# 1. Introduction

This chapter gives the background to the project, a quick introduction to how climate change has been assessed at global, Australian and state levels, and the motivation for producing new work at this time.

## 1.1 Background

In 2018 the Victorian Department of Environment, Land, Water and Planning (DELWP) commissioned CSIRO's Climate Science Centre (CSC) to undertake new high-resolution climate modelling and produce a tailored climate projections and guidance package for Victoria. The package was commissioned to supplement the national projections at www.climatechangeinaustralia.gov.au (CCIA), the *Victorian Climate Initiative* (VicCI) and other projects supported by the Victorian Government. The package is titled *Victorian Climate Projections 2019* (VCP19), and this technical report is part of that package.

VCP19 has developed a new set of high-resolution regional climate simulations for Victoria using alternative methods from that used in VicCI and other previous studies (CSIRO and Bureau of Meteorology 2015; Hope et al. 2015a; Hope et al. 2017; Potter et al. 2018). VCP19 is designed to be complementary to VicCI and CCIA projections by adding new regional insights into future climate change and providing supplementary information and additional guidance to assessing climate change impacts. Projected changes in the climate can be better understood by using multiple lines of evidence and data where possible. For this reason, the new modelling results are put in context of previous work wherever possible, both in terms of identifying messages that are consistent between the different methods and identifying any new projected changes and regional insights from the new modelling. Differences between the different high-resolution climate data sets generally indicate the range of different possible changes to Victoria's future climate that can occur consistent with global warming (e.g. changes in extreme weather). Such differences in climate model results can be used to identify physical processes that underpin the projected changes and generally help to improve our understanding of the future climate. New insights from the climate projections are noted in the executive summary and highlighted throughout the report.

1  https://www.climatechange.vic.gov.au/information-and-resources

An example of using the new projections as a complement to previous work can be shown for water management. Victoria has a detailed water management plan to manage water resources under a changing climate https://www.water.vic.gov.au/water-for-victoria. The risk management plan includes a consideration of a range of projected changes in rainfall and evaporation by the end of the century, as well as the resampling of observations to produce severe hypothetical droughts as a worst-case scenario planning exercise for the coming years. The new VCP19 modelling has produced additional insights into the plausible change in rainfall over mountains, so provides a new dry case for the long-term future on the western slopes of the ranges that is consistent with the previous resampling method used to consider the near-term changes in climate. In this way, the new VCP19 projections add to the existing knowledge base rather than replace it.

DELWP and the Victorian Government supported the production of the *Climate-ready Victoria* set of products in 2016[1]. These products are based on the national climate projections reports and model inputs aggregated for the same regions used in VCP19. The messages and conclusions of *Climate-ready Victoria* are still current and relevant, and as for VicCI, the new VCP19 work presented here complements and adds to this work rather than replaces it.

## 1.2 Climate change in Victoria

Victoria's changing climate presents a significant challenge to individuals, communities, governments, businesses and the environment. Like the remainder of Australia, Victoria has already experienced increasing temperatures (Figure 1), shifting rainfall patterns and rising oceans.

The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC 2013) rigorously assessed the current state and future of the climate system, making several important conclusions:

▶ Greenhouse gas emissions have markedly increased because of human activities.

▶ Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea-level rise, and in changes in some climate extremes.

▶ It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century.

▶ Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system.

In recognition of the impact of climate change on the management of Australia's natural resources, the Australian Government funded CSIRO and the Australian Bureau of Meteorology (BOM) to develop tailored climate change projections reports for each of eight natural resource management (NRM) 'clusters' (i.e. clusters of existing NRM regions). These projections, *Climate Change in Australia* (CCIA), were released in 2015 and provide guidance on the changes in climate that need to be considered in planning.

Victoria is represented in these national projections as part of the Murray Basin (Timbal et al. 2015) and Southern Slopes (Grose et al. 2015a) clusters.

The 2018 State of the Climate (Bureau of Meteorology and CSIRO 2019) reports that:

▶ Australia's average temperature has increased by more than 1°C since 1910

▶ extreme heat events have increased in frequency

▶ rainfall in southeast Australia has declined by around 11% in the April to October period since the late 1990s

▶ extreme fire weather has increased in frequency and duration

▶ sea levels have risen leading to increased inundation risk.

Victoria has its own interests regarding climate change, risk and adaptation. For these reasons, in recent years the Victorian Government has supported climate research, climate projections, risk and adaptation work with a local focus. On the research and projections side, the *South East Australia Climate Initiative* (SEACI) and the *Victorian Climate Initiative* (VicCI) programs have generated science research and communication products targeted at Victoria and the Murray Basin.
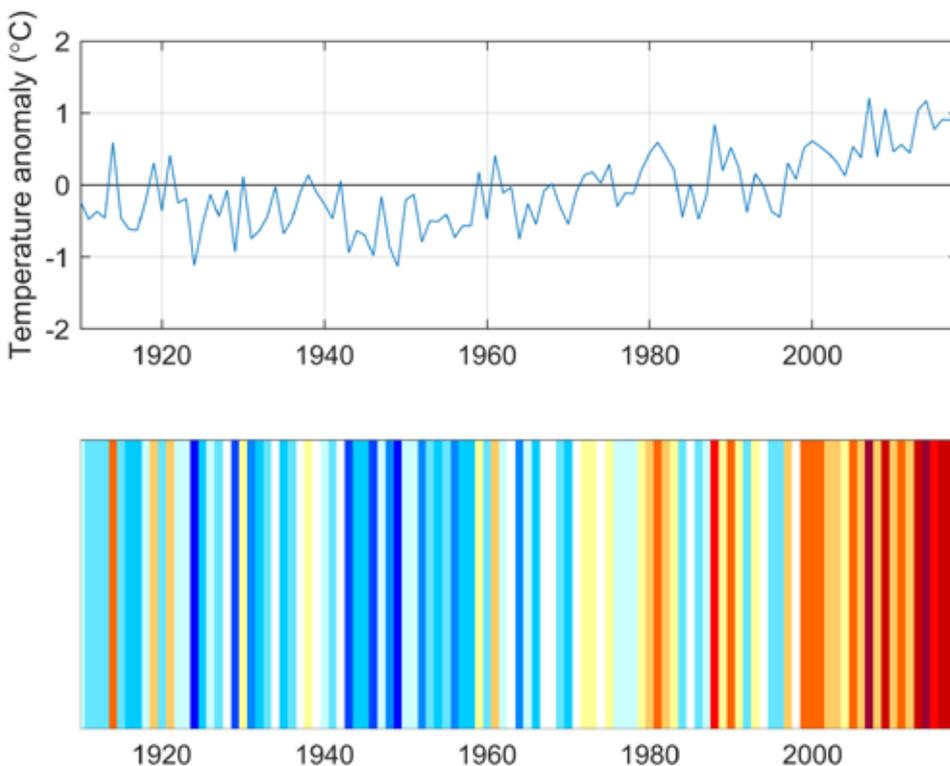


*Figure 1.   Average annual near-surface (2 m) temperature of Victoria 1910 to 2018 relative to the 1961–1990 baseline average. Panel on the bottom shows 'climate stripes' where each stripe represents the temperature anomaly of one year, reds indicate temperatures above the 1961–1990 average and blues, below average (ACORN-SATv2 data set, scale ranges from 1.5 to +1.5°C, methods of Ed Hawkins)*

## 1.3    Why produce new projections?

Since climate change operates over longer scales, climate projections do not need to be updated daily or monthly like weather or seasonal forecasts. However, as our observations of the climate continue, our climate knowledge continues to improve, models improve, and needs for climate information and projections continues to evolve. This means the credibility and salience of projections can be higher over time, so it is advisable to update climate assessments and projections when appropriate.

Milestones for developing projections include the release of IPCC assessment reports, and the release of new coordinated climate modelling ensembles under the Coupled Model Intercomparison Project (CMIP) structure. These international milestones then influence the development of projections at the national, state and local level. The most recent IPCC assessment report was released in 2012/13 and this draws on the latest round of coordinated global climate models known as CMIP5 released in 2011/12, among many other lines of evidence. The CCIA climate projections draw on the science and model simulations from this period, as well as drawing on high-resolution climate modelling based on the CMIP5 outputs. VCP19 uses the same CMIP5 outputs, as well as new high-resolution climate modelling, combined with subsequent research and observations. VCP19 is expected to be current until at least the release of the sixth IPCC assessment and CMIP6 in 2022, and for some time beyond as the new research and modelling will take time to be translated to local issues. Future climate research and modelling are likely to incrementally improve our understanding and refine our projections of climate change; however, this work is unlikely to change the fundamental understanding of climate change in Victoria. This means the VCP19 projections are expected to be relevant after 2022, with some contextualising of the results consistent with the future research.

Global climate model data is available for a range of future greenhouse gas emission scenarios agreed to by the international climate research community. However, due to limitations on modern supercomputing resources, the new high-resolution climate modelling focused on a medium emissions scenario (RCP4.5, see the glossary of terms at the end of this report) and a high emissions scenario (RCP8.5).

These emissions scenarios were chosen to explore some of the larger potential changes in the Victorian climate that can arise under different greenhouse gas emission scenarios. The use of the two greenhouse gas emissions scenarios in the high-resolution modelling was made possible by combining the resources of the VCP19 projections project with an existing project undertaken by Wine Australia and lead by researchers at the University of Tasmania. Both sets of high-resolution climate simulations were performed concurrently with common model configuration and methods, allowing for a broader assessment of potential changes to climate than would otherwise be possible. This technical report presents the results of this work at the spatial scale of the state of Victoria and sub-regions within Victoria.

The outputs from the VCP19 project are available to the Victorian Government, broader community and the scientific community to improve understanding and application of climate projections. The outputs of VCP19 are:

► this technical report – aimed at scientists

► 10 regional reports – aimed at non-scientists

► projections and data for medium (RCP4.5) and high (RCP8.5) scenarios of future greenhouse gas emissions

► projections of Victoria's climate under the Paris Agreement target of 2°C global mean temperature increase compared to the pre-industrial era

► good practice guidance for how to make best use of the new projections and data sets

► data sets of projected regional changes for 12 climate variables (including four measures of climate extremes) for 10 regions on annual, seasonal and monthly time scales

► gridded (5 km) and town-based 'application-ready' data sets for 10 climate variables for annual to daily time scales

► gridded (5 km) change data sets for 11 climate variables for annual to daily time scales

► gridded (5 km and 50 km) output for six high-resolution climate model experiments with more than 20 climate variables for up to hourly time scales

► new functionality on the *Climate Change in Australia* website, providing access to the new data and products.