Far West
Climate change snapshot

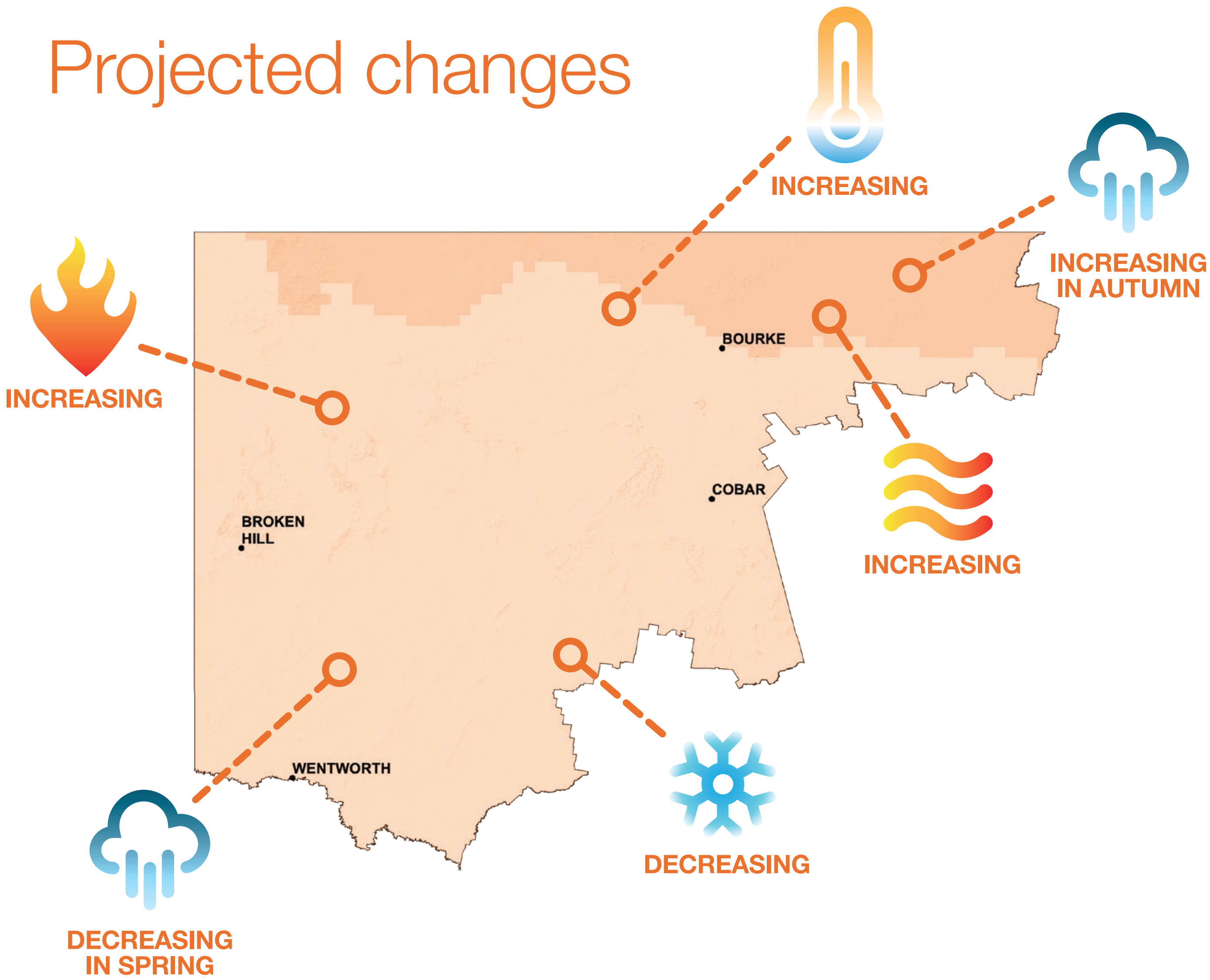
Overview of **Far West Region** climate change

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

The Far West Region 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 2.1°C in the far future. The number of high temperature days is projected to increase, with fewer potential frost risk nights anticipated.

The warming trend projected for the region is large compared to natural variability in temperature and is of a similar order to the rate of warming projected for other regions of NSW.

Projected changes



Projected **temperature** changes	
Maximum temperatures are projected to increase in the near future by 0.3 – 1.0°C	Maximum temperatures are projected to increase in the far future by 1.8 – 2.7°C
Minimum temperatures are projected to increase in the near future by 0.4 – 0.8°C	Minimum temperatures are projected to increase in the far future by 1.4 – 2.7°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 summer and spring	Number of days with severe fire weather is projected to increase in summer and spring

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 available and provide climate change information specific to each region.

The regional 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 Far West Region of NSW. It outlines some key characteristics of the region, including its current climate, before detailing the projected changes to the region's climate in the near and far future.

Location and topography

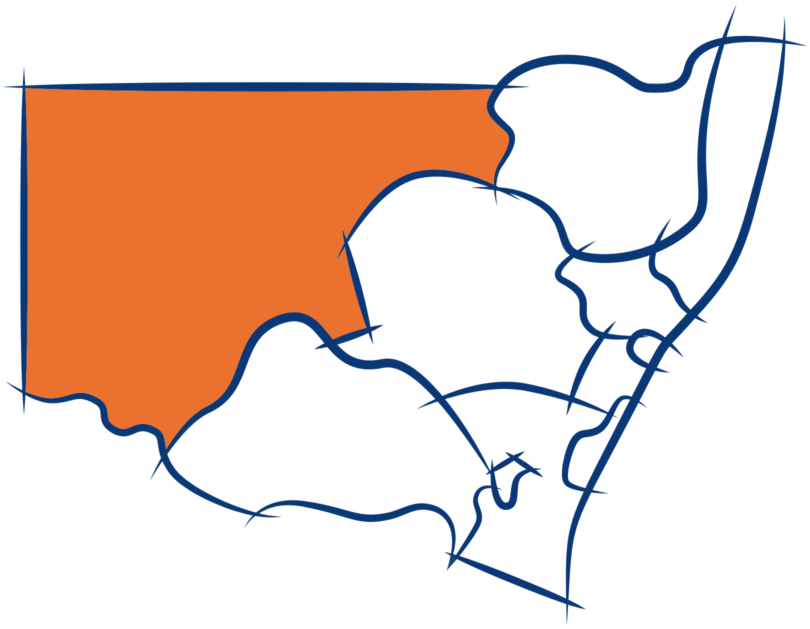
Bordering Queensland to the north, South Australia to the west and Victoria to the south, the Far West Region is the largest NSW planning region. Much of the area falls within the Murray–Darling Basin, dominated by wide floodplains and tributaries into the Darling River. Situated west of the Great Dividing Range, the Far West Region is dominated by brown and grey clay soils.

Population and settlements

The Far West Region is the largest by area but has the smallest population of all the NSW planning regions. It has approximate population of 48,100 in an area that includes Broken Hill and the Unincorporated Far West. With a work force of approximately 18,700, the largest employers include agriculture, educational services and metal ore mining.

Natural ecosystems

The region supports a high diversity of species and ecosystems. The Barwon–Darling system is located entirely within the region. Major wetlands, including the internationally significant Narran Lake and Paroo River Wetlands on the Darling Riverine Plains, and Lake Pinaroo in the Bulloo 'Overflow'. Major conservation reserves include Sturt, Paroo–Darling, Mutawintji, Kinchega and Mungo national parks. The vegetation and landscapes of this region have been substantially modified through the expansion of pastoralism and artificial water sources derived from the Great Artesian Basin, and impacts of feral animals, in particular goats.



Climate of the region

The climate of the Far West Region is influenced by its low-lying topography and distance from the coast. The eastern fringe experiences the highest rainfall totals in the region, whilst the central and western parts are very dry. It is hot in the north of the region during summer, with cool winters in the southern and central areas. Milder conditions are found along the southern fringe adjacent to the Victorian border, with cooler summers than the rest of the region.

Temperature

The region experiences a distinct seasonal and spatial variation in temperature. There is little variation in the winter minimum temperatures; however, maximum summer temperatures increase towards the north. In summer, average temperatures range from 22–24°C in the south of the region to 28–30°C across the north. In winter, average temperatures range from 12–14°C in the north to 8–10°C in the south east.

Maximum temperatures during summer range from 30°C in the south close to the Victorian border and around Broken Hill to 36°C in the north and north-west from Bourke through to Tibooburra. In winter, the average minimum temperatures is 4–6°C for most of the region, while the areas along the South Australian border generally average 6–8°C.

Temperatures have been increasing since about 1950, with the largest increase in temperature experienced in recent 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

The number of hot days (maximum temperature above 35°C) ranges from 30–40 days per year in the south to over 70 days per year in the north-west of the region around Bourke and Tibooburra. The region generally experiences more hot days each year on average than the other regions in NSW due to its distance from the coast.

Cold nights

The number of cold nights (minimum temperatures below 2°C) per year decreases towards the west of the region, with isolated areas around Ivanhoe experiencing between 30–50 nights per year. Most of the Far West Region experiences fewer than 20 cold nights per year.

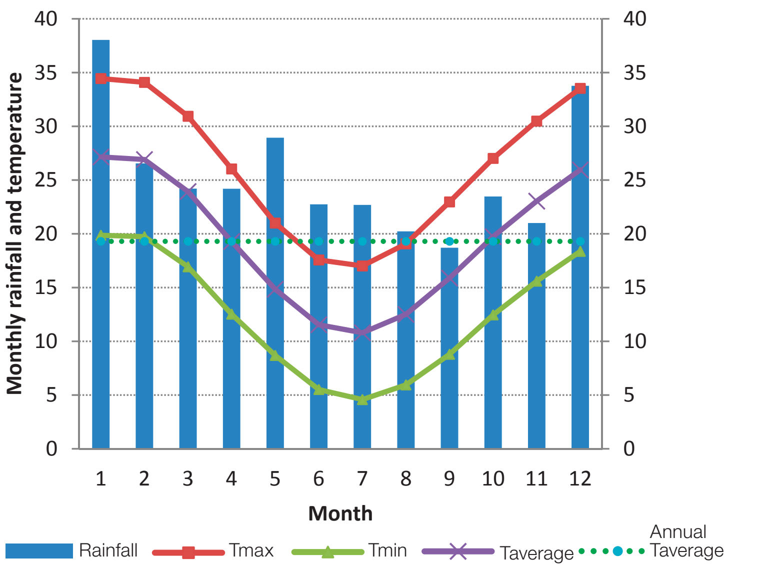
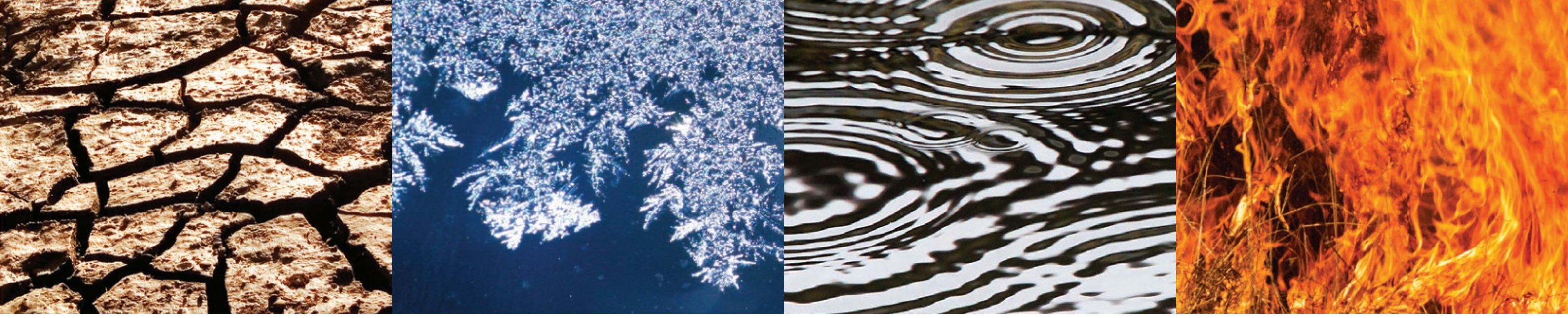


Figure 1: Seasonal rainfall and temperature variations (AWAP[1] data for 1960–1991).

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



Rainfall

Rainfall variability occurs due to complex interactions between several rainfall drivers influencing the region, including synoptic weather patterns and larger-scale influences such as El Niño Southern Oscillation.

Much of the Far West Region is semi-arid and receives 200–400 mm of rainfall per year on average. Parts of the eastern fringe receive over 400 mm, whilst along the South Australian border it is more arid recieving less than 200 mm of rain per year.

Throughout the central parts of the region, rainfall is fairly uniform throughout the year, experiencing 50–100 mm each season. The northern areas of the Far West Region typically has more summer rain. In winter and spring, the north-western corner generally receives less than 50 mm per season, whilst most of the eastern parts of the region experience from 50–100 mm per season.

During much of the first half of the 20th century the region experienced drier conditions. Greater inter-annual variability is evident in the rainfall during the 1950s to 1990s. The first decade of the 21st century was characterised by below average rainfall during the Millennium Drought. This dry period ended with two of the wettest years on record for Australia (2010–2011).

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 estimates are available for five meteorological station within the Far West Region, Tibooburra and Broken Hill in the west, Wilcannia near the centre and Cobar and Bourke (Table 1).

The average annual FFDI values estimated for the period 1990–2009 range from 12.1 in Broken Hill to 21.2 in Tibooburra. The highest average FFDI values occur in summer and spring and the lowest in winter.

Fire weather is classified as 'severe' when the FFDI is above 50. 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 fire weather days occur two days per year in Broken Hill to almost 20 in Tibooburra.

Average FFDI					
Station	Annual	Summer	Autumn	Winter	Spring
Tibooburra	21.2	31.1	18.2	10.3	25.1
Broken Hill	12.1	17.7	10.3	6	14.8
Wilcannia	18.5	28.3	16.4	8.6	21.2
Bourke	16.3	24.4	13.9	8	19.4
Cobar	14	21.5	11.9	6.3	16.3
Number of severe fire weather days (FFDI>50)					
Tibooburra	19.9	11.15	1.3	0.3	7.15
Broken Hill	2.2	0.7	0.15	0.05	1.3
Wilcannia	12.4	6.75	1.1	0.2	4.35
Bourke	7.2	4.7	0.2	0.05	2.25
Cobar	5.25	3.35	0.15	0	1.75

Table 1: Baseline FFDI values for meteorological stations within the Far West Region.

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 Far West Region 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 2.1°C

Minimum temperatures are projected to increase by near future by 0.7°C

Minimum temperatures are projected to increase by far future by 2.1°C

Hot days are increasing and cold days are decreasing

Projected regional climate changes

The Far West 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 2.1°C in the far future. Summer and spring will experience the greatest changes in maximum temperatures, with 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 0.7°C in the near future and by 2.1°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 region, with a slightly greater increase in the far north-west (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.

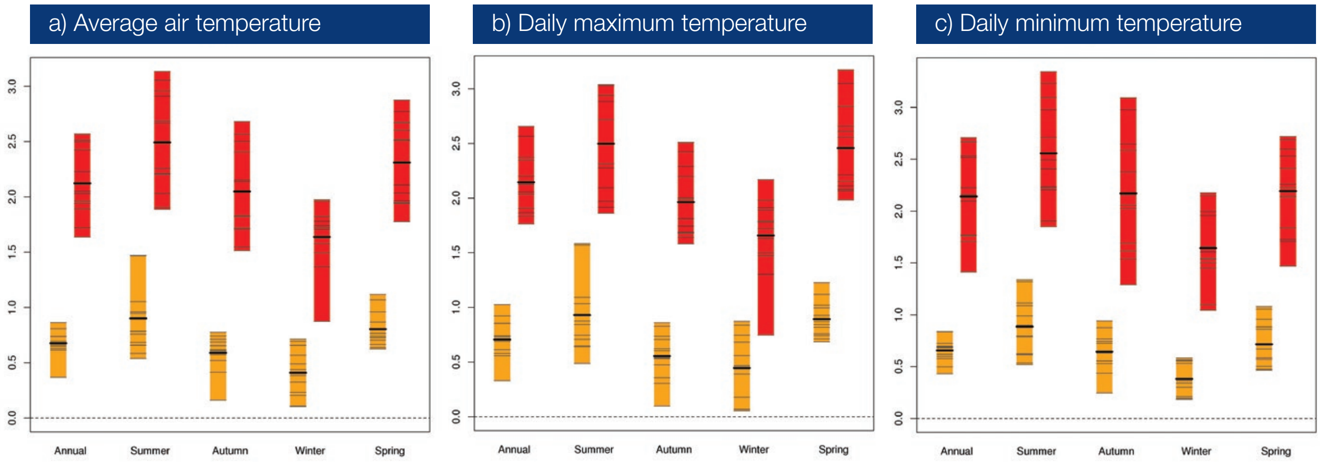


Figure 2: Projected air temperature changes for the Far West, annually and by season (2030 yellow; 2070 red): a) average, b) daily maximum, and c) daily minimum. (Appendix 1 provides help with how to read and interpret these graphs).

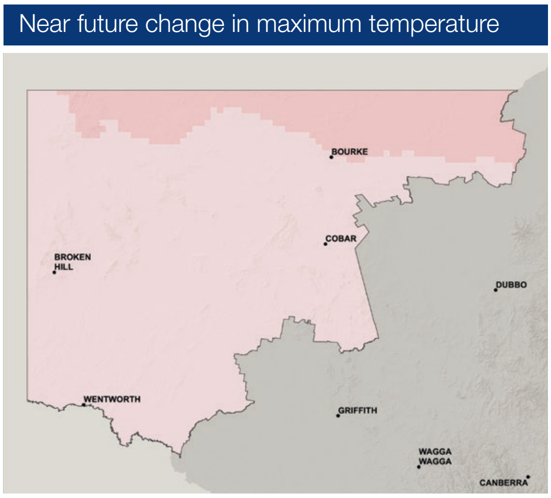


Figure 3: Near future (2020–2039) change in annual average maximum temperature, compared to the baseline period (1990–2009).

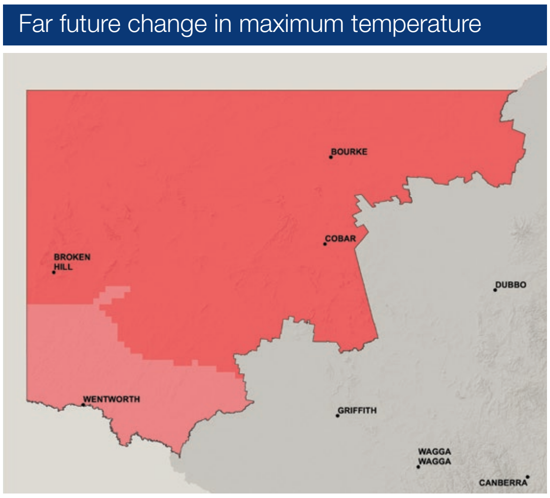


Figure 4: Far future (2060–2079) change in annual average maximum temperature, compared to the baseline period (1990–2009).

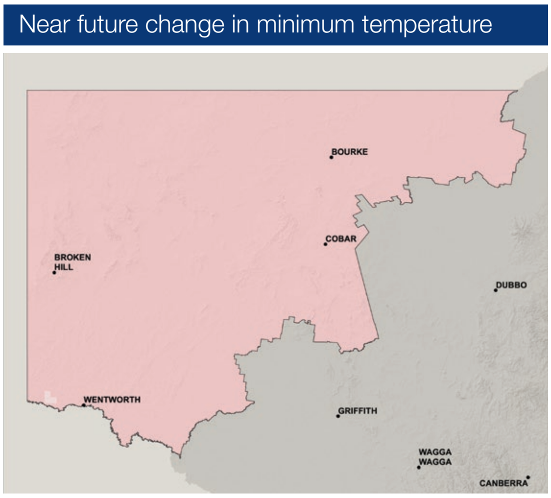


Figure 5: Near future (2020–2039) change in annual average minimum temperature, compared to the baseline period (1990–2009).

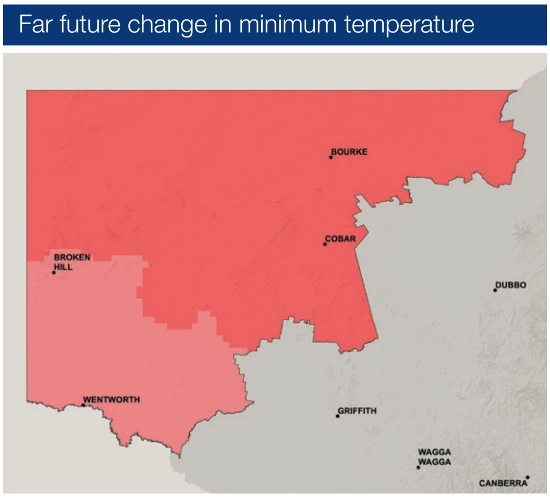


Figure 6: Far future (2060–2079) change in annual average minimum temperature, compared to the baseline period (1990–2009).

Far West

Change in annual average daily temperature (°C)

- 2.5 – 3.0
- 2.0 – 2.5
- 1.5 – 2.0
- 1.0 – 1.5
- 0.5 – 1.0
- 0.0 – 0.5

Hot days

DAYS PER YEAR ABOVE 35°C

FUTURE CLIMATE

Currently the Far West Region experiences an average of 30–40 days above 35°C each year in the south and over 70 days in the north. 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.

Projected regional climate changes

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

The greatest increase is projected for the northern parts with an additional 10–20 days in the near future (Figure 8). By 2070 the northern half of the region is projected to have 30 more hot days, with over 40 hot days for the north-western plains around Bourke (Figure 9). Considerable increases are also projected for the southern half of the region with 20–30 additional hot days (Figure 9).

The region, on average, is projected to experience an additional 12 hot days in the near future (6–18 days per year across the 12 models) and 35 more hot days in the far future, (27–43 days per year across the 12 models) (Figure 7).

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

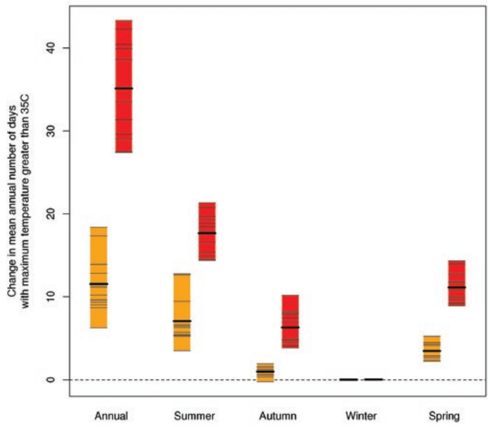


Figure 7: Projected changes in the number of hot days (with daily maximum temperature of above 35°C) for the Far West Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

Near future change in days per year above 35°C

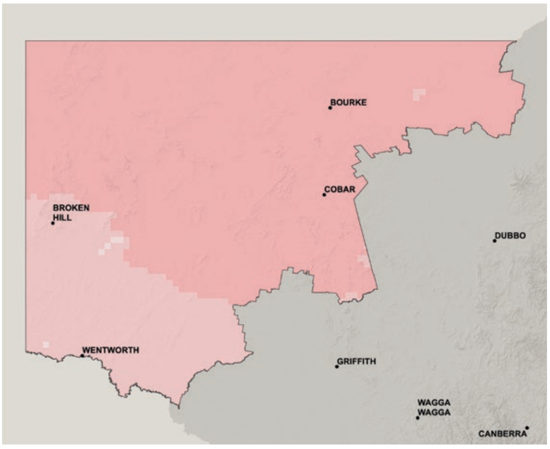


Figure 8: Near future (2020–2039) projected changes in the number of days per year with maximum temperatures above 35°C.

Far future change in days per year above 35°C

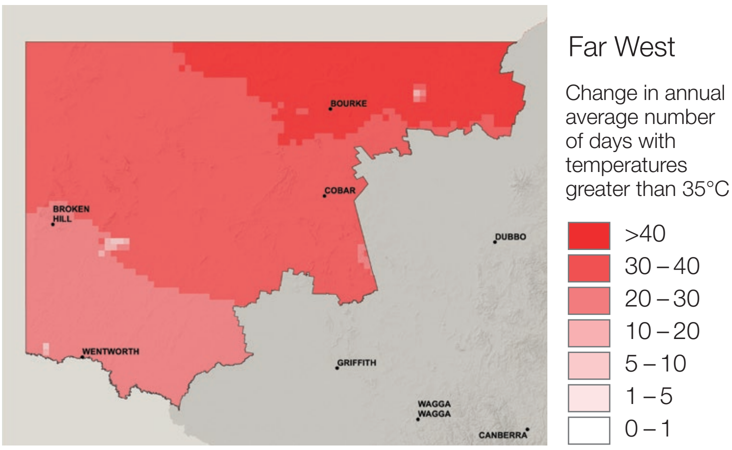
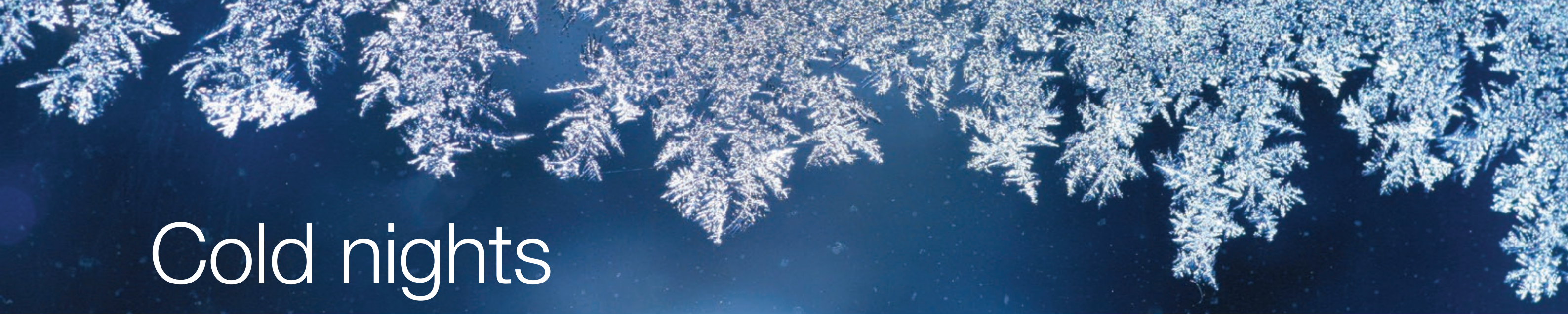


Figure 9: Far future (2060–2079) projected changes in the number of days per year with maximum temperatures above 35°C.



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.

Projected regional climate changes

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

The greatest decreases are projected to occur in the south-eastern parts of the region which are projected to experience 5-10 fewer cold nights in the near future and 10-20 fewer cold nights by 2070. Fewer decreases are projected for areas around Broken Hill and Tibooburra (Figures 11 and 12).

All of the models all agree that there will be fewer cold nights. Averaging across the whole region there is projected to be three fewer cold nights in the near future (ranging from 2–5 across the individual models). The decrease in the number of cold nights is projected to be greater by 2070, with an average of 10 fewer nights per year (ranging from 6–12 nights across the individual models) (Figure 10).

The projected decrease in the number of cold nights is dominated by decreases in winter and spring (Figure 10).

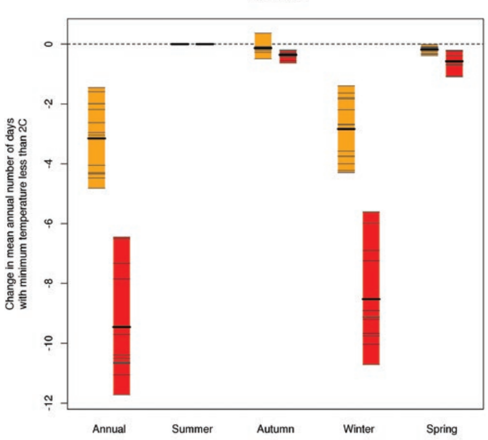


Figure 10: Projected changes in the number of low temperature nights for the Far West, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

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

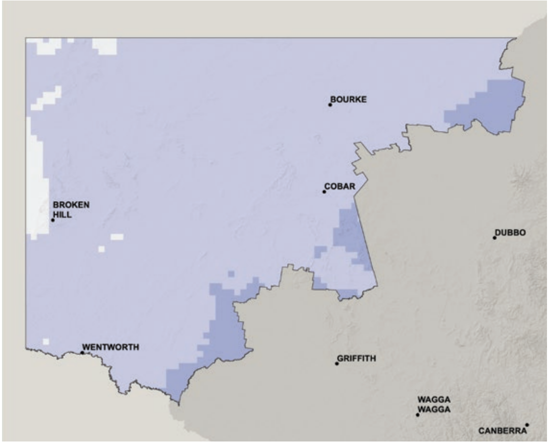


Figure 11: Near future (2020–2039) change in the number of days per year with minimum temperatures below 2°C, compared to the baseline period (1990–2009).

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

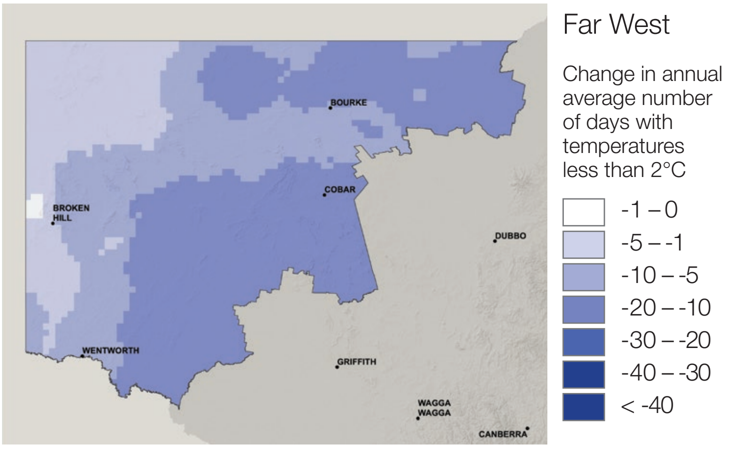


Figure 12: Far future (2060–2079) change in the number of days per year with minimum temperatures below 2°C, compared to the baseline period (1990–2009).

Rainfall

Changes in rainfall patterns have the potential for widespread impacts. Seasonal shifts in rainfall can 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 to increase in autumn

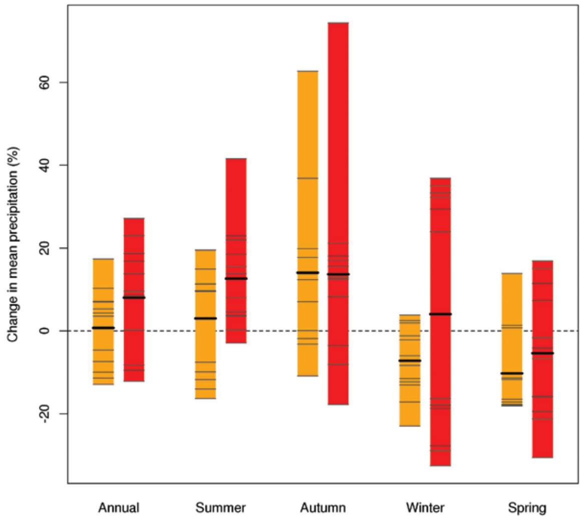


Figure 13: Projected changes in average rainfall for the Far West Region, annually and by season (2030 yellow; 2070 red) . (Appendix 1 provides help with how to read and interpret these graphs).

Projected regional climate changes

In the Far West the majority of models (9 out of 12) agree that spring rainfall will decrease in the near future and far future (8 out of 12 models) (Figures 13).

In the Far West the majority of models (8 out of 12) agree that autumn rainfall will increase in the near future and far future (Figures 13).

Nine out of 12 models project a decrease in rainfall during winter by 2030. The changes are less clear for winter rains in the far future (Figure 13).

The majority of models project an increase in summer rainfall in the near future (7 out of 12 models) and the far future (11 out of 12 models) (Figure 13).

The greatest reduction in rainfall is projected in the southern part of the region in spring (Figures 14 and 15). Autumn increases are relatively uniform across the region but higher on the nort-west plains around Bourke (Figures 14 and 15).

Seasonal rainfall projections for the near future and far future span both drying and wetting scenarios. In the near future the changes are: summer –16% to +20%, autumn –11% to +63%, winter –23% to +4% and spring –18% to +14%;. In the far future the changes are: summer –3% to +27%, autumn –18% to +74%, winter –33% to +37%, and spring –31% to +17% (Figure 13).

Projections for the region's annual average rainfall range from a decrease (drying) of 13% to an increase (wetting) of 17% by 2030 and still span both drying and wetting scenarios (–12% to +27%) by 2070.

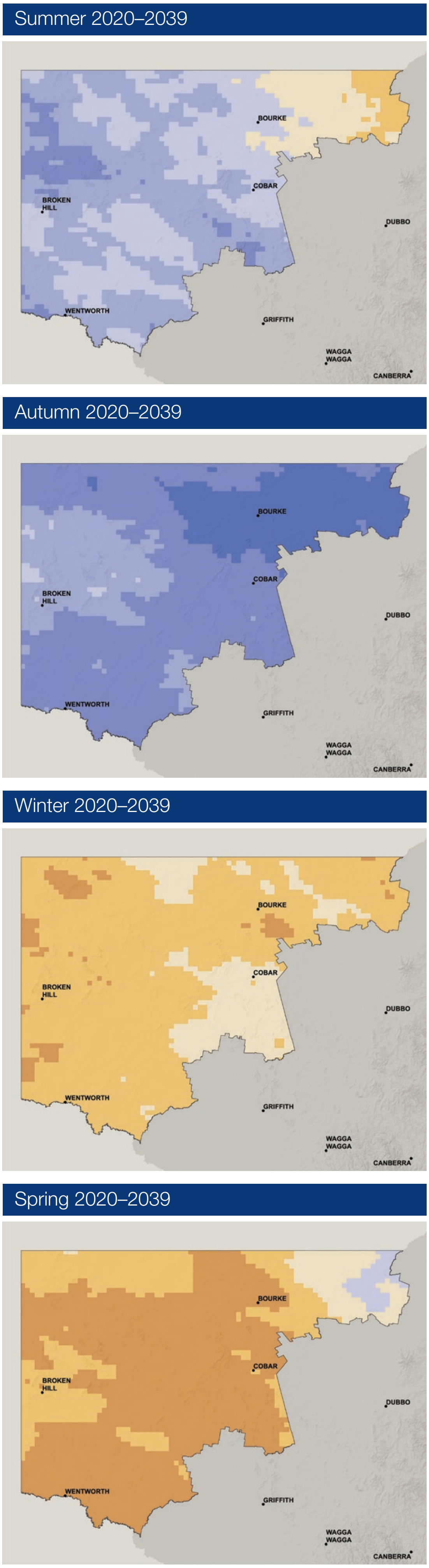


Figure 14: Near future (2020–2039) projected changes in average rainfall by season.

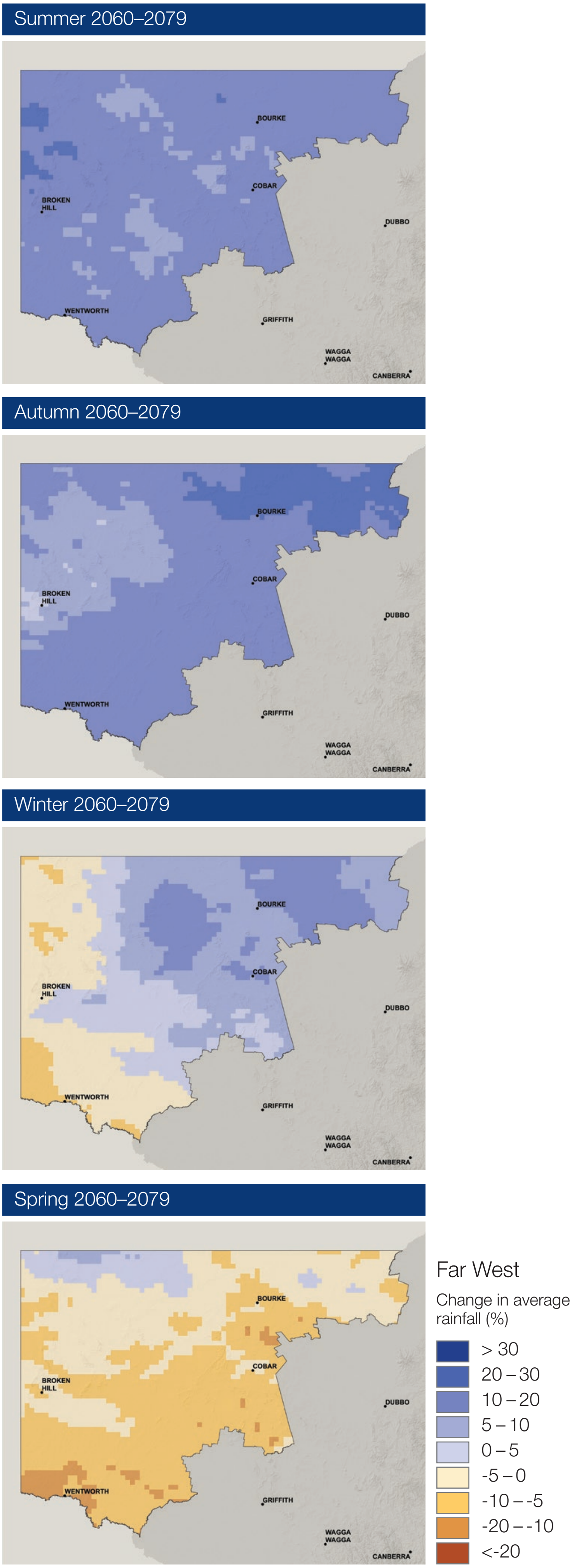


Figure 15: Far future (2060–2079) projected changes in average rainfall by season.

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 and severe fire weather days are projected to increase in summer and spring

Severe fire weather in the near future is projected to decrease in autumn

Projected regional climate changes

The Far West is projected to experience an increase in average and severe fire weather in the near future and the far future (Figures 16 and 17).

Average fire weather risk is projected to increase in all seasons except for autumn in the far future. These increases are in prescribed burning periods (spring) and peak fire risk season (summer), reducing the ability for preventative works (Figure 18).

The greatest increases in average and severe fire weather are in spring which is showing considerable increases across the whole region by 2070 (Figures 18 and 19). It is important to note that due to the predominance of grasslands in this region, fire risk may be more accurately assessed using the Grass Fire Danger Index (GFDI).

Autumn is projected to have a slight decrease in severe fire risk in the south of the region (Figure 19). As fire weather measurements take into account rainfall, it is likely that the decrease in autumn FFDI is due to projected increases in autumn rainfall across the region (compare Figures 14 and 15).

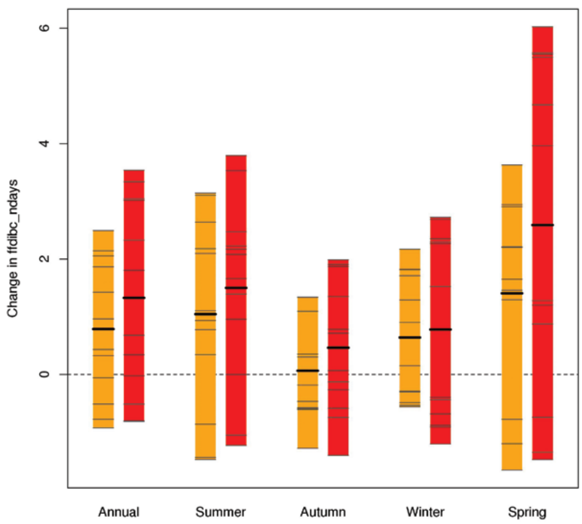


Figure 16: Projected changes in the average daily forest fire danger index (FFDI) for the Far West Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

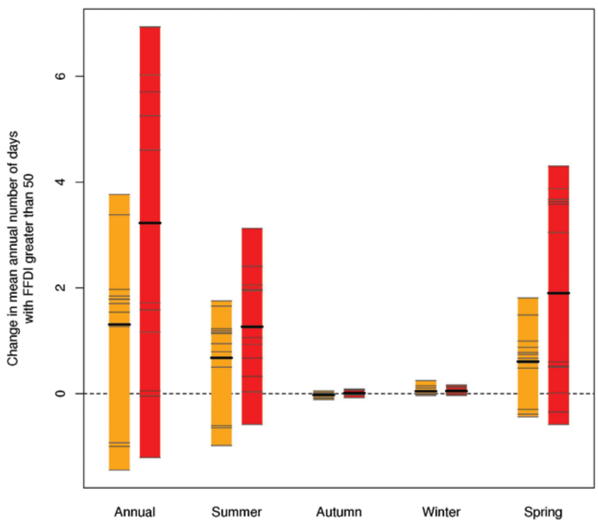


Figure 17: Projected changes in average annual number of days with a forest fire danger index (FFDI) greater than 50 for the Far West Region, annually and by season (2030 yellow; 2070 red).

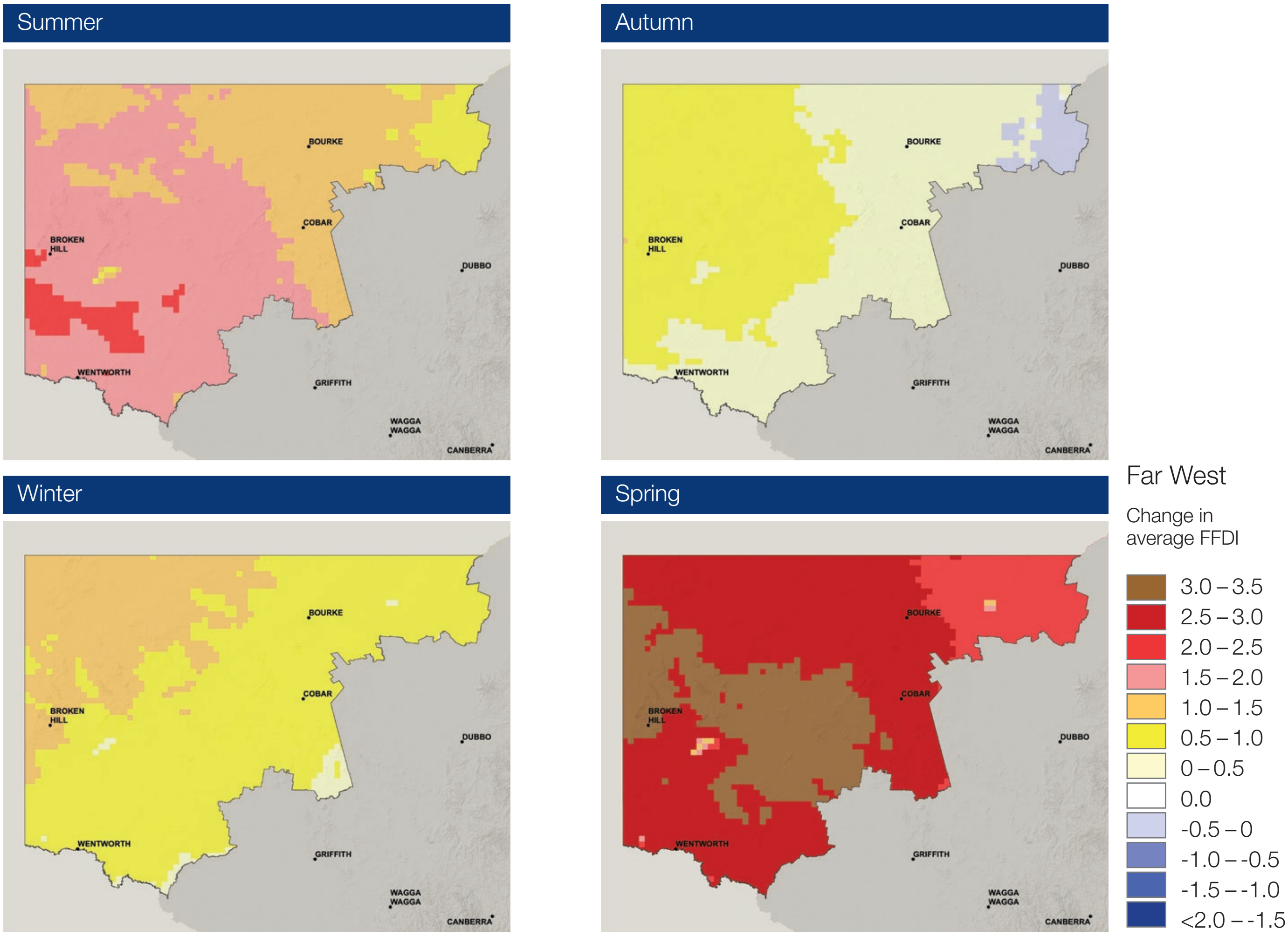


Figure 18: Far future (2060–2079) projected changes in average daily FFDI, compared to the baseline period (1990–2009).

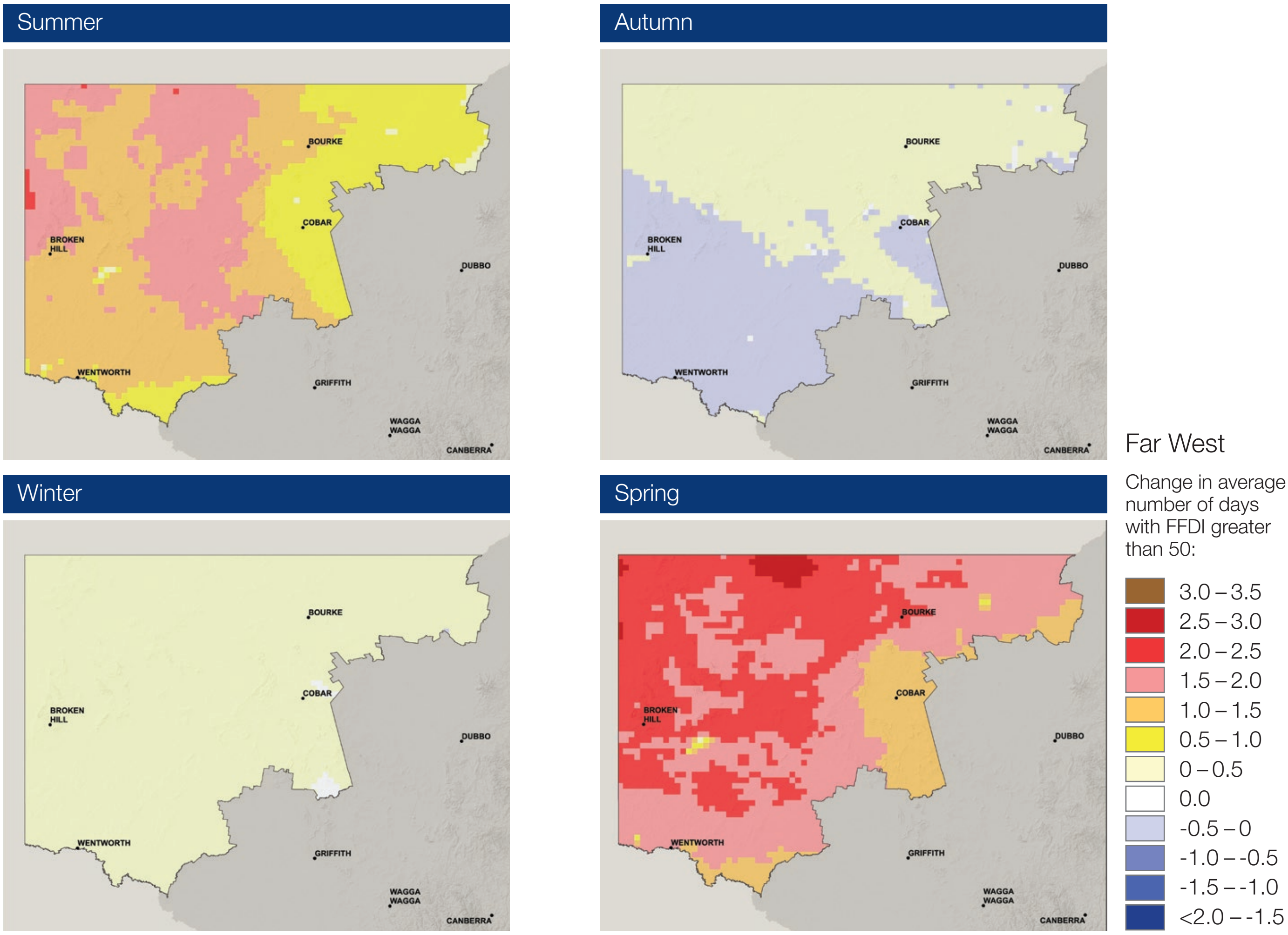


Figure 19: Far future (2060–2079) projected changes in average annual number of days with a FFDI greater than 50, compared to the baseline period (1990–2009).

Appendix 1 Guide to reading the maps and graphs

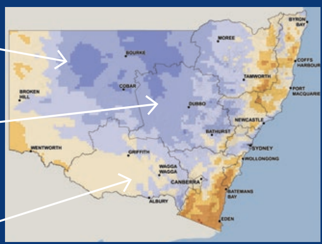
This document contains maps and bar graphs of the climate change projections. The maps present the results of the twelve models as an average of all twelve models. The bar graphs show projections averaged across the entire state and do not represent any particular location within the state. The bar graphs 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.



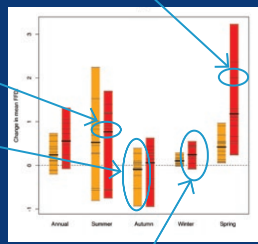
How to read the bar graphs

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 bar is the **average for one model** for the region. They do not represent a single location in the region.



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

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