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14th May 2024

Climate Change Authority (CCA) 2024 - Issues paper responses

The **ARC Centres of Excellence for Climate Extremes and for 21st Century Weather** welcome the opportunity to make a joint submission to the Climate Change Authority's consultation 2024 Issues paper: Targets, Pathways and Progress.

The ARC Centre of Excellence for Climate Extremes works to understand and reduce Australia's vulnerability to climate extremes through leading the development of fundamental climate science and improving models which analyse the extremes of the past and predict the extremes of the future.

21st Century Weather is researching how Australia's weather is being reshaped by climate change, and what this means for our weather resources and high impact weather.

Both centres comprise of five partner universities - The University of New South Wales, Monash University, The Australian National University, The University of Melbourne and The University of Tasmania, as well as multiple national and international partner organisations.

Thank you for the opportunity to make a submission on this important topic at a pivotal point in our nation's history. We stand ready to offer the combined expertise of our Centres on any matters arising from this submission.

Yours sincerely,

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Executive Summary

As Australian Centres of Excellence in climate research, the ***ARC Centres of Excellence for Climate Extremes*** and ***21st Century Weather***, we are pleased to participate and contribute to the Climate Change Authority's consultation on 2024 Issues Paper: Targets, Pathways and Progress.

The focus of our submission concentrates on the importance of climate science in assessing Australia's international obligations of emissions reduction and the ensuing policy related to the target National Determined Contribution. Against a backdrop of increasingly frequent and more disturbing climate data, the current state of the climate serves to highlight the need to turbo-charge Australia's sluggish lack of progress on emissions reduction.

Whilst the Centre recognises that the Australian government has implemented an emissions reduction policy agenda in its first term and we support their activities in this area, the action is yet to be realised in meaningful emissions reduction.

It is important that Australia undertakes rapid reductions in accordance with the 'best available science'. As such, climate science must be the basis for setting future emissions reductions targets and is central to decision-making.

Limiting warming is subject to uncertainties in how the climate system will react or is reacting. Understanding these uncertainties help us to navigate effective policy responses. We demonstrate how considering components of the climate system including: the carbon budget, tipping points, climate sensitivity and a better understanding of how the day-to-day weather will be affected by climate change, are all integral to climate policy.

Although many see overshooting the 1.5C target as now inevitable and call for a 'war footing', reversing a higher global temperature would demand much greater effort than acting now. Both Centres therefore advocate for an emissions reduction target in line with Article 4 of the Paris agreement, that is an emissions reduction target of 74% below 2005 levels by 2030, with net-zero emissions reached by 2035.

Introduction

Headlines about the climate crisis are increasingly frequent and more disturbing. Climate scientists are becoming increasingly candid in how they describe the state of the climate in the media: 'World's top climate scientists expect global heating to blast past 1.5°C target[1]' or 'Scientists deliver final warming on climate crisis[2]'. Globally, 2023 was the warmest year in recorded history, mirroring global emissions of fossil carbon dioxide which hit another record high[3].

Global warming reached an estimate of 1.27°C in February 2024, figure 1. During the period from February 2023 to January 2024 global average temperatures were above 1.5°C.

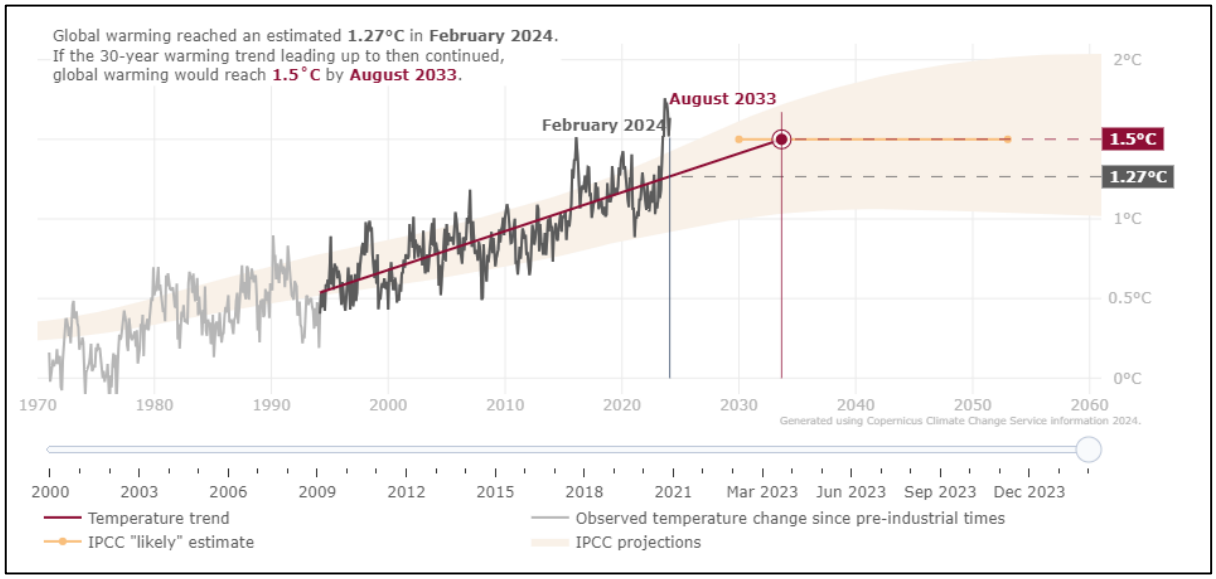

Figure 1: How close are we to reaching a global warming of 1.5°C. Source: https://cds.climate.copernicus.eu/cdsapp#!/software/app-c3s-global-temperature-trend-monitor?tab=app.

In the latest quarterly update, Australia's greenhouse gas emissions, for the year to September 2023, were 459.7 Mt CO2-e. National emissions are preliminarily estimated to be 459 Mt CO2-e to December 2023[4]. This is a decrease of just 0.5 % (2.2 Mt CO2-e) from the previous year and a deficit of 105.7 Mt CO2-e relative to an Australian government[5] target of annual emissions of 354 Mt CO2-e by 2030.

Whilst we recognise that the Australian government has implemented an emissions reduction policy agenda in its first term and we support their actions in this area, the action is yet to be realised in emissions reduction data. The Climate Action tracker gave Australian efforts in emissions reduction an overall rating of 'insufficient'[6]. The next Nationally Determined Contribution for Australia is required to be submitted by 2025. With the onus on G20 countries to take a lead, since they produce around 80% of global emissions, targets need to be ambitious. Against this backdrop, this submission examines the climate science that underpins emissions reduction policies and highlights some of the factors that the Climate Change Authority should consider in formulating their advice. Our submission provides responses to questions: 1, 2, 7, 9, 13, and 14.

[1] World's top climate scientists expect global heating to blast past 1.5C target | Climate crisis | The Guardian
[2] Scientists deliver 'final warning' on climate crisis: act now or it's too late | Climate crisis | The Guardian
[3] Fossil CO_2 emissions hit record high yet again in 2023 - CSIRO
[4] National Greenhouse Gas Inventory: Quarterly updates - DCCEEW
[5] Australia's emissions projections 2022 (dcceew.gov.au)
[6] https://climateactiontracker.org/countries/australia/

1. How should the authority take account of climate science and Australia's international obligations in considering possible emissions reductions targets for 2035?

Australia's international obligations are informed by climate science.

Climate science underpins Australia's international obligations to reduce greenhouse gas emissions. The Paris Agreement's commitment to 'holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C', is enshrined in Australia's Climate Change Act 2022 and forms the basis of our nationally determined commitment. Article 4 of the Paris Agreement[7] states that Parties undertake rapid reductions in accordance 'with best available science'.

The science is clear: burning fossil fuels releases greenhouse gases that raise temperature, leading to more severe natural and human system impacts. Climate science must be the basis for setting any future emissions reductions targets and is essential for decision-making.

The risks of warming

The pervasive impacts of even relatively small increases in temperature are well documented by the Intergovernmental Panel on Climate Change (IPCC)[8]. Figure 2 illustrates some of the climate risks which are likely to occur at a 1.5°C level of warming compared to 2°C and provides the stark choices that increased warming brings. How is it possible to choose between losing 70% of the world's coral reefs by 2100 at 1.5°C or losing virtually all of them by 2100 at 2°C?

Figure 2 does not illustrate the health, sociological, psychological, and political costs of human-induced climate change, such as human mobility and immobility, its action as a driver of migration and displacement or the implications for security conflict and peacekeeping[9]. It also does not illustrate the economic and financial risks of climate change which are being recognised via, for example, the mandatory disclosure of climate risk by business.

The symbolic nature of 1.5C

The value of 1.5°C may not be the best limit in terms of the impacts we are already experiencing. However, 1.5°C was considered a 'stretch' target at the time of negotiations. With global average temperatures now at 1.27°C, as outlined earlier in this submission, climate impacts are already affecting communities in Australia. Just a few examples are:

- Climate change played a role in the conditions that led to the Black Summer fires of 2019/2020[10].
- Heavy rainfall events are increasing at a considerable rate of 20% per decade across the greater Sydney region. This is beyond anything that has been observed before[11].
- Heatwaves in Australia have undergone major increases in the 2000's compared to earlier decades. With increases in global warming of 1.5-2°C, heatwaves may be 85% more frequent[12].

[7] parisagreement_publication.pdf (unfccc.int)
[8] Chapter 3 — Global Warming of 1.5 ºC (ipcc.ch)
[9] https://www.aslcg.org/reports/too-hot-to-handle/
[10] Connections of climate change and variability to large and extreme forest fires in southeast Australia | Communications Earth & Environment (nature.com)
[11] Intensification of subhourly heavy rainfall | Science
[12] Tra7ncoso et al., 2020, Heatwaves intensification in Australia: A consistent trajectory across past, present and future, https://doi.org/10.1016/j.scitotenv.2020.140521

The imperative of adhering to a 1.5°C threshold is therefore a 'defence line'[13] against the most severe effects of climate change. It does not remove the risk of global temperatures being much higher than the pre-industrial average, or of some regional extremes reaching dangerous levels for ecosystems and societies over the coming decades'[14], it just lessens the risk of severity overall.

Global average temperatures will almost certainly breach the limit of 1.5°C. The value of 1.5°C should be a symbolic guide to anchor our progress and a guide to our actions on emissions reduction.

The urgency of emissions reduction

All feasible scenarios that achieve Paris warming targets of limiting warming to 1.5°C, reach net zero globally by 2050 and involve the steady reduction of emissions were modelled to start in 2020[15]. Sadly, carbon dioxide measured at Mauna Loa Observatory, Hawaii[16] in March 2024 hit another record high of 425.22 parts per million and is accumulating in the atmoshphere faster than ever.

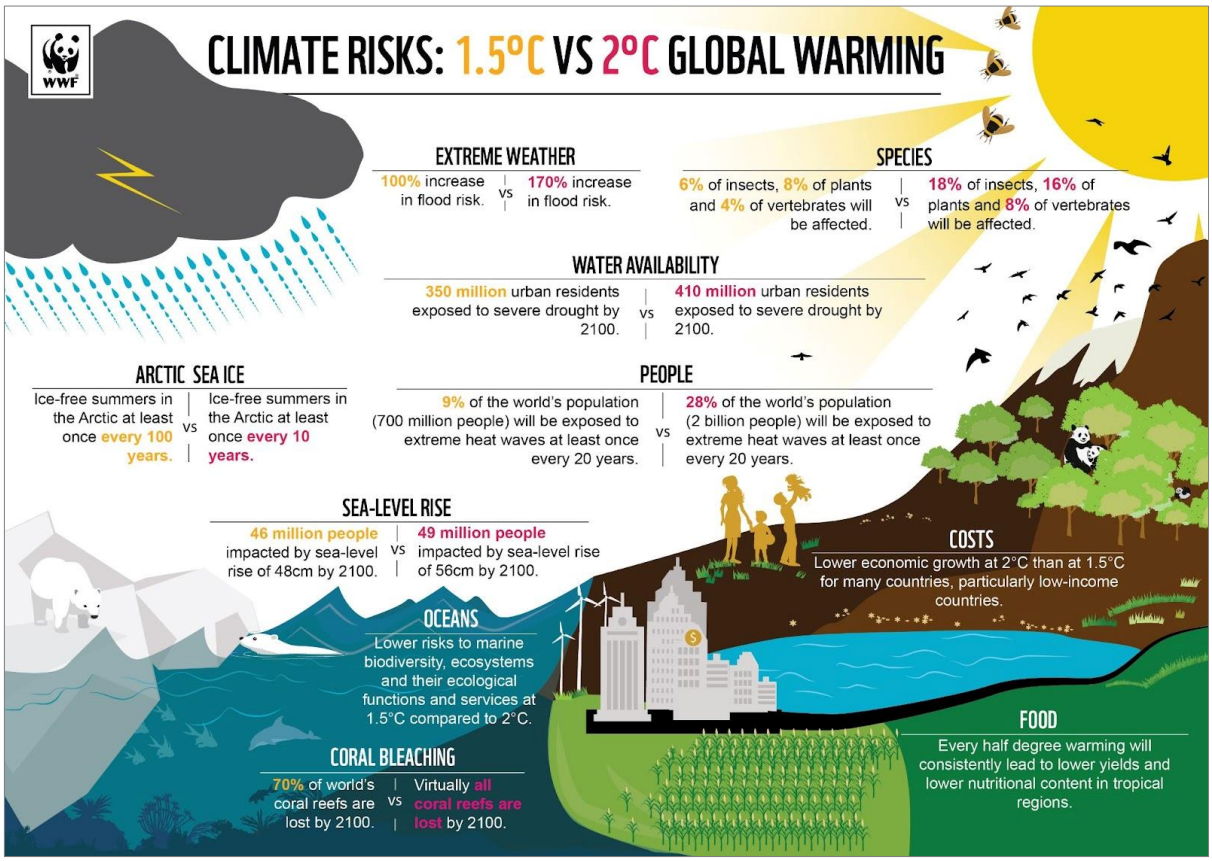

Figure 2: 1.5C Infographic. Source : https://wwf.panda.org/discover/our_focus/climate_and_energy_practice/ipcc152/

[13] The 1.5 C climate threshold: What it means and why it matters | World Economic Forum (weforum.org)
[14] Seneviratne et al. (2018). The many possible climates from the Paris Agreement's aim of 1.5 °C warming. Nature. https://doi.org/10.1038/s41586-018-0181-4
[15] https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf
[16] Global Monitoring Laboratory - Carbon Cycle Greenhouse Gases (noaa.gov)

Considerations for further warming

Even limiting warming to 1.5°C is likely to be subject to uncertainties in how the climate system will react or is reacting. Every fraction of a degree matters[17]. Understanding some of these uncertainties help us to navigate the climate crisis.

Carbon budget

The global carbon[18] project has estimated the remaining carbon budget that gives us a 50% chance to limit warming to 1.5°C based on current emissions. The global carbon budget, based on current emissions trajectories, is likely to be exceeded in about the next 7 years. Note, this is a 50% chance and avoiding 1.5°C with a 2/3rds chance is now infeasible. There was a record high in total carbon dioxide emissions in 2023 of 36.8 billion tonnes. Current trajectories are grossly insufficient to reverse this trend.

Tipping points

The current conditions in Antarctica are concerning, with dramatic rates of decline in sea ice pointing to a possible regime shift[19]. This is just one of many tipping point elements, a component of the climate system, which is now vulnerable to a rapid change in state. A 'tipping point' is where part of the earth system reaches a threshold, undergoes substantial change and is established in another state. This may mean the system might behave differently and irreversibly hundreds of years afterwards. Conditions in Antarctica are therefore worrying. Dramatically and urgently reducing emissions minimises the chances of triggering tipping points[20].

Increasing human-induced climate change increases the risk of triggering some tipping points, with different thresholds for different tipping elements. It is possible that we have already passed some tipping points but have not seen the consequences yet. Several tipping points may be triggered this century even with modest further warming, while others probably require higher levels of global warming. We cannot be precise about the conditions or timing of climate tipping points and in fact there are some deep uncertainties around some processes. Limiting further global warming limits the chances of triggering tipping points.

Climate sensitivity

The climate is sensitive to increases in CO_2 and the magnitude of this sensitivity is important for the impact of future emissions. Climate sensitivity is a measure of the response of the climate system as a whole (e.g., clouds, water vapour, carbon cycle, ocean currents) to CO_2. The term refers to the amount of global surface warming that will occur in response to a doubling of atmospheric CO_2 concentrations compared to pre-industrial levels. It is a good indicator of the rate of future global warming for a given scenario of greenhouse gas emissions. It is hard to estimate because of the uncertainties in the behaviour of the climate system and also depends on a range of different feedback processes in the Earth's climate system.

Positive feedbacks act to amplify the warming of the planet while negative feedbacks act to dampen it, figure 3. The size of many (some key) feedback effects is uncertain, making it difficult to estimate climate sensitivity precisely. It is currently estimated to be in the range between 2.6°C and 4.1°C[21]. That means for a certain amount of carbon emissions, a higher climate sensitivity, say 4.1°C, results in a lower remaining carbon budget for a given global warming amount. The uncertainties around estimating climate sensitivity therefore have implications for carbon budget estimates for the Paris Agreement goals. We may be in a far more precarious position.

[17] IPCC adaptation report 'a damning indictment of failed global leadership on climate' | IPCC report says human actions are causing dangerous disruption, and window to secure a liveable future is closing UN News
[18] GCP : Global Carbon Project : Homepage
[19] https://journals.ametsoc.org/view/journals/clim/37/7/JCLI-D-23-0479.1.xml
[20] CSIRO Workshop Report. (2024) Understanding the risks to Australia from global climate tipping points. CSIRO, Australia.
[21] BriefingNote12_Climate_sensitivity_20201106-3.pdf (climateextremes.org.au)

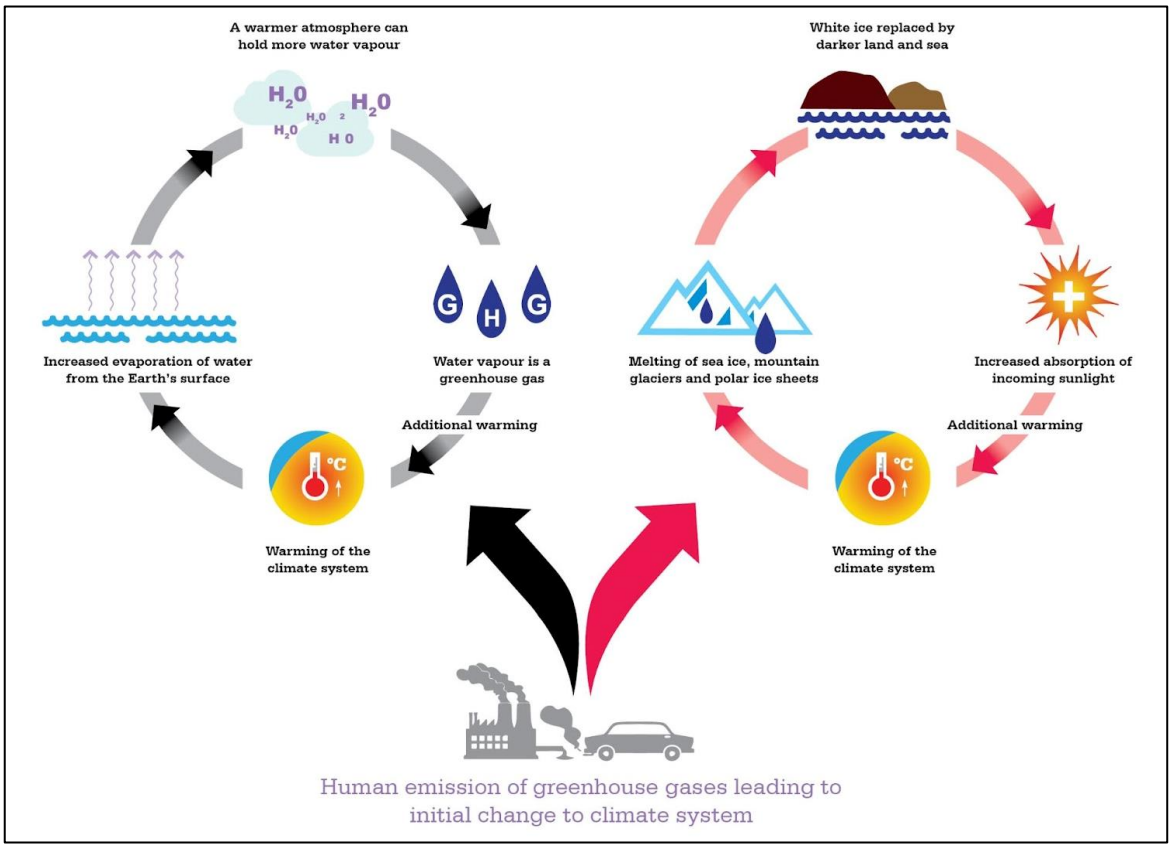

Figure 3: Climate feedbacks. Source: Climate change feedback loop illustration… | Download Scientific Diagram (researchgate.net)

Our uncertain future behaviour

To project how temperatures will rise under different warming regimes, we need to make critical assumptions about our future human behaviour, such as:

- how population numbers will change
- the nature of economic and technological development,
- the types of energy and agricultural systems we'll use in the future, or
- incentives to drive change such as carbon pricing.

Uncertainty arises from future human behaviour and the complexity of the climate system. Human behaviour is the largest source of uncertainty in estimating our future climate. Depending on the emission scenario, model results can give a wide range of possible outcomes. Despite uncertainty in emissions, human society retains the capacity to shape the future via our own actions.

Is the target of 1.5°C feasible?

There are a wide range of possible outcomes due to uncertainties in the earth system. If all emissions had stopped in 2020 (as Paris target scenarios were modelled) there was a 15% chance of overshooting the 1.5°C target, and 1%–2% chance for 2°C. These risks are now much higher following four years of near record levels of emissions.

If emissions stabilize in 2020 and stop in 2040, these probabilities increase to 90% of overshooting 1.5°C target and 17% chance for 2°C. The earlier we take aggressive action on reducing emissions, the less the probability of reaching 2°C limit imposed by the Paris Agreement[22].

Overshooting the 1.5°C warming limit

Overshooting the 1.5°C target is very probably now inevitable[23]. However, reversing a higher global temperature would demand much greater effort than a lower temperature. Leaving action on emissions reduction to a future point in time risks greater climate impacts and greater efforts on carbon storage. These technologies are currently not able to operate at scale and are costly. Returning global temperatures below these thresholds after they have been crossed would require a massive scale-up of carbon dioxide removal after global net zero emissions had been reached. While limiting warming to 1.5°C is likely impossible, the closer we remain to the 1.5°C target the smaller the impacts, and the easier it will be to deal with overshoot.

Targets are essential

There is a need for a dramatic decrease in emissions in the short term for the nationally determined contribution in 2035 and to net zero by 2050. This is why both targets are essential; a 2050 target alone does not work. Rapid reductions in greenhouse gas emissions are the only way to stop global temperatures increasing.

An increased ambition for Australia's nationally determined contribution for 2035 makes actions incisive and highlights the urgency. It applies the threat of legal action, public pressure, political embarrassment amongst our peer nations around the world and provides a signal for companies and industries to strengthen their investment in low emissions technologies and net zero behaviour, Recently the European Court of Human rights ruled in favour of a group of more than 2,000 older Swiss women[24], finding that Switzerland was in violation of the European convention on human rights for failing in its duties to combat climate change.

A rigorous reading of the science underpinning climate change points to the need for an emissions reduction target in line with Article 4 of the Paris agreement. That is an emissions reduction target of 74% below 2005 levels by 2030, with net-zero emissions reached by 2035[25,26]. We appreciate this is extremely ambitious, but the evidence is that this is less expensive and likely less challenging than dealing with the consequences of higher levels of global warming.

Climate science is key to the emissions reduction response

We would also like to bring to the attention of the Climate Change Authority that setting realistic emission reduction targets and, more importantly, achieving them, requires the development of entirely new approaches to climate science. This is a result of the need to develop a renewable energy grid that supplies electricity reliably, without major interruptions, every day of the year. As our economy will become increasingly weather fuelled, there is an urgent need to better understand how the day-to-day weather will be affected by climate change and look beyond the current strong focus on extreme weather and disaster risk reduction only. Quantifying our currently available weather resources (wind, sunshine, rainfall, etc.) as well as their susceptibility to climate variability and change must become a high priority for research.

[22] An Assessment of Earth's Climate Sensitivity Using Multiple Lines of Evidence - Sherwood - 2020 - Reviews of Geophysics - Wiley Online Library.
[23] The World Will Likely Miss 1.5 Degrees C--Why Isn't Anyone Saying So? | Scientific American
[24] https://theconversation.com/older-swiss-women-just-set-a-global-legal-precedent-for-challenging-their-nations-climate-change-policy-227629
[25] https://www.climatecollege.unimelb.edu.au/files/site1/docs/%5Bmi7%3Ami7uid%5D/ClimateTargetsPanelReport.pdf
[26] Chapter 2 — Global Warming of 1.5 ºC (ipcc.ch)

Achieving this quantification requires an urgent uplift in our weather-climate interaction research capabilities and the research infrastructure they depend on. In particular, the development of high-resolution climate modelling tools as well as a closer collaboration of the weather and climate community are critical. The ARC Centre of Excellence for the Weather of the 21st Century is a national hub for research in this area and is looking forward to ongoing discussions with the Climate Change Authority on how to transform the national research agenda to focus on the important area of weather change and its impact on our weather-fuelled economy. We note that the development of high-resolution climate modelling tools would also help identify locations that would be resilient in the context of nature-based solutions, where agriculture would remain viable, how to design our cities to be resilient and so on.

2. How should the authority weight the goals of ambition and achievability in considering possible emissions reduction targets for 2035?

The science is clear, the more we emit now, the worse climate change will be in the future. With the frequency of climate extremes to increase, action towards future prevention of additional warming is a national responsibility. In short, every additional fraction of a degree of warming increases the risk of extreme weather events.

The current cost of living crisis already has a component due to past carbon emissions and resulting global warming (even if not the main cause). For example, prices of olive oil[27], chocolate[28], coffee[29] and some other crops have risen substantially due to droughts or severe rains hitting multiple growing regions, which have been influenced by global warming. Drought has also been implicated in the Syrian civil war[30] which has contributed thus increasing oil prices[31]. If Paris targets are not met these impacts will dramatically worsen as crops and people hit tolerance limits.

Achievability is down to the priority that the government places on the issue. Multiple parties have already called for a 'war footing'[32] over the years. Emissions reduction targets must have the highest ambition and with government backing, it will be achievable.

7. How can governments better support markets, including carbon markets, to deliver emissions reduction outcomes?

The mitigation potential of carbon offsets for emissions reductions remains highly uncertain and will never replace mitigation by reducing emissions. However, their use is widespread and requires improved governance to increase transparency particularly for offset schemes.

[27] Olive oil gets more expensive because of climate change (qz.com)
[28] Chocolate price hikes: A bittersweet reason to care about climate change | UNCTAD
[29] Climate Change Impacts to Drive Up Coffee Prices - Our World (unu.edu)
[30] How drought linked to climate change helped cause the Syrian civil war - InterClimate Network
[31] Middle East conflict pushes surge in crude oil prices - ABC News
[32] https://press.un.org/en/2008/ga10725.doc.htm

The implementation of the NetZero agenda will make our economy, and hence markets, more weather dependent. Hence, reliable weather information at all timescales, from days, to weeks, to years, to a century ahead will be critical for market operations. There is currently no strategy on how to bring together a very disjointed community to carry out the research required (see Q1), build the operational systems to provide a seamless predictive capability and the services that translate the prediction data into actionable information for markets to act on. Achieving this will require a national strategy that considers research, operations, and service as a well-connected continuum rather than separate, disconnected pieces.

9. How should governments decide upon the appropriate allocation of resources towards reducing emissions, removing carbon from the atmosphere, and adapting to climate change impacts?

The climate crisis - a time of intense difficulty or danger that requires urgent action. With every tonne of greenhouse gas emitted, warming increases. In order to stop global warming completely, carbon dioxide emissions have to reach net zero urgently, i.e., stop emitting.

The optimal allocation of resources then is to principally reduce emissions. We need to adapt to the world we have and researching the scalable ways to remove carbon from the environment.

In principle resource allocation should be done via a cost-benefit analysis incorporating a social cost of carbon (as done in the US). However current calculations of the social cost of carbon are deficient and almost certainly underestimate the true dollar-equivalent cost of global warming, perhaps by a huge factor. These damages already outweigh the mitigation costs required to limit global warming to 2 °C by sixfold over this near-term time frame[33].

It is likely that scientific and economic work will before long begin to correct this, so governments should plan for the estimated costs of future climate change (and hence) to increase in the coming years. Additionally, as highlighted in Q1, a key limitation for resource allocation is our lack of understanding of weather change, which inhibits our ability to plan our future electricity grid and the speed of its implementation and the resulting emission reductions.

Furthermore, the lack of a national strategy that unites climate research, operations, and climate services (see Q7) severely limits our ability to plan rationally with the best information possible available to those involved.

Hence, the decision on how to allocate resources to the three areas above will require to also allocate significant resources to research and the formation of institutions that unite research, operations, and services.

13. How can governments help Australians prepare for and respond to the impacts of climate change?

[33] The economic commitment of climate change | Nature

Promoting the communication of expected or likely climate-change impacts is a major part of preparing and responding to the impacts of climate change. Translating scientific research into 'plain English' that are both scientifically sound and understandable to the public are challenging.

Understanding audience requirements, as well as working closely with scientists, sometimes word by word to provide accessible, easy to understand, but not misleading explanations is essential. This is generally not well funded or supported and can be hit and miss.

Article 12 of the Paris Agreement details the need to take, 'measures, as appropriate, to enhance climate change education, training, public awareness, public participation and public access to information…'. Communicating climate science is improving but needs to move at speed to increase Australia's education for climate preparation and response to benefit.

However, most fundamentally, helping Australians prepare for climate change necessitates an awareness of what these changes will be. At the level of adaptation, at the level a Federal or State government invests in adaptation, we simply do not know how climate change will affect Australians (perhaps with the exception of heat events). This is not merely a lack of scientific capability - rather it is a failure over decades to invest in the science that underpins our climate projections. It is a failure of organisation, and of strategy as investments are ad hoc, duplicative, and fail to build the understanding and capability that would now have existed.

Unless Australia recognises the need for an end-to-end approach to understanding climate change, and harnesses the national capabilities that exist across CSIRO, the Bureau of Meteorology, the Antarctic Division and the University sector we will remain largely blind to how climate will affect us. A strategy that integrates investments in observations, through scientific understanding, and on to the development of models that are scientifically rigorous is vital, and this strategy needs to be ambitious. Perhaps most critically, the era of scientists creating products to inform adaptation and climate risk needs an urgent reappraisal. Specifically, a focus by the scientists to create the understanding, and the development of the models is required, but the climate projections needed by government, business and so on have to urgently evolve into managed operational systems.

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14. What else should the authority be considering in its advice to government?

See our answers to Q1, Q7 and Q9. They contain two major recommendations the authority should make to government:

1) Our activities need to pivot from climate change to understanding and predicting weather change, that is the influence of climate change on the day-to-day weather that continuously provides resources to our economic activities as well as the high-impact weather events that disrupt them.

2) We need a national strategy for climate research that underpins operational prediction systems that in turn are the foundation for weather and climate information services that inform government, businesses, and the community at large (see #13).
