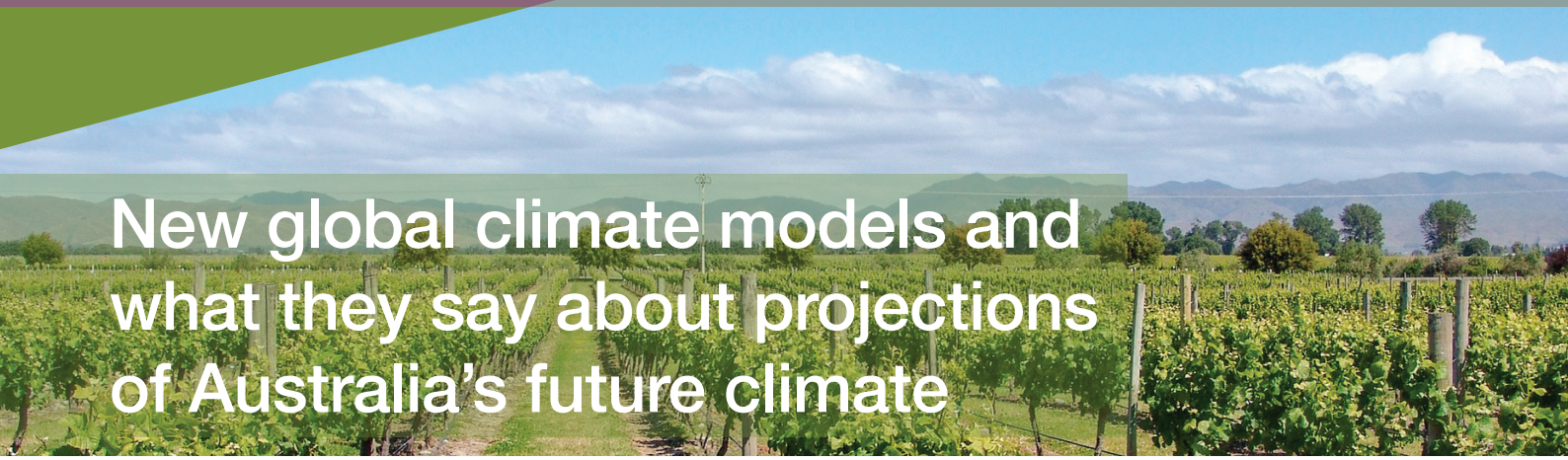
Earth Systems and Climate Change Hub

National Environmental Science Programme

climate change **science brief**



New global climate models and what they say about projections of Australia's future climate

Climate models are used to produce simulations of past, current and future climates. These models are the best available tools to investigate and understand possible future climates under different emissions scenarios.

While future warming in Australia is certain, the projected rate and nature of these future changes vary substantially among different climate models.

Earth Systems and Climate Change Hub researchers have studied a suite of new global climate models to evaluate their improved ability to project future changes to Australia's climate.

A new set of global climate models

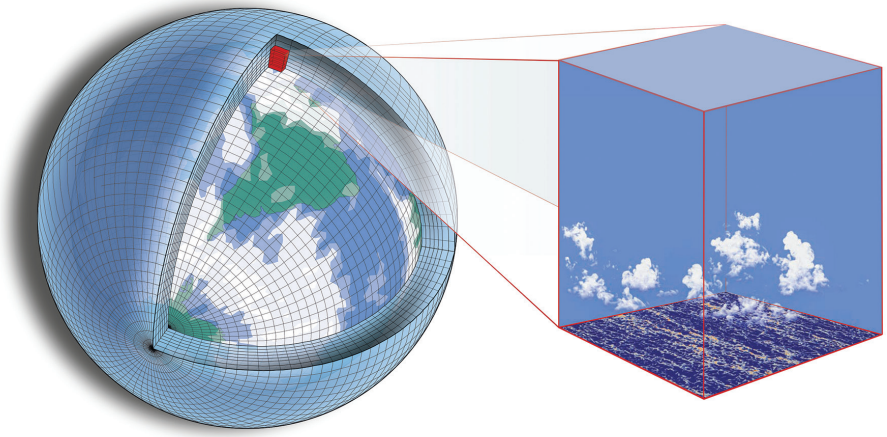
Projections of possible future global and Australian climate use multiple lines of evidence, of which a key tool is climate models. The World Climate Research Programme (WCRP) coordinates an international climate modelling project where simulations of future climate from modelling groups across the globe are made available for researchers and decision makers. For the last 25 years, this international 'Coupled Model Intercomparison Project' (CMIP) has provided new sets of global climate projection datasets every 6–7 years. The first datasets from the newest CMIP (CMIP6) are being produced and published across 2020 and 2021. To date, more than 50 new models under CMIP6 are available for analysis and evaluation, with more models expected to be progressively released during 2021. These new projections represent the latest iteration of global climate simulations based on the latest scientific understanding from modelling groups around the world.

The latest models were run at the finest 'resolution' computational power currently permits.

Researchers in the Earth Systems and Climate Change (ESCC) Hub have used the available CMIP6 climate models to evaluate how they have improved on previous global models in representing past and current climate, and to investigate how Australia's climate will change into the future.

How do CMIP6 climate models compare to previous models?

When evaluated against previous climate models, ESCC Hub researchers found that the new CMIP6 climate models provide incremental improvements in the representation of Australian temperature and rainfall patterns and their interactions, although some important model 'biases' and limitations remain as continuing scientific challenges to solve.



RIGHT: **Global climate models are the best tools for projecting possible future climates.** Climate models are mathematical representations of the climate system run on powerful computers. They represent the climate system on three-dimensional grids.
Image: Schneider *et al*. 2017.

One key finding from the evaluation of the new CMIP6 climate models was that a number of models exhibit a somewhat different range of 'equilibrium climate sensitivity' than previous (CMIP5) models. Equilibrium climate sensitivity tells us how much the Earth's temperature is expected to rise for a doubling of the amount of carbon dioxide in the atmosphere.

This is crucial for understanding climate change. Understanding and narrowing this range is a key on-going scientific challenge and is important for the development of future climate change projections for Australia.

Some CMIP6 models indicate a new upper range of climate sensitivity, with values spanning 1.8 to 5.6 °C across models and exceeding 4.5°C in more than ten of the new models. This exceeds the previously accepted likely range of 1.5 to 4.5 °C estimated by multiple lines of evidence in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report.

Understanding Australia's future climate using CMIP6

Using the new CMIP6 climate models, ESCC Hub researchers looked at what these climate models project for Australia's changing climate into the future. Two key findings are provided below:

Temperature: CMIP6 models project warming temperatures and increases in hot extremes. Under the highest emission scenario, mean annual temperatures in Australia are expected to warm by 3.5°C to 6.5°C by the end of the century.

This CMIP6 projection is higher beyond 2050 than previous projections due to the increased climate sensitivity found in some of the new CMIP6 models.

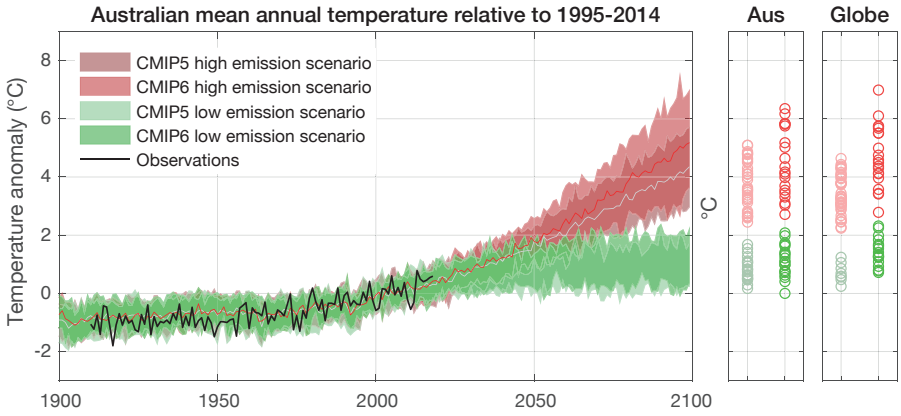


FIGURE 1 **Comparing CMIP6 and CMIP5 climate model simulations of Australian mean annual temperature.** Australian mean annual surface air temperature in observations (ACORN-SATv2), CMIP5 and CMIP6 (relative to 1995–2014) and multi-model mean global warming between 1995–2014 and 2080–2099. CMIP5 and CMIP6 high emission scenarios are RCP8.5 and SSP585 and low emission scenarios are RCP2.6 and SSP126. Circles in the panel to the right show the value for individual models (CMIP5 on the left, CMIP6 on the right). Adapted from (Grose et al. 2020).

Rainfall: CMIP6 models project a significant future drying of southern Australia in the cool season (particularly so in the southwest), and less certain or less significant rainfall changes elsewhere. These projections are qualitatively similar to previous projections under CMIP5.

Next generation projections for future climate decisions

The demand for regionalised, tailored and accessible science-based future climate information is high, and expected to increase as Australian sectors and industries come to understand, acknowledge and act on their climate risks. As the number of users of climate change information continues to grow, so too do their data and information needs. The next generation of climate change projections must try to meet this demand while at the same time incorporating the latest scientific understanding and climate modelling capability. The increase in detail required must be accompanied by clear guidance on the level of confidence in those projections.

Research by the ESCC Hub to evaluate and understand the new suite of CMIP6 climate models and their ability to project future changes to Australia's climate is an important step in the development and planning pathway for future new climate change projections for Australia. This will ensure current and future decisions are based on the most up-to-date and relevant climate change related information and evidence.

> *ESCC Hub researchers found that the new CMIP6 climate models have incrementally improved performance compared to CMIP5 models, but challenges remain in using the new models to produce projections.*

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