21st Century Weather
ARC Centre of Excellence

ARC Centre of Excellence for the Weather of the 21st Century
School of Earth, Atmosphere, and Environment
Monash University, Level 2,
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Wellington Road, Clayton VIC 3800, Australia

Monash, Tuesday 8 of April 2025

Subject: Victoria's Climate Change Strategy – Have your say

Dear Department of Energy, Environment and Climate Action,

As your formal partner, the Australian Research Council Centre of Excellence for the Weather of the 21st Century welcomes the opportunity to contribute to Victoria's Climate Change Strategy.

We support the Minister's acknowledgement that climate change is here, hurting and costing Victorians now and will get worse if we do not act to protect working families against it.

We commend the strategy to reduce greenhouse gas emissions to limit global warming to 1.5°C and strengthen climate resilience by adapting to the impacts of climate change.

Our submission highlights how climate change might change weather patterns and conditions. We propose actions, strategies and research, some of which 21st Century Weather is leading.

We are happy to answer any additional questions you may have about our submission. Please feel free to reach out for further clarification or information.

Professor Christian Jakob
Director, ARC Centre of Excellence for the Weather of the 21st Century

The **ARC Centre of Excellence for the Weather of the 21st Century** is a consortium of world-leading climate and weather researchers based across five Australian universities, together with major domestic and international partner organisations, including the Bureau of Meteorology and CSIRO

21st Century Weather aims to address these challenges by answering a vital question: **How will Australia's weather transform as our climate changes?**

We will advance our understanding of atmospheric circulation and weather systems, and develop ultra-high-resolution climate models to enhance our understanding of Australia's weather and climate.

The foundational knowledge we create will enable policymakers, industry and communities to make better decisions, harness weather resources and help us prepare for high-impact weather.

Victoria's 2026-30 Climate Change Strategy must give equal importance to mitigation and adaptation efforts.

Global temperature levels mean that we are already locked into climate change impacts. Slow ocean processes mean it will take a long time for reductions in atmospheric carbon dioxide to significantly cool our planet. In fact, projections show that the deeper ocean will continue to warm for centuries even after we halt emissions. In SSP5-8.5 simulations, which project the most extreme global warming, a five-year delay in reaching net-zero emissions results in higher temperatures around the world. For Victoria, a five-year delay means more severe future heatwaves. Taking decisive action now to cut emissions and move towards a net zero future will lessen the climate challenges that next generations face in the decades and centuries to come.

Managing the impacts of climate change is a matter of life and death.

Heatwaves are Australia's deadliest natural disaster. The combination of hot and humid weather conditions significantly increases health risks, as humidity prevents sweat evaporation, making it difficult for the body to cool down. Hours-long exposure without shelter can lead to heatstroke or death. Extreme heat can also worsen kidney and heart problems and be deadly in dry conditions, adding to mortality rates during heatwaves.
Strengthening healthcare services is vital to manage the rising number of heat-related casualties. This includes ensuring proper resources, well-trained staff, ample ambulances and medical equipment. Preventive measures like robust warning systems, public education and access to cooling spaces are also crucial. Further, we need more research to understand how heat and humidity affect vulnerable groups like children and pregnant people.

Extratropical cyclones influence heatwaves and fire weather, particularly in southern Australia. Heatwaves are linked to large atmospheric waves in the extratropical jet stream and are intensified by extratropical cyclones' moist airstreams. Strong summertime cold fronts—a feature of extratropical cyclones—create hot, dry, and windy conditions ahead of them that promote fire weather. Both fire weather and heatwaves are aggravated by preceding hot and dry spells, heavily influenced by the presence or absence of extratropical systems.

A lack of extratropical weather systems can lead to widespread drought in Australia. Extratropical cyclones are responsible for a significant portion of rainfall in the southern regions of the continent and influence tropical rainfall during the Australian monsoon.

Heatwaves, droughts, and fires are interconnected; drought increases the likelihood of extreme heat, which in turn heightens fire risk. Southeast Australia faces longer fire seasons and more extreme fire weather as heatwaves intensify, like we saw during the Black Summer of 2019-2020. **Conversely, the heavy rainfall that ends droughts can lead to flooding, not just the prospect of replenishing depleted dams.** To prepare for these intertwined risks and opportunities, our understanding of climate-weather-catchment interactions and the impacts of human activities on these systems must deepen.

Sea level rise has accelerated along Australia's east and southeast coasts over the past 2-3 decades. Tropical and extratropical cyclones exacerbate sea level rise impacts on local communities. The intense surface winds associated with these weather systems can drive heightened sea states with high waves ahead of the system and storm tides at landfall, resulting in additional coastal erosion and flooding.

Severe convective storms cause extensive damage and substantial insured losses due to extreme wind, destructive hail and heavy rainfall. A single hailstorm can result in over $1 billion in insured losses. Despite this high damage potential, the impact of climate change on the frequency and severity of these storms is still uncertain, making research into this area essential for sound decision-making.

Climate literacy is crucial across all levels of government, industry and society. By integrating climate and weather education from early stages onward, we can empower individuals to make informed decisions. Tertiary training is particularly vital to develop the next generation of weather and climate scientists, ready to work across sectors.

The most significant challenges in adapting to climate change

Future changes in the frequency, intensity and paths of tropical and extratropical cyclones could significantly impact Australia. While research indicates that tropical cyclones may happen less often, the ones that do occur could be more intense. This means we could see more cyclones

that last longer, move more slowly, bring heavier rainfall, and track further south than before. The interaction of extratropical cyclones with hazards like heatwaves, droughts, fire weather, heavy rain, flooding and sea level rise will change under global climate change. Improving our understanding of these interactions is essential to predict future climate impacts in Australia.

Weather can greatly affect transportation, like fog on highways or floods on roads. However, understanding these impacts requires small-scale localised data that is difficult to measure by traditional meteorological methods. Enhancing the exchange of this information between climate scientists and transport network managers would be highly beneficial to better understand and respond to these weather-related issues.

In cities, urban growth is uncharted and evolving rapidly. Densification is happening in our major cities without thorough assessments of how these changes will interact with future climate conditions. Future climate projections often overlook future urban scenarios despite the known feedback loops between urban development and high-impact weather events, like heatwaves, heavy rainfall and hail.

In preparing for future scenarios, there are extensive gaps in our national capabilities. Well-established and highly effective global climate models are great for capturing global circulation patterns, but struggle to represent conditions within urban areas. When zooming in on cities, they lose accuracy and precision, representing cities as oceans, concrete slabs or rocks. As a result, they miss the unique challenges and details of urban spaces, and this gap limits businesses' ability to gauge their climate risks. These limitations are incompatible with the mandatory climate-related financial disclosures for large businesses and financial institutions mandated by the Australian Government. We need to maintain and significantly uplift the key existing facilities involved in improving these modelling capabilities such as the National Computing Infrastructure and ACCESS-NRI.

Australia can harness the opportunity to become a renewable energy superpower

To become a leader in renewable energy, Victoria needs to tailor the installation of renewable energy to match the times of year and day when energy use is highest. Given that Victoria is strongly influenced by rapidly changing weather systems and variations in weather and climate,

there is a unique chance to pioneer the design of an energy network informed by weather systems and their future changes as the climate warms.

A critical challenge in achieving net zero is ensuring renewable energy meets demand precisely when and where it is needed. It is not enough to have excellent energy resources if they do not produce electricity at peak times. Even though battery storage can help balance supply and demand, a better long-term solution is to match regions of systematic supply and demand. This balancing includes:

- **Identifying the best spots for wind and solar energy** to generate power during peak demands, such as during heatwaves and cold snaps. This includes optimising the solar output when the wind is low, and the wind resource in periods of low insolation. Supply and demand in these periods are influenced by weather conditions.
- **Ensuring installed renewable resources meet daily demand cycles**, especially morning and evening peaks not aligned with solar energy, by considering small-scale wind energy sites that can provide additional capacity during these peaks.
- **Preparing for longer-term weather variations** that can affect energy supply, like those caused by the El Niño Southern Oscillation and the Indian Ocean Dipole.

Solar panel efficiency decreases with higher temperatures, and our energy grids cannot handle the supply from rooftop solar systems. When excess energy overwhelms the grid, these systems must shut down, wasting potential energy generation. Upgrading the energy grid and implementing public energy storage systems are essential steps to achieve net zero targets.

By focusing on these strategies, Victoria can not only meet its energy needs more effectively but also position itself as a pioneer in renewable energy solutions.