SENATE FINANCE AND PUBLIC ADMINISTRATION REFERENCES COMMITTEE

ANSWERS TO QUESTIONS ON NOTICE

LESSONS TO BE LEARNED IN RELATION TO THE AUSTRALIAN BUSHFIRE SEASON 2019-20

Public Hearing – Wednesday, 27 May 2020

REFERENCE: Questions on notice (Hansard, Page 17)

QUESTION: 1

CHAIR: Is there research that you're able to point to that would be of value for the committee to consider? It's an important issue, and I want to make sure that the committee has the right material in front of it. There's plenty of conjecture in the community. If we're taking an evidence based approach, are you in a position to point us to useful material on this area of policy?

Dr Metcalfe: Yes, I could certainly point you to some publications that we have delivered. There is also some really significant work that has been done across the sector, in understanding the contextual relevance of hazard reduction burning, that's been delivered through agencies, through universities and through the Bushfire and Natural Hazards CRC. We could certainly point you in that direction

ANSWER

See Question 4

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REFERENCE: Questions on notice (Hansard, Page 19)

QUESTION: 2

Senator SCARR: Okay. Let me refer you to another potential example along those lines just to give me a feel for how it may have worked in another context. I saw on this time line of research that there was a substantial project undertaken with respect to what's referred to as the Powerline Bushfire Safety Program in Victoria. Did the work done on that project roll out in a similar way, or was there an iterative process where other jurisdictions, including my home state of Queensland, engaged with CSIRO to try and leverage off that work that you'd done coming out of the Victorian commission?

Dr Metcalfe: I'm not an expert on that particular piece of work. I'm aware that there's been substantial investment in Victoria in identifying where the greatest risk of bushfire ignition from powerlines or distribution networks is, and that's led to significant investments into rerouting distribution lines underground. I would have to refer to my colleagues as to how that piece of work has been taken up by agencies or companies in other states and the extent to which it's extended from the distribution network to the transmission network.

ANSWER

Yes, CSIRO risk analytics work demonstrated through the Bushfire Safety Program in Victoria has led to work in NSW regarding bushfire risk for the Sydney Train network, and in South Australia.

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REFERENCE: Questions on notice (Hansard, Page 19-20)

QUESTION: 3

Senator RICE: Right. I want to take you to those trends, then. We had some discussions about this at estimates, and I got a response to a question on notice from the past estimates, from the Minister representing the Minister for the Environment, which says, 'Based on historical observations and future projections, global warming of 3.4 degrees Celsius is estimated to translate to the warming of between 3.4 and 4.4 degrees Celsius for Australia.' That's from CSIRO and the bureau's work, isn't it? Do those figures sound right to you?

Dr Mayfield: I'd have to check specifically which scenarios they were referring to, Senator Rice. The numbers are broadly in the ballpark. I'd have to check with our climate scientists just to make sure that they're fully consistent.

Senator RICE: Okay, that would be useful—if you could take that on notice.

ANSWER

CSIRO understands that the answer quoted was provided by the Bureau of Meteorology. It does not relate directly to work undertaken by CSIRO.

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LESSONS TO BE LEARNED IN RELATION TO THE AUSTRALIAN BUSHFIRE SEASON 2019-20

Public Hearing – Wednesday, 27 May 2020

REFERENCE: Questions on notice (Hansard, Page 21)

QUESTION: 4

CHAIR: Dr Metcalfe, I asked this earlier, but I want to make sure that the request is clear from our end: is the CSIRO able to provide to the committee a synopsis of the material you took us to, in relation to hazard reduction, and point us to some useful material that underscores the message that you have brought to the committee, about the contextual and complex nature of approaches to hazard reduction?

Dr Metcalfe: Yes. I can provide you with some pointers both as to our data and where other people have contributed significantly to that discussion. I can do that on notice.

ANSWER

The effect of hazard reduction burning (also referred to as 'prescribed burning') on fire behaviour is not simple nor one-dimensional. It must be considered as part of a suite of fire and land management activities to reduce the impact of wildfires including ignition controls such as Total Fire Bans, early detection, and coordinated and effective initial and extended suppression with a range of resources properly utilised (particularly in first attack where success is more likely under a broad range of conditions).

Reducing fuel in the leaf-litter, grassy-field and shrub layers can have the effect of reducing fireline intensity and the propensity for associated phenomena such as spotting, tree torching and crowning, but this is achieved through more than just reducing the amount of fuel—it also results from changes to the structure of the fuels, such as removing or reducing particular components in the fuel strata, such as elevated fuels like shrubs, dead branches and bark on the stems of trees (i.e. ladder fuels).

A hazard-reduction fire may remove all the surface litter but have little effect on the near-surface or elevated fuels. Very often fuels are not reduced to zero in the wake of a fire because leaves that are scorched in the fire fall within a few days to weeks reintroducing a surface litter layer, which then may be enough to carry subsequent fire to the residual fuels higher in the forest fuel profile. Therefore, knowledge of the application of a hazard reduction burn is not enough to predict a reduction in risk; the impact of the fire in terms of the layers affected and the magnitude of the effect must also be known to determine the change in total available fuels and the resultant hazard.

As fire weather deteriorates, the chances of a fire becoming larger increases for all fuel hazards, but the rate at which it spreads is much decreased in fuels with lower hazard. Thus, a hazard reduction burn may be effective in reducing fire behaviour up to, for example, a Forest Fire Danger Index (FFDI) of 25 but becomes less effective above FFDI of 50. At higher wind-speeds, hazard

reduction burning may be effectively irrelevant as the release of energy from available fuels is sufficient to enable the fire to spread at its full potential involving all fuel layers at which point its behaviour is dominated by the weather driving the fire.

Hazard reduced fuels may also extend the period from ignition until the fire is beyond direct suppression, so increasing the opportunity that first responders have to control or extinguish the fire, though this again is dependent on vegetation type, topography, fuel loads and distribution, and weather.

CSIRO's Project Vesta experiments were the first robust attempt to quantify experimentally the effect of fuel age (time since prescribed fire) on fire behaviour and show that the effect of hazard reduction burning on fuel hazard can last anywhere from a couple of years for elevated fuels up to more than 10 years for surface fuels depending on forest type and productivity.

Indigenous approaches to landscape management and burning (often described as 'cultural burning') may also achieve fuel reduction. Importantly, Indigenous fire practitioners do not just burn for hazard reduction but use fire as way to carry out their rights and responsibilities to Care for Country. This requires Indigenous leaders to consult with local communities, decide on important cultural and natural landscapes that need to be burnt, and work with relevant (Indigenous and non-Indigenous) partners to negotiate the timing, scale and purpose of landscape burning activities. Building collaborative partnerships between relevant Indigenous and non-Indigenous partners is critical to ensure cultural burning can be practiced on landscapes that have experienced long periods where cultural burning (or any other types of fuel management) has been denied or restricted, areas where there are multiple tenures and land-use histories, changing climate. This can mean that there are complex phenological indicators of appropriate timing for burning and can require Indigenous and non-Indigenous fire practitioners to work together to build the knowledge needed to reduce fuel and to appropriately manage Australia's diverse landscapes.

This is an area of significant debate and strong opinions. The most recent compilations of views are as follows:

A special issue (Volume 29, numbers 4 &5) of the *International Journal of Wildland Fire* with the title "**Adaptive prescribed burning in Australia for the early 21st Century**" was published in April 2020, containing eleven peer-reviewed articles from leading scientists. Available from CSIRO Publishing at https://www.publish.csiro.au/WF/issue/9893

The latest publication from the Centre of Excellence for Prescribed Burning , this book includes contributions from more than 50 authors, reflecting the diversity, complexity and scope of bushfire knowledge: Thornton, R, Leavesley, A & Wouters, M (2020) **Prescribed burning in Australasia: the science, practice and politics of burning the bush**. Centre of Excellence for Prescribed Burning, AFAC. Published in May 2020, available from AFAC bookshop: https://www.afac.com.au/auxiliary/shop/product?ID=19417

Bushfire and Natural Hazards CRC and the Australian Academy of Science **National Fire Fuels Science Webinars** series – a series of three webinars held in May 2020 addressing the science, the beliefs and the issues around hazard reduction burning in Australia, originally intended as a two-day forum. Webinars are available at: https://www.bnhcrc.com.au/2020/firefuels

Summary of practical measures CSIRO has supported Indigenous landscape burning in Australia
https://ecos.csiro.au/three-practical-ways-to-support-indigenous-landscape-burning-in-australia/

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REFERENCE: Questions on notice (Hansard, Page 21)

QUESTION: 5

CHAIR: Secondly, I did watch with interest the CSIRO presentation to the bushfire royal commission, in relation to the impacts of climate change on bushfire seasons, which somewhat goes to Senator Rice's questions. Are you able to provide that presentation to the committee as well?

Dr Mayfield: Yes, we'd be able to provide that presentation.

ANSWER

See Attachment 1

SENATE FINANCE AND PUBLIC ADMINISTRATION REFERENCES COMMITTEE

ANSWERS TO QUESTIONS ON NOTICE

LESSONS TO BE LEARNED IN RELATION TO THE AUSTRALIAN BUSHFIRE SEASON 2019-20

Public Hearing – Wednesday, 27 May 2020

REFERENCE: Written question - Senator Rice

QUESTION DATE: 29 May 2020

QUESTION: 6

Evidence from CSIRO to the Royal Commission indicates that the projections in the Climate Change in Australia project are still current. Is there a date when those will no longer be current? When is modelling or analysis expected to start for the next round of projections?

ANSWER

Climate projections are about long-term trends and changes due to the underlying climate. They are not predictions or forecasts of events and don't need to be produced every year. It makes sense to update climate projections when there:

- is notable new data over multiple years to draw on,
- there are advances in the underpinning research or
- there are advances in the modelling tools used.

Recent Australian national climate projections have followed the cycle of Intergovernmental Panel on Climate Change (IPCC) reports and releases of global climate model (GCM) simulations under the World Climate Research Program's Coupled Model Intercomparison Project (CMIP). The next generation of IPCC and CMIP products will be released over the next couple of years and new national projections could be tied to this. CSIRO expect a significant increase in data downloaded and stored in Australia from now until 2022, and to revisit climate projections to parallel this.

SENATE FINANCE AND PUBLIC ADMINISTRATION REFERENCES COMMITTEE

ANSWERS TO QUESTIONS ON NOTICE

LESSONS TO BE LEARNED IN RELATION TO THE AUSTRALIAN BUSHFIRE SEASON 2019-20

Public Hearing – Wednesday, 27 May 2020

REFERENCE: Written question - Senator Rice

QUESTION DATE: 29 May 2020

QUESTION: 7

Is CSIRO aware of any more recent analysis since Dowd *et al.* (2019) that analyses the impact of different RCP scenarios on fire seasons or fire conditions? Including either on the impact on number of days with FFDI ≥25, or other metrics?

ANSWER

The work of Dowdy et al (2019) was produced in part through the Earth Systems and Climate Change (ESCC) hub supported by the Australian Government's National Environmental Science Program (NESP). The ESCC hub is a partnership between CSIRO, the Bureau of Meteorology and Universities and while Dr Dowdy is an employee of the Bureau of Meteorology, CSIRO is aware and supportive of this work. CSIRO is aware of ongoing research into fire weather projections, and is not aware of any published results that counter or alter the findings of the Dowdy study.

More information about this work is available through the ESCC website at http://nespclimate.com.au/new-information-on-extreme-weather-and-natural-hazards-in-our-changing-climate/

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Public Hearing – Wednesday, 27 May 2020

REFERENCE: Written question - Senator Rice

QUESTION DATE: 29 MAY 2020

QUESTION: 8

Does CSIRO have or know of any quantitative projections, forecasts or models of the number of days with FFDI≥25 under RCP 8.6 (or other RCP scenarios) after 2050?

ANSWER

There are numerous studies from Australian research agencies and universities into FFDI beyond 2050. These include studies of days with a FFDI over 25, dating back to when the RCPs became commonly used in 2011/12, and for other sets of scenarios prior to this. Studies dating back to at least 1988 have consistently projected an increase in dangerous fire danger days in a future climate.

The national climate projections released in 2015 used a limited number of climate models to examine FFDI over 50, including in periods later than 2050 (See Technical Report Table7.8.1 in the Technical Report: https://www.climatechangeinaustralia.gov.au/en/publications-library/technical-report/). However, this is not the only relevant study and dataset, there are other more recent studies available.

CSIRO Presentation

Helen Cleugh and Michael Grose

May 25, 2020

OCEANS AND ATMOSPHERE
www.csiro.au

Defining weather and climate modelling, and information needs

Looking into the future: forecasting, predicting and foresighting

Weather forecasts (days to a week ahead)

Australian Government Bureau of Meteorology

- Rainfall, temperatures (heatwaves, frost) and wind
- Flood forecasting, warning services
- Short-term streamflow forecasts

Seasonal climate prediction (1 – 3 months ahead)

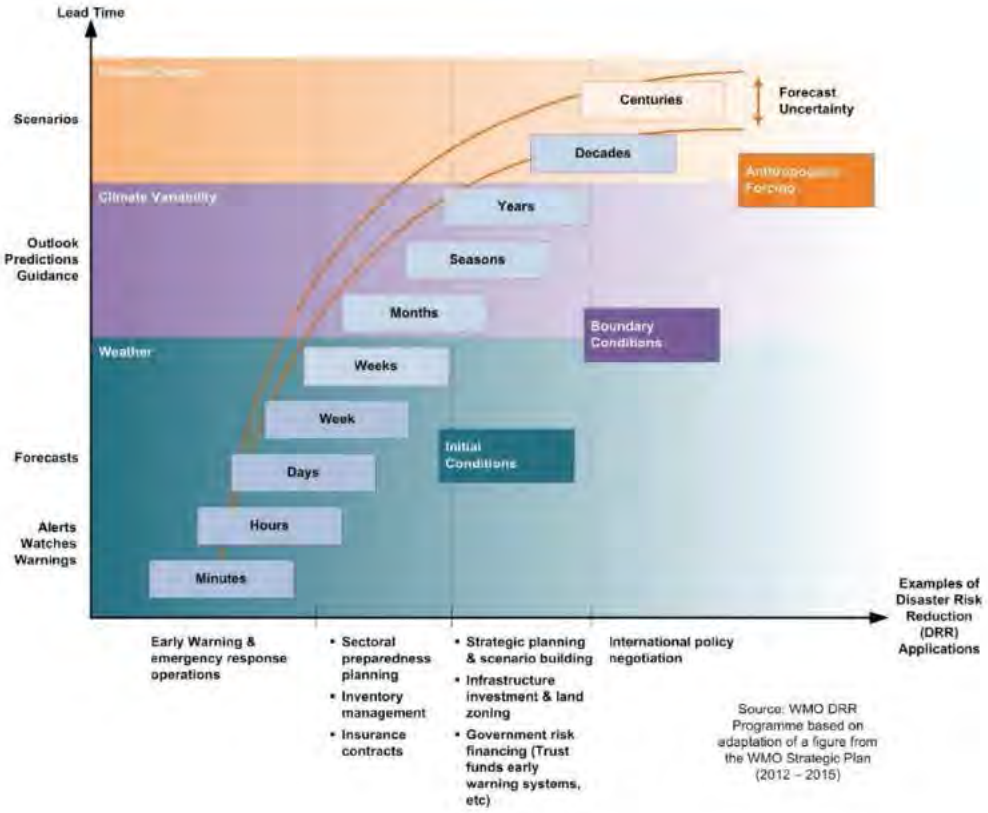
Australian Government Bureau of Meteorology

- Climate outlooks: rainfall, temperature, bushfire weather
- Water availability outlooks: rivers, storages, soil moisture
- Drought

Climate change scenarios (30 – 50+ years ahead)

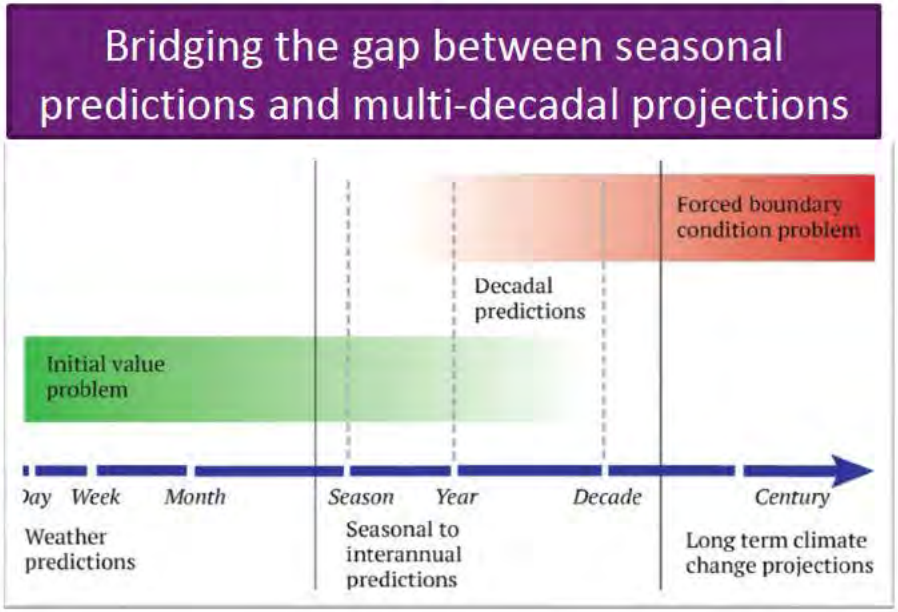
CSIRO

- Foresighting for impact assessment / risk management / adaptation
- Multi-sector: agriculture, water, defence, infrastructure



Multi-year to Decadal Prediction

- Climate predictions for a year or more into the future is a significant scientific challenge, being addressed by many climate modelling centres around the world, including the Bureau and CSIRO in Australia.
- Apart from a coupled climate model, this requires:
  - High quality observations, especially the ocean (where the climate "memory" resides)
  - Data assimilation scheme, and observations
  - Large ensembles
  - Guidance regarding how to use a probabilistic forecast
- CSIRO's Decadal Forecasting Project is addressing these scientific challenges.



Climate drivers affecting Australia and our region

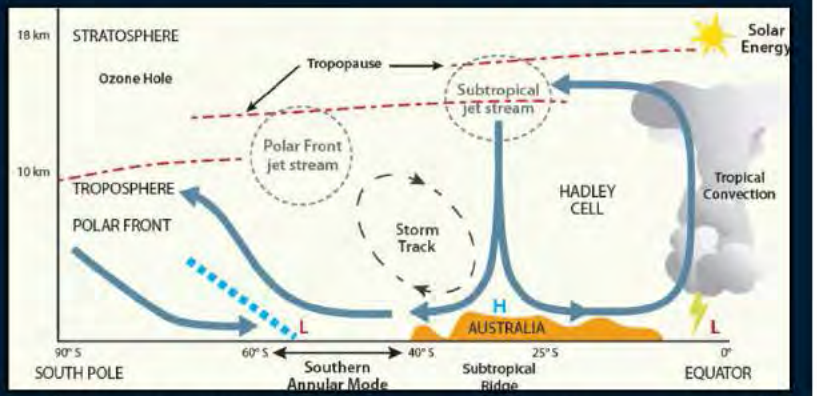
Key “climate drivers”:

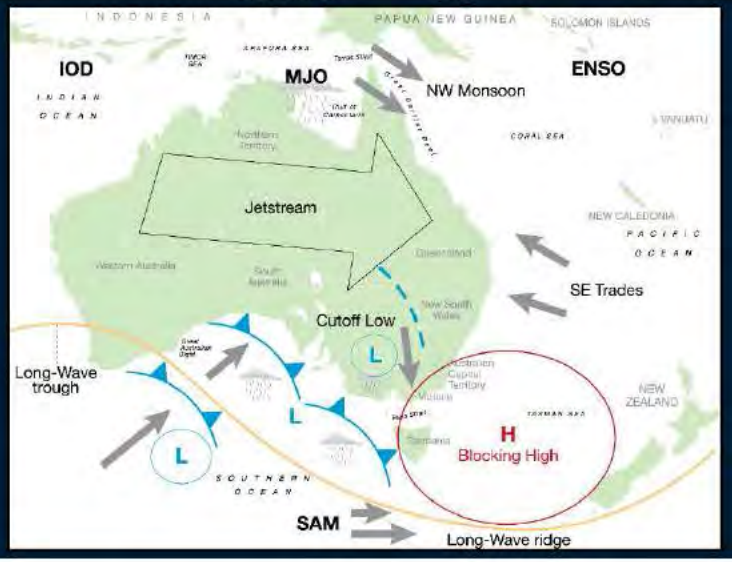
- El Niño–Southern Oscillation (ENSO)
- Indian Ocean Dipole (IOD)
- Southern Annular Mode (SAM)

And the meridional circulation:

- Hadley Cell (HC)
- Subtropical ridge (STR)
- Tracks of rain bearing fronts

→ All are affected by climate change.

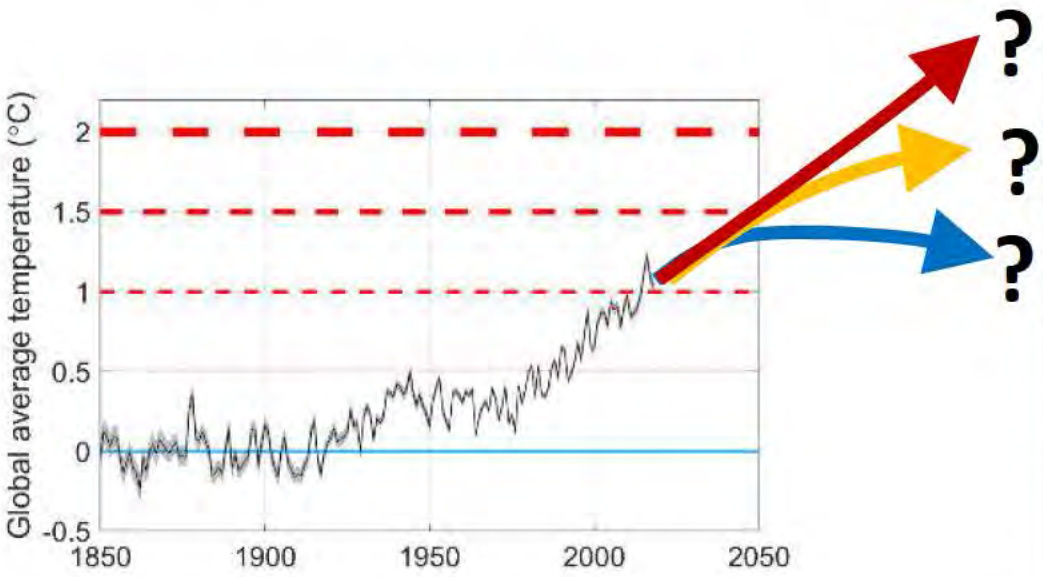




Climate drivers affecting Australia and our region
These can also be affected by a changing climate

Driver	Dry and drought	Floods	Heat and temperature extremes	Tropical cyclones	Fire danger	Other
El Niño	Increased	Reduced	Increased	Reduced number	Increased in SE Australia	Reduced snow, but increased frost risk
La Niña	Reduced	Increased	Possibly reduced	Increased number	Likely reduced in Eastern and Northern Australia	
IOD positive	Increased	Reduced	Increased	Unclear	Increased	
IOD negative	Reduced	Increased	Reduced	Unclear	Reduced	
SAM positive	Varies by region and season	No documented effect	Varies by region and season	No documented effect	Increased	
SAM negative					Decreased	

Projections far into the future – there are many plausible trajectories



Source: Australia's Changing Climate, ACCSP 2016
http://nespclimate.com.au/outreach-publications/

The climate we will experience in the future depends on 3 factors:

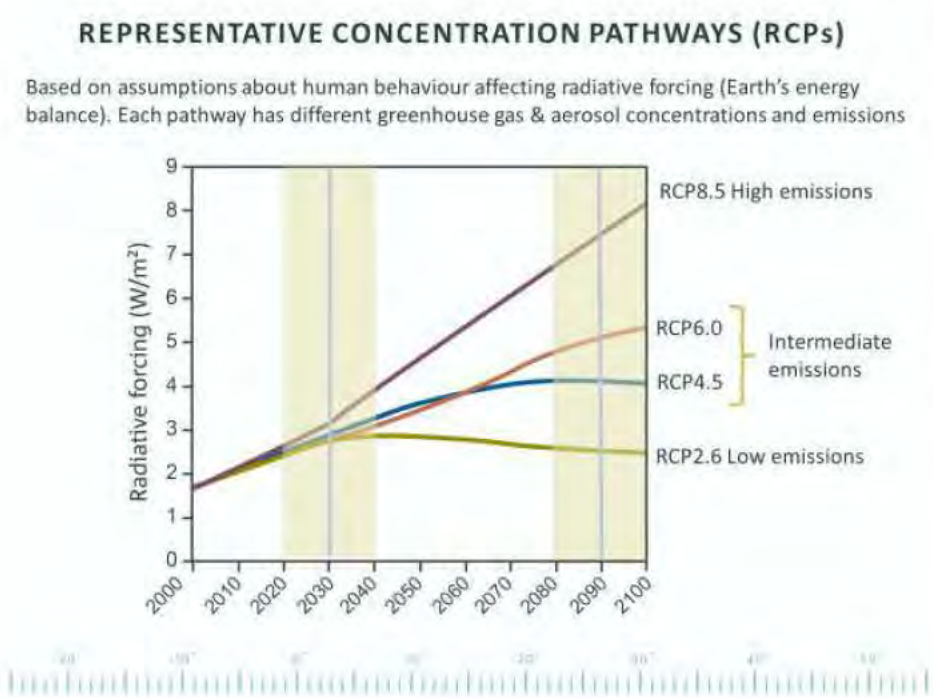
1. Internal, natural climate variability – is the largest factor affecting the year-to-year climate, e.g. El Nino Southern Oscillation, and will continue as the underlying climate changes

→ Means that trends can be negative for 10 years even in a warming climate

2. Future emissions of greenhouse gases, aerosols – these future emissions scenarios describe plausible "Representative Concentration Pathways" (see next slide)

3. Response – a range of plausible future climates for a scenario (example on next slide + 1)

Future scenarios - emissions and socioeconomic factors



Source: Climate Change in Australia
www.climatechangeinaustralia.gov.au

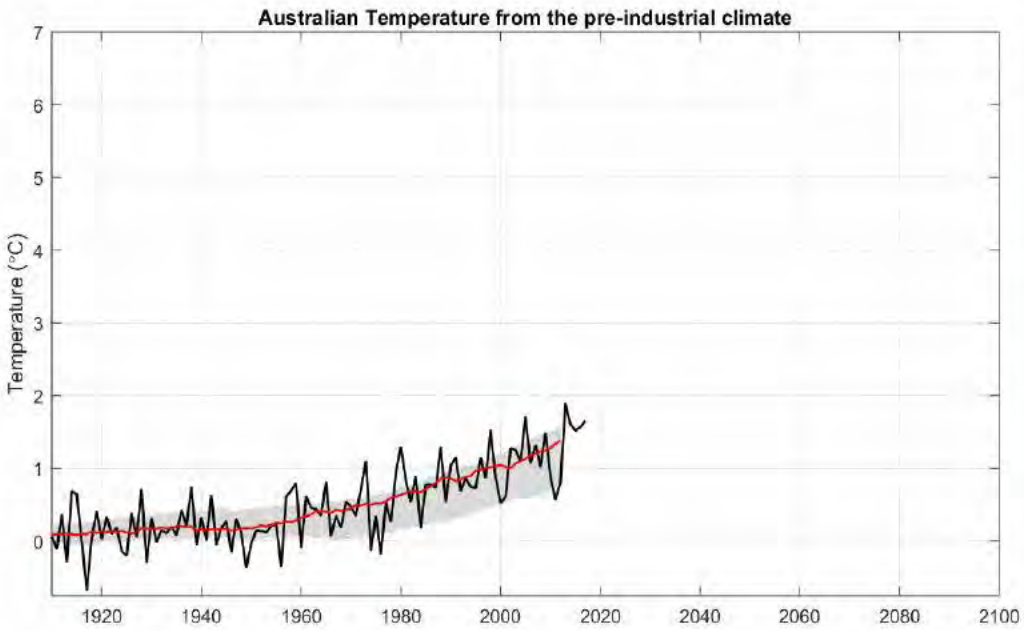
Climate models simulate the future climate for **a range of future emission scenarios**

These are represented by **Representative Concentration Pathways (RCPs)**

Using RCPs means that we can explore a future where there is ….

- **Strong mitigation** with l**ower net greenhouse gas** emissions (RCP2.6)
- **Very high ongoing net greenhouse gas** emissions (RCP8.5)
- **Intermediate net greenhouse gas emissions** (RCP6.0 and 4.5).

Understanding and simulating future climates



The climate we will experience in the future depends on 3 factors:

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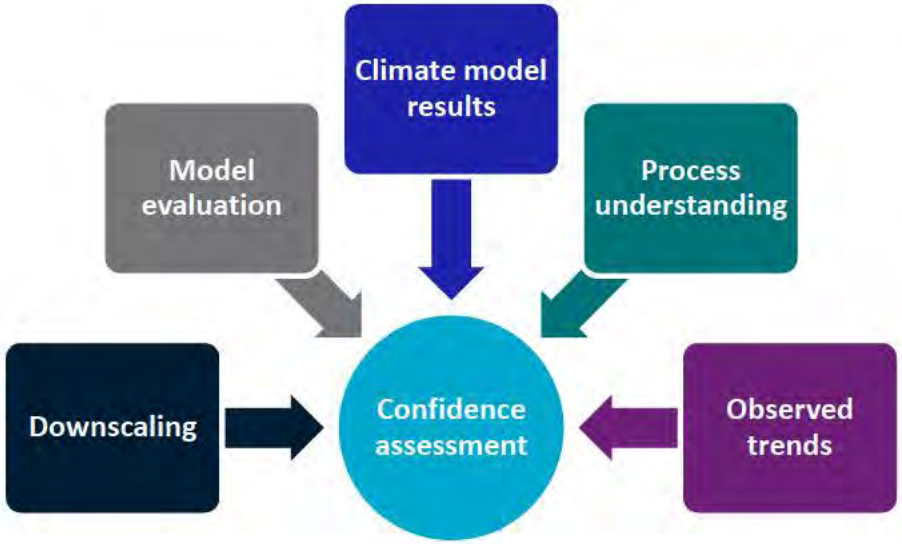
→ Means that trends can be negative for 10 years even in a warming climate

2. Future emissions of greenhouse gases, aerosols – these future emissions scenarios describe plausible "Representative Concentration Pathways".

3. Response – a range of plausible future climates for a scenario.

Defining Confidence: based on *evidence* and *agreement*



Source: Climate Change in Australia
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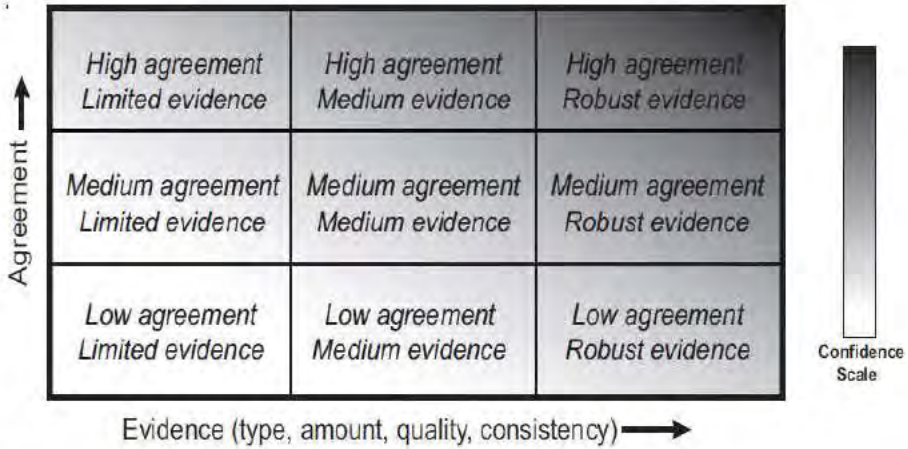

Terminology	Degree of confidence in being correct
Very High confidence	At least 9 out of 10 chance of being correct
High confidence	About 8 out of 10 chance
Medium confidence	About 5 out of 10 chance
Low confidence	About 2 out of 10 chance
Very low confidence	Less than 1 out of 10 chance

Based on methodology recommended by IPCC Fifth Assessment (figure adapted from Mastrandrea et al, 2010)

National Climate Projections

For Australia's regions and coasts; information for planning, decision- and policy-makers.

CSIRO have been undertaking long-term, regional climate projections for over 30 years (starting around 1992).

Aligned with IPCC Assessment Reports and the accompanying new Global Climate Model results.

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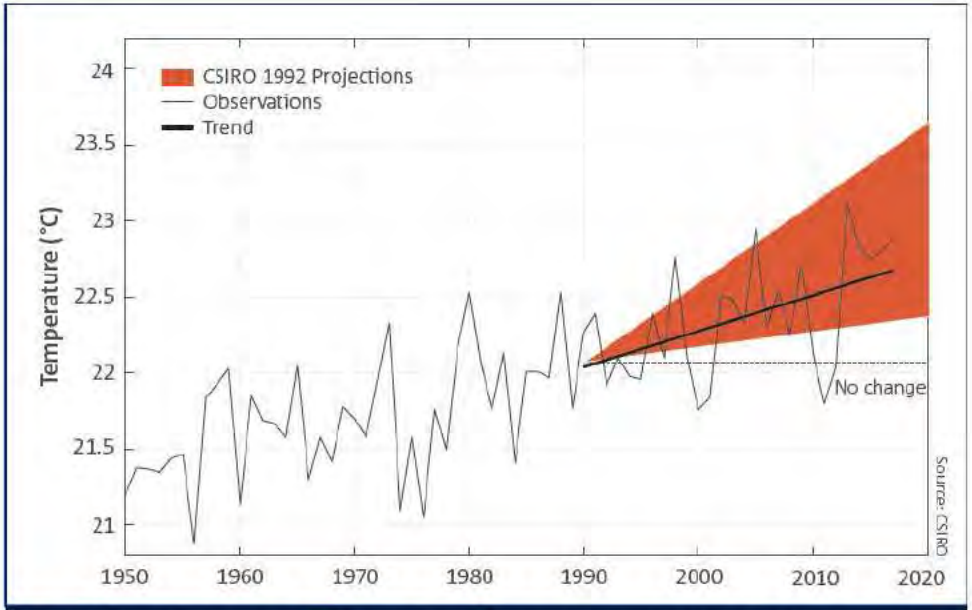


Projections of Australian temperatures made in 1992

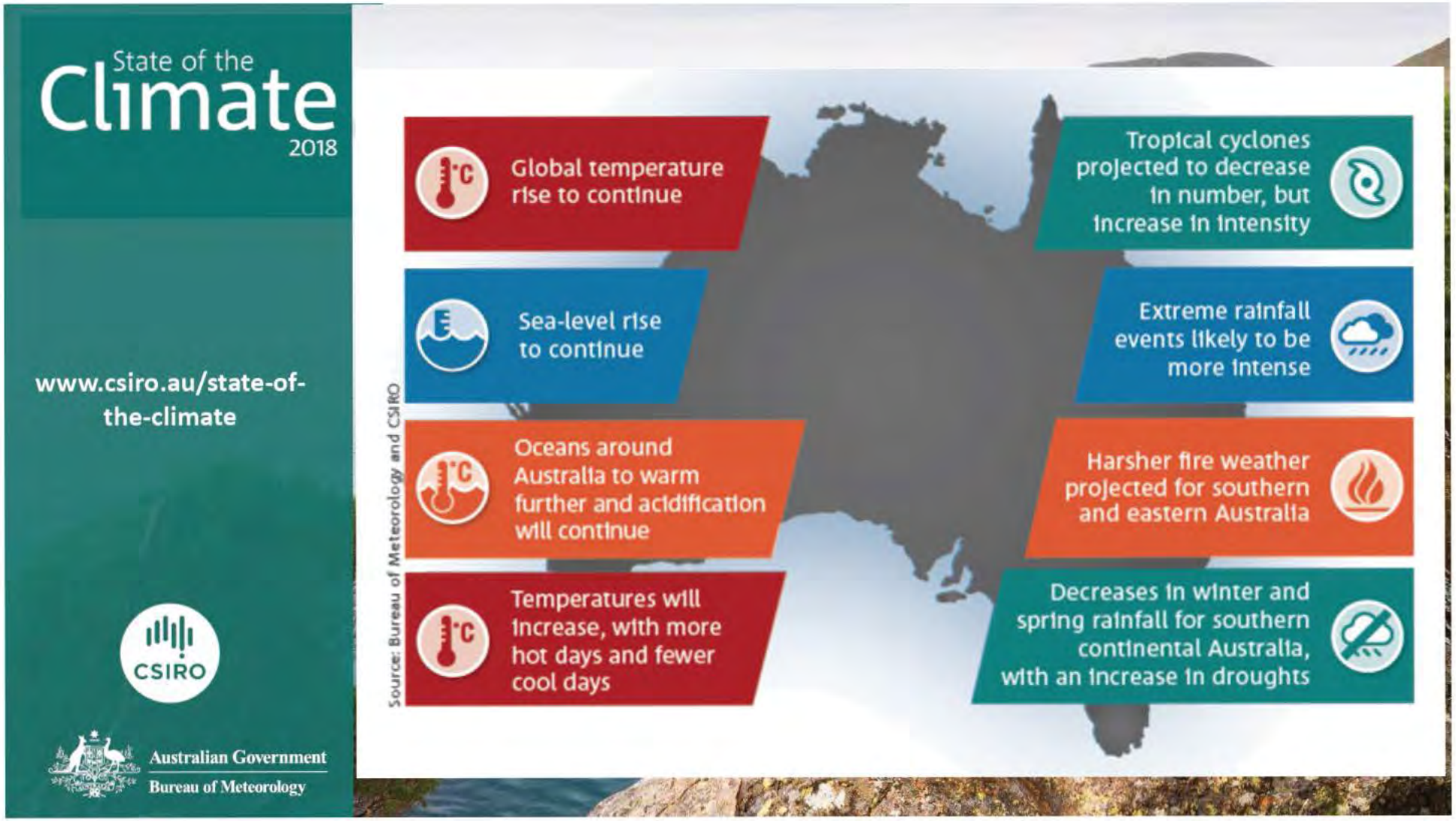
Observations have been within the projected range

Source: State of the Climate 2018, based on Grose et al. 2017. www.csiro.au/state-of-the-climate

National Climate Projections

- Latest climate change projections for regional Australia, including coasts
- A nationally consistent approach:
  - Latest Global Climate Models from IPCC Fifth Assessment and CMIP5.
  - Regional climate models ("downscaling") for finer-scale climate information.

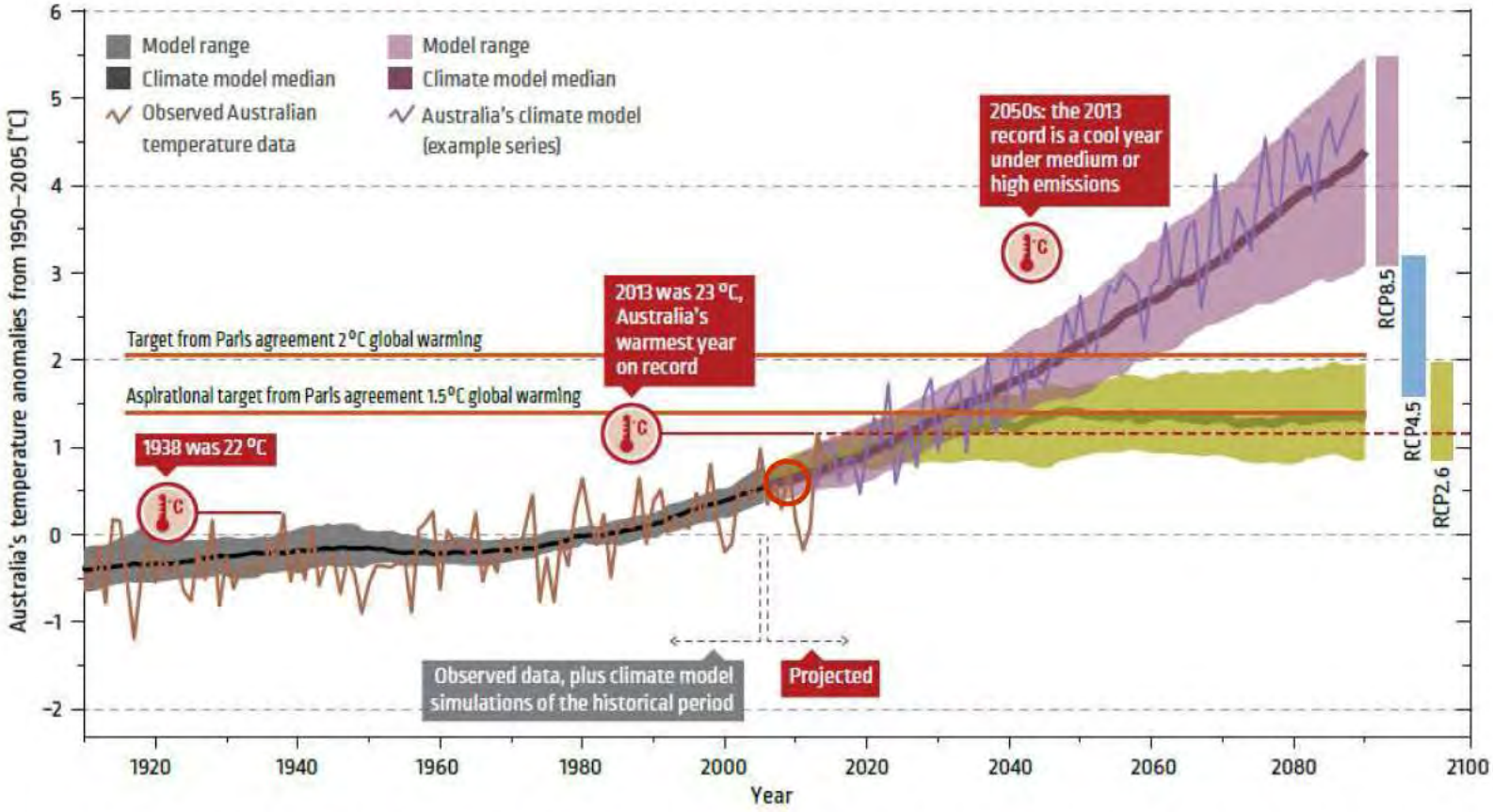
www.climatechangeinaustralia.gov.au


State of the
Climate
2018
www.csiro.au/state-of-the-climate
CSIRO
Australian Government
Bureau of Meteorology
Global temperature rise to continue
Sea-level rise to continue
Oceans around Australia to warm further and acidification will continue
Temperatures will increase, with more hot days and fewer cool days
Tropical cyclones projected to decrease in number, but increase in intensity
Extreme rainfall events likely to be more intense
Harsher fire weather projected for southern and eastern Australia
Decreases in winter and spring rainfall for southern continental Australia, with an increase in droughts
Source: Bureau of Meteorology and CSIRO

Some impacts from changes in climate

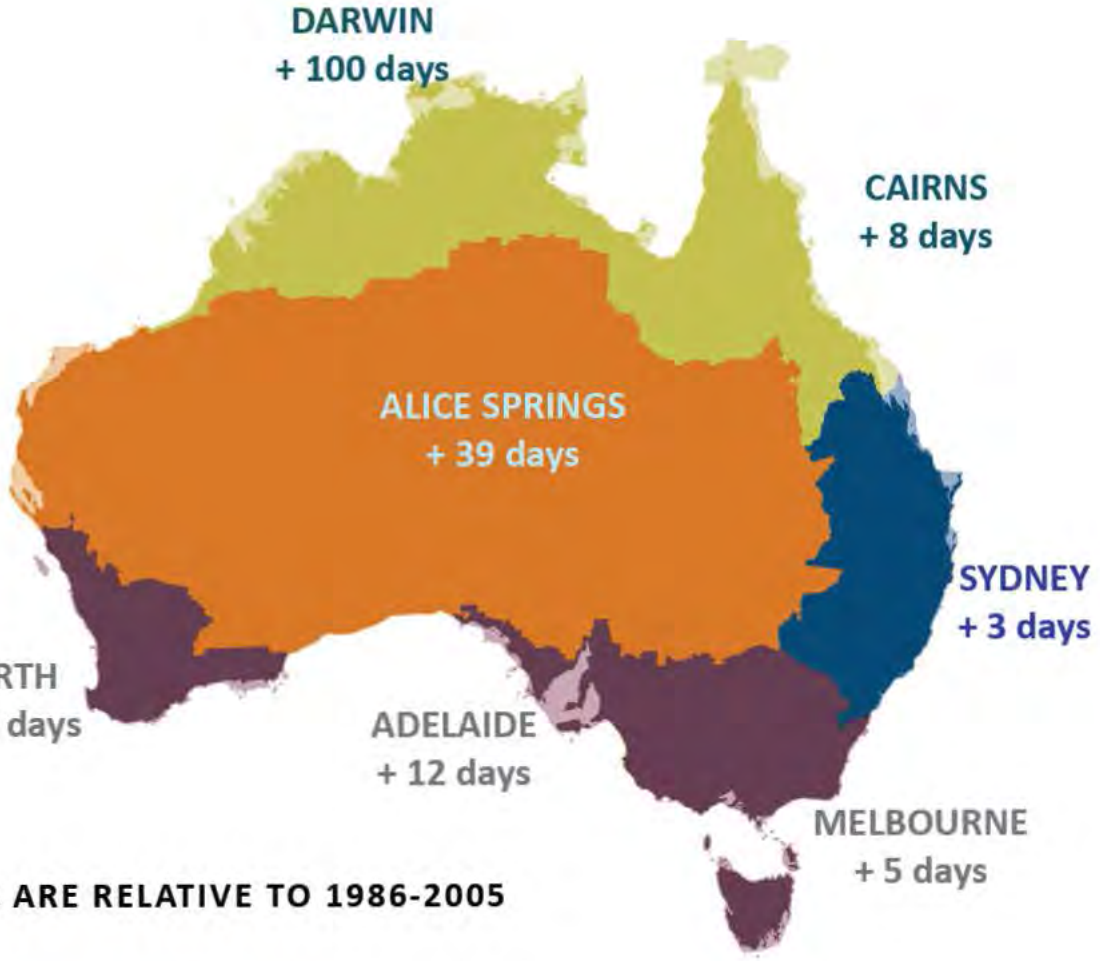
Hotter temperatures, more heatwaves and marine heatwaves	• Increased heat-related impacts on human health, ecosystems and productivity; and reduced winter mortality for people, livestock, crops.
Increase in extreme fire weather in southern and eastern Australia	• Closely linked to increased fire danger risk and extreme fire danger days.
Lower cool-season rainfall in eastern and southern Australia and increased drought	• Increased intensity, duration, frequency, time in drought; contributes to greater risk of hazards such as bushfires and heatwaves.
More intense hourly to daily rainfall extremes	• Likely increased flash floods (especially in small catchments) and urban flooding.
Fewer, but more intense, tropical cyclones	• Likelihood of greater impacts, especially in combination with rising sea levels.
Higher sea levels and more extreme sea levels events Reduced time between extreme sea level events	• Increased risk of storm surge, flooding and inundation; and damage to beaches, communities and infrastructure.

Australia will warm substantially during the 21st century



Source: Australia's Changing Climate, ACCSP 2016 (http://nespclimate.com.au/outreach-publications/)

ADDITIONAL **HOT DAYS**
DAYS OVER 35 °C
2090 / RCP4.5

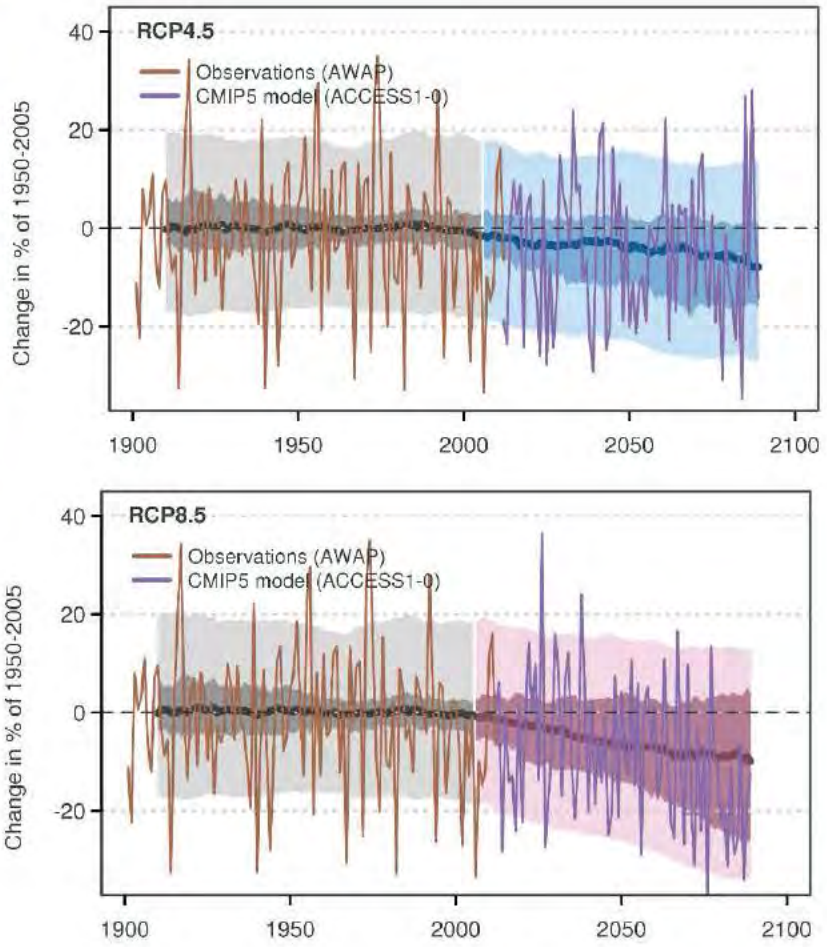


CHANGES ARE RELATIVE TO 1986-2005

Source: www.climatechangeinaustralia.gov.au

RAINFALL VARIABILITY AND CHANGE

SOUTHERN AUSTRALIA

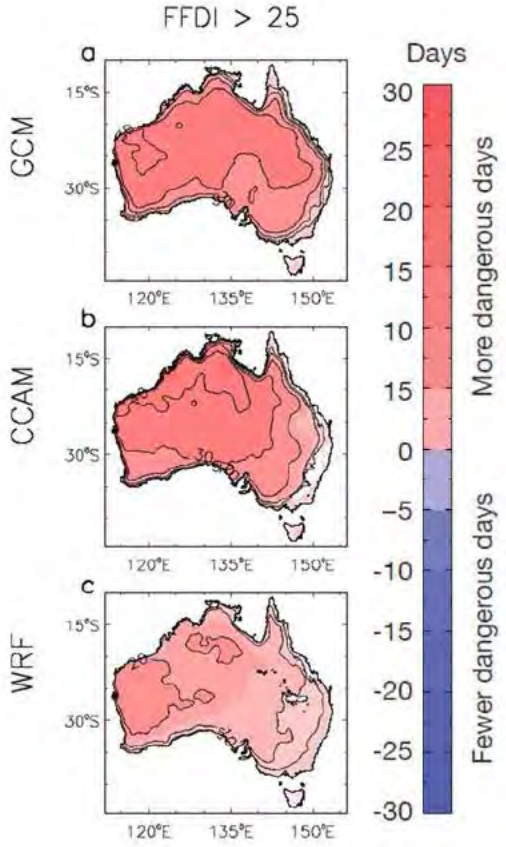


Source: www.climatechangeinaustralia.gov.au

Climate Projections and Natural Disasters: Fire Weather

Changes in the number of days per year where FFDI exceeds 25 (from 1990–2009 to 2060–2079), for 3 modelling methods and RCP of 8.5.

Coloured regions indicate where at least two thirds of the ensemble members for each modelling method agree on direction of change.



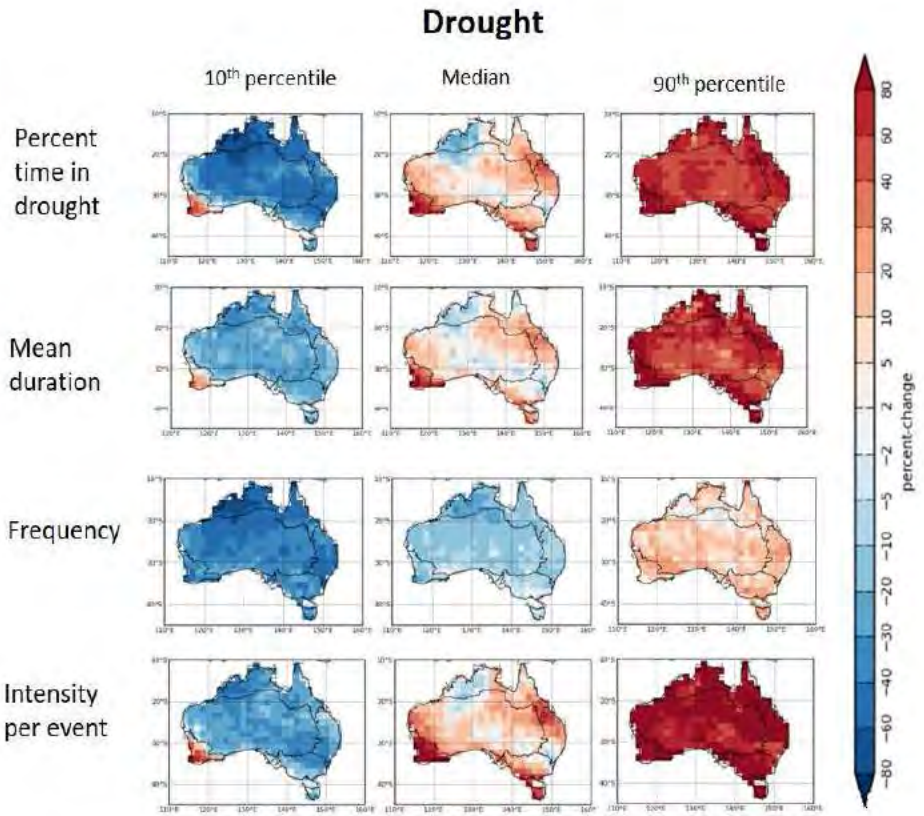
"Fire danger is very likely to increase in the future for many regions of Australia, exacerbated by the increased occurrence of extreme heat events....

.... more dangerous weather conditions for bushfires are very likely to occur due to increasing greenhouse gas emissions.

... Plus an increase in dangerous pyroconvection conditions for many regions of Southern Australia"

Source: From Figure 6 in Dowdy et al (2019). Future changes in extreme weather and pyroconvection risk factors for Australian wildfires Scientific Reports, 9:10073, and NESP ESCC Hub Brochure, 2019

Climate Projections and Natural Disasters: Drought

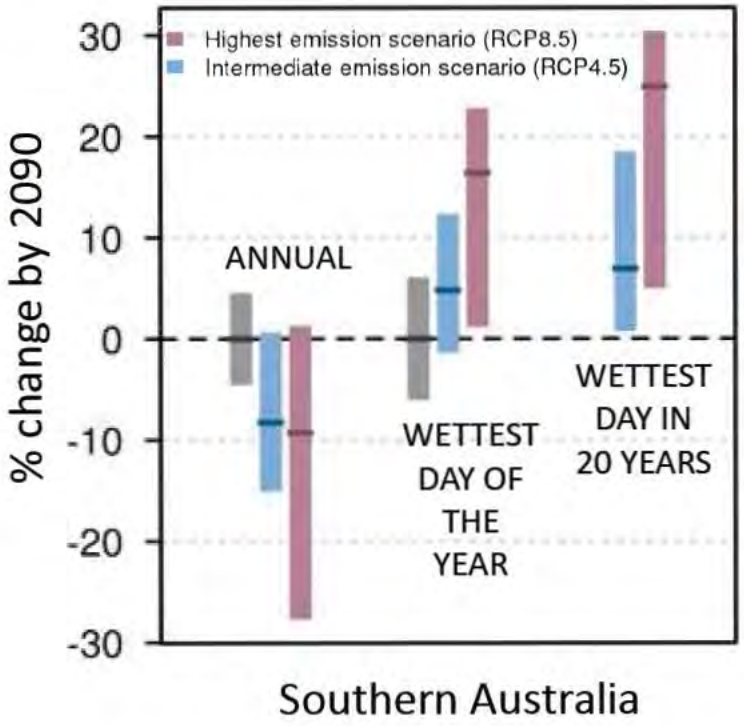


Projected percentage changes in meteorological drought in Australia:

- From 1900 – 2005 to 2006 – 2100
- CMIP5 multi-model ensemble
- RCP8.5

Source: From Figure 8 in Kirono et al, Submitted to Weather and Climate Extremes, 2020 (under review)

EXTREME RAINFALL



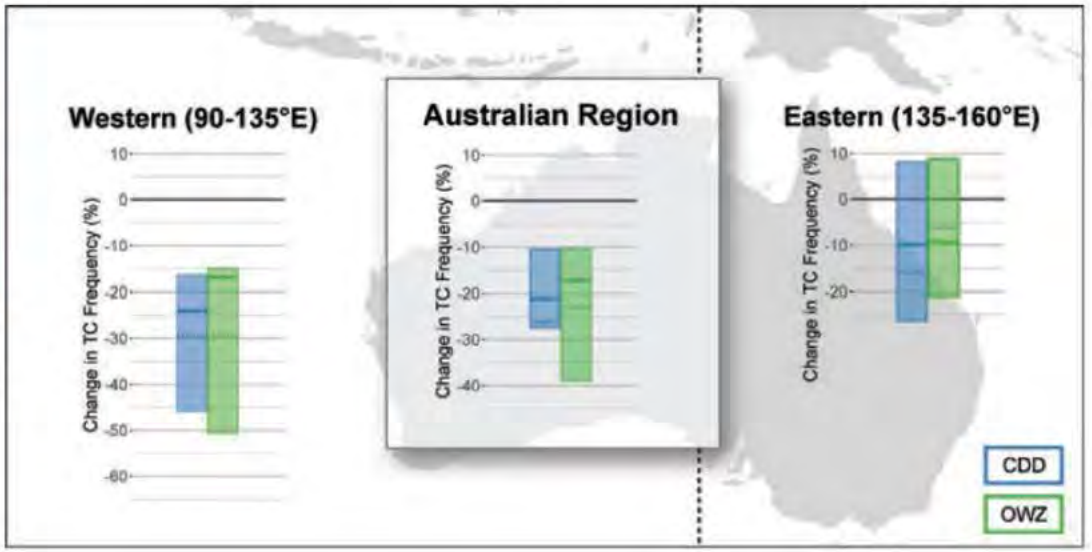
Source: www.climatechangeinaustralia.gov.au

Climate Projections and Natural Disasters: Tropical Cyclones

Projected changes in frequency of tropical cyclones (TCs) in Western, Eastern and whole of Australian region.
From 1970 – 2000 to 2070 – 2100 (RCP8.5).
Based on CMIP5 multi-model ensemble and two methods of identifying TCs in GCMs.

Climate models project a future decrease in the total number of TCs, but an increase in the proportion of high intensity storms (stronger winds and greater rainfall)

Coastal impacts from TC's are likely to worsen due to rising sea levels and increases in TC-related extreme rain and wind events



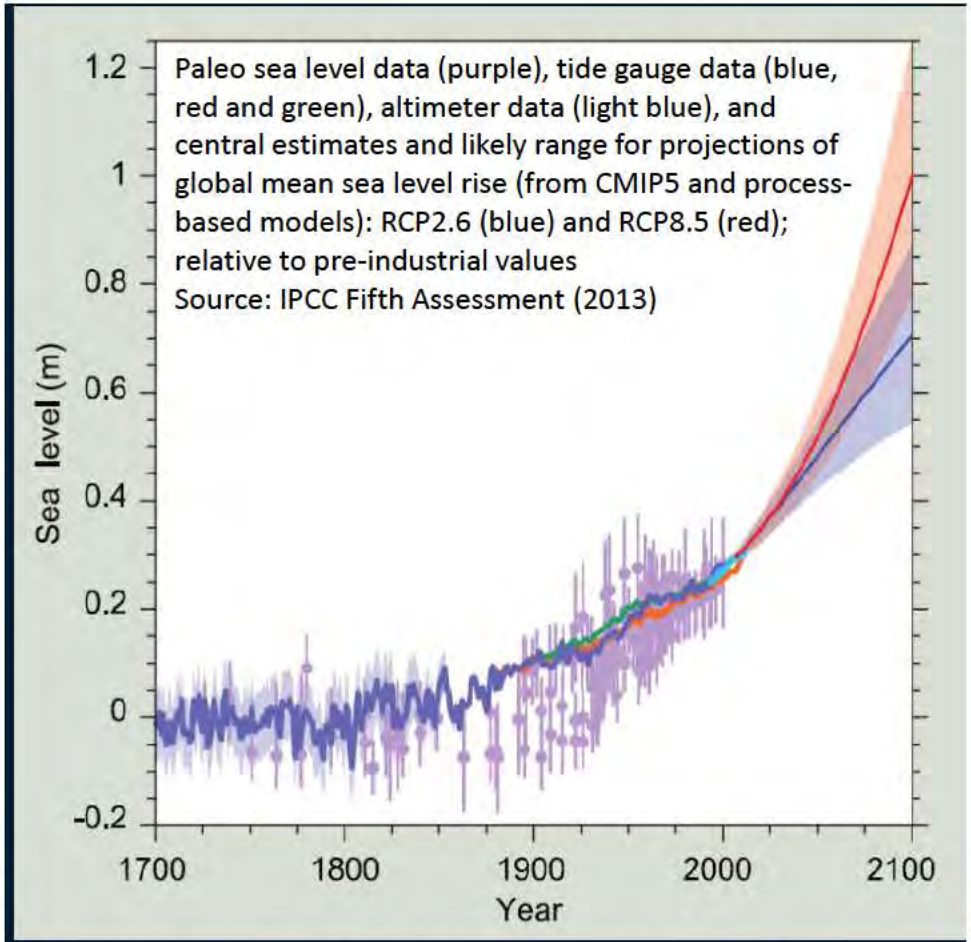
Source: NESP ESCC Hub Brochure, 2019

Climate Projections and Natural Disasters: Sea Level Rise

By 2090, global sea levels are projected to rise by 26-55 cm (RCP2.6) to 45-82 cm (RCP8.5) (medium confidence)

Sea level rise for Australia will be similar, or slightly larger (up to about 6 cm) than, these global projections

Rising sea levels pose a threat to coastal communities by amplifying the risks of coastal inundation and storm surge



Source: CCiA Technical Report, 2015

https://research.csiro.au/slrwavescoast/sea-level/future-sea-level-changes/

Thank You