



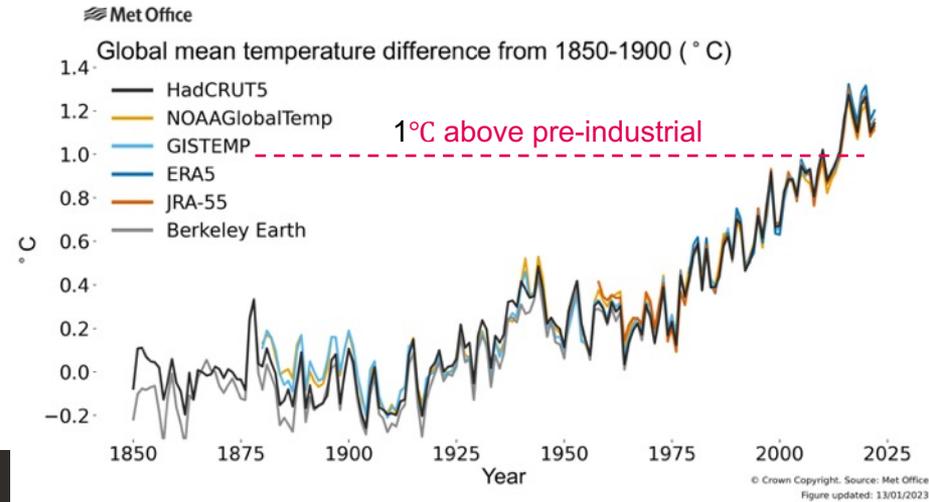
Update on Climate Change Science, Impacts and Solutions for Victoria

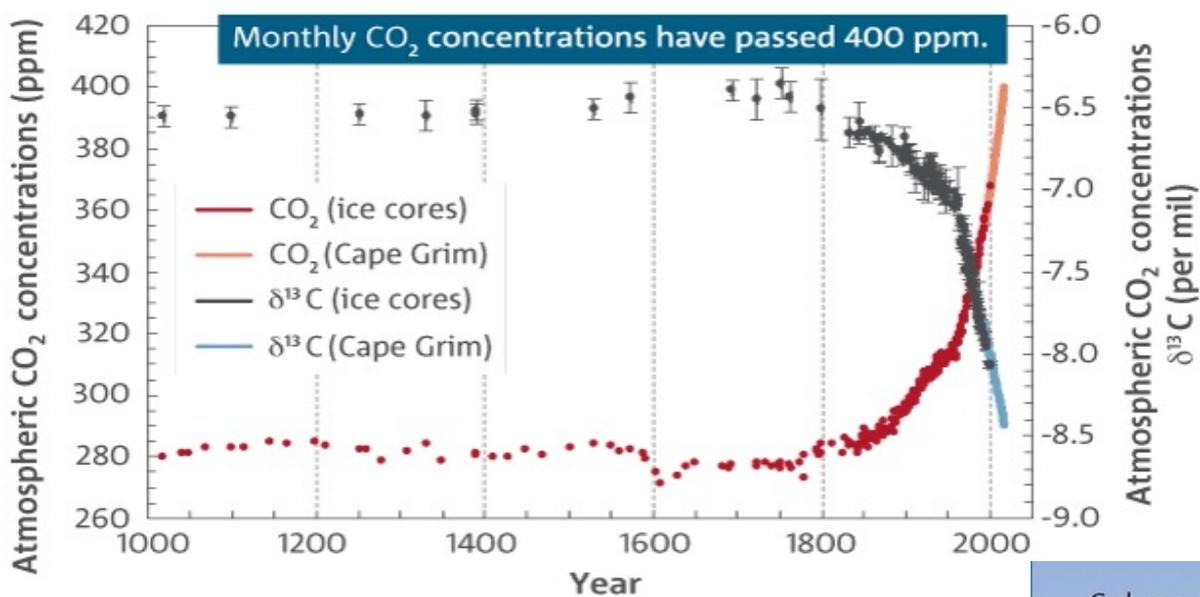
Professor David Karoly
University of Melbourne

Some views from leaders

**Antonio Guterres,
UN Secretary-General, 2021**
*“The IPCC Report is a code red
for humanity”*

Andrew Mackenzie, BHP, 2019
*“The evidence is abundant:
Global warming is indisputable.
The planet will survive.
Many species may not”*



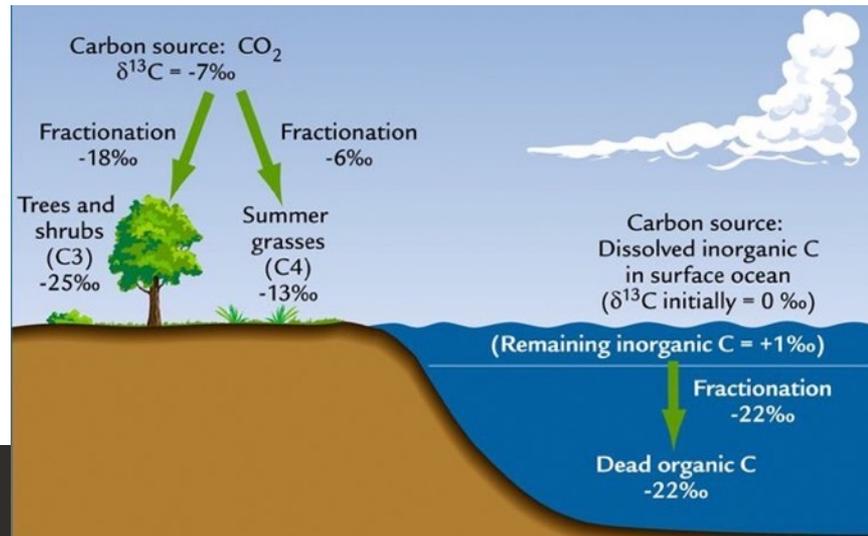


Observed global climate change

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.

from *State of the Climate, 2016*

2022 CO₂ of 414 ppm at Cape Grim



Observed global climate change

a) Change in global surface temperature (decadal average) as **reconstructed** (1-2000) and **observed** (1850-2020)

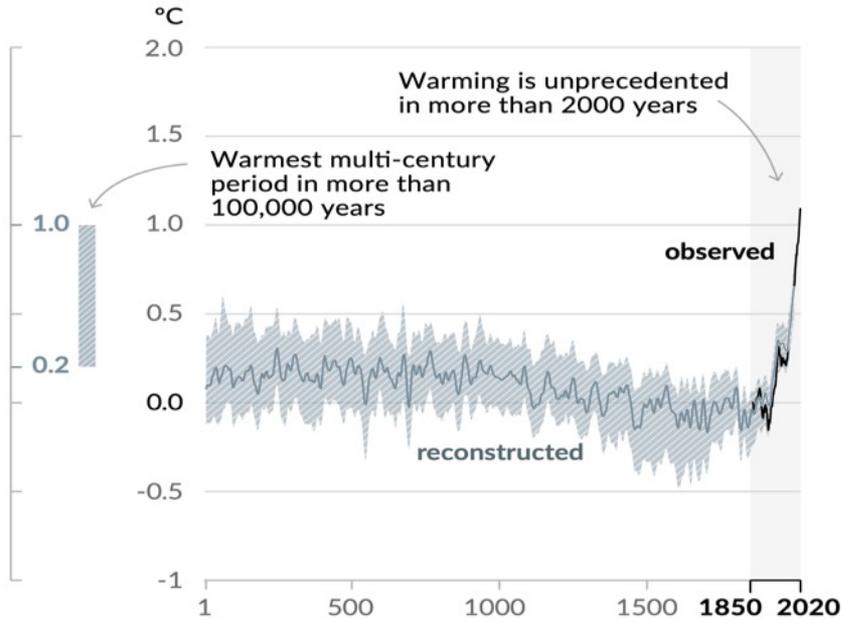


Fig SPM.1, IPCC AR6 WG1

Observed warming

a) Observed warming 2010-2019 relative to 1850-1900

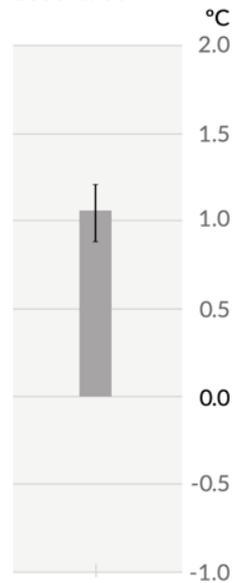
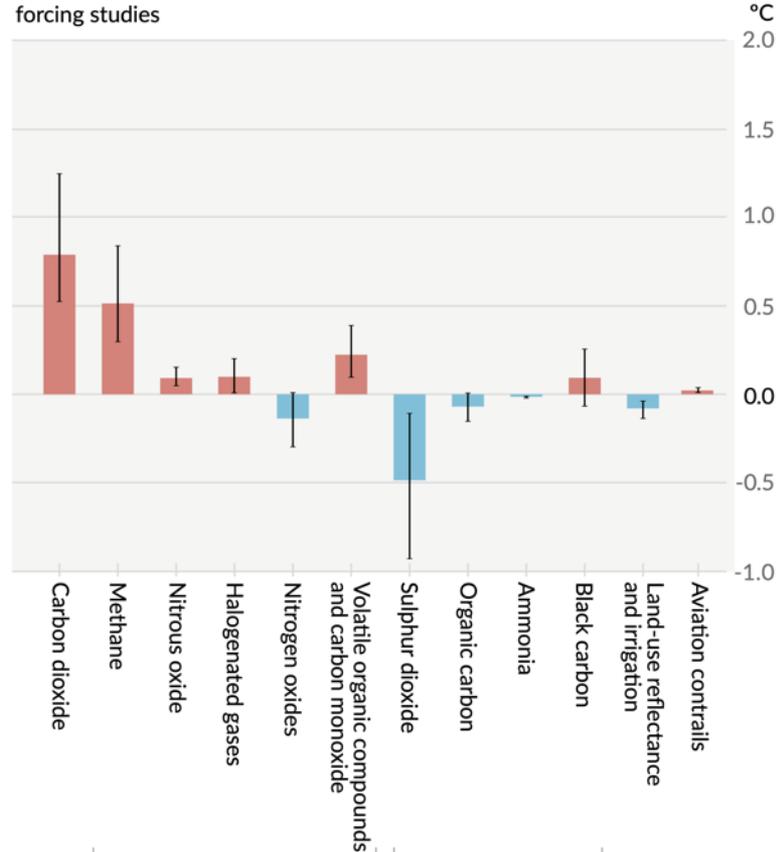
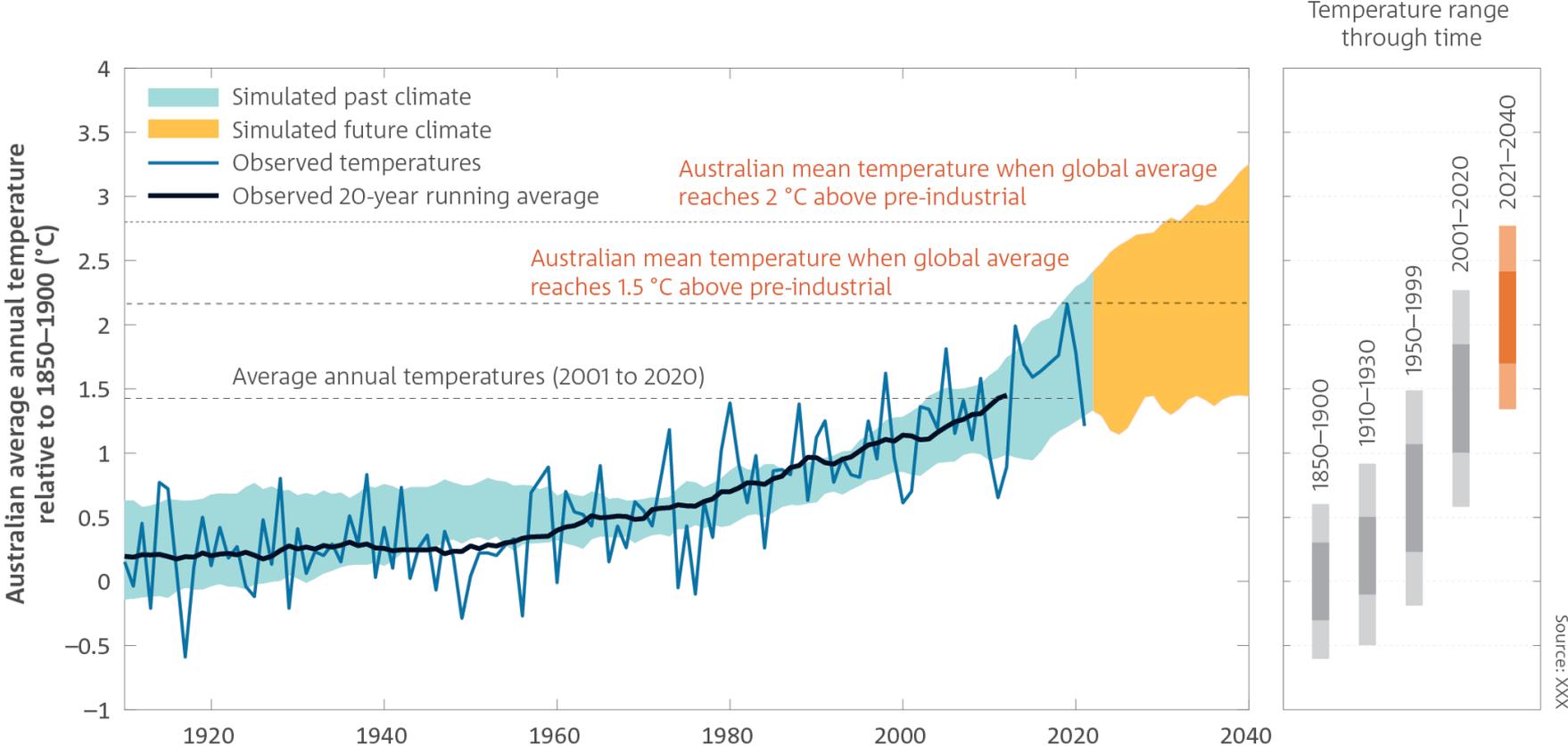


Fig SPM.2

c) Contributions to 2010-2019 warming relative to 1850-1900, assessed from radiative forcing studies

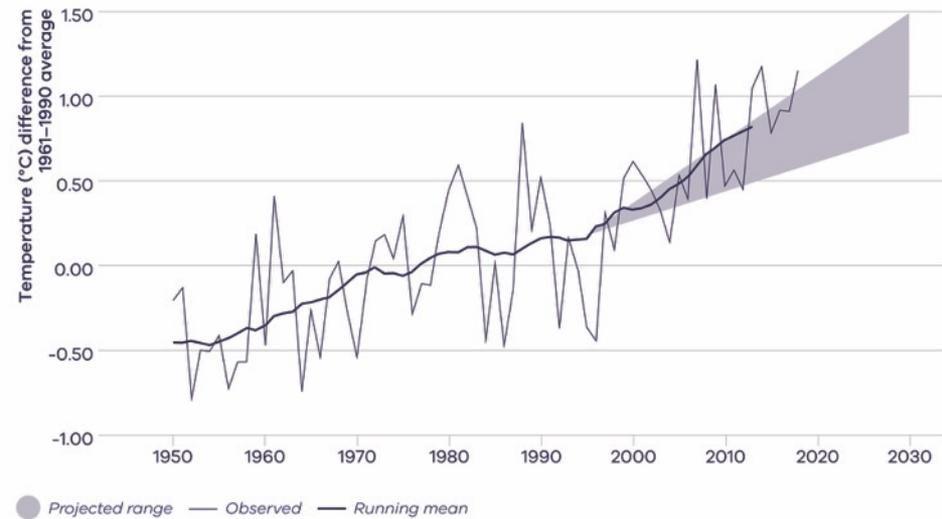


Observed and simulated Australian temperature



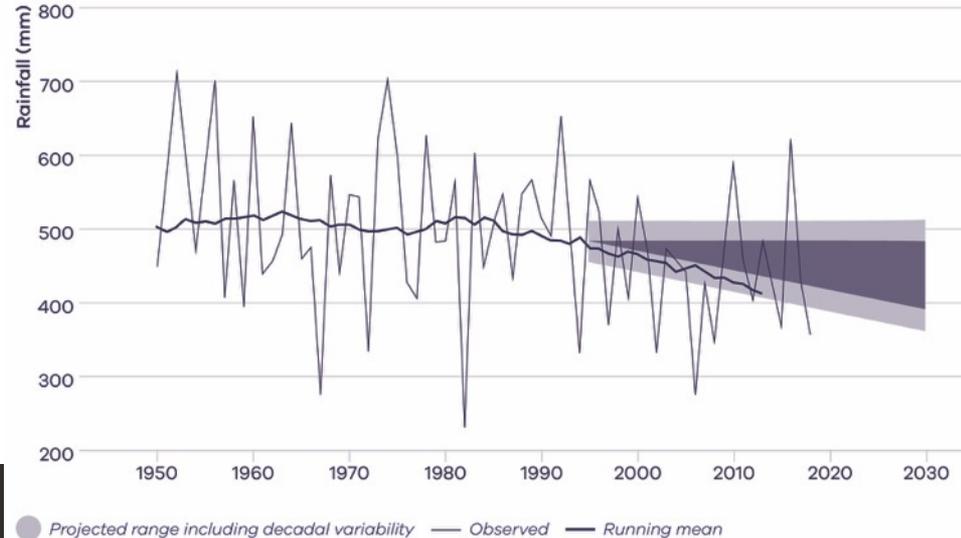
State of the Climate Report, 2022

Observed temperature in Victoria is tracking towards the upper limit of projections



Observed and projected Victorian climate change

Observed winter rainfall in Victoria is tracking towards the drier end of projections

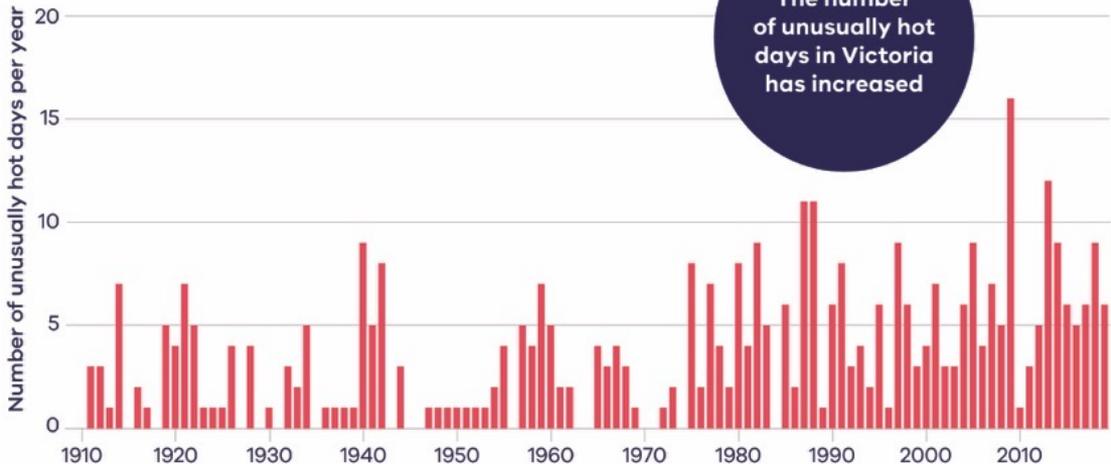


From Victoria's Climate Science report 2019

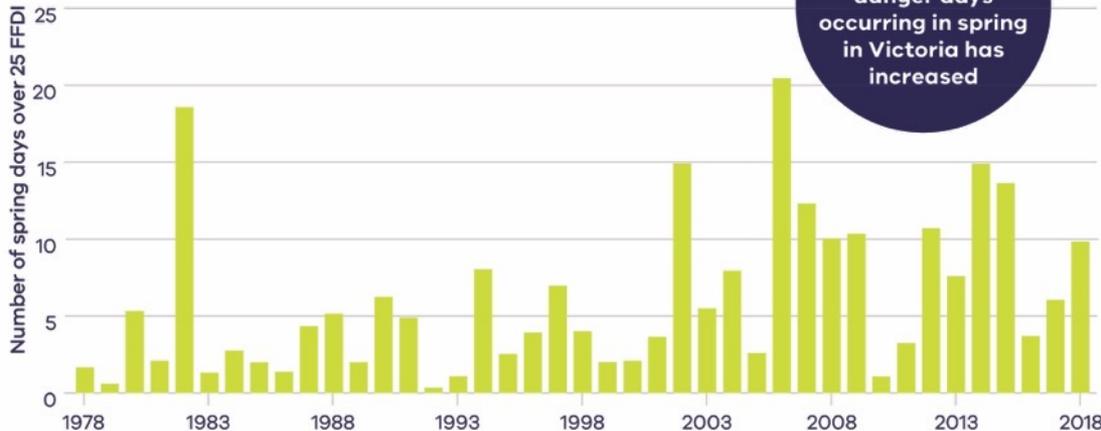
Observed Victorian climate change: extremes

The number of unusually hot days in Victoria has increased

Unusually hot weather



Spring bushfire weather



The number of very high fire danger days occurring in spring in Victoria has increased

Projected climate change

a) Global surface temperature change relative to 1850-1900

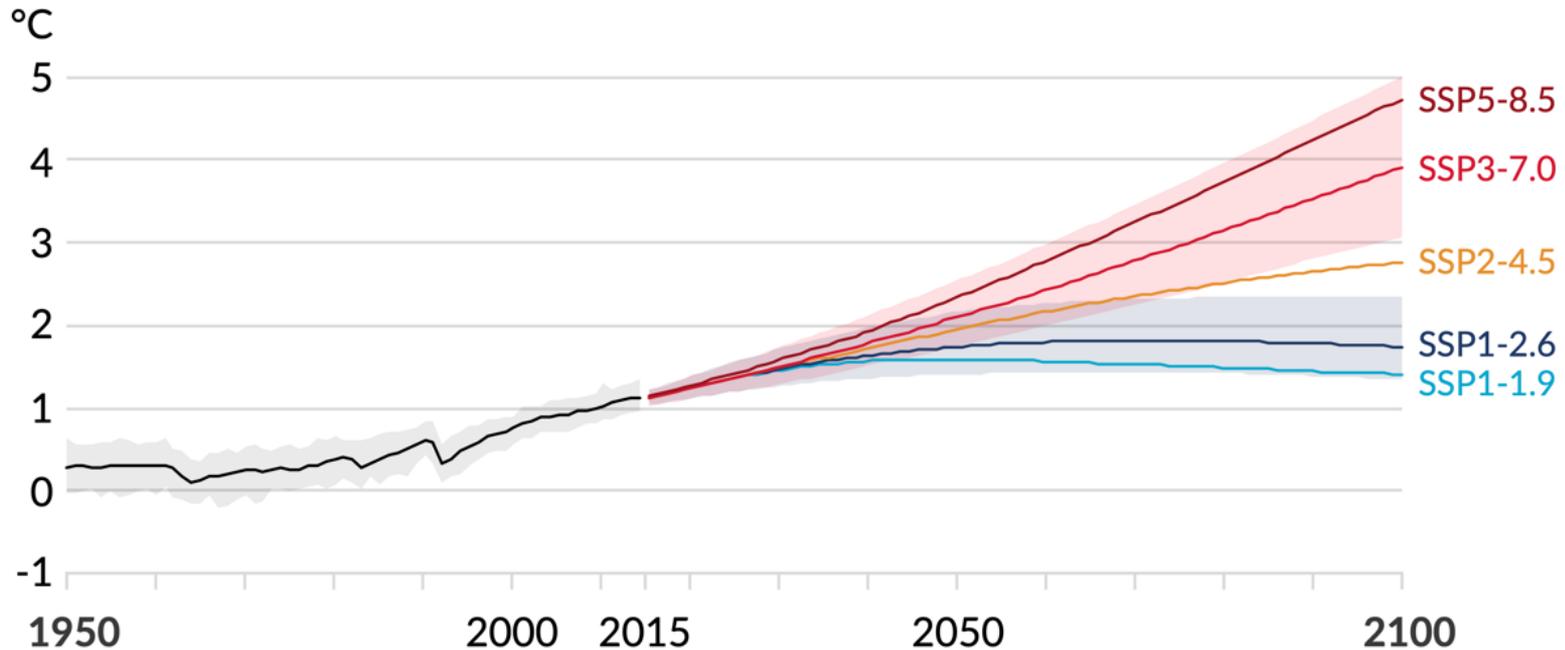


Fig SPM.8, IPCC AR6 WG1

Very low emissions gives >50% chance of warming less than 2°C

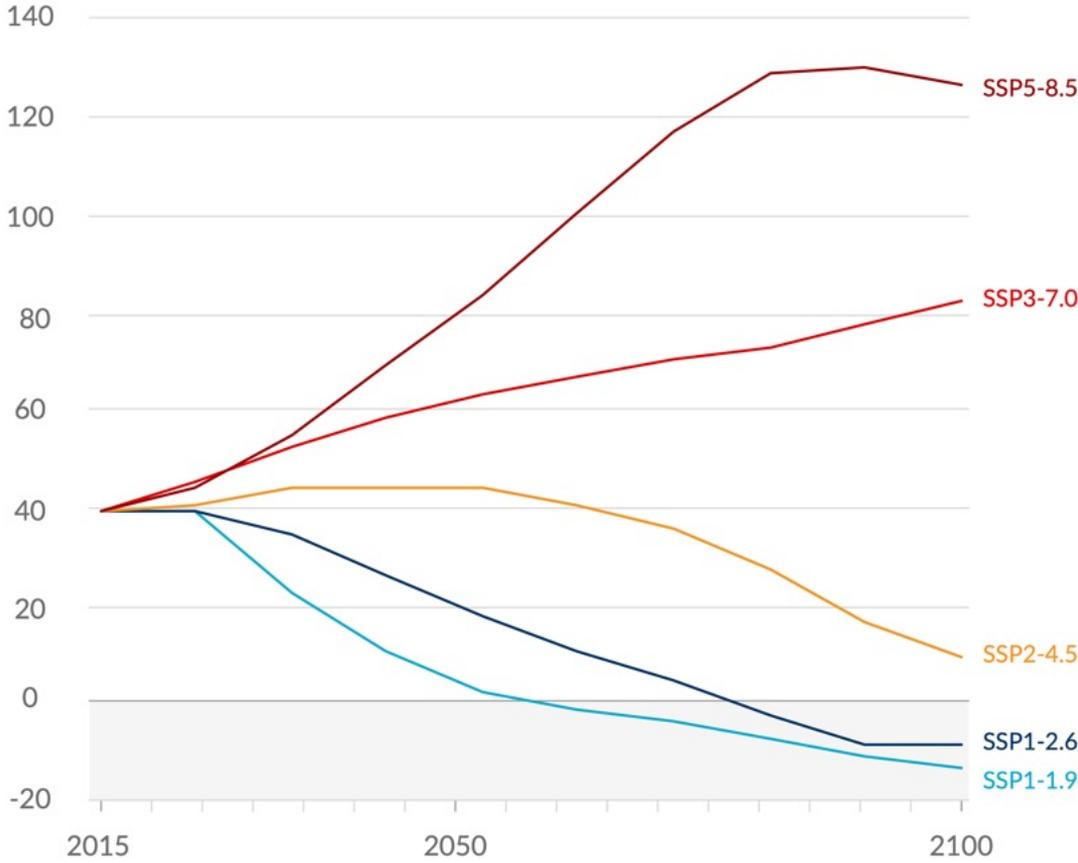
IPCC AR6 Climate change impacts

Some high confidence key risks for Australia

- Loss ... of coral reefs ... due to marine heatwaves
- Increase in heat-related mortality ... for people and wildlife due to heatwaves
- Cascading impacts on cities, settlements, infrastructure and services due to wildfires, floods, droughts, heatwaves, storms and sea-level rise
- Inability of institutions and governance systems to manage climate risks

IPCC AR6 WG2 Regional Factsheet Australasia

Carbon dioxide (GtCO₂/yr)



Global warming

4.8°C

4.0°C

2.8°C

1.8°C

1.5°C

Future emission scenarios

'Every tonne of CO₂ emissions adds to global warming'

Fig SPM.4 IPCC AR6 WG1

Future climate change

c) The extent to which current and future generations will experience a hotter and different world depends on choices now and in the near-term

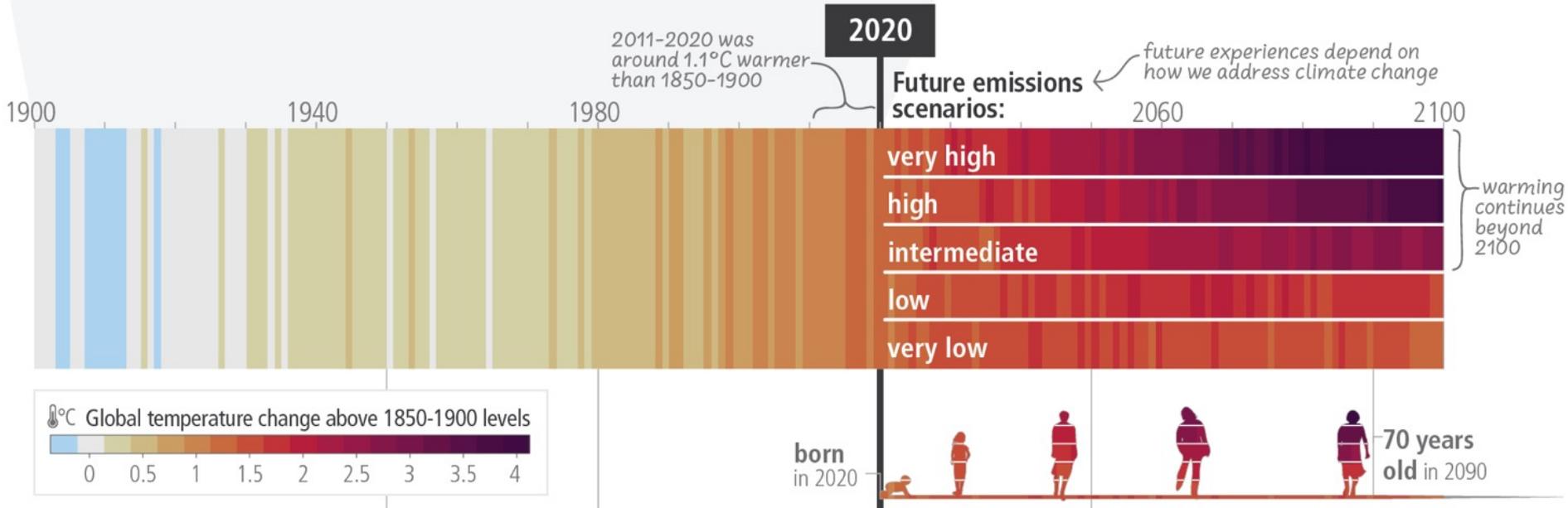


Fig SPM.1, IPCC AR6 Synthesis Report

Australia's emissions projections to 2035 by sector

Sector	National Greenhouse Gas Inventory		Projection	
	2005	2020	2030	2035
Electricity	197	172	79	66
Stationary energy	82	101	101	94
Transport	82	93	103	99
Fugitives	43	53	55	55
Agriculture	86	73	79	78
Industrial processes and product use	30	32	28	25
Waste	16	13	11	10
Land use, land-use change and forestry	85	-39	-33	-44
Total	621	498	422	383

Table 5, *Aust. Emissions Projections 2022*, DCCEEW

(-32%)

****Australia's export of coal and fossil gas more than double these domestic emissions**

Victoria's climate has changed

Temperature **INCREASE** of 1.2°C since 1910



DECREASE in average rainfall



Significant **INCREASE** in fire danger in spring



If global emissions continue to increase, in the 2050s Victoria ~~may~~ experience... will

Average annual temperature **INCREASE** of up to 2.4°C



DOUBLE the number of very hot days



Sea levels **RISING** by around 24 cm



LONGER fire seasons, with up to double the number of high fire danger days



DECLINE in alpine snowfall of 35-75%



DECLINE in cool season rainfall



More **INTENSE** downpours



Future climate change in Swanpool

	Baseline 1986-2005	2030 (2020-2039)	2050 medium emissions
Ann mean max temp	21°C	1.0°C (0.9 to 1.3°C)	1.7°C (1.2 to 2.0°C)
Annual rainfall	792 mm	-5% (-11 to -2%)	-6% (-12 to +1%)
Days/year over 35°C	8	13 to 16	13 to 20
Days/year below 2°C	28	21 to 25	17 to 22

- Larger rainfall decline in cool season
- Increased intensity of extreme daily rainfall events (*high confidence*)
- Increased evapotranspiration (*high confidence*)
- A harsher fire-weather climate (*high confidence*)

From Victoria's future climate projections tool

Adapting to a changing climate

- Reduce impacts of increased heat stress
 - Improved building design, better insulation, more shade
 - Improved urban design, more trees
- Changes in farming practices
 - Changes in crops, fruits and livestock
 - Changes in practices to use less water and increase soil carbon
 - Plant more trees to increase shade and capture carbon dioxide
- Improve water use efficiency
 - Increased water recycling
 - Increased local water capture

Mitigation Measures



More efficient use of energy



Greater use of low-carbon and no-carbon energy

- Many of these technologies exist today (solar and wind)



Improved carbon sinks

- Reduced deforestation and improved forest management and planting of new forests
- Bio-energy with carbon capture and storage



Lifestyle and behavioral changes

AR5 WGIII SPM

From IPCC AR5 Synthesis Report

Summary

- **We all need to manage climate risks associated with**
 - **physical risks due to the impacts of climate change**
 - **transition to a zero-carbon emission economy**
- Climate change has already led to significant increases in climate risks and will continue to do so for the next 30-100 years or more
- Most confident projected changes are for increases in heat waves, extreme fire weather, coastal flooding and extreme short-term rainfall
- Recent observed increases in temperature extremes and rainfall declines in Victoria are tracking at the worst case projected for 2030
- Much stronger global and Australian emission reductions are needed to limit global warming to 1.5°C above pre-industrial levels
- Victoria's new emissions reduction target **75–80 per cent by 2035**

Carbon – the unauthorised biography

New prize-winning documentary in 2022
on **carbon** everywhere on our planet;
in life, ecosystems and our society

<https://www.thecarbonmovie.com/>

No longer on ABC iview

<https://iview.abc.net.au/show/carbon-the-unauthorised-biography>

Teacher's study guide available at

https://www.thecarbonmovie.com/_files/ugd/e851d1_ab635e79ded64dd5b3b0c0696b5ec16a.pdf



References

- IPCC AR6 WG1 Climate change 2021: Summary for All
https://www.ipcc.ch/report/ar6/wg1/downloads/outreach/IPCC_AR6_WGI_SummaryForAll.pdf
- CSIRO & Bur of Met State of the Climate 2022
<https://www.csiro.au/en/Showcase/state-of-the-climate>
- Victoria's Climate Science Report 2019
https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0029/442964/Victorias-Climate-Science-Report-2019.pdf
- Victoria's changing climate <https://www.climatechange.vic.gov.au/victorias-changing-climate>
- Victoria's Future Climate tool, available from <https://vicfutureclimatetool.indraweb.io/>
- Australian Academy of Science *The risks to Australia of a 3°C warmer world, 2021*
<https://www.science.org.au/files/userfiles/support/reports-and-plans/2021/risks-australia-three-deg-warmer-world-report.pdf>

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