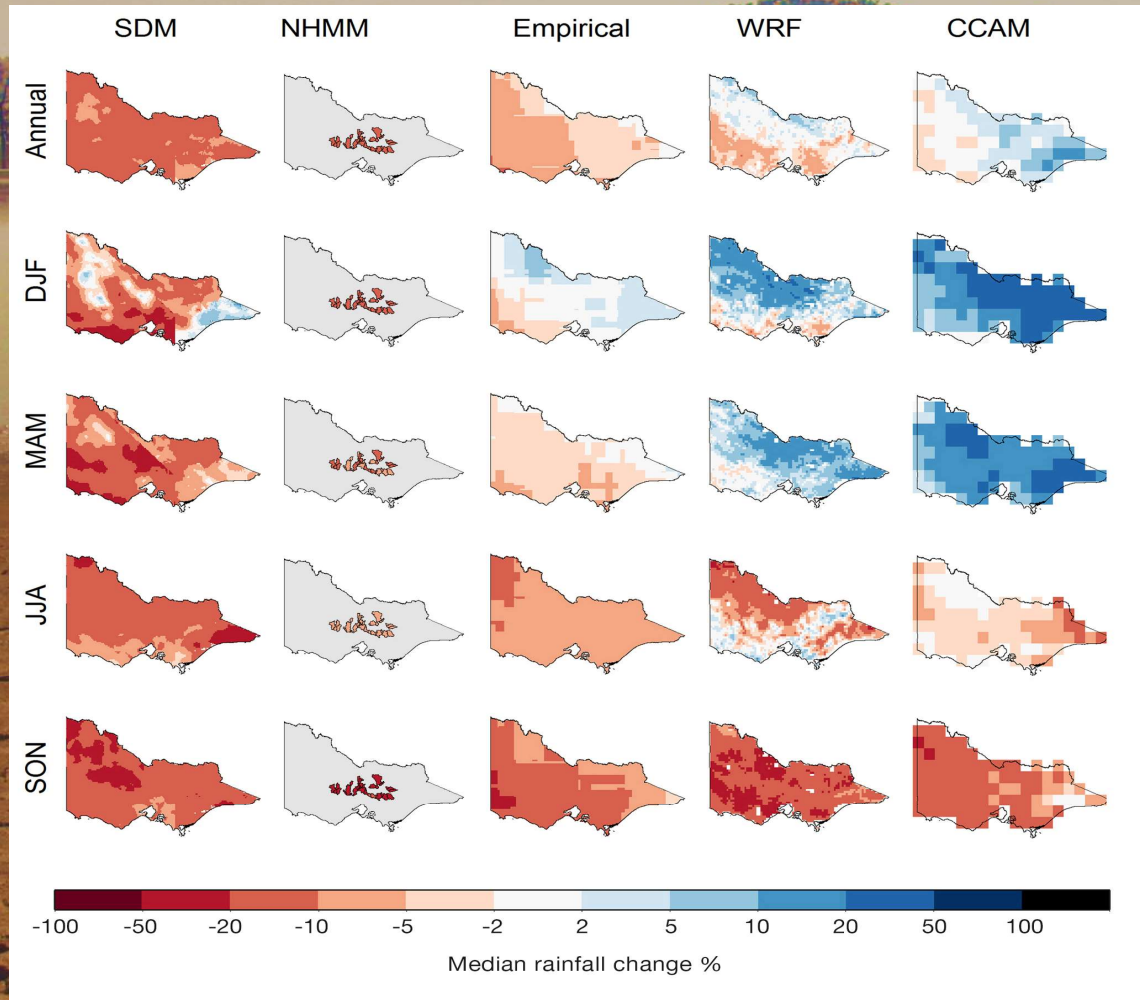
Wonthaggi Desalination Plant, Victoria



Thomson Dam, Melbourne's largest water storage, during the Millennium Drought

Median rainfall for Victoria later this century

High resolution climate projections



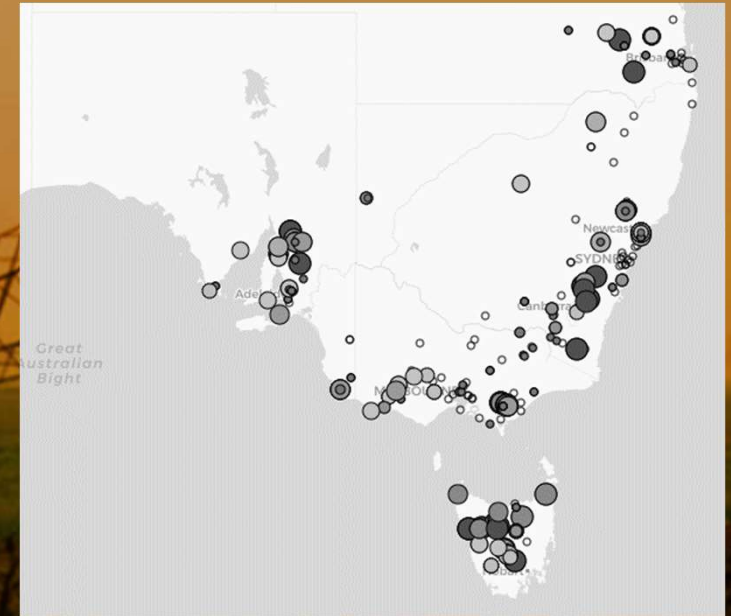
Victorian Climate Change Initiative:
Median rainfall changes (%) for available downscaling ensembles for later this century under a high emission scenario : Bureau of Meteorology Statistical Downscaling Model (SDM), statistical downscaling (NHMM; Note that only selected catchments were analysed), empirical downscaling (Empirical), dynamical downscaling from NARCIIM ensemble (WRF), and CSIRO dynamical downscaling (CCAM).

Building climate resilience in the NEM

Southeast Australia's Transmission and Generation Assets



Southeast Australia's electricity transmission network, linking the major load centres (most populous cities) in Australia



Generation assets across the southeastern grid of the NEM



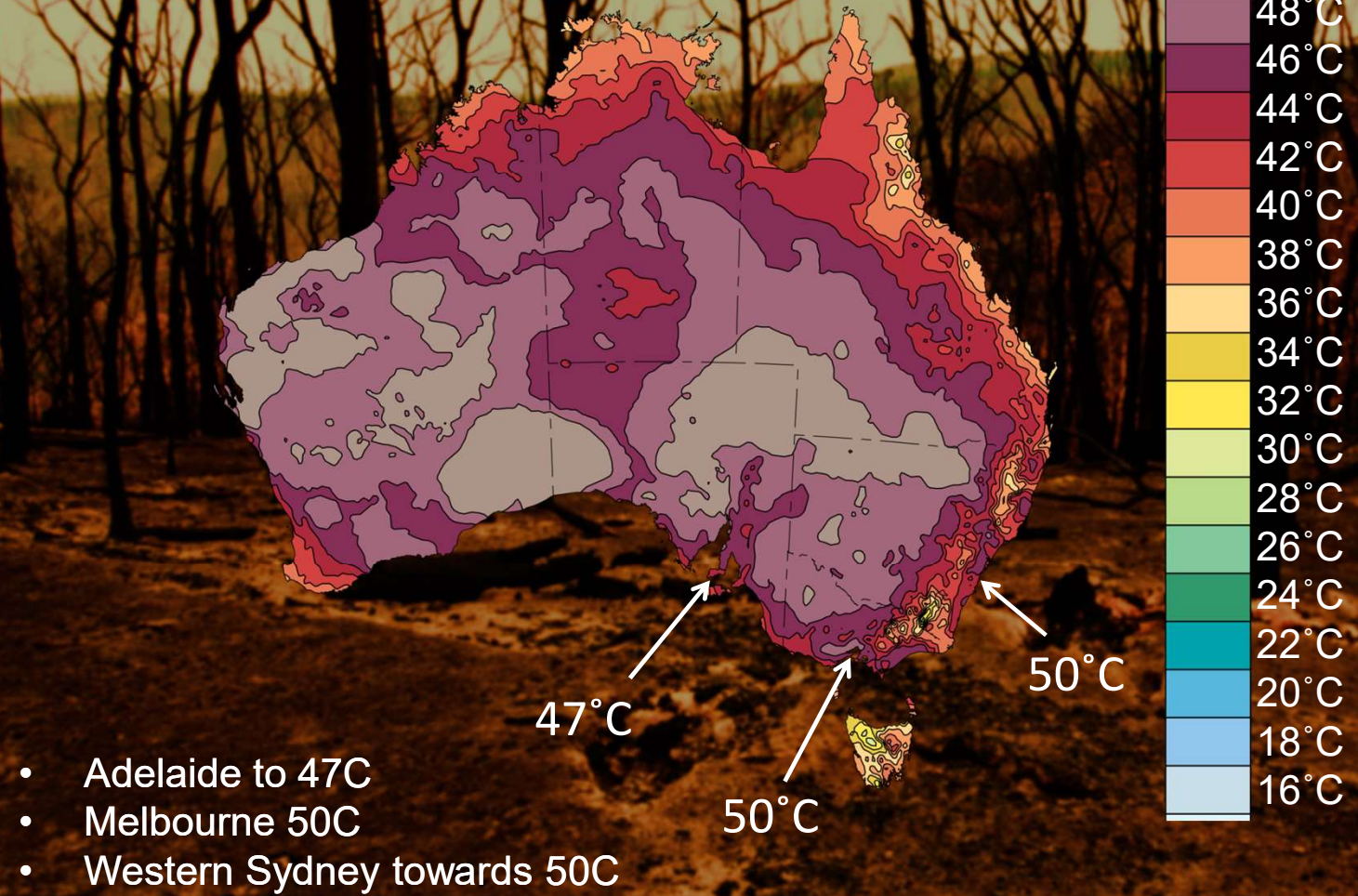
Australian Government
Bureau of Meteorology

Downed transmission lines between SA and Vic Sept 2016 Source: ABC

Scenario:

Record-breaking extreme heat

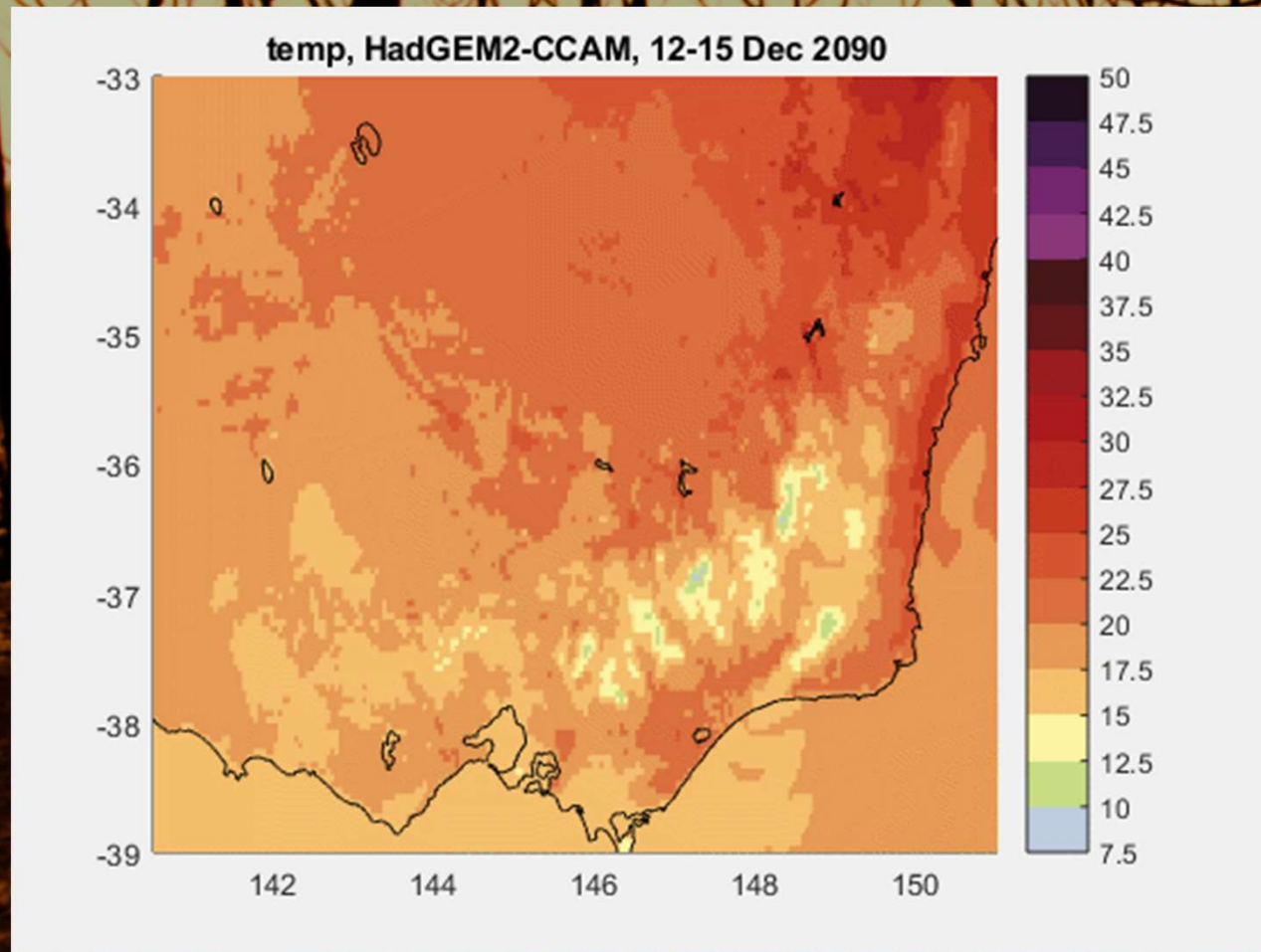
A heatwave like 1939, 2009 and 2017 combined, but hotter.



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Scenario:

Record-breaking extreme heat



DoEE Electricity Sector
Climate Information
Project:

CSIRO CCAM model
downscaling UK
MetOffice HadGCM2-
CC for RCP8.5 to 5km
resolution/

Top of the scale are
surface temperatures
above 50 degrees
Celsius for 12-15
December 2090.











Australian Government
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High resolution climate projections

<https://www.climatechangeinaustralia.gov.au/en/>

Thank you

CLIMATE CHANGE IN AUSTRALIA

 GETTING STARTED Support and guidance for use of information and data.	 CLIMATE CAMPUS Learn about the underpinning science of climate change, modelling and projections.	 PROJECTIONS AND DATA Explore Australia's projected climate and access model data. Register for data access.	 IMPACTS AND ADAPTATION Learn about possible regional impacts on natural resources and management responses.
 NEW & UPDATES Keep up to date on datasets, impacts, GHG and downtime	 HISTORIC CLIMATE CHANGE Learn about observed climate change over Australia.	 REGIONAL CLIMATE CHANGE EXPLORER Summary of climate change projections for Australian regions.	 PUBLICATIONS LIBRARY Download technical and regional reports and other publications.

 
Australian Government
Department of the Environment
Bureau of Meteorology

State of the Climate 2018

Report at a glance	Australia's changing climate	Oceans	Cryosphere	Greenhouse gases	Future climate and further information	References
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<http://www.bom.gov.au/state-of-the-climate/>

Prof. Andy Pitman

*Director, ARC Centre of
Excellence for Climate Extremes,
University of New South Wales*





Future projections for Australia

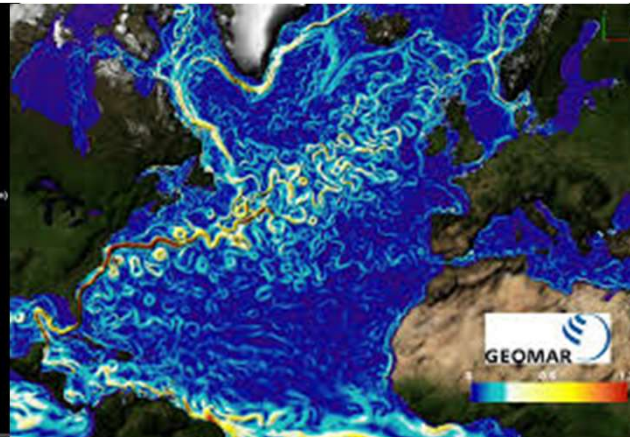
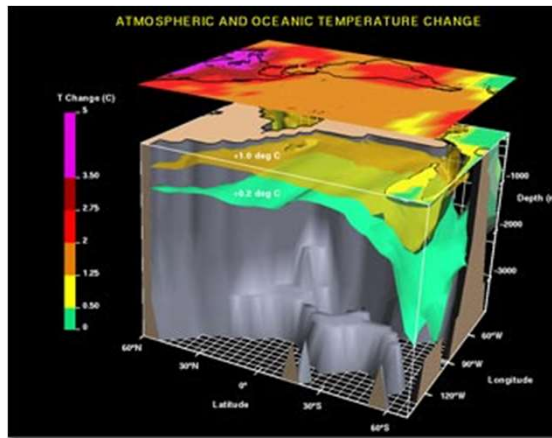
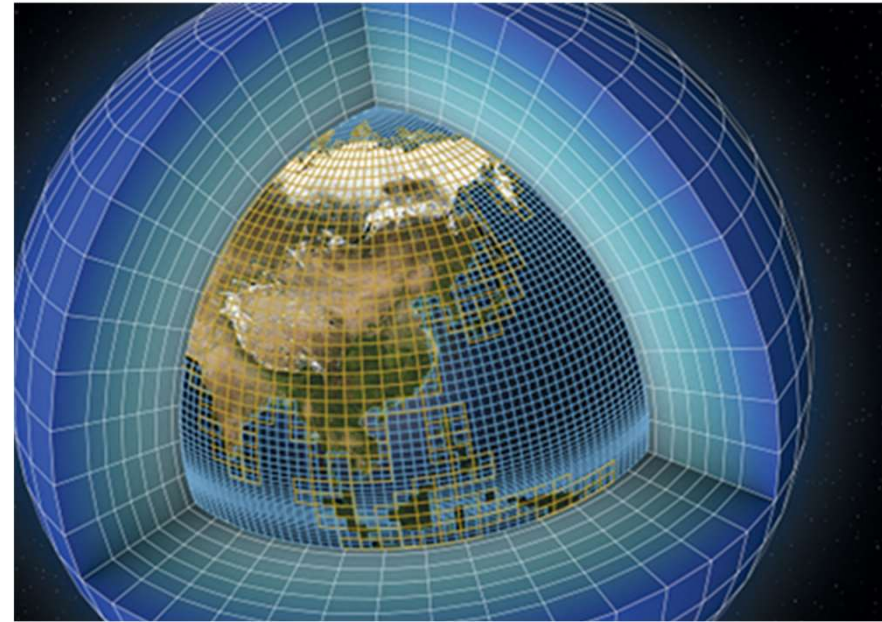
Andy Pitman

ARC Centre of Excellence for Climate Extremes

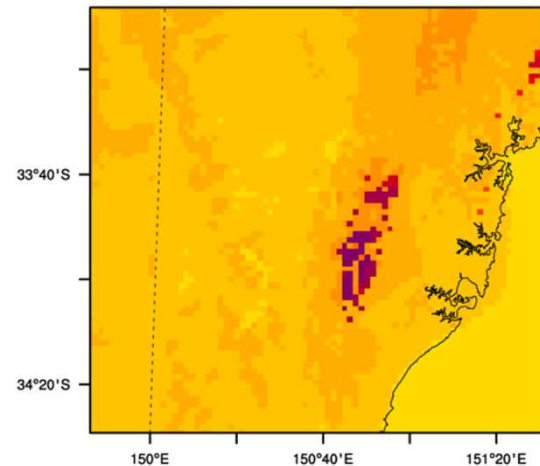
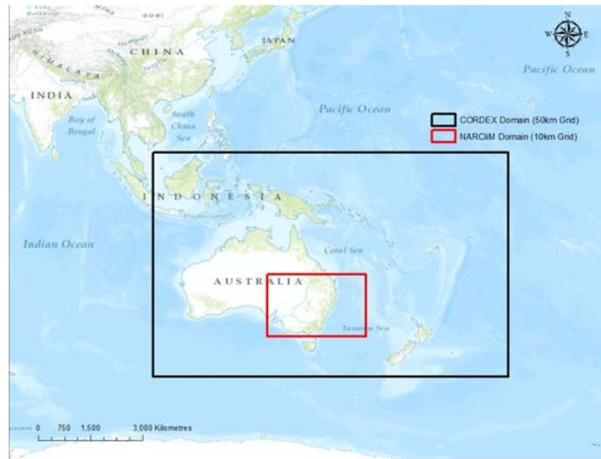


The future: climate models

- Use laws of physics
- 3 million lines of code
- Robust at continental scales and above
- Not statistical or regression-based



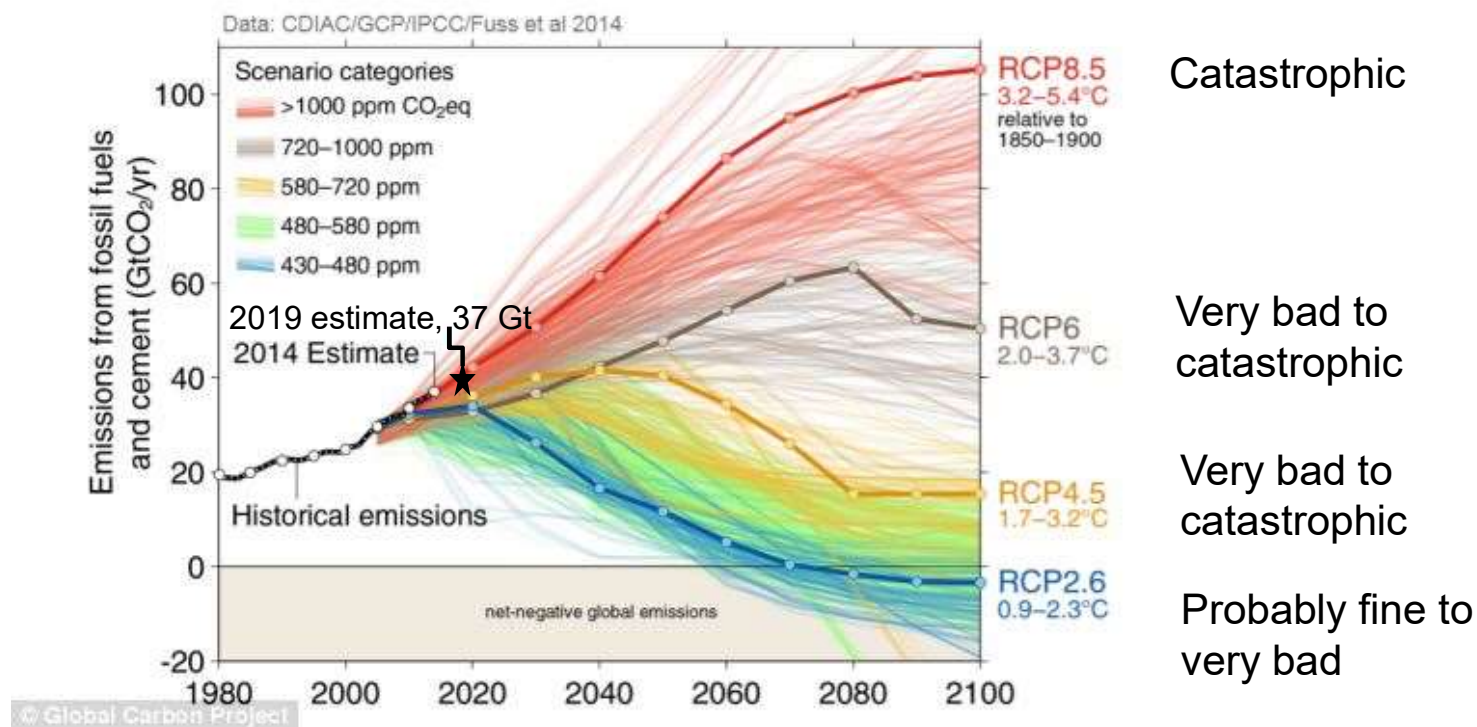
Regional downscaling: NARCLiM



Impact of urbanization to 2030 on minimum temperatures over Sydney Basin

- More regional detail than climate models
- Better representation of extremes
- Computationally very expensive
- Some significant limitations
- Bespoke downscaling for a specific need possible
- Expensive, needs technical and science expertise

Estimate future CO₂ equivalent emissions



Catastrophic

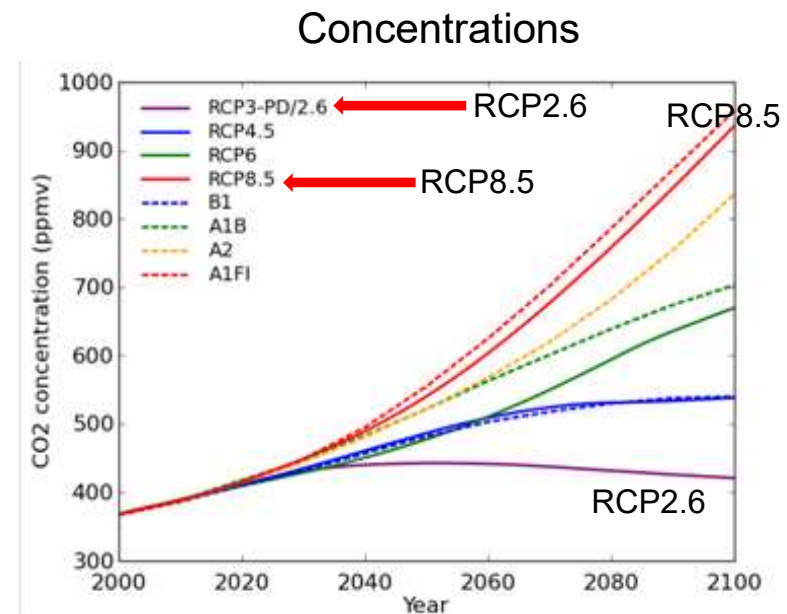
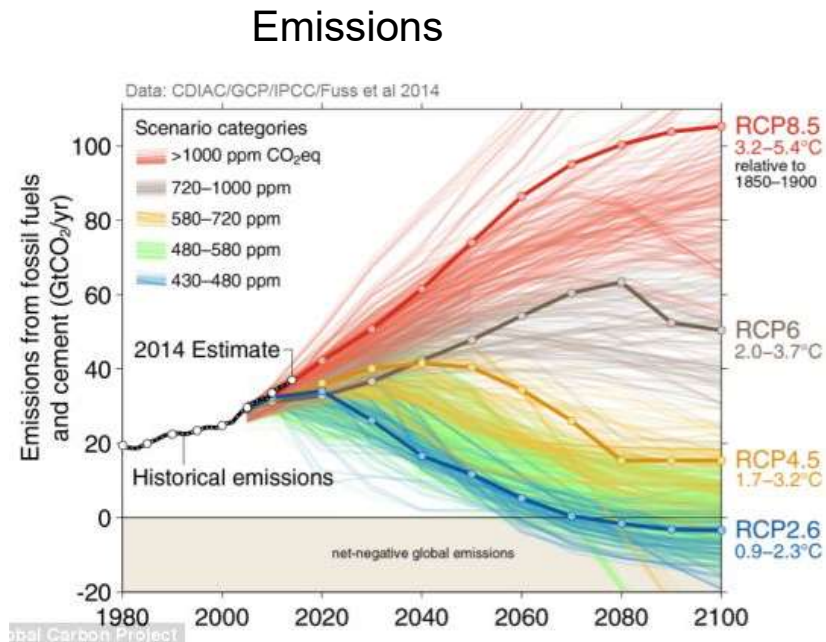
Very bad to catastrophic

Very bad to catastrophic

Probably fine to very bad

Depends on demography, technology, economics etc

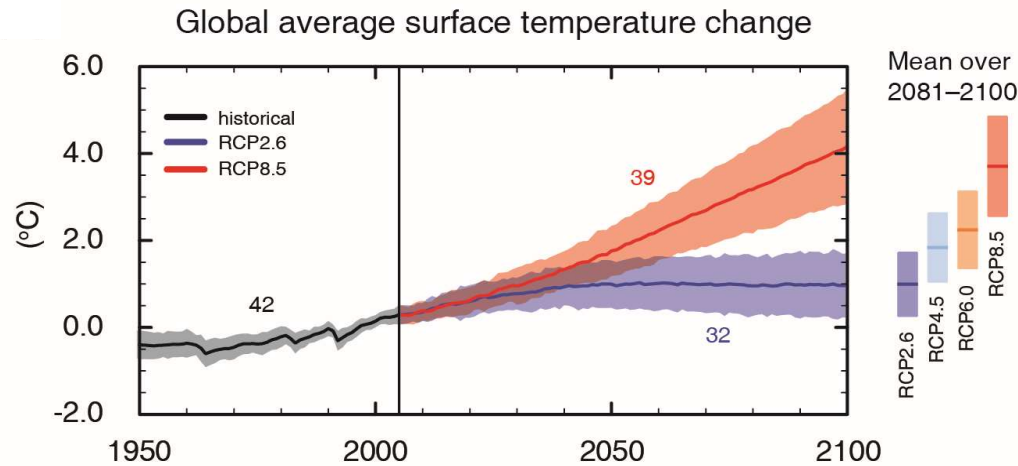
Estimate future CO₂ concentrations



Notes:

- RCP4.5 does not reduce concentrations in the atmosphere
- Different scenarios do not matter a great deal to concentrations @ 2030
- Different scenarios matter a great deal after 2050

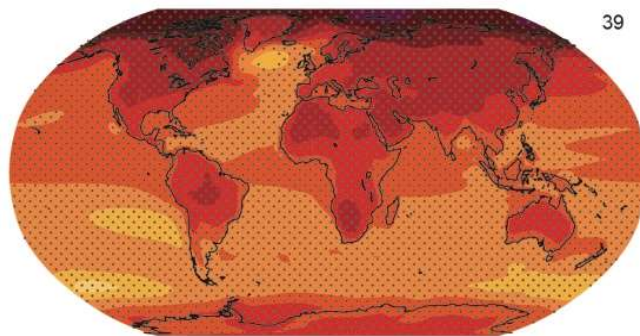
Future temperatures



It is important to understand that a change in the global average hides much larger changes in some regions over land

Future averaged warming

RCP8.5 at 2100



+4°C over 2000

RCP2.6 at 2100



+1°C over 2000



The future: inertia



@110 km, takes
~100m to stop



Stop emissions, takes ~20 years
for temperature to stop rising.

Takes a millennium for sea
levels to stop rising

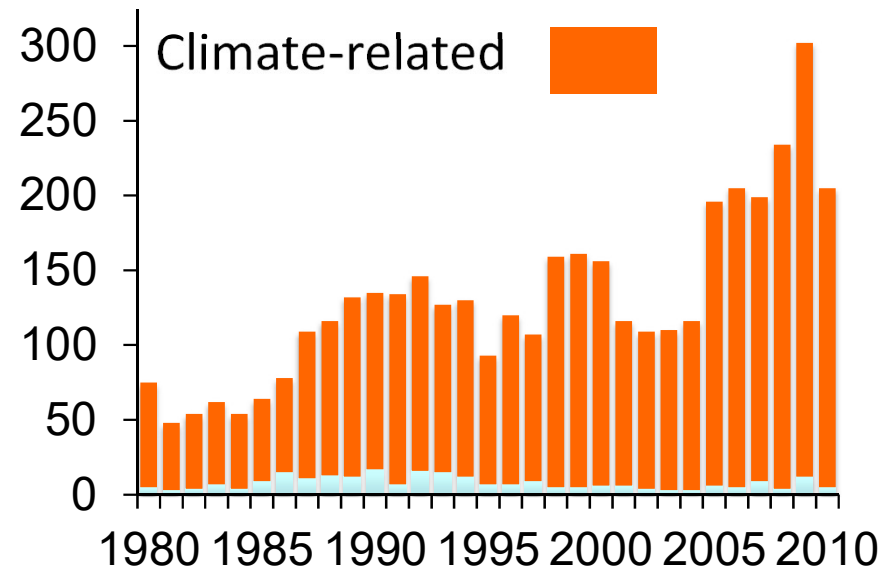
Mitigation (cutting CO₂ emissions) is 20 years late. We argued for deep cuts in 2000 to 7 billion tonnes of emissions – 20 years later we emit 10 billion tonnes

Adaptation is necessary, but adaptation to 4°C is unlikely to be feasible

Why Climate Extremes?

- Biggest global health threat of the 21st century [The Lancet Commission, 2015]
- Financial risk: Investors managing \$24 trillion signed the 2014 Global Investor Statement on Climate Change

Number of US “loss events”



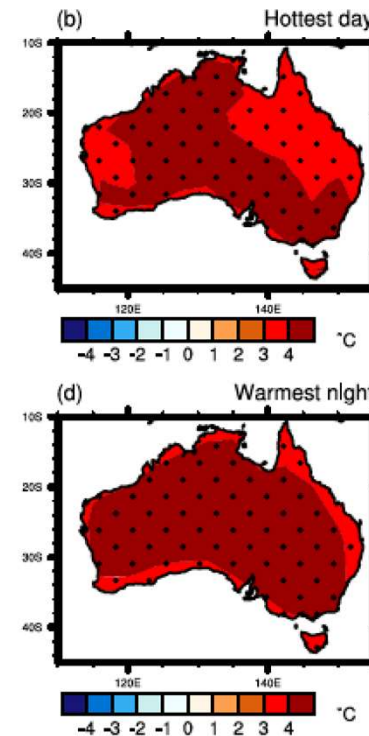
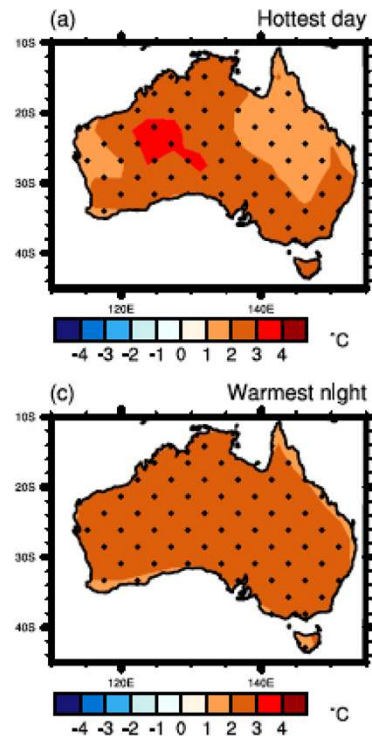
Munich Re, 2015

Projections of future temperatures

2046-2065

RCP8.5

2081-2100



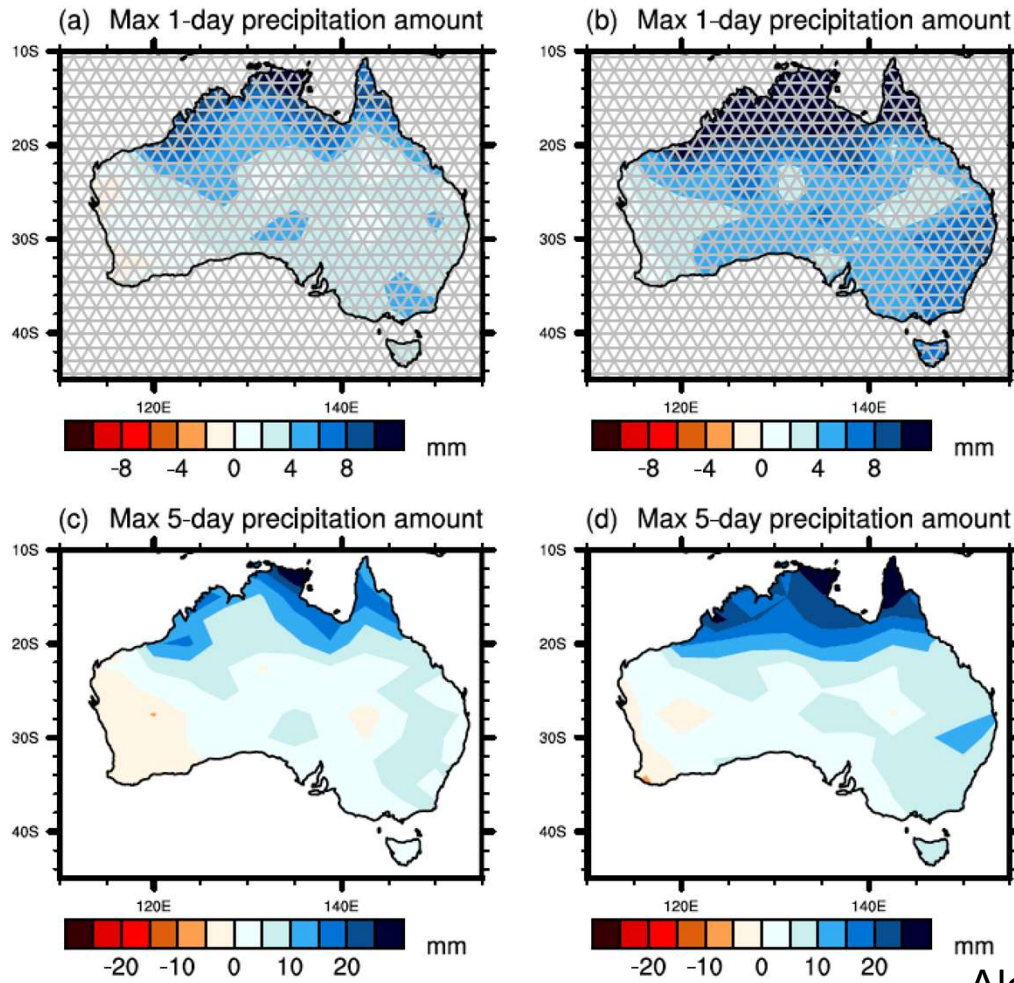
Dots point to areas of high agreement

High emissions future

Alexander and Arblaster, 2017

Projections of future climate

2046-2065 RCP8.5 2081-2100

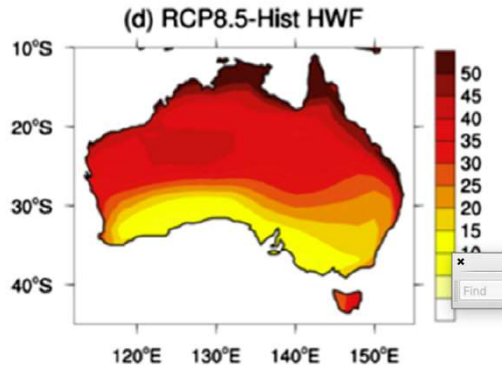


Shading is where models do not agree or cannot simulate the present well

But observations point to increasingly intense rainfall

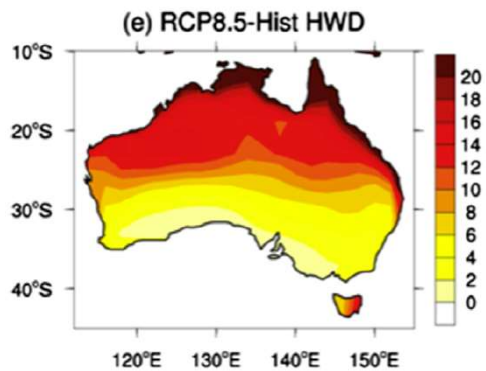
Alexander and Arblaster, 2017

Projections of future climate



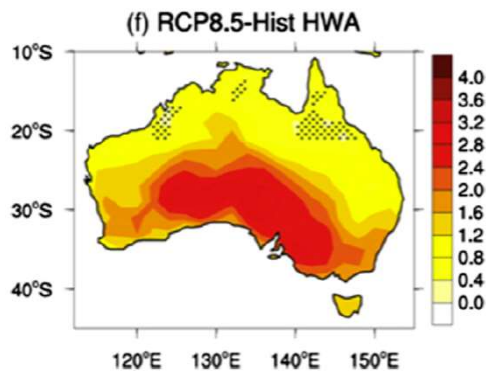
Changes in heatwave days (days)

Shading is where changes are not significant



Changes in heatwave duration (days)

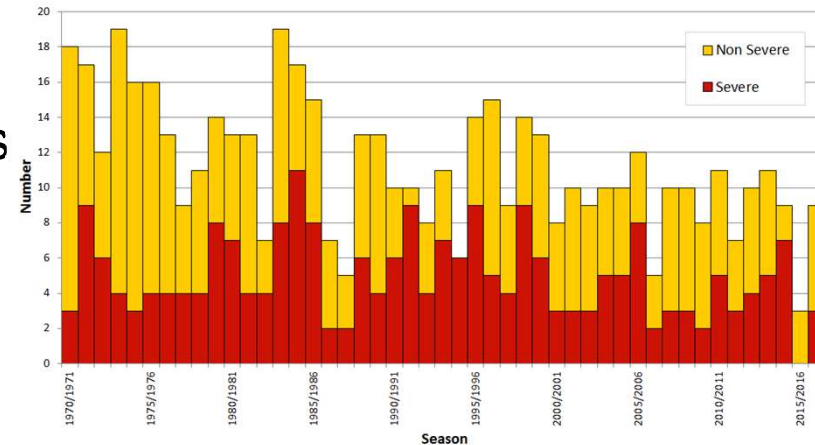
Observations point to increasing magnitude, frequency and duration of heatwaves



Changes in hottest day of the hottest event (°C)

Other extremes

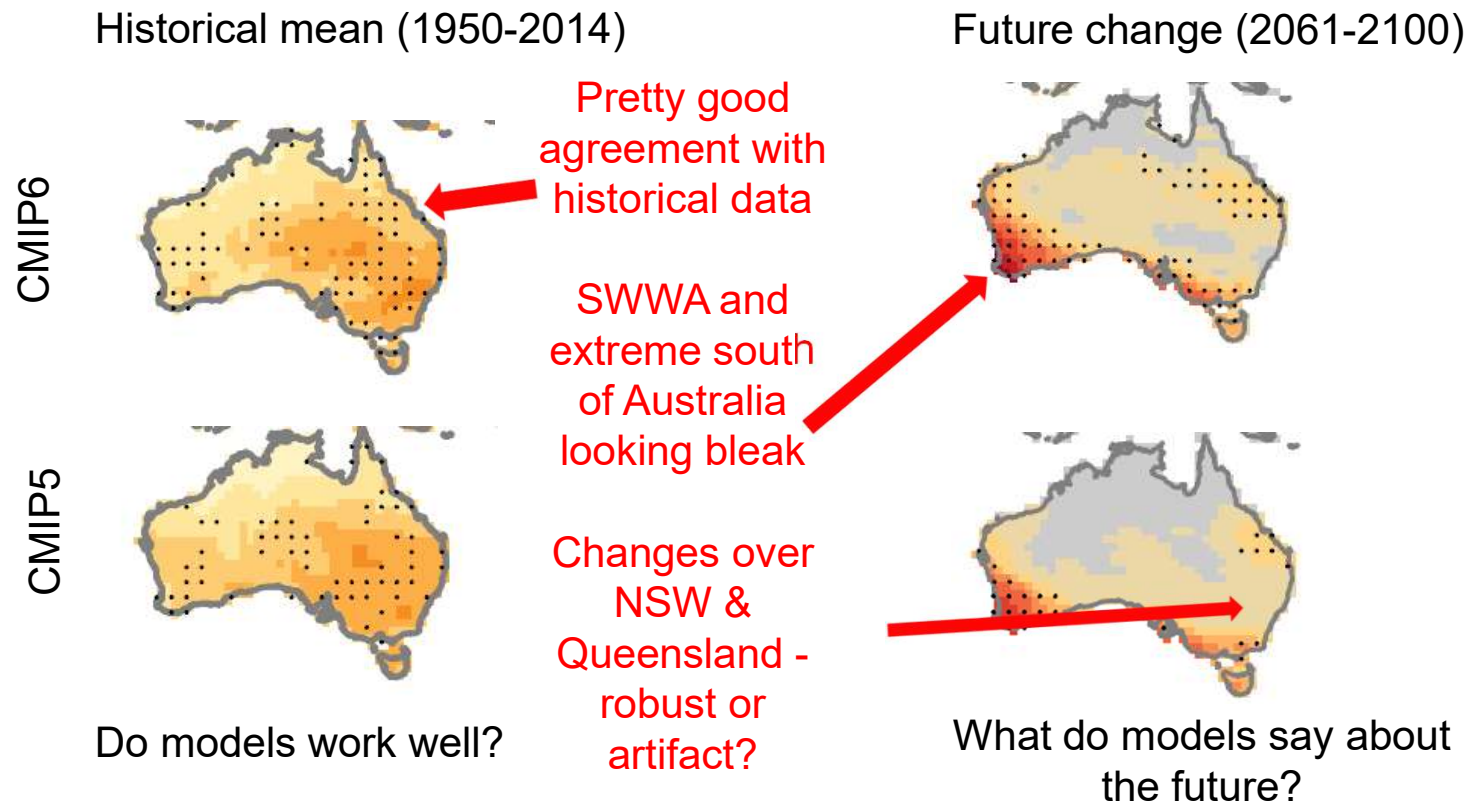
- Cyclones
 - Not clear - Best guess slightly more intense, slightly less frequent
- Fire risk
 - Increasing because every driver is adding risk
- GBR
 - On-going bleaching
 - Marine heatwaves



Number of severe and non-severe tropical cyclones from 1970 - 2016 (BoM)



Drought duration



This work does not tell us about long droughts

Drought intensity



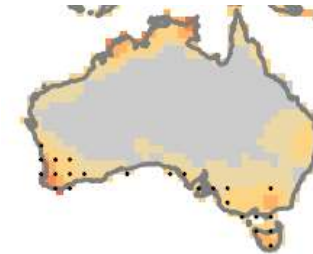
Historical mean (1950-2014)

Future change (2061-2100)

CMIP6

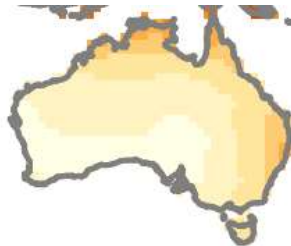


Little agreement
with historical data



SWWA and
extreme south of
Australia still
looking bleak

CMIP5



Nothing much we
can say elsewhere



Do models work well?

What do models say about
the future?

Future droughts?

- Depends on what happens to the El Nino-La Nina and Indian ocean temperatures
 - Evidence points to increased risk of future drought, but contradictory evidence exists.
 - There is a risk of much worse droughts
- On balance – drying over SWWA and southern Victoria likely robust, less clear elsewhere
- Significant evidence of increased rainfall *variability*

Summary

- Higher temperatures are locked in
 - Hotter days, hotter nights, heatwaves
 - But smaller increases if emissions are rapidly reduced
- More intense rainfall is locked in where rainfall occurs in storms.
 - Evidence that the most intense storms are intensifying most
 - Some places will see less rain due to how the large-scale climate changes
 - Increase in the variability of rainfall

Summary

- Everything is worse at RCP8.5 cf. RCP4.5 cf. RCP2.6 but at local to regional scales the benefits of low emissions must be assessed case-by-case
- In a risk framework, deeply cutting emissions – so net zero fast – is required.
- To get an accurate picture of changes at the scale of a city is very challenging. Climate models are not designed for this

Break & Networking



**Discussion: implications for
the Australian Climate
Roundtable**



Discussion questions

1. What physical risks or impacts have we not considered yet today, but are relevant to you/your sector/constituency/business?
2. How well are physical risks and impacts factored into public or private analysis, decision making or discussion?
 - How could we take better account of them?
3. What range of outcomes can or should we meaningfully prepare for?
4. How do we think about risks versus 'central scenarios'?

Close

