Office of Environment & Heritage

AdaptNSW

Metropolitan Sydney
Climate change snapshot

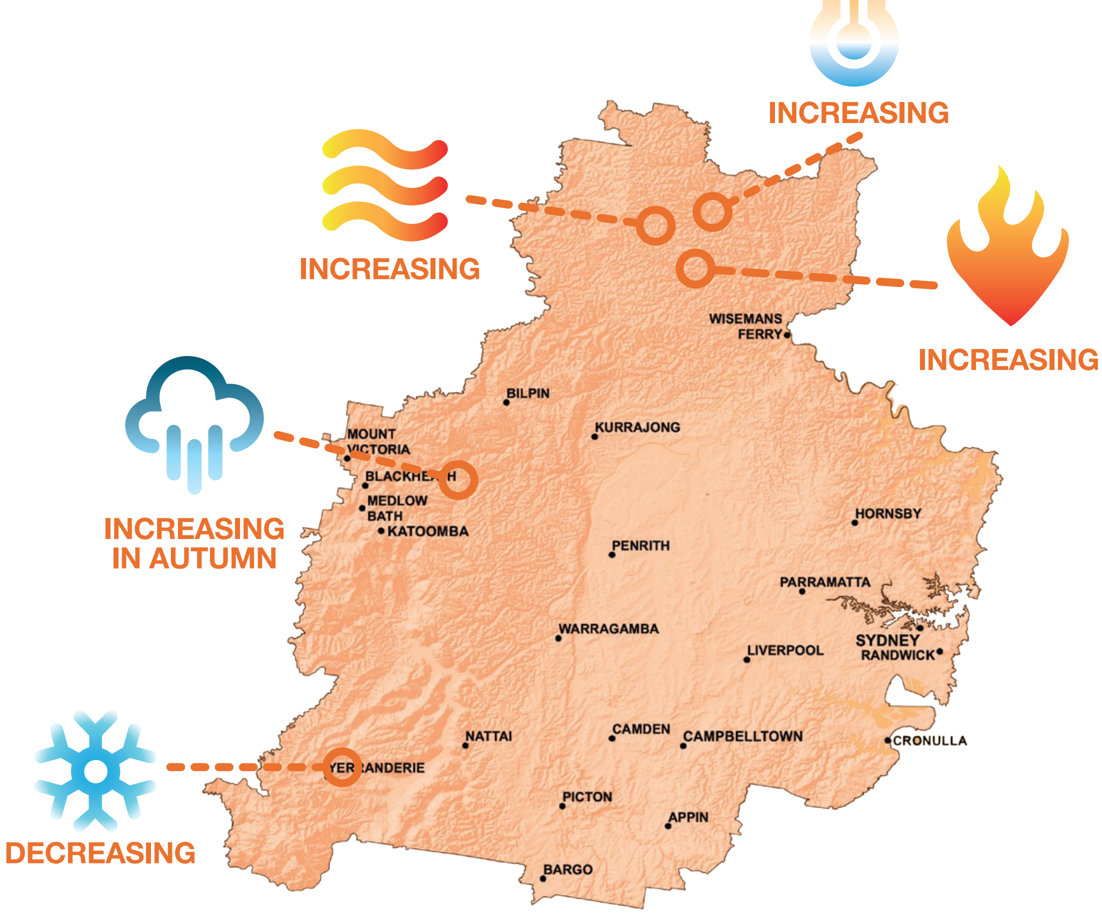
Overview of **Metropolitan Sydney Region** climate change

Based on long-term (1910–2013) observations, temperatures in the Sydney Region have been increasing since about 1960, with higher temperatures experienced in recent decades.

The 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 1.9°C in the far future. Inland, away from the coast, the number of high temperature days is projected to increase. Fewer cold nights are projected in inland areas and the Blue Mountains.

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

Projected changes



Projected **temperature** changes

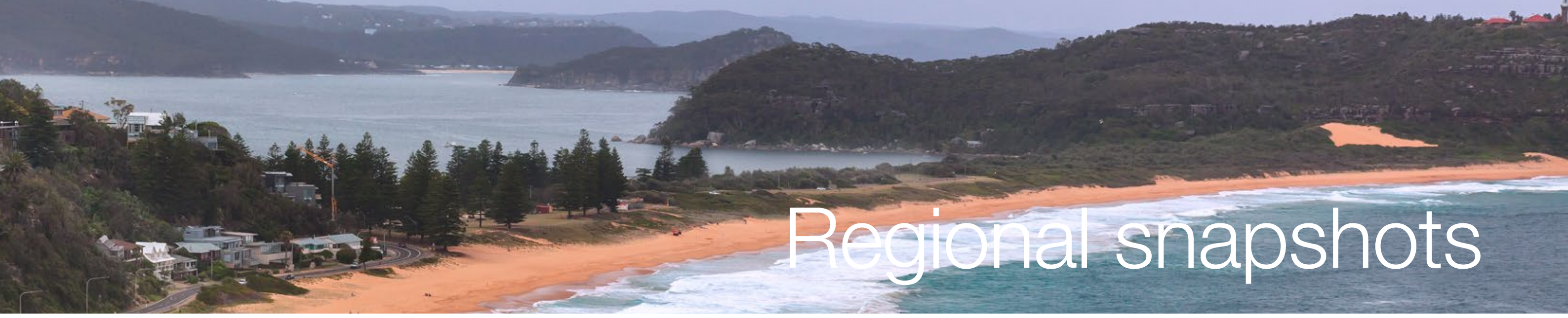
Maximum temperatures are projected to increase in the near future by 0.3–1.0°C	Maximum temperatures are projected to increase in the far future by 1.6–2.5°C
Minimum temperatures are projected to increase in the near future by 0.4–0.8°C	Minimum temperatures are projected to increase in the far future by 1.4–2.5°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 and winter	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 by 2070	Severe fire weather days are projected to increase in summer and spring by 2070



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 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 Sydney region. 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

Famous for its large natural harbour and its status as a global city, the Sydney region encompasses the Cumberland Plain and extends west to the Blue Mountains in the Great Dividing Range. The Metropolitan Sydney Region extends from Broken Bay in the north, to Garie Beach in the Royal National Park in the south. The Cumberland Plain is bordered by the Woronora plateau to the south and Hornsby plateau to the north.

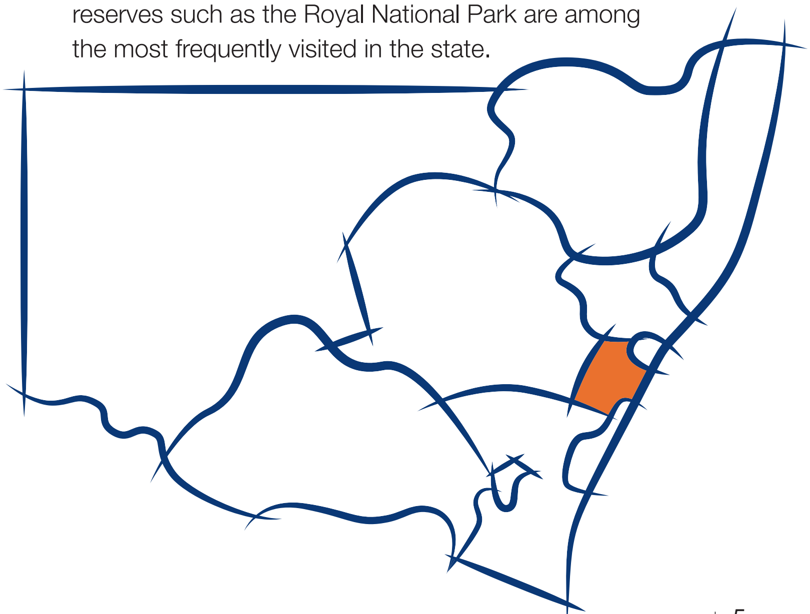
The region contains a number of important estuaries and drowned river valleys, including parts of the Georges River and the Parramatta River at Sydney Harbour. The region is home to the second oldest national park in the world – the Royal National Park, and the World Heritage Listed Blue Mountains National Park.

Population and settlements

With over four million people, the Metropolitan Sydney Region is the most populous region in NSW. It accounts for approximately 20% of Australia's population, and consists of great cultural and ethic diversity. The major industries for the approximately 1.9 million employees include professional, scientific and technical services, retail and hospitality. As a global city, the region plays a major role in Australia's international trade, with both Sydney Harbour and Port Botany working ports. Sydney airport is the busiest airport in the country, and tourism plays a major role in the economy.

Natural ecosystems

The Metropolitan Sydney Region's sandstone plateau is largely covered in dry sclerophyll forest, though rainforest and tall eucalypt forest occur along the escarpment and in sheltered gorges. Smaller patches of heath and upland swamps are interspersed among the dry forests. Saline wetlands are found in all of the major estuaries and include the Ramsar-listed Towra Point. Freshwater wetlands occur around the margins of coastal lakes, and on coastal sand plains and the floodplains of the major rivers such as the Hawkesbury. Large tracts of the sandstone plateau remain relatively unmodified and have been included in an extensive network of conservation reserves. Eight of the hinterland reserves, including the Blue Mountains, Wollemi and Yengo national parks, constitute the Greater Blue Mountains World Heritage Area. Coastal reserves such as the Royal National Park are among the most frequently visited in the state.



Climate of the region

The complex topography of the region and it's coastal setting result in a variety of climates across the region. It is relatively wet along the coast and in the Blue Mountains. During summer it is warmer in Western Sydney than near the coast and in the mountains. Winters are cool in the mountains. Temperatures are more mild along the coast with cooler summers and warmer winters compared to much of the rest of the region.

Temperature

The Sydney region experiences large variations in temperature between the coast, Western Sydney and in the Blue Mountains.

In summer, average temperatures range from 16–18°C in the Blue Mountains to 22–24°C in Western Sydney. In winter, average temperatures range from 12–14°C along the coast to 4–6°C in the upper Blue Mountains.

Average maximum temperatures during summer range from 28–30°C in Western Sydney to 22–24°C in the Blue Mountains. In winter, average minimum temperatures range from 8–10°C along the coast to 0–2°C in the upper Blue Mountains.

Long-term temperature records show an increase in temperature in the region since the 1960s. The most sustained period of warming has occurred in the most 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 Sydney region experiences fewer hot days (maximum temperature above 35°C) on average than inland regions of NSW. On average there are fewer than 10 hot days per year across much of the region, but in Western Sydney there are on average 10–20 hot days per year.

Cold nights

The number of cold nights per year, where minimum temperatures are below 2°C, increases moving away from the coast and up to the Blue Mountains. Much of the region experiences fewer than 10 cold nights per year, while in Western Sydney there is on average between 10 to 20 cold nights per year. In the upper Blue Mountains there are typically over 70 cold nights per year.

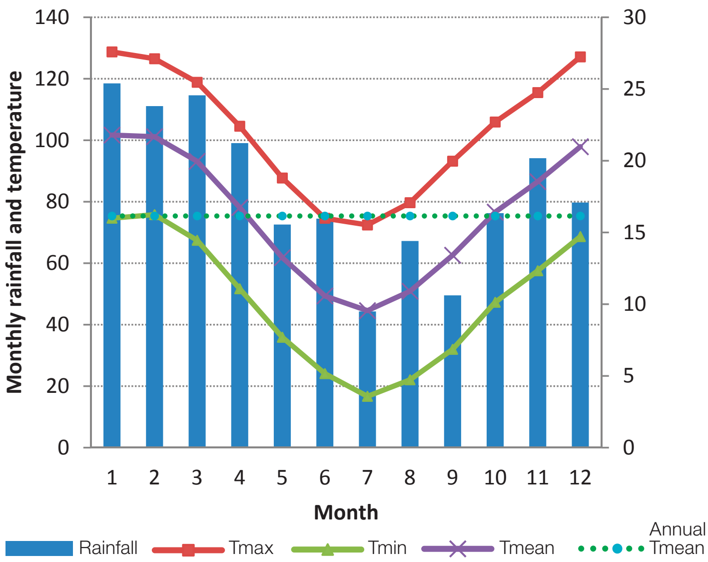


Figure 1: Map of average annual daily average temperatures across NSW, 1961–1990.

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




Rainfall

Rainfall varies across the Sydney region. 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, the topography of the Blue Mountains and the Great Dividing Range and the influence of the coast.

Annual average rainfall is in the range of 800–1200 mm for much of the region. More rainfall is recorded close to the coast and in the upper Blue Mountains (1200–1600 mm per year). There is some seasonal variation in rainfall with more rainfall in summer and autumn than winter and spring. Rainfall is most varied along the Blue Mountains with on average 400–600 mm during summer, but as little as 100–200 mm in some areas of the mountains during winter. In Western Sydney rainfall is more uniform with totals ranging from 200–300 mm in summer, autumn and spring, to 100–200 mm in winter. Rainfall along the coast is higher and varies between 300–400 mm in summer and autumn and 200–300 mm during winter and spring.

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). Although these stations are spread fairly evenly across the state, there are no stations in alpine regions.

Long-term FFDI estimates are available for two weather stations in the region, Sydney Airport and Richmond. The average annual FFDI for the period 1990–2009 is 5.5 at Sydney Airport and 7.1 at Richmond.

Fire weather is classified as ‘severe’ when the FFDI is above 50, and most of the property loss from major fires in Australia has occurred when the FFDI reached this level (Blanchi et al. 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.

Severe fire weather conditions are estimated to occur on average one day per year at Sydney Airport and 1.8 days per year at Richmond. These days are more likely to occur in summer and spring months.

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

Temperature is the most reliable indicator of climate change. Across NSW all of the models agree that average, minimum and maximum temperatures are all 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 1.9°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

Metropolitan Sydney 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 up to 1.9°C in the far future (Figure 2b). Spring will experience the greatest change in maximum temperatures, increasing by up to 2.2°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 up to 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 region (Figures 3–6).

The long-term temperature trend indicates that temperatures in the Sydney region have been increasing since approximately 1960, with the largest increase in temperature in the most recent decades.

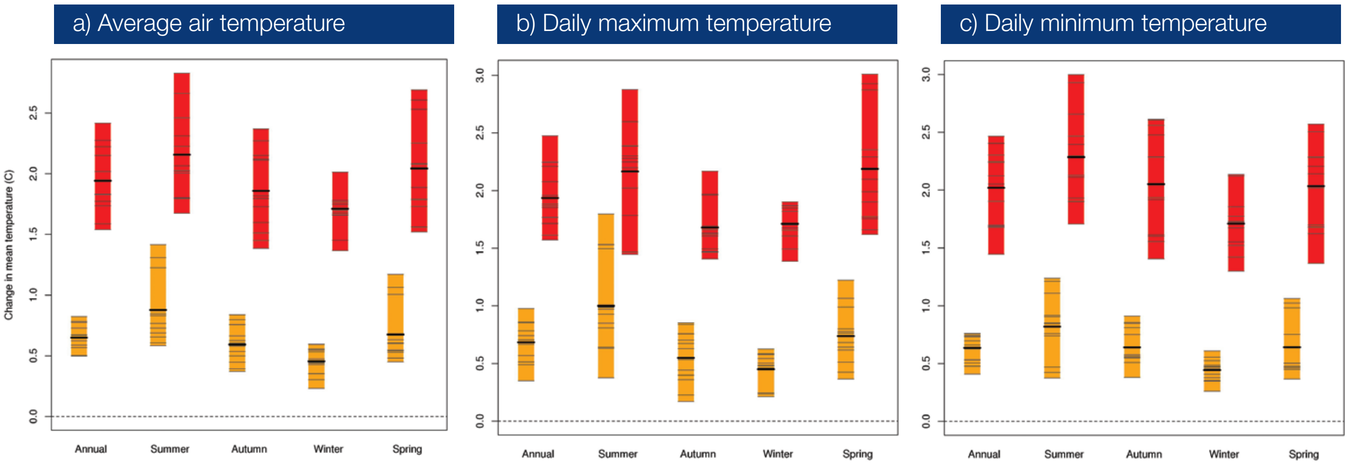


Figure 2: Projected air temperature changes for the Metropolitan Sydney Region, annually and by season (2030 yellow; 2070 red): a) average, b) daily maximum, and c) daily minimum. (Appendix 1 provides help with how to read and interpret these graphs).

Near future change in maximum temperature

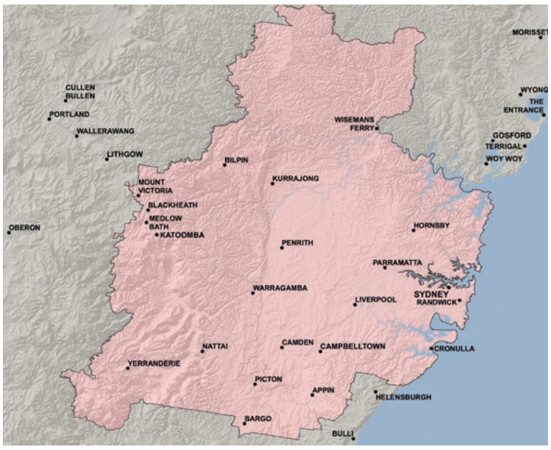


Figure 3: Near future (2020–2039) change in annual average maximum temperature, compared to the baseline period (1990–2009).

Far future change in maximum temperature

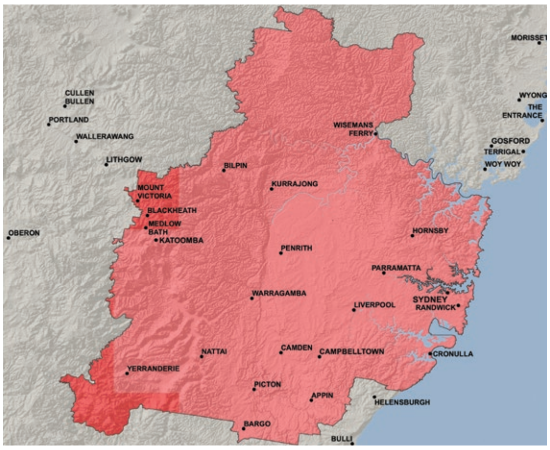


Figure 4: Far future (2060–2079) change in annual average maximum temperature, compared to the baseline period (1990–2009).

Near future change in minimum temperature

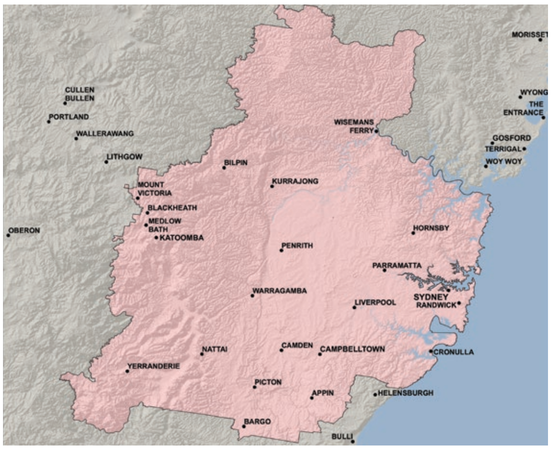
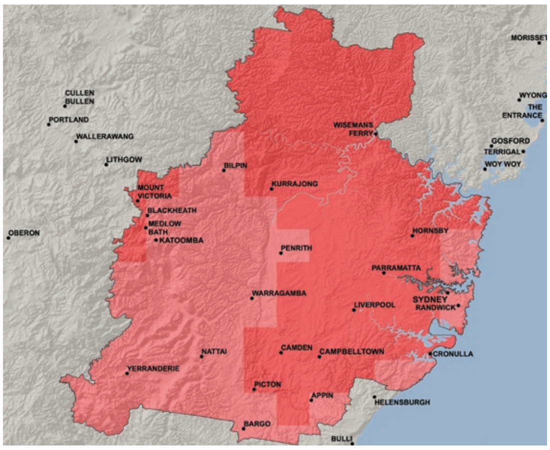


Figure 5: Near future (2020–2039) change in annual average minimum temperature, compared to the baseline period (1990–2009).

Far future change in minimum temperature



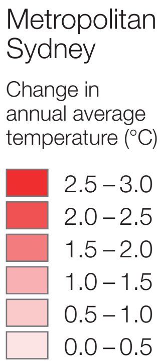


Figure 6: Far future (2060–2079) change in annual average minimum temperature, compared to the baseline period (1990–2009).

Hot days

DAYS PER YEAR ABOVE 35°C

Currently the Sydney region experiences fewer than 10 days above 35°C each year due to its proximity to the coast. Areas in Western Sydney experience 10–20 hot days on average. 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 Metropolitan Sydney Region is expected to experience more hot days in the near future and in the far future (Figure 7).

The greatest increase is projected for Western Sydney and the Hawkesbury with an additional 5–10 days in the near future, increasing to over 10–20 additional hot days per year by 2070 (Figures 8 and 9).

The region, on average, is projected to experience an additional four hot days in the near future and 11 days more hot days in the far future (Figure 7).

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

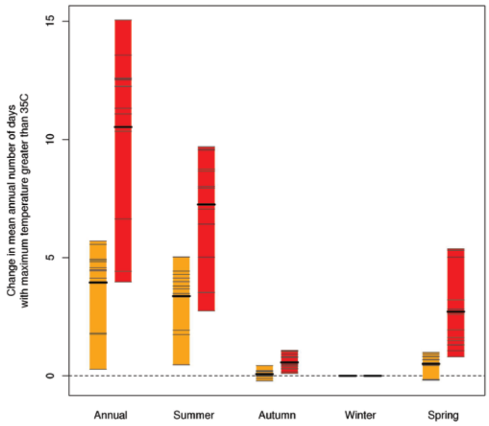


Figure 7: Projected changes in the number of hot days (with daily maximum temperature of above 35°C) for the Sydney Metropolitan Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read these graphs).

Near future change in days per year above 35°C

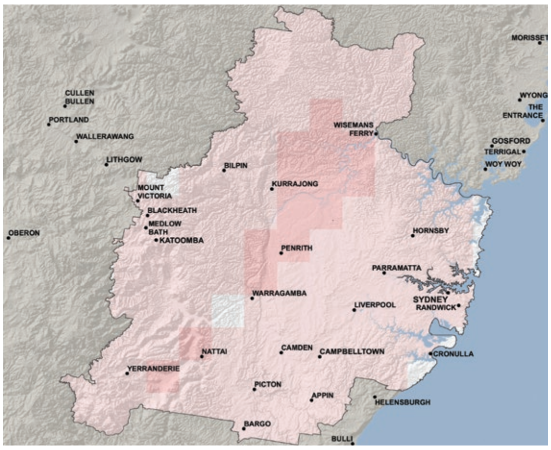
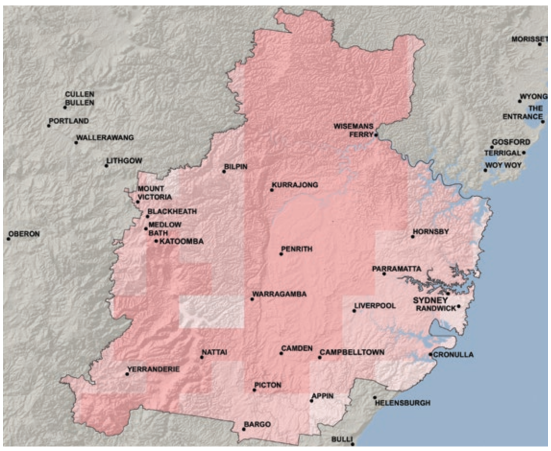


Figure 8: Near future (2020–2039) projected changes in the number of days per year with maximum temperatures above 35°C.

Far future change in days per year above 35°C

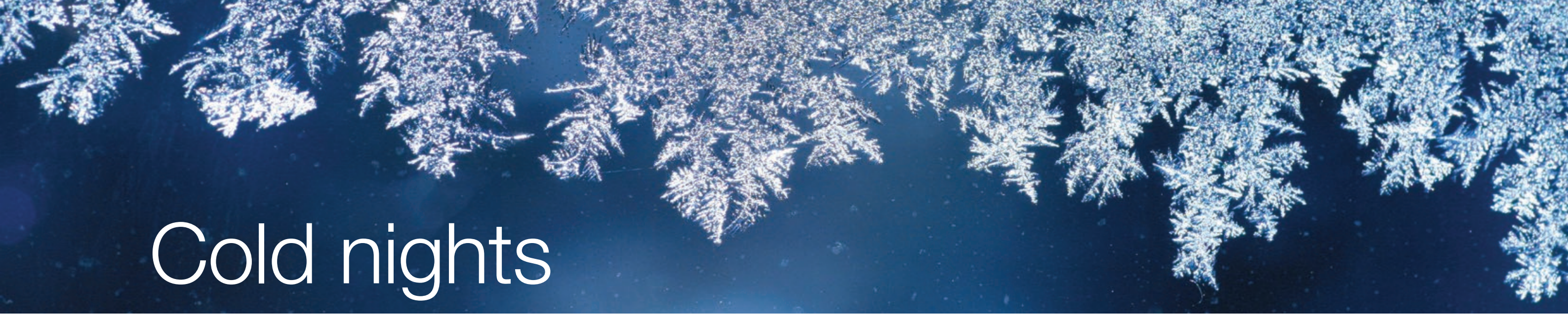


Metropolitan Sydney

Change in annual average number of days with temperatures greater than 35°C

- >40
- 30 – 40
- 20 – 30
- 10 – 20
- 5 – 10
- 1 – 5
- 0 – 1

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 Sydney region 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-west and in the Blue Mountains, with decreases of up to 20 nights by 2030 and more than 40 fewer cold nights by 2070 (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 five fewer cold nights per year in the near future (ranging from 4–6 days across the individual models). The decrease in the average number of cold nights is projected to be even greater in the far future, with an average of 12 fewer cold nights per year (ranging from 10–13 across the individual models) (Figure 10).

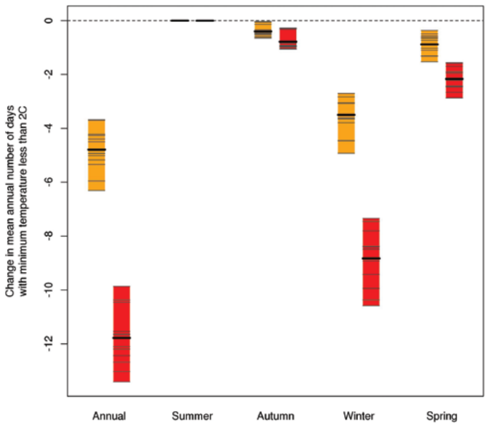


Figure 10: Projected changes in the number of low temperature nights for the Metropolitan Sydney Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

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

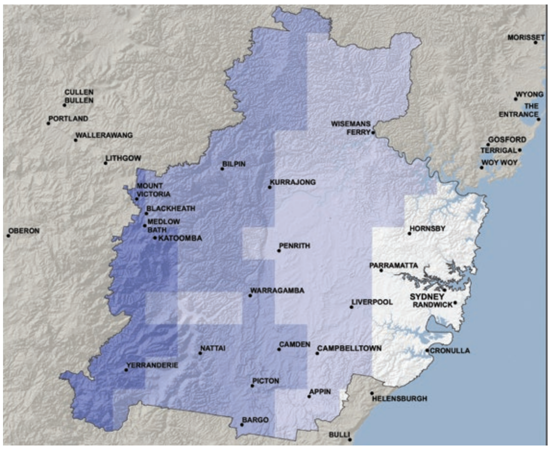
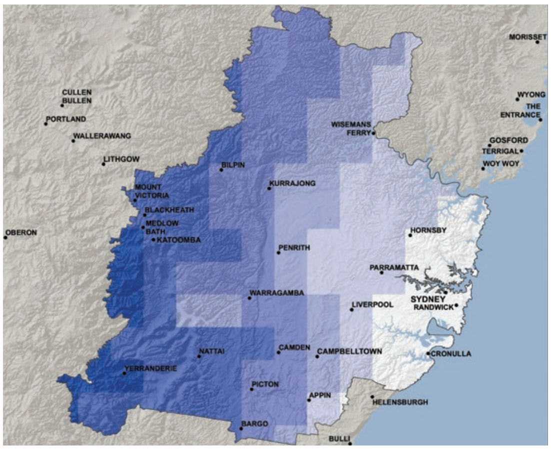


Figure 11: Near future (2020–2039) projected changes in the number of nights per year with minimum temperatures below 2°C, compared to the baseline period (1990–2009).

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



Metropolitan Sydney

Change in annual average number of days with temperatures less than 2°C

- -1 – 0
- -5 – -1
- -10 – -5
- -20 – -10
- -30 – -20
- -40 – -30
- < -40

Figure 12: Far future (2060–2079) projected changes in the number of nights 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 increase in autumn

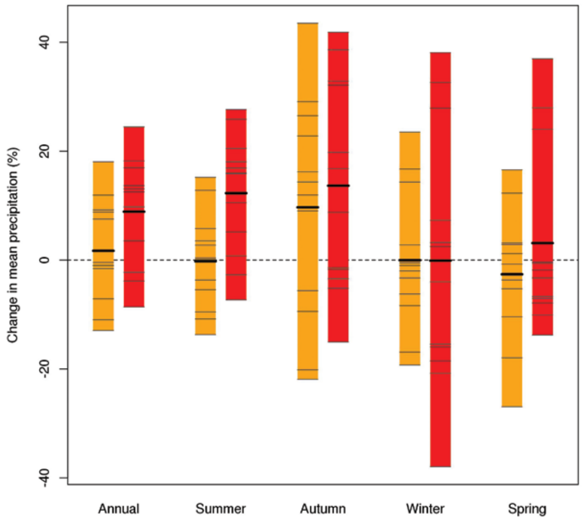


Figure 13: Projected changes in average rainfall for the Metropolitan Sydney Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

Projected regional climate changes

In the Sydney region the majority of models (8 out of 12) agree that autumn rainfall will increase in the near future and the far future (7 out of 12) (Figure 13).

The majority of models (7 out of 12) agree that spring rainfall will decrease in the near future, but this change is less clear in the far future (Figure 13).

The Sydney region currently experiences considerable rainfall variability across the region, from season-to-season and from year-to-year, and this variability is also reflected in the projections (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 ranges are: summer (–14% to +15%), autumn (–22% to +43%), winter (–19% to +23%), and spring (–27% to +17%); in the far future the changes are: summer (–7% to +28%), autumn (–15% to +42%), winter (–38% to +38%), and spring (–14% to +37%) (Figures 13, 14 and 15).

Projections for the region's annual average rainfall range from a decrease (drying) of 13% to an increase (wetting) of 18% by 2030 and still span both drying and wetting scenarios (–9% to +24%) by 2070.

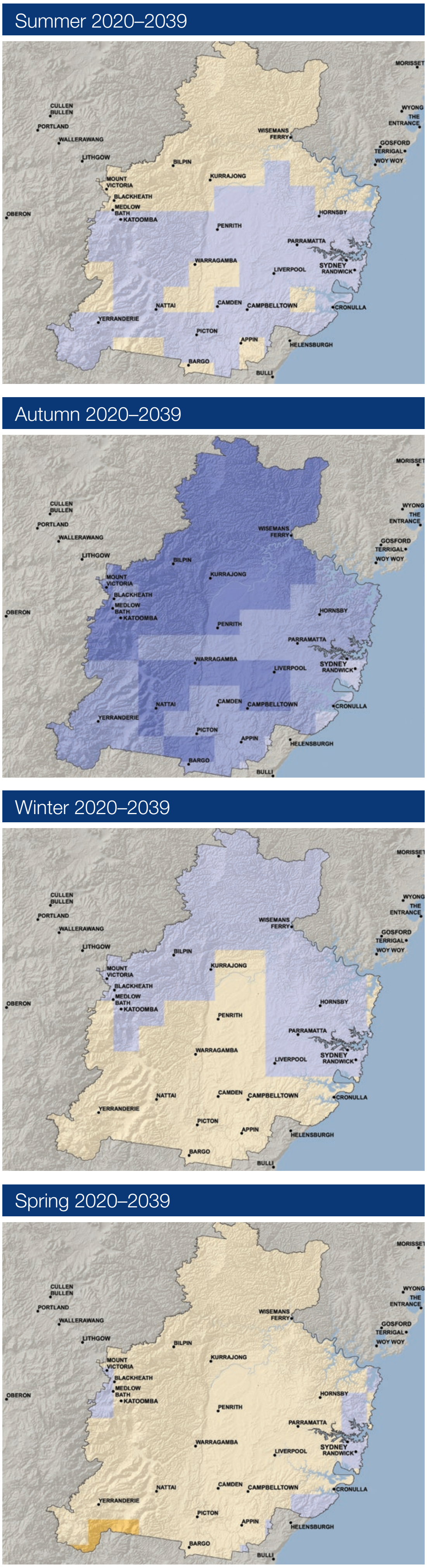


Figure 14: Near future (2020–2039) projected changes in average rainfall by season.

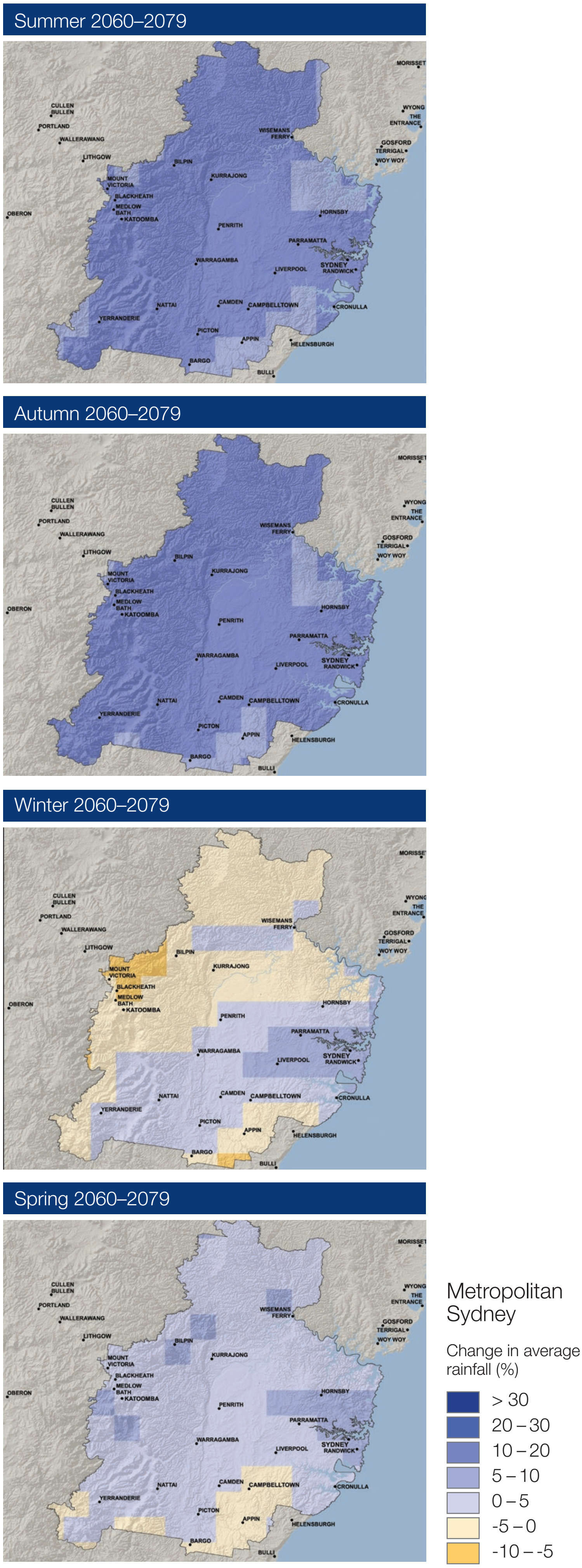


Figure 15: Far future (2060–2079) projected changes in average rainfall by season.

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.

Average fire weather and severe fire weather days are projected to increase in the far future

Projected regional climate changes

Metropolitan Sydney is expected to experience an increase in average and severe fire weather in the near future and the far future (Figures 16 and 17).

The increases are projected mainly in summer and spring in the far future (Figures 18 and 19). These changes are projected in prescribed burning periods (spring) and the peak fire risk season (summer).

During spring the greatest increases are in the north-west and south-west of the region in the far future (Figure 18).

The majority of models (7 out of 12) project an increase of severe fire weather in spring in the near future, with a greater confidence in the increase in the far future (Figure 17).

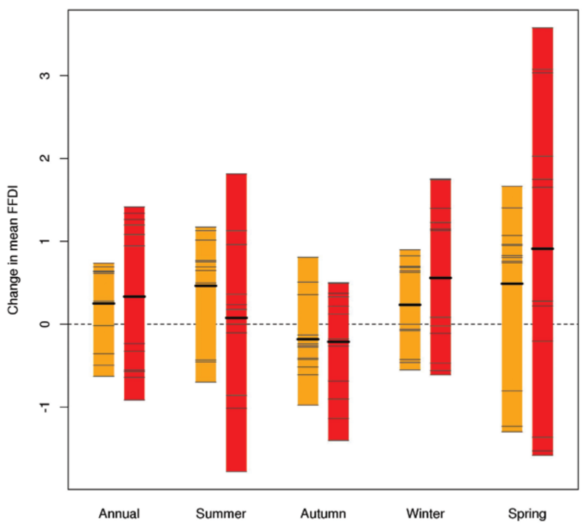


Figure 16: Projected changes in the average daily forest fire danger index (FFDI) for the Metropolitan Sydney Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

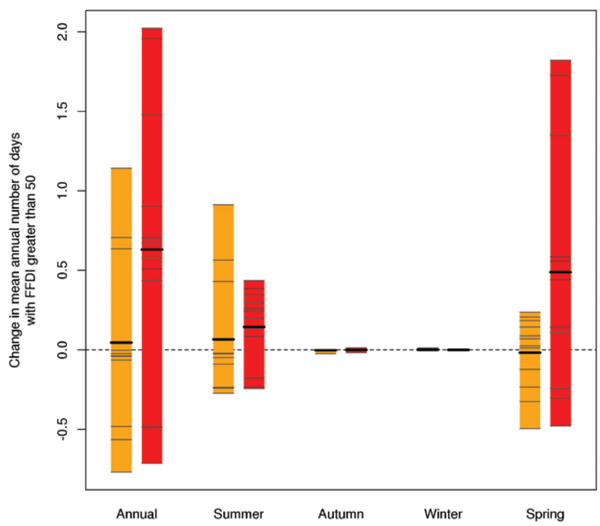


Figure 17: Projected changes in average annual number of days with a forest fire danger index (FFDI) greater than 50 for the Metropolitan Sydney Region, annually and by season (2030 yellow; 2070 red).

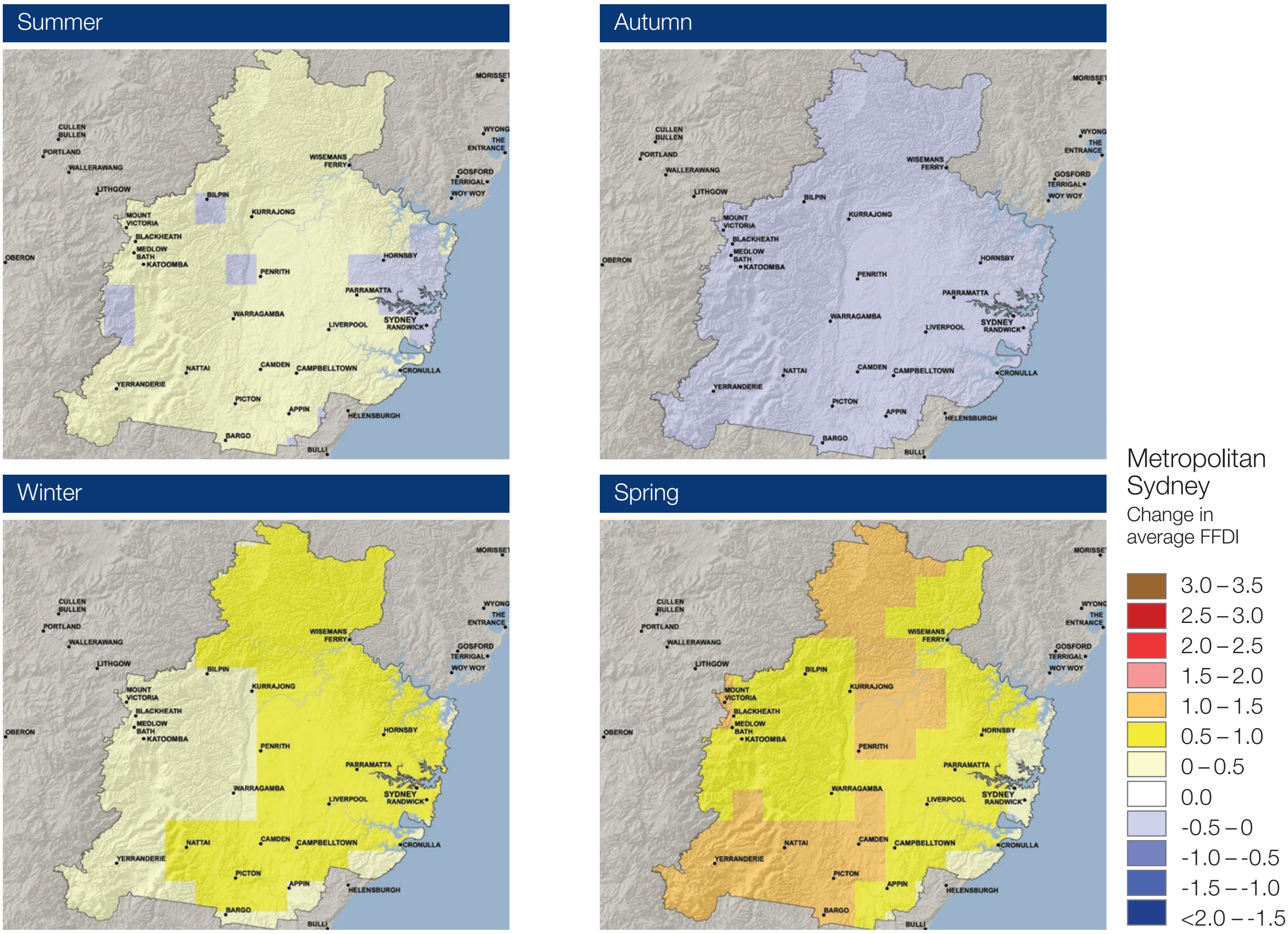


Figure 18: Far future (2060–2079) projected changes in average daily FFDI, compared to the baseline period (1990–2009).

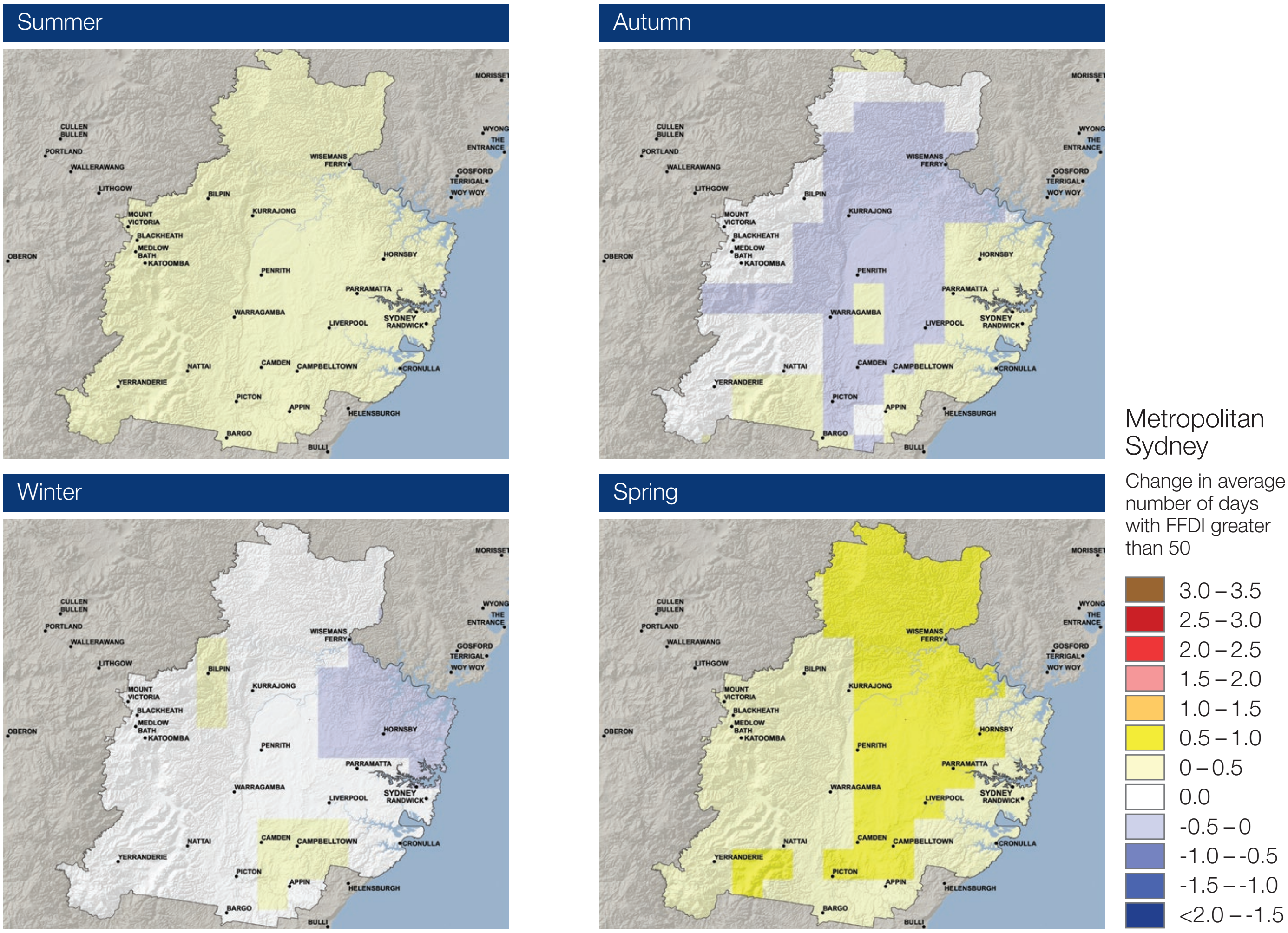


Figure 19: Far future (2060–2079) projected changes in average annual number of days with a FFDI greater than 50, compared to the baseline period (1990–2009).

Appendix 1 Guide to reading the maps and graphs

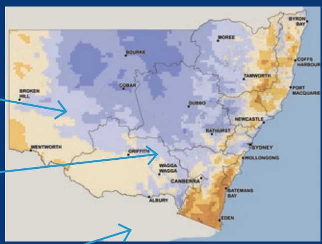
This document contains maps and bar graphs of the climate change projections. The maps present the results of the twelve models as an average of all twelve models. The bar graphs show projections averaged across the entire state and do not represent any particular location within the state. The bar graphs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



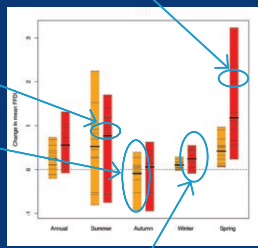
How to read the bar graphs

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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