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Victorian Climate Projections 2019

Technical report

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Executive summary

This report describes a set of climate projections featuring new high-resolution climate change simulations for Victoria developed by CSIRO's Climate Science Centre (CSC), which describe how the regional climate of Victoria is likely to respond to global warming with different scenarios of human greenhouse gas emissions. This work was commissioned by the Victorian Department of Environment, Land, Water and Planning (DELWP) to supplement previous projections of climate change for Victoria and to develop a tailored climate projections and guidance package for Victoria.

An important consideration when developing regional climate change projections is to avoid basing the projections on a single modelling system or an individual line of evidence. For this reason, it was decided to extend the existing climate change projections information from the *Victorian Climate Initiative* (VicCI) summarised in (Hope et al. 2017), and presented in the guidelines for assessing the impact of climate change (DELWP 2016). Those projections drew strongly on statistically downscaled simulations of climate change for Victoria and were aimed primarily at water managers. The new results presented here feature a dynamically downscaled set of simulations based on the Conformal Cubic Atmospheric Model (CCAM), as well as drawing on the full range of outputs from *Climate Change in Australia* (CCIA) using global climate models and other climate modelling data sets. For the new CCAM simulations, six global climate models were downscaled to 5 km resolution over Victoria. The six high-resolution CCAM simulations are based on a subset of the global climate model simulations recommended by CCIA as representative of the range of projected changes in temperature and rainfall as well as other climate variables. The regional climate change projections described in this report combine the results of the new and previous climate model simulations to provide an assessment of plausible changes to the regional climate that could pose significant risks for the state of Victoria.

The climate of Victoria has been getting warmer, with the mean annual temperature rising by just over 1°C between 1910 and 2018 according to high quality observations from ACORN-SATv2. There have been more warm years than cool years in recent decades, and the last year with below-average temperature was 1996 relative to the 1961–1990 baseline. Simulations of future warming under plausible greenhouse gas emission scenarios are consistent with a 0.5 to 1.3°C increase in temperature between the 1990s and 2030s. After superimposing natural variability on the global warming signal, it is possible to observe negligible or even negative short-term trends in temperature between 2019 and 2030. Beyond the next couple of decades, the projected change in temperature depends strongly on the greenhouse gas emissions pathway that the world follows. For example, between the 1990s and 2090s, the temperature over Victoria is projected to warm on average by 2.8 to 4.3°C under a high emissions scenario or warm by 1.3 to 2.2°C under a medium emissions scenario. In the case where global warming is limited to 2°C, matching aspirations under the Paris Agreement, then Victoria is expected to warm by a similar amount, in contrast to many other places in the world that will warm by more or less than the global average. The new high-resolution simulations suggest that increases in average temperature can be higher than previously estimated, especially in spring. This means a hotter 'worst-case' scenario should be considered to manage risks appropriately.

Victoria is projected to continue becoming drier in the long term in all seasons except summer, for which models indicate that both increases and decreases in average rainfall are possible. Large rainfall variability at scales from days to decades is expected to continue. The new regional climate model simulations are broadly consistent with previous climate projections across Victoria as a whole, except for the summer and autumn signature where the new simulations show high agreement on a projected decrease whereas previous dynamical downscaling indicated an increase (Grose et al. 2015a; Hope et al. 2015b; Timbal et al. 2015; DELWP 2016; Hope et al. 2017; Potter et al. 2018). The projection of autumn and summer rainfall in the new dynamical downscaling agrees more with the global climate model projections and statistical downscaling, as well as the recent observed decrease in autumn rainfall, leaving the previous downscaling as exceptions. However, there is not sufficient evidence to reject any set of results as implausible and this reinforces the need to consider a range of models and multiple lines of evidence when assessing projected change in the regional climate. The new high-resolution modelling identifies a greater projected decrease in the annual-averaged rainfall than in the surrounding regions – on the windward (western) slopes of the Australian Alps (primarily in the Ovens Murray region) in autumn, winter and spring compared to the surrounding regions.

Consistent with previous studies of projected regional climate change, extreme events such as heatwaves, bushfires and extreme rainfall are expected to continue to become more frequent in the decades to come. The intensity and/or frequency of past 1-in-20-year extreme daily rainfall is expected to increase, even in areas where average rainfall is expected to decline. The number of fire days are expected to increase under most global warming scenarios, with a larger increase in fire days for alpine regions. The results of the new high-resolution modelling are consistent with more favourable conditions for thunderstorms under global warming.

New high-resolution climate modelling has produced several important new insights about the possible future climate of Victoria.

Caution should always be employed when interpreting the results of a single climate modelling system until combined with additional lines of evidence and data from other available models. Nevertheless, the new high-resolution downscaling indicates that it is possible for regional daily average temperatures to increase up to 1°C more than was projected by the global climate models in some seasons and regions. For example, for Gippsland in spring under a high emissions scenario around the end of the century, the upper range of daily average temperature change from global models is 3.9°C. In contrast, the high-resolution simulations suggest the change could be up to 5.1°C. This result is considered plausible as the regional model captures the feedback from the drier landscape under hotter daytime temperatures, and better represents the weather effects from the finer resolution of the boundary between land and oceans. Extreme daily maximum temperatures are projected to increase by as much as twice the increase in the average maximum temperatures. The new high-resolution modelling also indicates that large increases in winter extreme daily maximum temperatures are possible. Another important insight from the new regional projections for Victoria is that the new modelling indicates that rainfall and inflows over the Australian Alps and in the Murray River catchments may be affected to a greater degree than has been previously expected under high greenhouse gas emission scenarios.

The new regional climate projections for Victoria described in this report indicate that climate change poses a serious risk for Victoria. The data in this study are intended to support planning and policy decisions made by the Victorian Government and community as well as being used by scientific researchers to better understand the consequences of global climate change. Regional climate projections will continue to be improved and enhanced as new climate change information becomes available but building on foundations developed in this study as well as previous projects such as VicCI, and findings coming out of the current *Victorian Water and Climate Initiative*. It is important to combine future climate projections with knowledge of climate exposure and vulnerability, as well as adaptive capacity to assess what a changing climate means to any given question or sector.