Australian Capital Territory Climate change snapshot

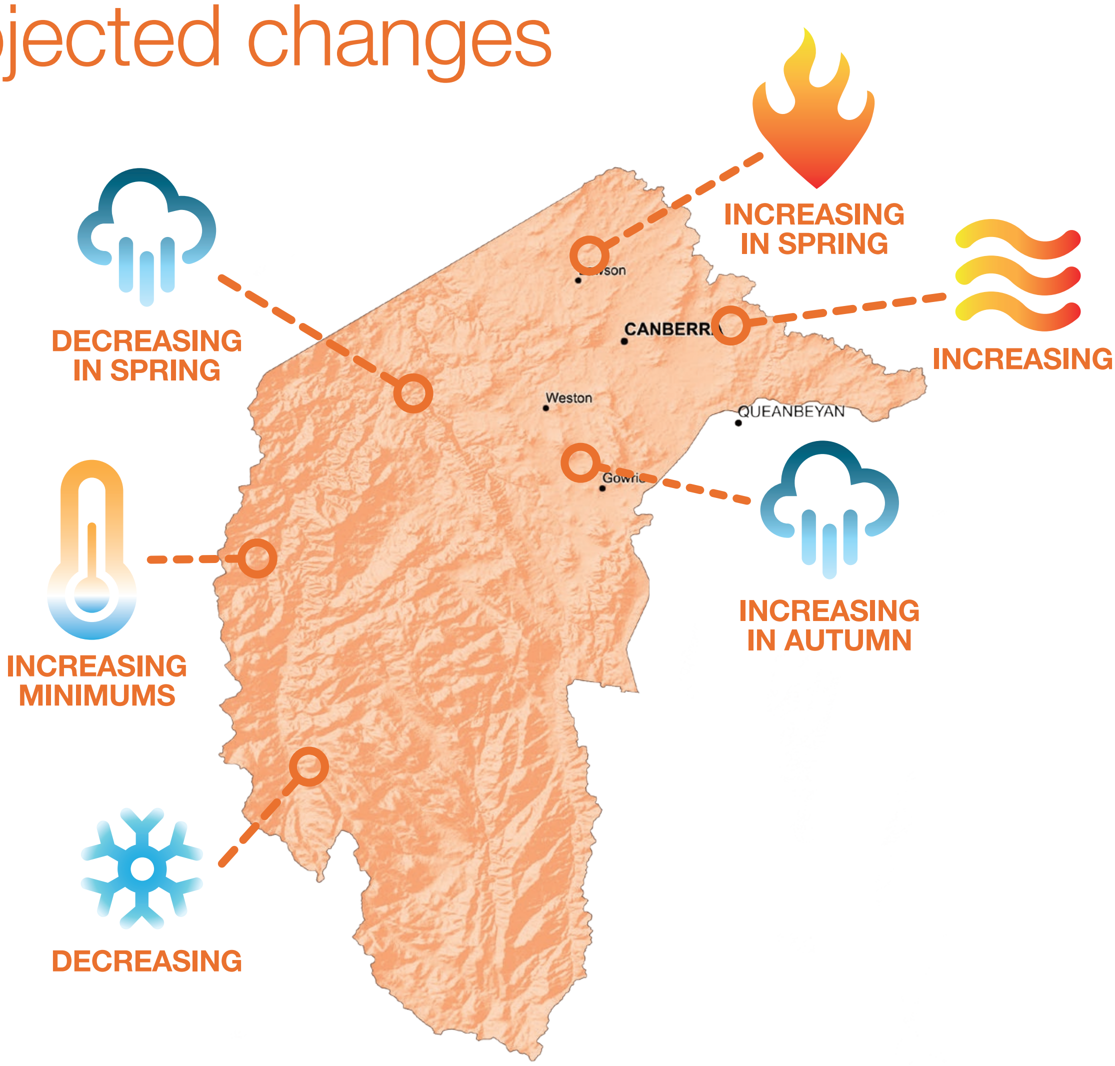
Overview of **Australian Capital Territory** climate change

Based on long-term (1910–2011) observations, temperatures in the Australian Capital Territory (ACT) have been increasing since about 1950, with higher temperatures experienced in recent decades.

The ACT is projected to continue to warm during the near future (2020–2039) and far future (2060–2079), compared to recent years (1990–2009). The warming is projected to be on average about 0.7°C in the near future, increasing to about 2°C in the far future. The number of hot days is projected to increase, with fewer cold nights.

The warming trend projected for the ACT is large compared to natural variability in temperature and is similar to the rate of warming projected for NSW.

Projected changes



Projected **temperature** changes	
Maximum temperatures are projected to increase in the near future by 0.6 – 0.9°C	Maximum temperatures are projected to increase in the far future by 1.4 – 2.3°C
Minimum temperatures are projected to increase in the near future by 0.4 – 0.7°C	Minimum temperatures are projected to increase in the far future by 1.4 – 2.3°C
The number of hot days will increase	The number of cold nights will decrease
Projected rainfall changes	
Rainfall is projected to decrease in spring	Rainfall is projected to increase in summer and autumn
Projected Forest Fire Danger Index (FFDI) changes	
Average fire weather is projected to increase in spring, summer and winter	The number of severe fire weather days is projected to increase in summer and spring

Regional snapshots

NSW and ACT Regional Climate Modelling project (NARCliM)

The climate change projections in this snapshot are from the NSW and ACT Regional Climate Modelling (NARCliM) project. NARCliM is a multi-agency research partnership between the NSW and ACT governments and the Climate Change Research Centre at the University of NSW. NSW Government funding comes from the Office of Environment and Heritage (OEH), Sydney Catchment Authority, Sydney Water, Hunter Water, NSW Office of Water, Transport for NSW, and the Department of Primary Industries.

The NARCliM project has produced a suite of twelve regional climate projections for south-east Australia spanning the range of likely future changes in climate. NARCliM is explicitly designed to sample a large range of possible future climates.

Over 100 climate variables, including temperature, rainfall and wind are available at fine resolution (10km and hourly intervals). The data can be used in impacts and adaptation research, and by local decision makers. The data is also available to the public and will help to better understand possible changes in NSW climate.

Modelling overview

The NARCliM modelling was mainly undertaken and supervised at the Climate Change Research Centre. NARCliM takes global climate model outputs and downscales these to provide finer, higher resolution climate projections for a range of meteorological variables. The NARCliM project design and the process for choosing climate models has been peer-reviewed and published in the international scientific literature (Evans et. al. 2014, Evans et. al. 2013, Evans et. al. 2012).

Go to climatechange.environment.nsw.gov.au for more information on the modelling project and methods.

Interpreting climate projections can be challenging due to the complexities of our climate systems. 'Model agreement', that is the number of models that agree on the direction of change (for example increasing or decreasing rainfall) is used to determine the confidence in the projected changes. The more models that agree, the greater the confidence in the direction of change.

In this report care should be taken when interpreting changes in rainfall that are presented as the average of all of the climate change projections, especially when the model outputs show changes of both wetting and drying. To understand the spread of potential changes in rainfall the bar charts should be considered along with the maps provided in this document. Help on how to interpret the maps and graphs in this report is provided in Appendix 1.

Summary documents for each of the state planning regions of NSW are also available and provide climate change information specific to each region.

The snapshots provide descriptions of climate change projections for two future 20-year time periods: 2020–2039 and 2060–2079.

1. The climate projections for 2020–2039 are described in the snapshots as **NEAR FUTURE, or as 2030**, the latter representing the average for the 20-year period.
2. The climate projections for 2060–2079 are described in the snapshots as **FAR FUTURE, or as 2070**, the latter representing the average of the 20-year period.

Further information about the regions will be released in 2015.

Introduction

This snapshot presents climate change projections for the Australian Capital Territory (ACT). It outlines some key characteristics of the territory, including its current climate, before detailing the projected changes to the region's climate in the near and far future.

Location and topography

The ACT is home to Australia's capital city, Canberra. The territory lies between 35° and 36° latitude south at the northern extent of the Australian Alps bioregion, as an enclave within NSW. The total area of the ACT is about 2352 km^2, of which 60 per cent is hilly or mountainous with northern parts of the territory comprising more undulating terrain. Elevations range from 450 m along the Murrumbidgee River to 1911 m above sea level at the top of Mount Bimberi. Situated on the Eastern Lachlan Fold Belt, the ACT includes the eastern edge of the Brindabella Ranges with Bimberi Peak located on the NSW–ACT border (ABS 2007).

Notable physical features are timbered mountains located in the south and west of the territory, and plains and hill country in the north. The ACT is situated within the upper Murrumbidgee River catchment, in the Murray–Darling Basin. The Murrumbidgee flows through the territory from the south, and its tributary, the Molonglo, from the east. Other tributaries of the Murrumbidgee include the Cotter, Paddys, Naas and Gudgenby Rivers. The Molonglo River was dammed in 1964 to form Lake Burley Griffin (ABS 2007).

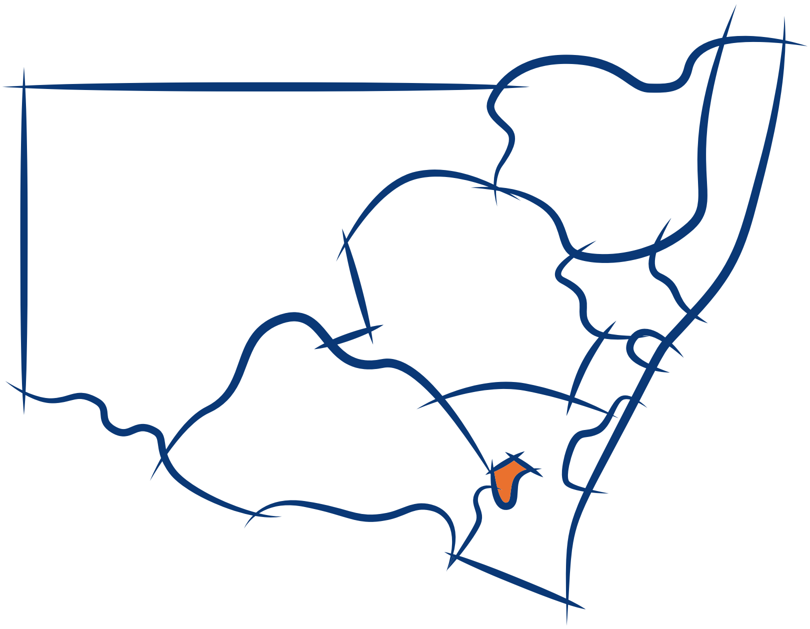
Population and settlements

In 2011, the population of the ACT was approximately 357,000, with Canberra the only city (ABS 2011). Smaller communities in the territory include Williamsdale, Tharwa, Hall, Naas and Uriarra. Public administration, health care and social assistance and education and training are the major employers of the 195,890 strong work force.

The population of the ACT is projected to increase by 50,350 persons, to a total population of 390,100 persons by 2019. Much of the territory's population growth is projected to occur in the new development areas of Gungahlin and Molonglo (ACT Government 2014).

Natural ecosystems

The Namadgi National Park, with its mountainous and forested areas, covers about 46 per cent of the ACT, protecting part of the northern end of the Australian Alps (Snowy Mountains). Despite the small size of the territory, it is home to a variety of habitats including open grasslands, low open woodlands and tall wet forests. Of particular importance are the sub-alpine heathlands and wetlands containing sedge ferns and sphagnum moss that are vital for the endangered northern corroboree frog. The Ginini Flats Wetlands Ramsar Site is of particular importance for the protection of the northern corroboree frog and the only such site in the ACT. There are 12 additional threatened species in the region.



Climate of the ACT

The varied topography of the ACT results in a large range of climate conditions over a relatively small area. In the north of the territory around Canberra it is relatively dry and warm compared to the much cooler and wetter south-western area around the northern Australian Alps. Northern parts of the territory experience mild summers, with cold winters experienced in the Alps. More mild conditions are experienced in the central part of the ACT with warmer winters than the south, but cooler summers than the north of the territory. A more detailed account of seasonal and spatial variations in temperature and rainfall is given below.

Temperature

Average annual temperatures range from 16°C in the north-west to 6°C in the Alps. Average daily temperatures in summer range from 20–22°C in northern parts of the territory to 12–14°C in higher altitudes of the Alps. During winter, average daily temperatures range from 6–8°C in the north to 0–2°C at higher elevations in the alps.

Average daily maximum temperatures during summer range from 26–28°C across the north of the ACT to between 18–20°C in the alps. The average minimum temperature in winter ranges from 2–4°C in the north, to between –4 and –2°C in the south and the alps.

The territory experiences distinct seasons. Seasonal variations are illustrated by the monthly changes in average, minimum and maximum temperatures (Figure 1). The average monthly temperature in the ACT ranges from approximately 18°C in January to around 4°C in July. The ACT has a large variation in temperature across the region with average temperatures decreasing as you move south.

Long term temperature records show an increase in temperatures in the ACT since approximately 1950, with an acceleration in the rate of increase in temperatures observed in the last two decades.

Temperature extremes

Temperature extremes, both hot and cold, occur infrequently but can have considerable impacts on health, infrastructure and our environment. Changes to temperature extremes often result in greater impacts than changes to average temperatures.

Hot days

On average, the ACT experiences fewer than 10 hot days each year (maximum temperatures above 35°C). A marginally greater number of hot days occur in the north of the ACT, and there are typically no days with temperatures greater than 35°C in the alps.

Cold nights

The number of nights per year with minimum temperatures below 2°C varies considerably across the territory, generally increasing southwards. Canberra typically experiences 70–90 cold nights per year, and in the mountainous areas have on average over 170 cold nights per year.

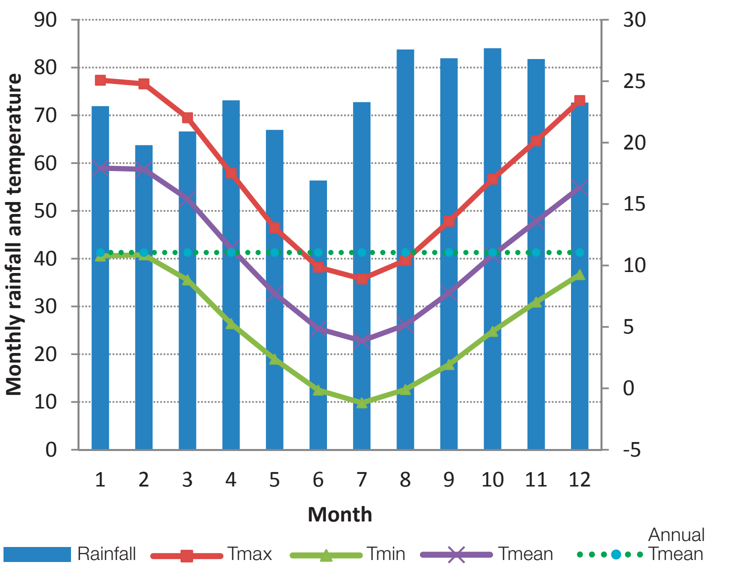
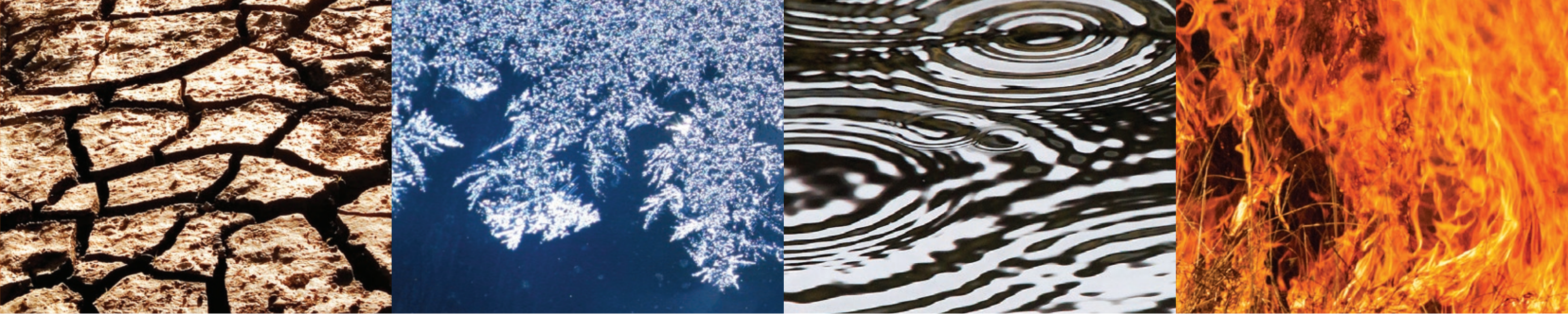


Figure 1: Seasonal rainfall and temperature variations (AWAP[1] data for 1960–1991).

1. Australian Water Availability Project, see www.csiro.au/awap/.



Rainfall

Rainfall varies considerably across the Australian Capital Territory. This variability is due to the complex interactions between weather patterns in the region, the influence of larger-scale climate patterns such as El Niño Southern Oscillation, and the topography of the Australian Alps and Great Dividing Range.

Rainfall ranges from over 1200 mm in the alps to 400–800 mm in the north and east of the territory (including Canberra). Central and western parts of the ACT receive an average of 800–1200 mm of rainfall each year.

Rainfall is uniform throughout the year across the north and central parts of the territory, which generally receives between 100 and 300 mm each season. Parts of the alps receive 300–400 mm in winter and spring.

During much of the first half of the 20th century the ACT has experienced drier conditions. There is more year-to-year variability in rainfall from the 1950s to 1990s. The first decade of the 21st century was characterised by below average rainfall during the Millennium Drought.

Fire weather

The risk of bushfire in any given region depends on four 'switches'. There needs to be enough vegetation (fuel), the fuel needs to be dry enough to burn, the weather needs to be favourable for fire to spread, and there needs to be an ignition source (Bradstock 2010). All four of these switches must be on for a fire to occur. The Forest Fire Danger Index (FFDI) is used in NSW to quantify fire weather. The FFDI combines observations of temperature, humidity and wind speed with an estimate of the fuel state.

Long-term observations of FFDI come from daily measurements of temperature, rainfall, humidity and wind speed at only a small number of weather stations in Australia, with 17 stations located in NSW and the ACT (Lucas 2010). FFDI values below 12 indicate low to moderate fire weather, 12-25 high, 25-49 very high, 50-74 severe, 75-99 extreme and above 100 catastrophic.

Long term FFDI estimates show average daily FFDI is 7 in Canberra.

Fire weather is classified as 'severe' when the FFDI is above 50. Canberra has on average 1.1 severe fire weather days each year.

Average FFDI					
Station	Annual	Summer	Autumn	Winter	Spring
Canberra	6.9	11.4	7.2	2.6	6.4
Number of severe fire weather days (FFDI>50)					
Canberra	1.1	0.8	0.2	0	0.2

Table 1: Baseline FFDI values for meteorological stations within the ACT

Temperature

Climate change projections are presented for the near future (2030) and far future (2070), compared to the baseline climate (1990–2009). The projections are based on simulations from a suite of twelve climate models run to provide detailed future climate information for NSW and the ACT.

Temperature is the most reliable indicator of climate change. Across the ACT all of the models agree that average, maximum and minimum temperatures are increasing.

Summary temperature

Maximum temperatures are projected to increase in the near future by 0.7°C

Maximum temperatures are projected to increase in the far future by 2.0°C

Minimum temperatures are projected to increase by near future by 0.6°C

Minimum temperatures are projected to increase by far future by 2.0°C

There are projected to be more hot days and fewer cold nights.

Projected regional climate changes

The ACT is expected to experience an increase in all temperature variables (average, maximum and minimum) for the near future and the far future (Figure 2).

Maximum temperatures are projected to increase by 0.7°C in the near future and by 2°C in the far future. Spring will experience the greatest changes in maximum temperatures, increasing by 2.5°C in the far future (Figure 2b). Increased maximum temperatures are known to impact human health through heat stress and increasing the number of heatwave events.

Minimum temperatures are projected to increase by 0.6°C in the near future by 2°C in the far future (Figure 2c). Increased overnight temperatures (minimum temperatures) can have a considerable effect on human health.

These increases are projected to occur across the ACT (Figures 3–6).

The long-term temperature trend indicates that temperatures in the region have been increasing since approximately 1950, with the largest increase in temperature variables coming in the most recent decades.

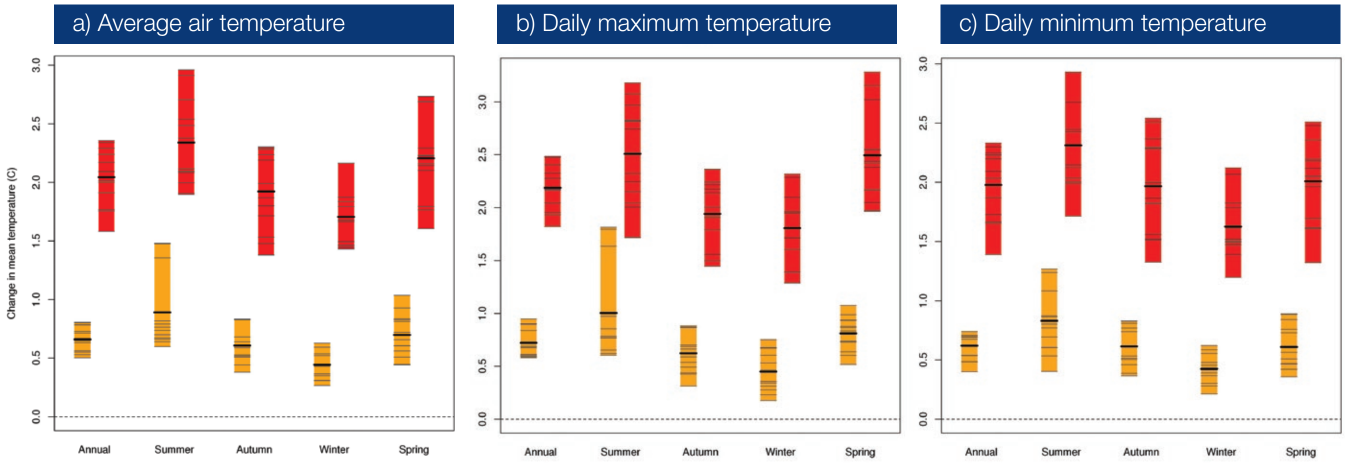


Figure 2: Projected air temperature changes for the ACT, annually and by season (2030 yellow; 2070 red): a) average, b) daily maximum, and c) daily minimum. (Appendix 1 provides help with how to read and interpret these graphs).

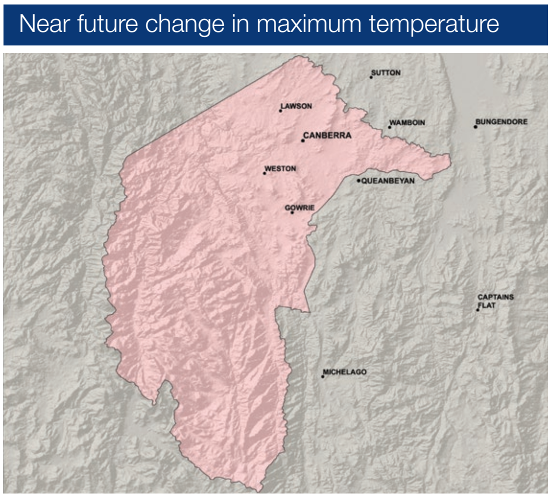


Figure 3: Near future (2020–2039) change in annual average maximum temperature, compared to the baseline period (1990–2009).

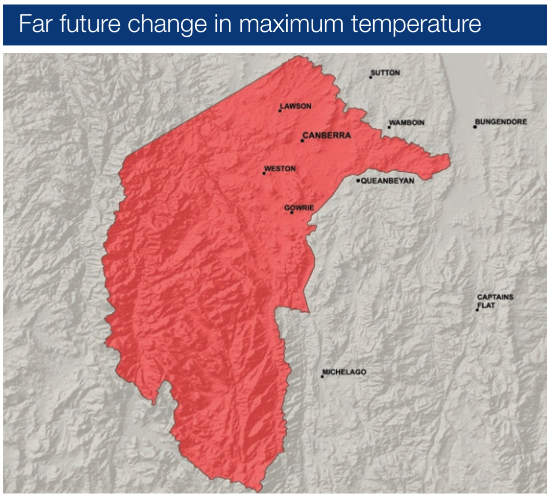


Figure 4: Far future (2060–2079) change in annual average maximum temperature, compared to the baseline period (1990–2009).

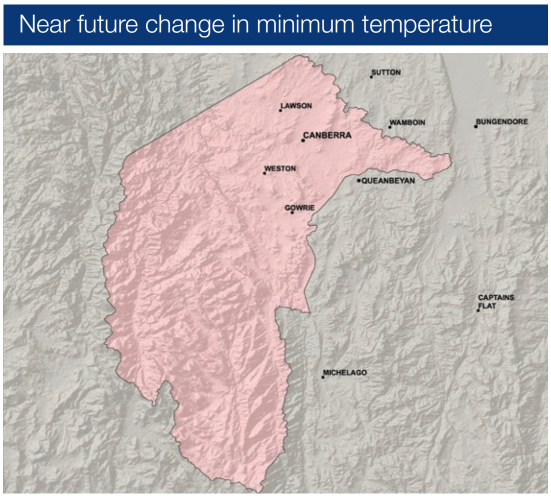


Figure 5: Near future (2020–2039) change in annual average minimum temperature, compared to the baseline period (1990–2009).

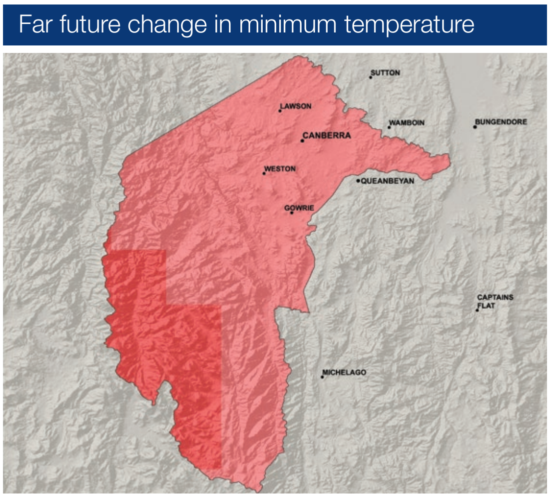
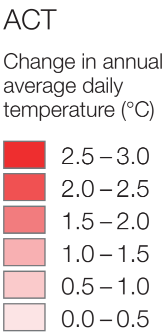


Figure 6: Far future (2060–2079) change in annual average minimum temperature, compared to the baseline period (1990–2009).



Hot days

DAYS PER YEAR ABOVE 35°C

Currently the ACT experiences fewer than 10 days each year (temperatures above 35°C). International and Australian experiences show that prolonged hot days increase the incidence of illness and death – particularly among vulnerable population groups such as people who are older, have a pre-existing medical condition or who have a disability. Seasonal changes are likely to have considerable impacts on bushfire danger, infrastructure development and native species diversity.

Projected regional climate changes

The ACT is expected to experience more hot days in the near future and the far future (Figure 7).

There are minor changes projected for much of the region with the greatest increase around Canberra where there are projected to be an additional 1-5 hot days in the near future (Figure 8) expanding to over 10–20 more hot days by 2070 (Figure 9).

The region, on average, is projected to experience an additional two hot days in the near future (0–3 days per year across the 12 models) and six more hot days in the far future (3–8 days per year across the 12 models) (Figure 7).

These increases are being seen mainly in spring and summer though in the far future hot days are also extending into autumn (Figure 7).

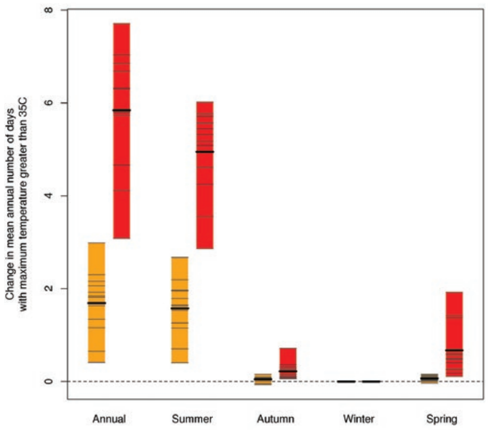


Figure 7: Projected changes in the number of hot days (with daily maximum temperature of above 35°C) for the ACT, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

Near future change in days per year above 35°C

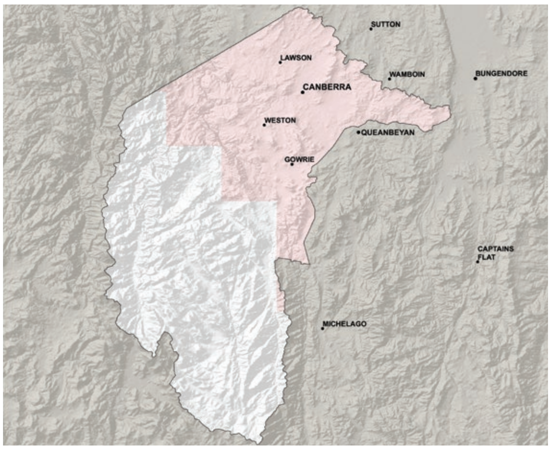


Figure 8: Near future (2020–2039) projected changes in the number of days per year with maximum temperatures above 35°C.

Far future change in days per year above 35°C

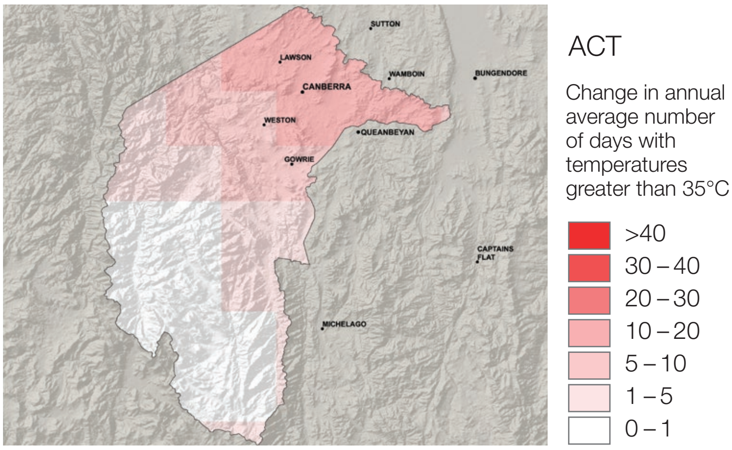
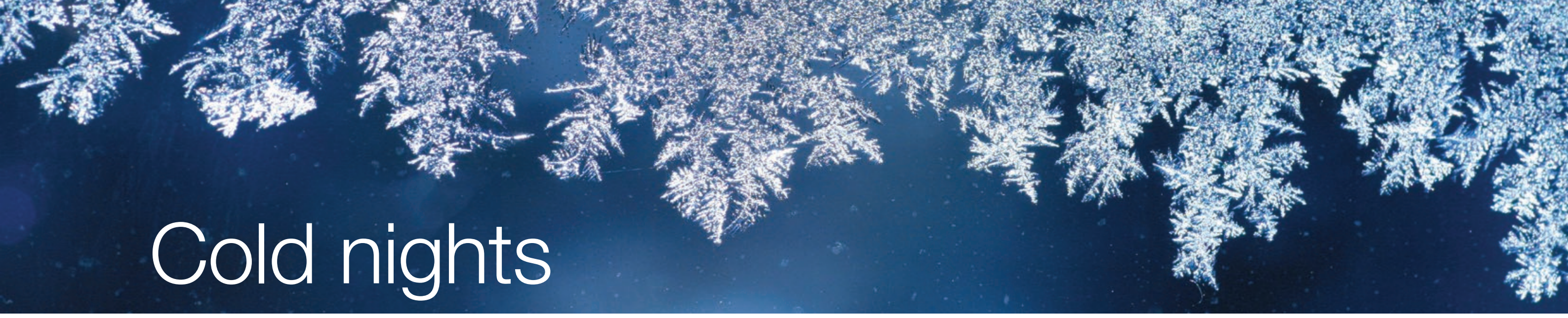


Figure 9: Far future (2060–2079) projected changes in the number of days per year with maximum temperatures above 35°C.



Cold nights

DAYS PER YEAR BELOW 2°C

Most of the emphasis on changes in temperatures from climate change has been on hot days and maximum temperatures, but changes in cold nights are equally important in the maintenance of our natural ecosystems and agricultural/horticultural industries; for example, some common temperate fruit species require sufficiently cold winters to produce flower buds. The Snowy Mountains is also home to alpine ecosystems reliant on long cold periods and snow.

Projected regional climate changes

The ACT is expected to experience fewer cold nights in the near future and the far future (Figure 10).

The decreases are projected to occur equally across the whole region (Figures 11 and 12).

All models agree that the region as a whole will see a decrease in cold nights with an average of approximately 13 fewer cold nights per year by 2030, ranging from 10–17 nights across the individual models. The decrease in cold nights is projected to be even greater in the far future, with an average of 43 fewer cold nights per year (ranging from 32–53 nights across the individual models) (Figure 12).

A decrease in the number of cold nights is projected for all seasons, dominated by decreases in winter and spring (Figure 10).

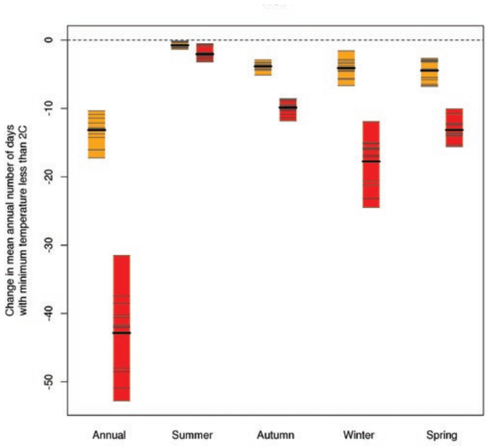


Figure 10: Projected changes in the number of low temperature nights for the ACT, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

Near future change in number of cold nights (below 2°C) per year

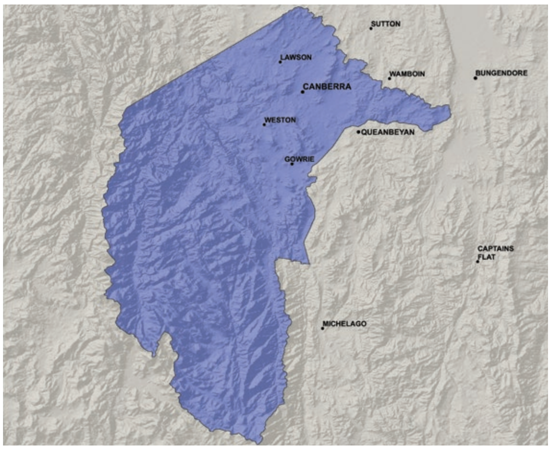
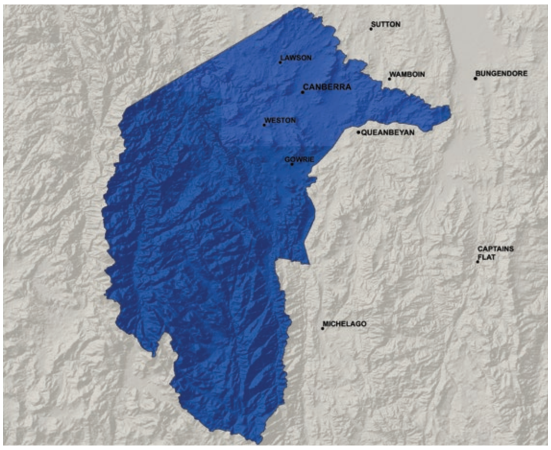


Figure 11: Near future (2020–2039) change in the number of days per year with minimum temperatures below 2°C, compared to the baseline period (1990–2009).

Far future change in number of cold nights (below 2°C) per year



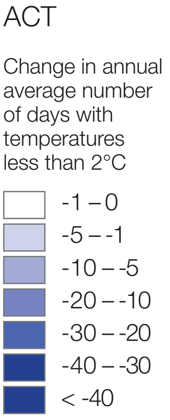


Figure 12: Far future (2060–2079) change in the number of days per year with minimum temperatures below 2°C, compared to the baseline period (1990–2009).

Rainfall

Changes in rainfall patterns have the potential for widespread impacts. Seasonal shifts can often impact native species' reproductive cycles as well as impacting agricultural productivity, for example crops that are reliant on winter rains for peak growth.

Rainfall changes are also associated with changes in the extremes, such as floods and droughts, as well as secondary impacts such as water quality and soil erosion that occur as a result of changes to rainfall intensity.

Modelling rainfall is challenging due to the complexities of the weather systems that generate rain. 'Model agreement', that is the number of models that agree on the direction of change (increasing or decreasing rainfall) is used to determine the confidence in the projected change. The more models that agree, the greater the confidence in the direction of change.

Care should be taken when interpreting changes in rainfall from averaging climate change projections when the model outputs project changes of both wetting and drying. To understand the spread of potential changes in rainfall the bar charts should be considered along with the maps provided in this document.

Rainfall is projected to decrease in spring and increase in autumn

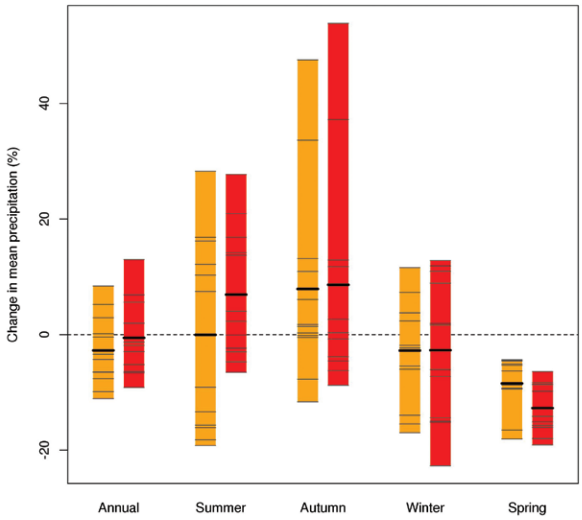


Figure 13: Projected changes in average rainfall for the ACT, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

Projected regional climate changes

In the ACT all models agree that spring rainfall will decrease in the near future and the far future. Winter rainfall is also projected to decrease, with the majority of models agreeing (8 out of 12) in the near future (Figure 13).

The ACT currently experiences considerable rainfall variability across the region, seasons and from year-to-year and this variability is also reflected in the projections.

Autumn rainfall is projected to increase by the majority of models in the near future (8 out of 12) and the far future (7 out of 12) (Figure 13). These increases are uniform across the region (Figures 14 and 15)

All models agree that spring rainfall is projected to decrease across the whole region in the near future and that the decrease continues into the far future (Figures 14 and 15).

Seasonal rainfall projections for the near future span both drying and wetting scenarios for summer (–19–% to +28%), autumn (–12% to +48%) and winter (–17% to +12%); in the far future the projected changes are summer (–7% to +28%), autumn (–9% to +54%), and winter (–23% to +13%) (Figure 13).

All models agree that spring rainfall will decrease (Figure 13) but the size of the decrease varies between models for both the near future (-18% to -4%) and the far future (-6% to -19%).

Projections for the region's annual average rainfall range from a decrease (drying) of 11% to an increase (wetting) of 8% by 2030 and still span both drying and wetting scenarios (–9% to +13%) by 2070.

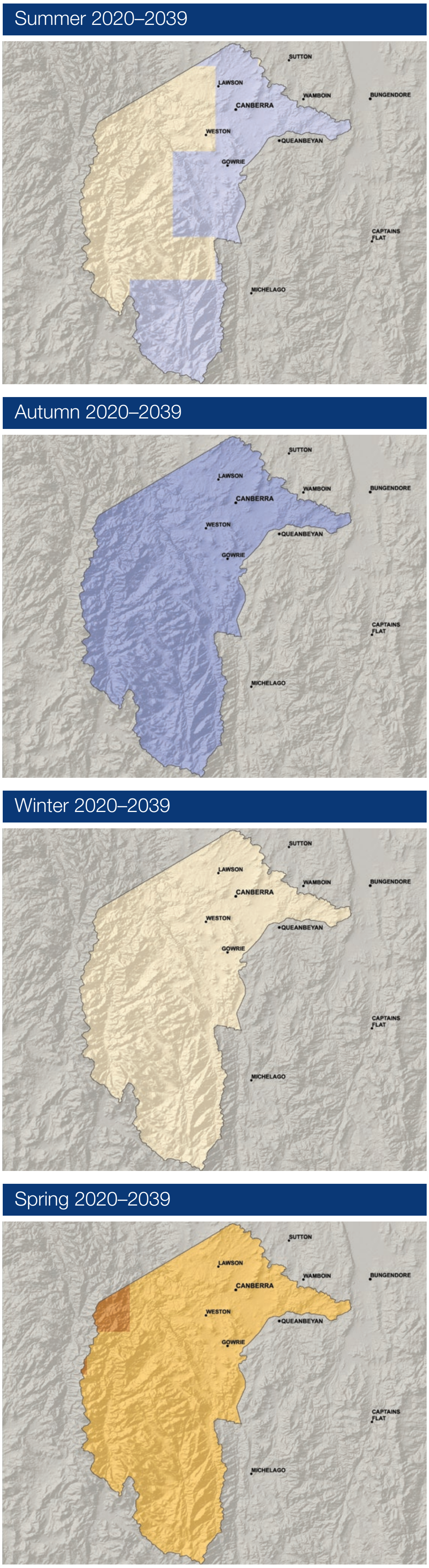


Figure 14: Near future (2020–2039) projected changes in average rainfall by season.

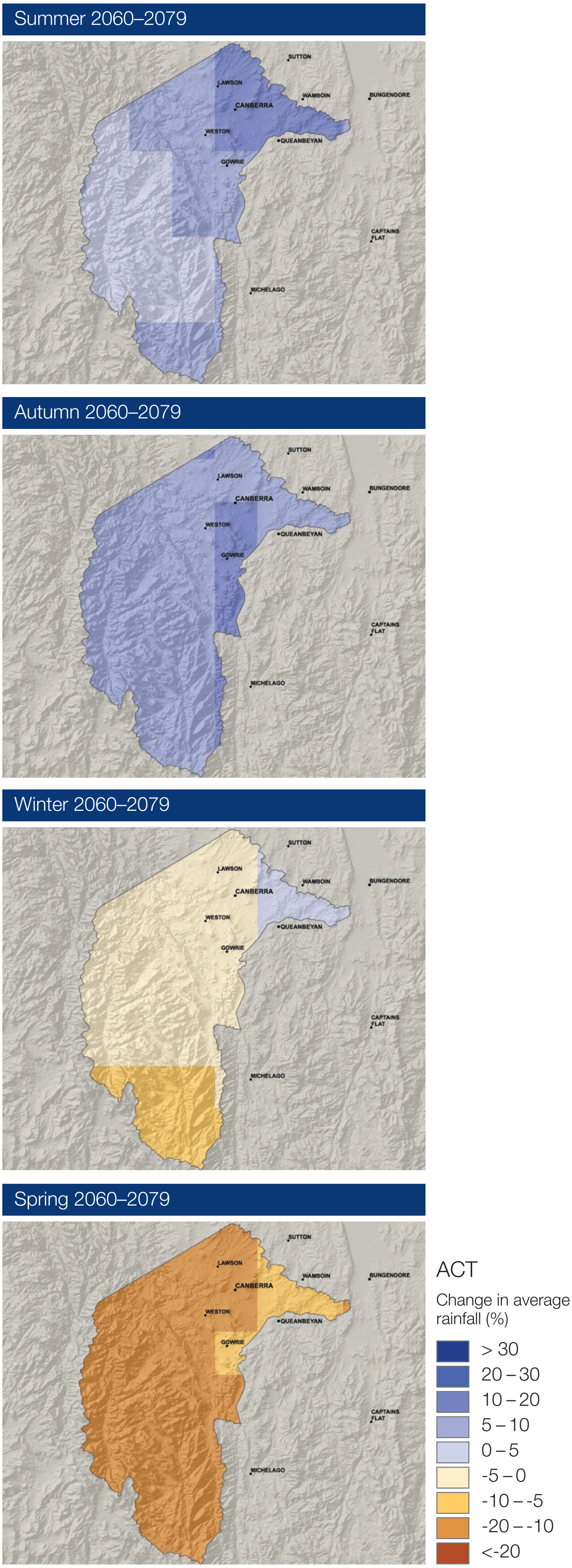


Figure 15: Far future (2060–2079) projected changes in average rainfall by season.

Fire weather

The Bureau of Meteorology issues Fire Weather Warnings when the FFDI is forecast to be over 50. High FFDI values are also considered by the Rural Fire Service when declaring a Total Fire Ban.

Average FFDI values are often used to track the status of fire risk. These values can be used when planning for prescribed burns and help fire agencies to better understand the seasonal fire risk. The FFDI is also considered an indication of the consequences of a fire if one was to start – the higher the FFDI value the more dangerous the fire could be.

FFDI values below 12 indicate low to moderate fire weather, 12-25 high, 25-49 very high, 50-74 severe, 75-99 extreme and above 100 catastrophic.

Severe and average fire weather is projected to increase

Projected regional climate changes

The ACT is projected to experience an increase in average and severe FFDI in the near future (2020–2039) and the far future (2060–2079) (Figures 16 and 17).

The increases in average fire weather are projected to occur mainly in summer and spring. The northern ACT has the greatest increases, and these increases occur across all seasons (Figures 18 and 19)

Increases in severe fire weather are projected in summer and spring. Although these changes are relatively small in magnitude (three more days every decade) they are projected to occur in prescribed burning periods (spring) and the peak fire risk season (summer) (Figure 17).

Autumn is projected to have a decreased severe fire risk in the near future but there is less confidence in the projections for the far future. As fire weather measurements take into account rainfall, it is likely that the decrease in autumn FFDI is due to the increase in autumn rainfall across the region (see Figures 14 and 15).

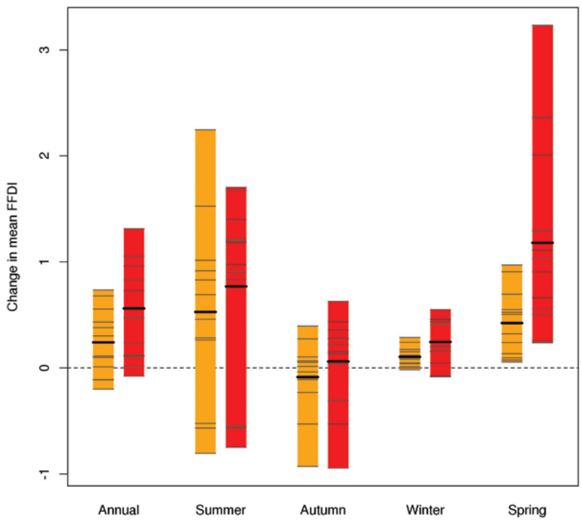


Figure 16: Projected changes in the average daily forest fire danger index (FFDI) for the ACT, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

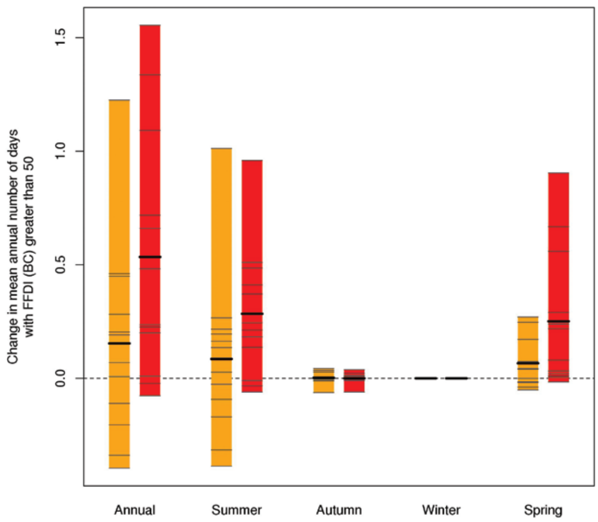


Figure 17: Projected changes in average annual number of days with a forest fire danger index (FFDI) greater than 50 for the ACT, annually and by season (2030 yellow; 2070 red).

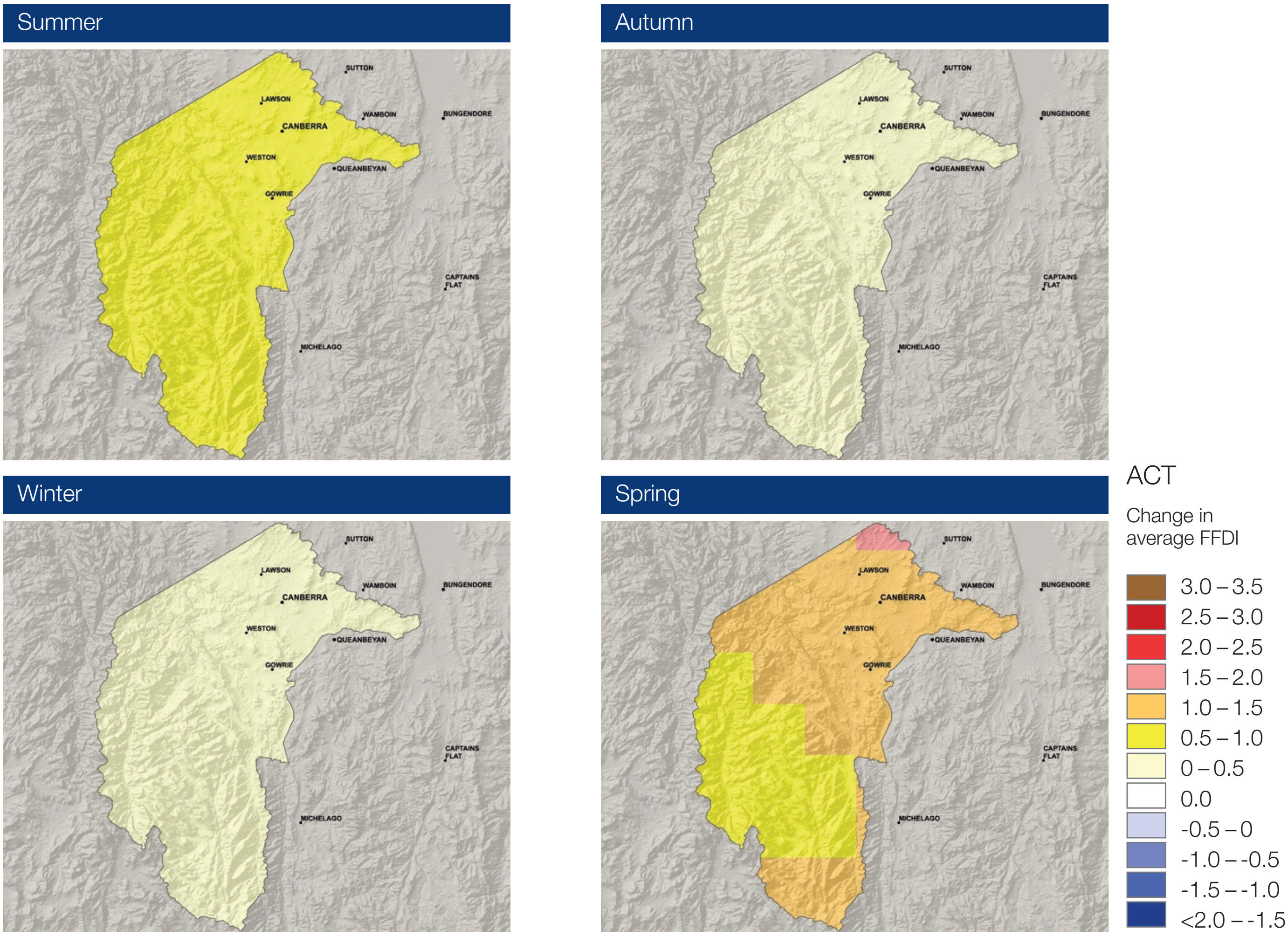


Figure 18: Far future (2060–2079) projected changes in average daily FFDI, compared to the baseline period (1990–2009).

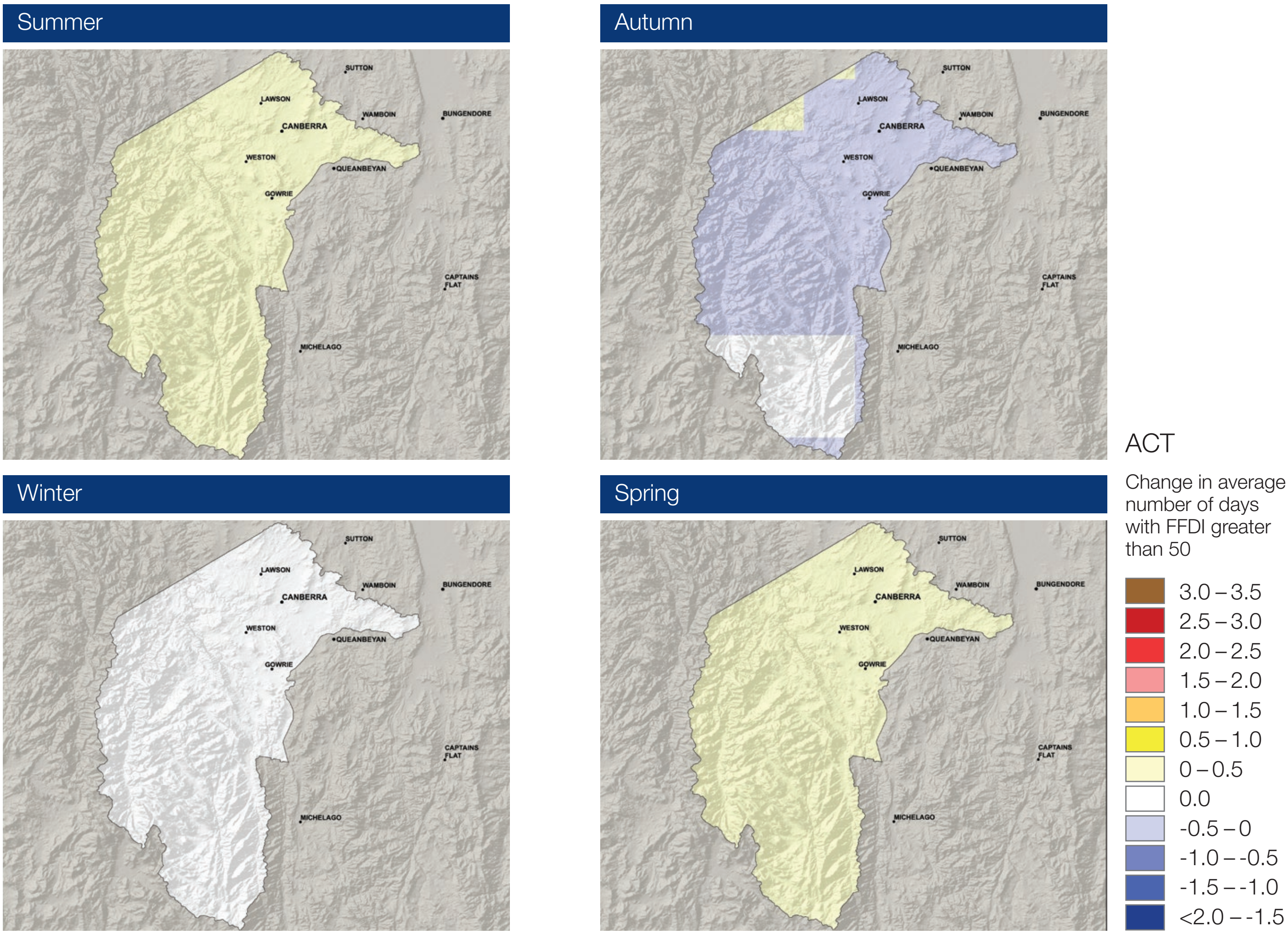


Figure 19: Far future (2060–2079) projected changes in average annual number of days with a FFDI greater than 50, compared to the baseline period (1990–2009).

Appendix 1 Guide to reading the maps and graphs

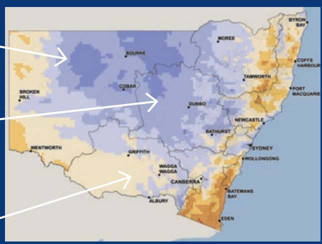
This document contains maps and bar graphs of the climate change projections. The maps present the results of the twelve models as an average of all twelve models. The bar graphs show projections averaged across the entire state and do not represent any particular location within the state. The bar graphs also show results from each individual model. See below for more information on what is displayed in the maps and bar graphs.

How to read the maps

The maps display a **10km** grid.

NSW has been divided into State Planning Regions and each region has a Local Snapshot report.

The colour of each grid is the **average of all 12 models** outputs for that grid.



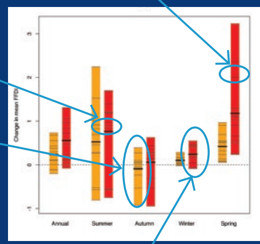
How to read the bar graphs

The thin grey lines are the **individual models**. There are 12 thin lines for each bar.

The thick line is **the average of all 12 models** for the region.

The length of the bar shows the **spread of the 12 model values** for the region

Each line is the **average for** the region. They do not represent a single location in the region.



Note: The yellow bars represent the near future (2020–2039), while the red bars represent the far future (2060–2079)..

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