Office of Environment & Heritage

AdaptNSW

South East and Tablelands
Climate change snapshot

Overview of **South East and Tablelands** Region climate change

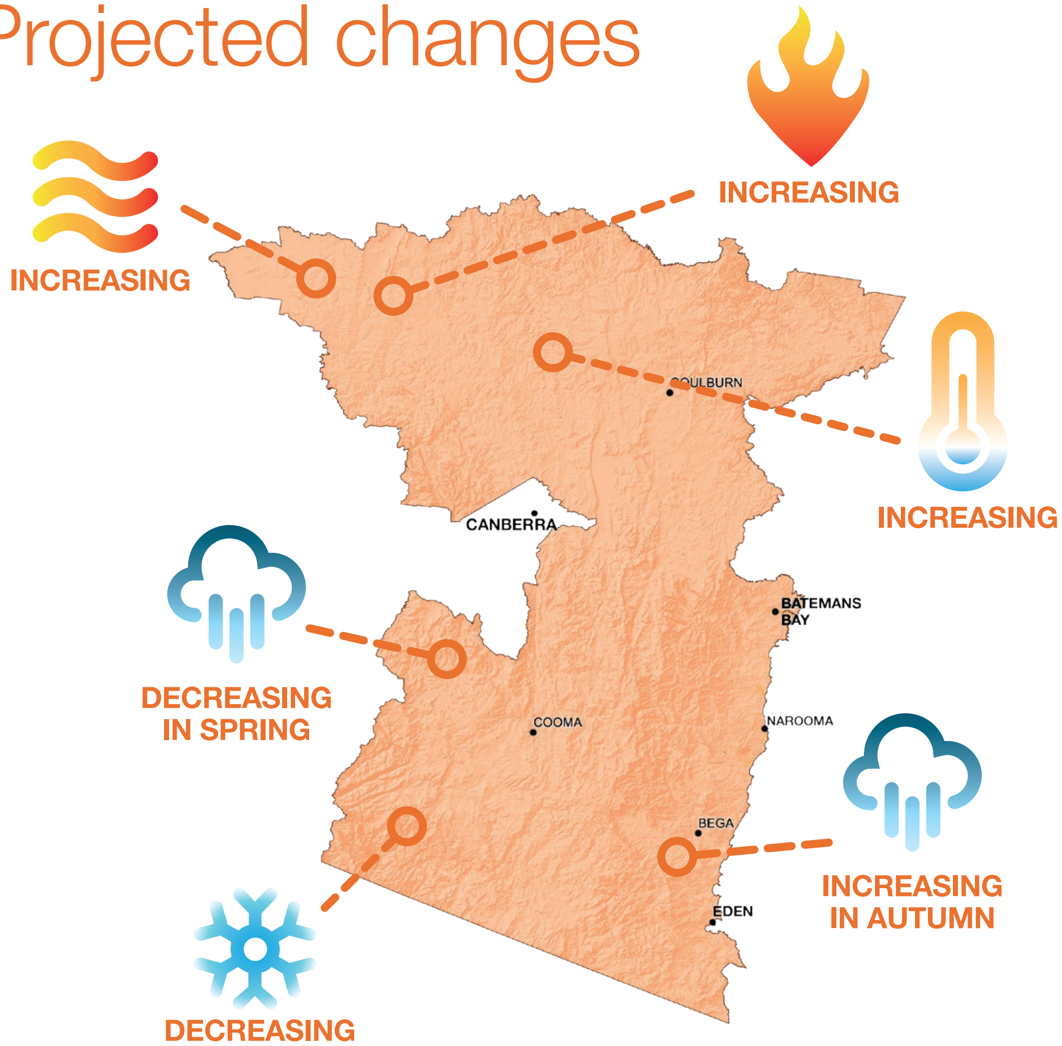
Based on long-term (1910–2011) observations, temperatures in the South East and Tablelands Region have been increasing since about 1960, with higher temperatures experienced in recent decades.

The region is projected to continue to warm in 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 0.6°C in the near future, increasing to about 2°C in the far future. There will be more hot days and fewer cold nights. The warming projected for the region is large compared to natural variability in temperature.

The South East and Tablelands currently experiences considerable rainfall variability across the region and from year-to-year - this variability is also reflected in the projections. However, all of the models agree that spring rainfall will decrease in the future.

Front cover photograph: Kosciuszko National Park, NSW, Australia. Copyright: Milosz_M. Page 2: A rural landscape with dead tree. Near Oberon, NSW, Australia. Copyright: Ilia Torlin. Page 4: Batemans Bay, NSW, Australia. Copyright: Alexandra Lang. Page 7: Sheep, standing in the snow, near Laggan, NSW, Australia. Copyright: Phillip Minnis. Page 9: Clyde River Bridge. Copyright: Christopher Meder.

Projected changes



Projected **temperature** changes	
Maximum temperatures are projected to increase in the near future by 0.5–1.0°C	Maximum temperatures are projected to increase in the far future by 1.8–2.5°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 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 summer and spring	Number of days with severe fire weather 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 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 regional climate change information will be released in 2015.

Introduction

This snapshot presents a summery of climate change projections for the South East and Tablelands 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

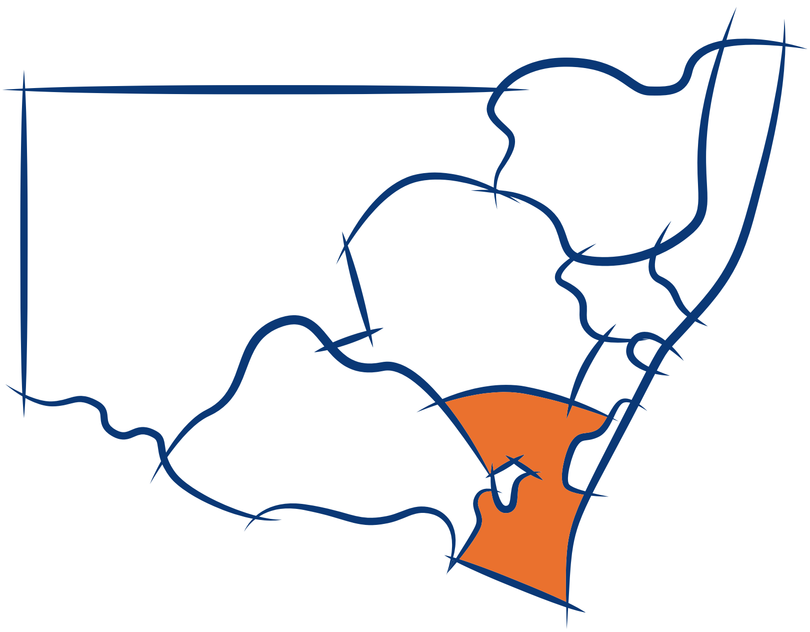
The South East and Tablelands Region spans the coastline from Durras Lake near Batemans Bay to the Victorian border. The south-eastern corner of NSW is home to Australia's highest summits, including Mount Kosciuszko and Mount Townsend, and the headwaters of the Snowy, Murray, Murrumbidgee and Lachlan rivers. Well known for its beaches, the South East and Tablelands Region includes enclosed beach compartments as well as large coastal embayments such as Batemans Bay.

Population and settlements

The population of the South East and Tablelands Region was approximately 261,750 in 2011 (ABS 2012), and is expected to grow to 310,400 by 2031 (Department of Planning & Environment 2014). The major cities in the region are Goulburn and Queanbeyan, with regional centres including Bega, Yass, Cooma, Batemans Bay and Eden. Public administration, hospitality, retail, tourism (coasts and ski fields) and primary industries employ the majority of the 113,800 strong workforce.

Natural ecosystems

The southern tablelands and south-eastern slopes contains many temperate grassland, woodland, wet forest and alpine ecosystems, and plant and animal species not found elsewhere in NSW. There are internationally significant (Ramsar) wetlands such as Blue Lake in the Snowy Mountains. Significant protected areas include Kosciuszko National Park, containing Australia's largest and highest alpine areas, the South East Forests and Deua-Wadbilliga national parks on the escarpment, and Nadgee Nature Reserve on the far south coast. The state's only pristine estuary, Nadgee Inlet, is located in the region. These biodiversity hotspots are also significant cultural landscapes for Aboriginal people.



Climate of the region

CURRENT CLIMATE

The topography of the South East and Tablelands Region results in a large range of climates. It is relatively wet close to the coast and Snowy Mountains, and drier inland. It is hot in summer in northern inland areas and very cold in winter in the Snowy Mountains. Milder conditions are found along the coast, with cooler temperatures in summer and warmer temperatures in winter.

Temperature

The region experiences a distinct seasonal variation in temperature. In summer, average daily maximum temperatures range from over 30°C in the north-west to below 18°C in the Snowy Mountains. In winter, the average daily minimum temperature ranges from 4–8°C at the coast, to 2–6°C in the north-west, and –6 to –4°C in the Snowy Mountains.

In summer, average temperatures range from 18–24°C at the coast and northern parts of the region, to 10–14°C across the southern elevated areas. In winter, average temperatures range from 8–12°C at the coast and northern parts of the region to 0–2°C in the Snowy Mountains.

Temperatures have been increasing since about 1960, with higher temperatures experienced in recent decades.

Temperature extremes

Temperature extremes, both hot and cold, occur infrequently but can have significant 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, much of the region sees fewer than 10 hot days each year. More hot days occur in the north-western most parts of the region. In contrast there are very few days above 35°C in the Snowy Mountains.

Cold nights

The number of nights per year with minimum temperatures below 2°C varies considerably across the region. Coastal areas experience the least number of cold nights (fewer than 10 nights per year). There are more cold nights as you move inland increasing to over 90 nights per year in central parts of the region, and over 200 nights per year in the Snowy mountains.

Rainfall

Rainfall varies considerably across the South East and Tablelands 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 Snowy Mountains and Great Dividing Range and the influence of sea surface temperature near the coast.

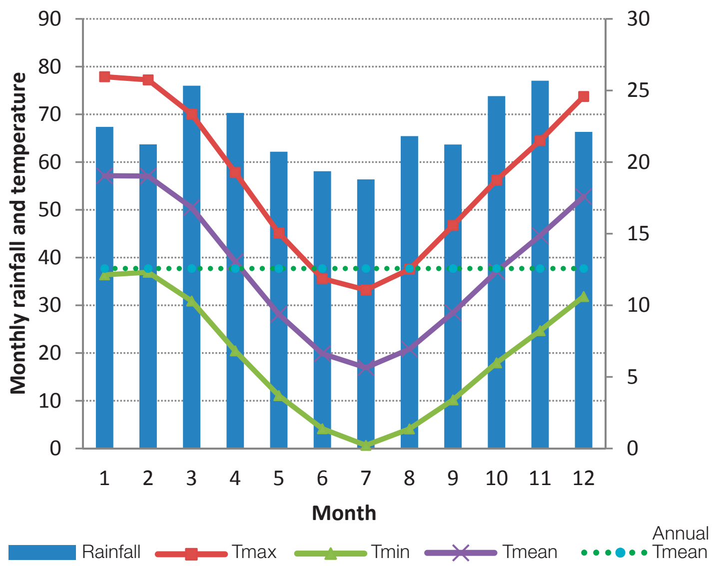


Figure 1: Seasonal rainfall and temperature variations (AWAP[1] data for 1960–1991).

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




The Snowy Mountains receives less rainfall during the summer compared to other seasons. The Monaro and southern coastal parts of the region receive less rainfall in winter due to the passage of southerly cold, moist air being blocked by the Snowy Mountains.

The annual rainfall ranges from over 1600 mm in the Snowy Mountains to 400–600 mm in the Cooma-Monaro region. The areas around Goulburn and the south-west slopes receive approximately 600–800 mm, with the coastal strip having 1000–1200 mm of rainfall per year.

The region has experienced considerable rainfall variability in the past with periods of both wetter and drier conditions. During much of the first half of the 20th century the region experienced drier conditions. The first decade of the 21st century saw a long period of below average rainfall during the Millennium Drought. This dry period ended with two of the wettest years on record for Australia (2010-2011), with 2010 being the third wettest year on record for NSW.

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).

There are no long-term FFDI stations within the South East and Tablelands Region. The two closest stations are Canberra and Nowra (Table 1). These stations have relatively low FFDI compared to more arid inland areas of NSW. Average daily FFDI is 6.9 in Canberra and 5.2 in Nowra.

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. Canberra and Nowra have 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
Nowra	5.2	5.6	4.3	4.4	6.6
Number of severe fire weather days (FFDI>50)					
Canberra	1.1	0.8	0.2	0	0.2
Nowra	1.1	0.6	0	0	0.5

Table 1: Baseline FFDI values for stations closest to the region.

Temperature

Climate change projections are presented for the near future (2030) and far future (2070), compared to the baseline modelled 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 South East and Tablelands 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 0.6°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

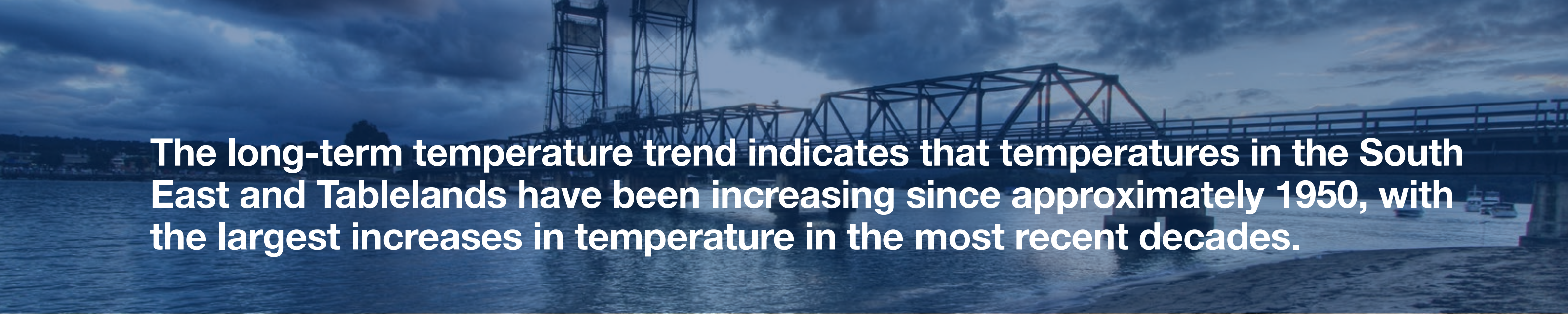
Projected regional climate changes

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

Maximum temperatures are projected to increase by 0.7°C in the near future, up to 2.1°C in the far future. Spring and summer will experience the greatest change with maximum temperatures increasing by up to 2.4°C by 2070 (Figure 2b). Increased maximum temperatures are known to impact human health through heat stress and by increasing the numbers of heatwave events.

Minimum temperatures are projected to increase by 0.6°C in the near future and up to 2.0°C in the far future (Figure 2c). Increased overnight temperatures (minimum temperatures) can have a significant effect on human health, especially during heatwaves.

The greatest increase in maximum temperatures are projected away from the coast. Minimum temperatures are projected to increase the most in the Snowy Mountains and on the south-west slopes and the Upper Lachlan (Figures 3–6).



The long-term temperature trend indicates that temperatures in the South East and Tablelands have been increasing since approximately 1950, with the largest increases in temperature in the most recent decades.

a) Average air temperature

b) Daily maximum temperature

c) Daily minimum temperature

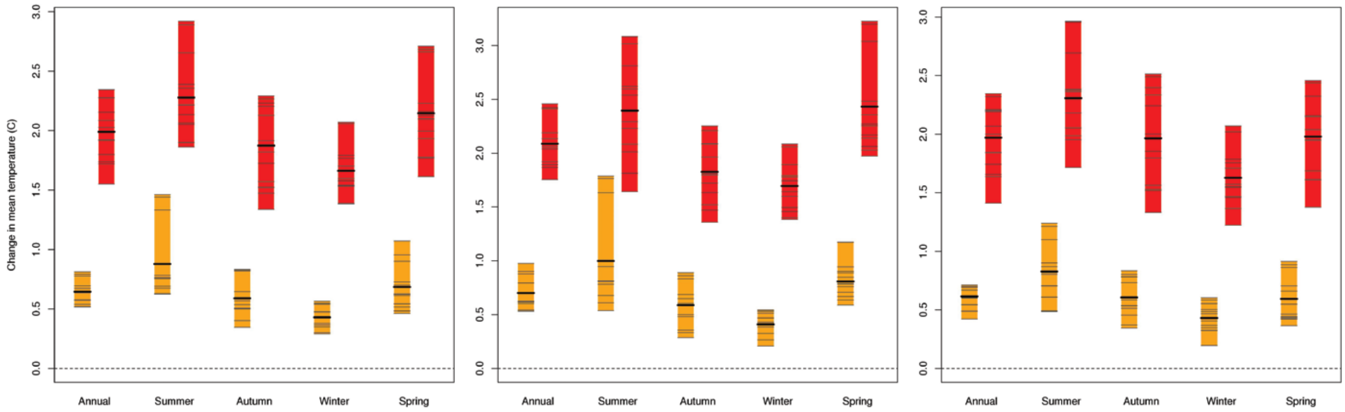


Figure 2: Projected air temperature changes for the South East and Tablelands Region, annually and by season (2030 yellow; 2070 red): a) average, b) daily maximum, and c) daily minimum. (Appendix 1 provides help with how to read and interpret these graphs).

Near future change in maximum temperature

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

Far future change in maximum temperature

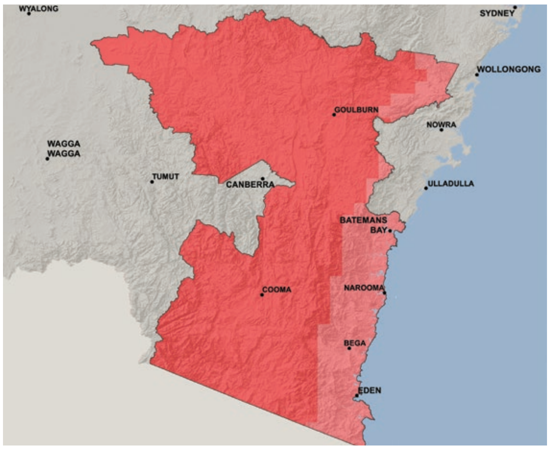


Figure 4: Far future (2060–2079) change in average maximum temperature, compared to the baseline period (1990–2009).

Near future change in minimum temperature

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

Far future change in minimum temperature

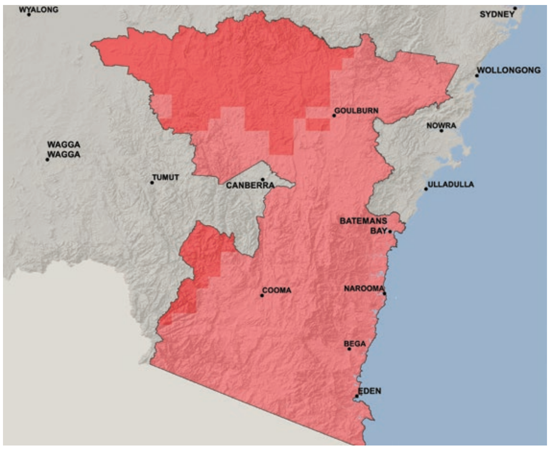


Figure 6: Far future (2060–2079) change in average minimum temperature, compared to the baseline period (1990–2009).

South East Tablelands

Change in annual average 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

Most of the South East and Tablelands Region experiences approximately 10 hot days each year. The exceptions are in the Snowy Mountains where there are very few hot days, and the south-west slopes where there are between 10-30 hot days per year. 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 in hot days could have significant impacts on bushfire danger, infrastructure development and native species diversity.

Projected regional climate changes

The South East and Tablelands Region is expected to experience more hot days in the near future and the far future (Figure 7).

The greatest change is projected for the south-west slopes, with an additional 5–10 hot days in the near future (Figure 8), increasing to over 30 additional hot days per year by 2070 (Figure 9).

The region, on average, is projected to experience an additional three hot days per year in the near future and up to eight 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).

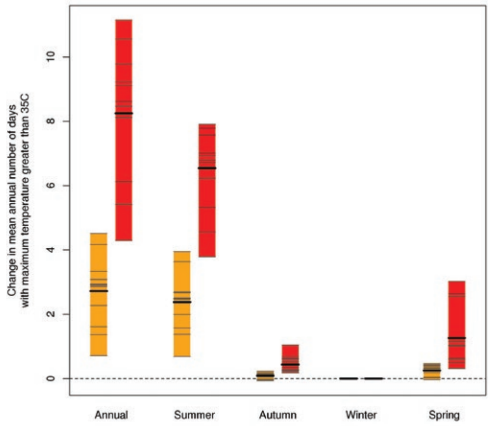


Figure 7: Projected changes in the number of hot days (maximum temperatures above 35°C) for the South East Tableland Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

Near future change in days per year above 35°C

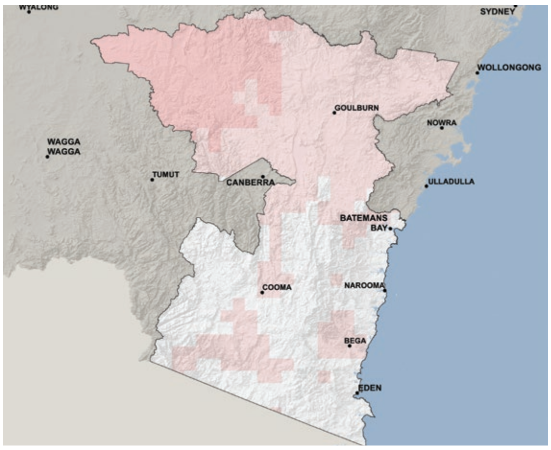


Figure 8: Near future (2020–2039) projected changes in the number of days per year with maximum temperatures above 35°C.

Far future change in days per year above 35°C

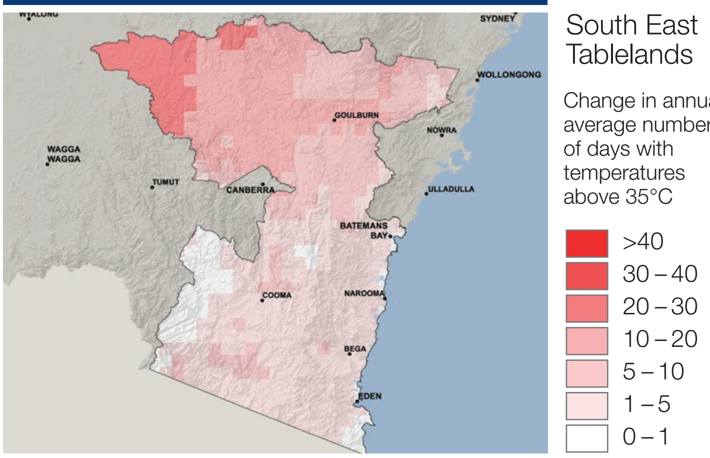
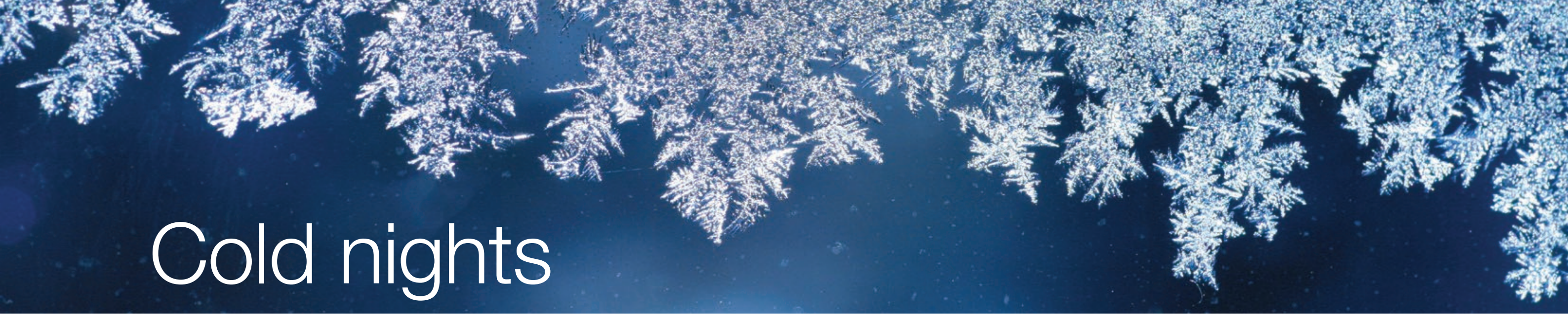


Figure 9: Far future (2060–2079) projected changes in the number of days per year with maximum temperatures above 35°C.



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. The Snowy Mountains is also home to alpine ecosystems reliant on long cold periods and snow.

In the South East and Tablelands Region, coastal areas experience the fewest cold days (less than 10 days per year), while there are over 200 cold days each year in the Snowy Mountains.

Projected regional climate changes

The South East and Tablelands Region is expected to experience fewer cold nights in the near future and the far future (Figure 10).

The greatest changes are projected to occur in the Cooma-Monaro and the Snowy Mountains, with 10–20 fewer cold nights in the near future, and over 40 fewer cold nights by 2070 (Figures 11 and 12). This is a considerable reduction in cold nights for our Alpine regions, with the potential to impact our natural ecosystems, snow tourism and industry. Fewer decreases are projected along the coast (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 12 fewer cold nights per year by 2030 (ranging from 9–15 fewer across the individual models) (Figure 10). The decrease in cold nights is projected to be even greater by 2070, with an average of 35 fewer cold nights per year (ranging from 27–42 across the individual models).

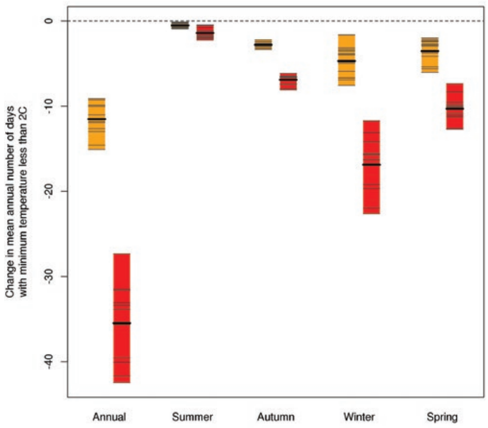


Figure 10: Projected changes in the number of low temperature nights for the South East and Tablelands Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

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

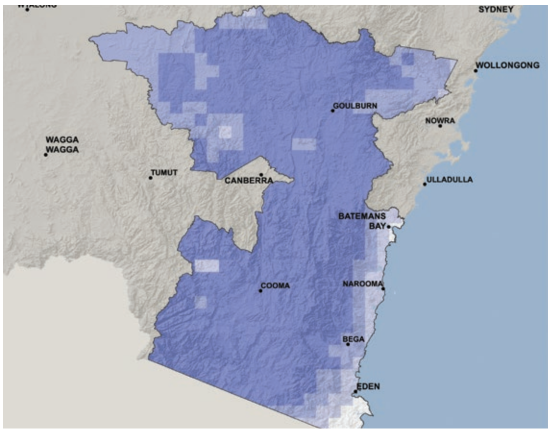


Figure 11: Near future (2020–2039) change in the number of days per year with minimum temperatures below 2°C, compared to the baseline period (1990–2009).

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

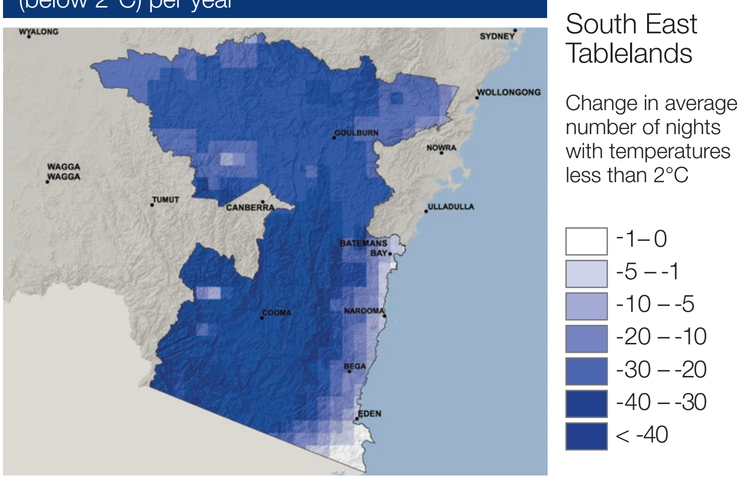


Figure 12: Far future (2060–2079) change in the number of days per year with minimum temperatures below 2°C, compared to the baseline period (1990–2009).

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 winter and to increase in autumn

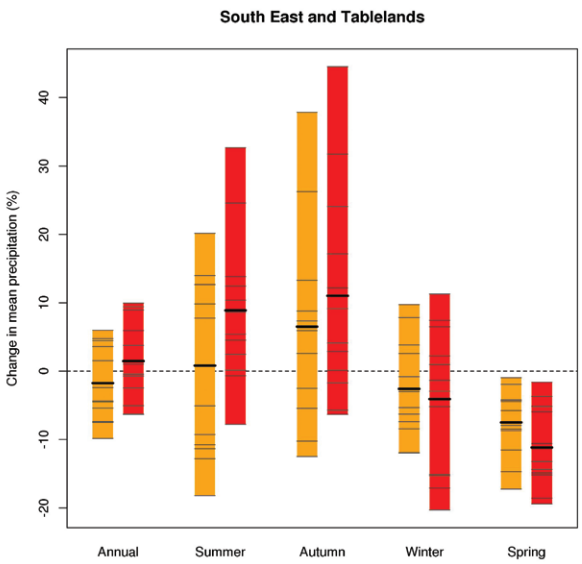


Figure 13: Projected changes in average rainfall for the South East Tablelands Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

Projected regional climate changes

In the South East Tablelands all models agree that spring rainfall will decrease in the near future and the far future (Figure 13).

The majority of models (8 out of 12) agree that autumn rainfall will increase and that winter rainfall will decrease in the near future and the far future (Figure 13).

Spring rainfall is projected to decrease across the region. The greatest change is projected for the south-west slopes in the near and far future and the Snowy Mountains in the far future (Figures 14 and 15).

Autumn rainfall is projected to increase across the region with the largest increases around Bega and Eden. Summer rainfall is projected to increase by 2070 across most of the region except the Snowy Mountains (Figure 15). Winter rainfall changes vary across the region.

Seasonal rainfall projections for the near future span both drying and wetting scenarios for summer (–18% to +20%), autumn (–12% to +38%) and winter (–12% to +10%). By 2070 the projections are: summer –8% to +33%, autumn –6% to +45%, and winter –20% to +11% (Figure 13).

All models agree that spring rainfall will decrease. The range of decrease spans –1% to –17% in the near future and –2% to –19% in the far future (Figure 13).

Projections for the region's annual average rainfall range from a decrease (drying) of 10% to an increase (wetting) of 6% by 2030 and still span both drying and wetting scenarios (–6% to +10%) by 2070.

The South East and Tablelands currently experiences considerable rainfall variability across the region and from year-to-year and this variability is also reflected in the projections.

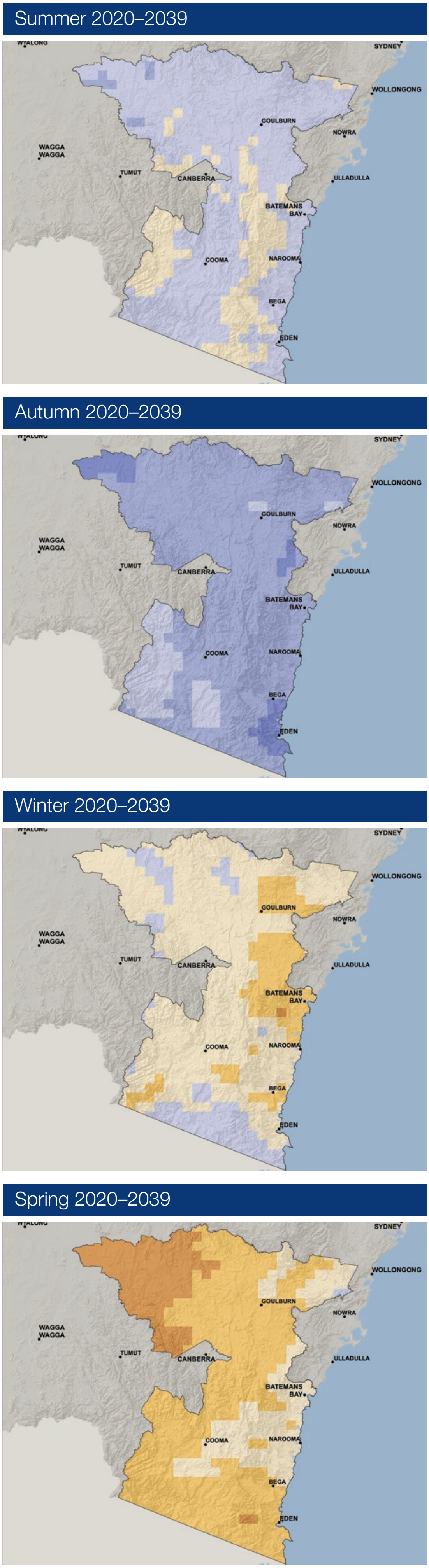


Figure 14: Near future (2020–2039) projected changes in average rainfall by season.

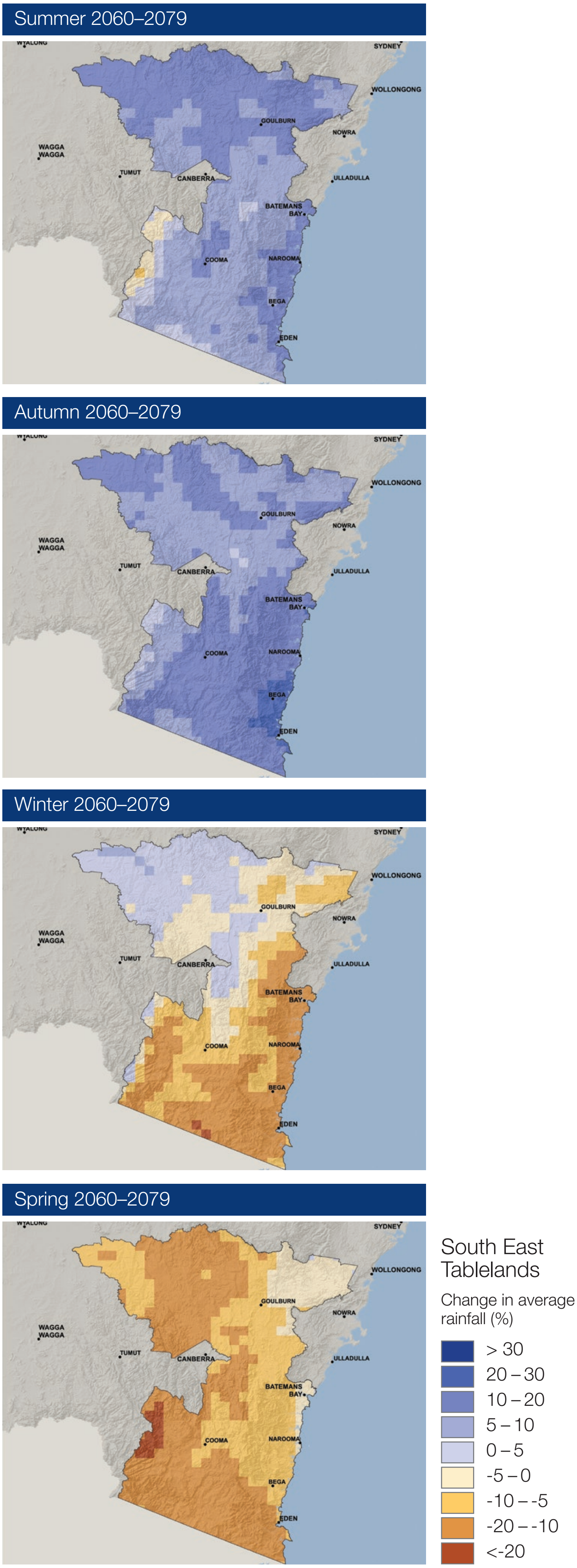


Figure 15: Far future (2060–2079) projected changes in average rainfall by season.

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 summer and spring

Severe fire weather for the region is projected to decrease in autumn

Projected regional climate changes

The South East and Tablelands Region 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 in average and severe fire weather are projected to occur mainly in spring and summer.

Although the increases in severe fire weather are relatively small in magnitude (up to two more days every five years by 2030) they are projected to occur in prescribed burning periods (spring) and the peak fire risk season (summer) (Figure 19).

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

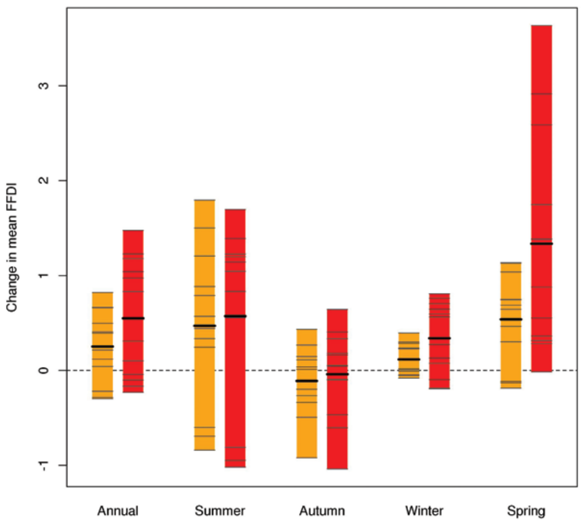


Figure 16: Projected changes in the average daily forest fire danger index (FFDI) for the South East and Tablelands Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

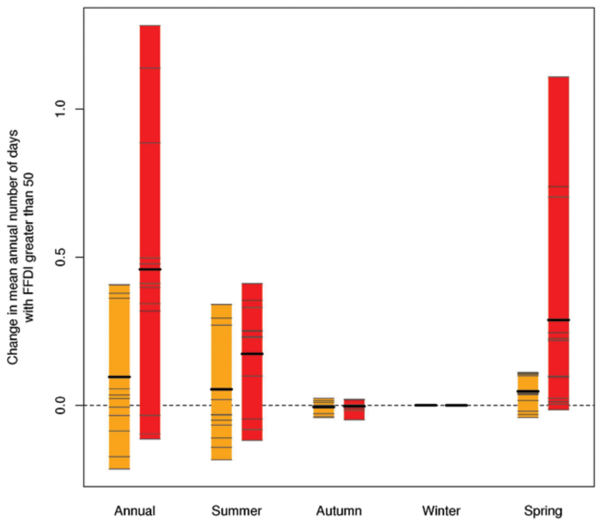


Figure 17: Projected changes in average annual number of days with a forest fire danger index (FFDI) greater than 50 for the South East and Tablelands Region, annually and by season (2030 yellow; 2070 red).

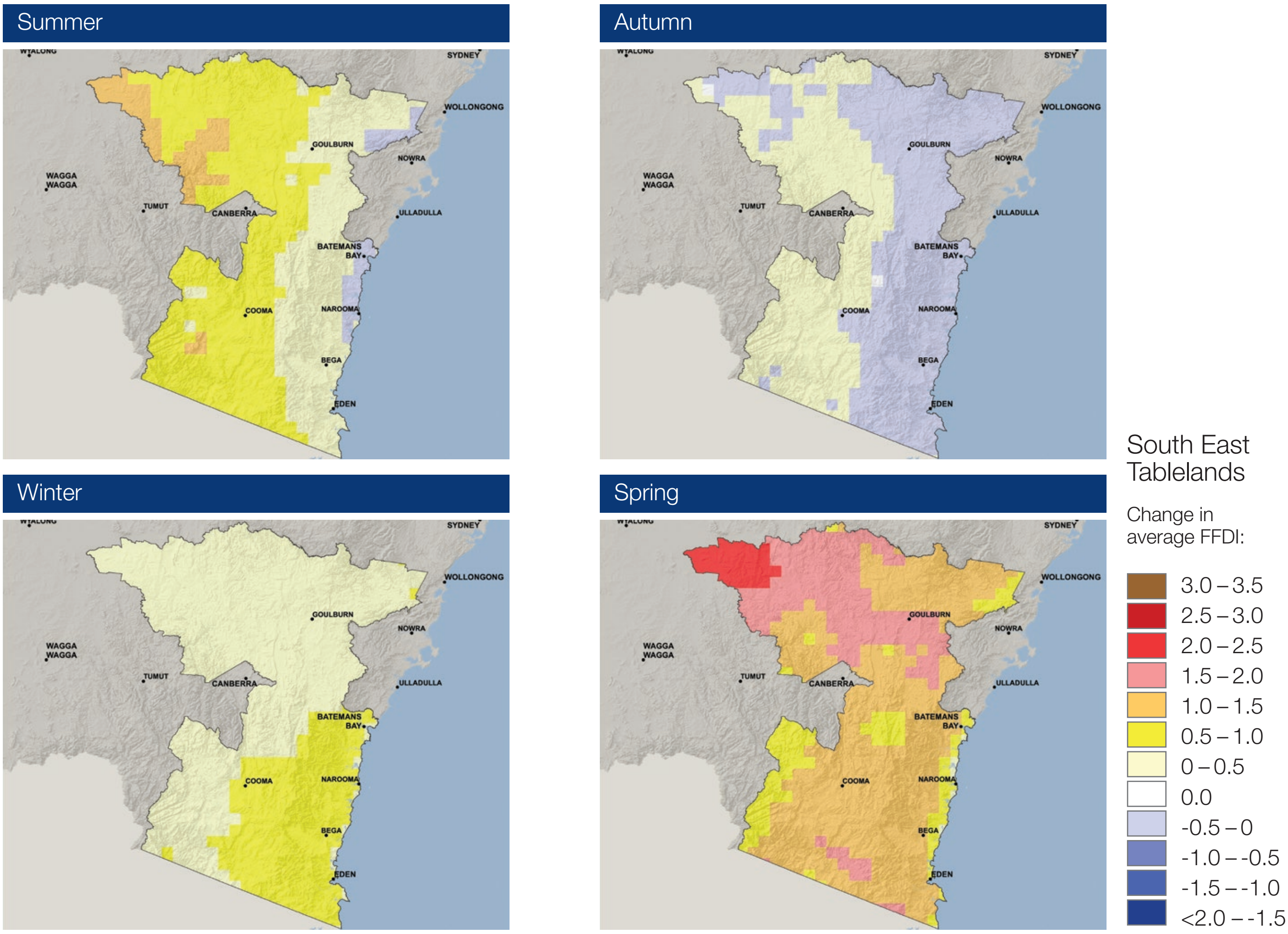


Figure 18: Far future (2060–2079) projected changes in average FFDI, compared to the baseline period (1990–2009).

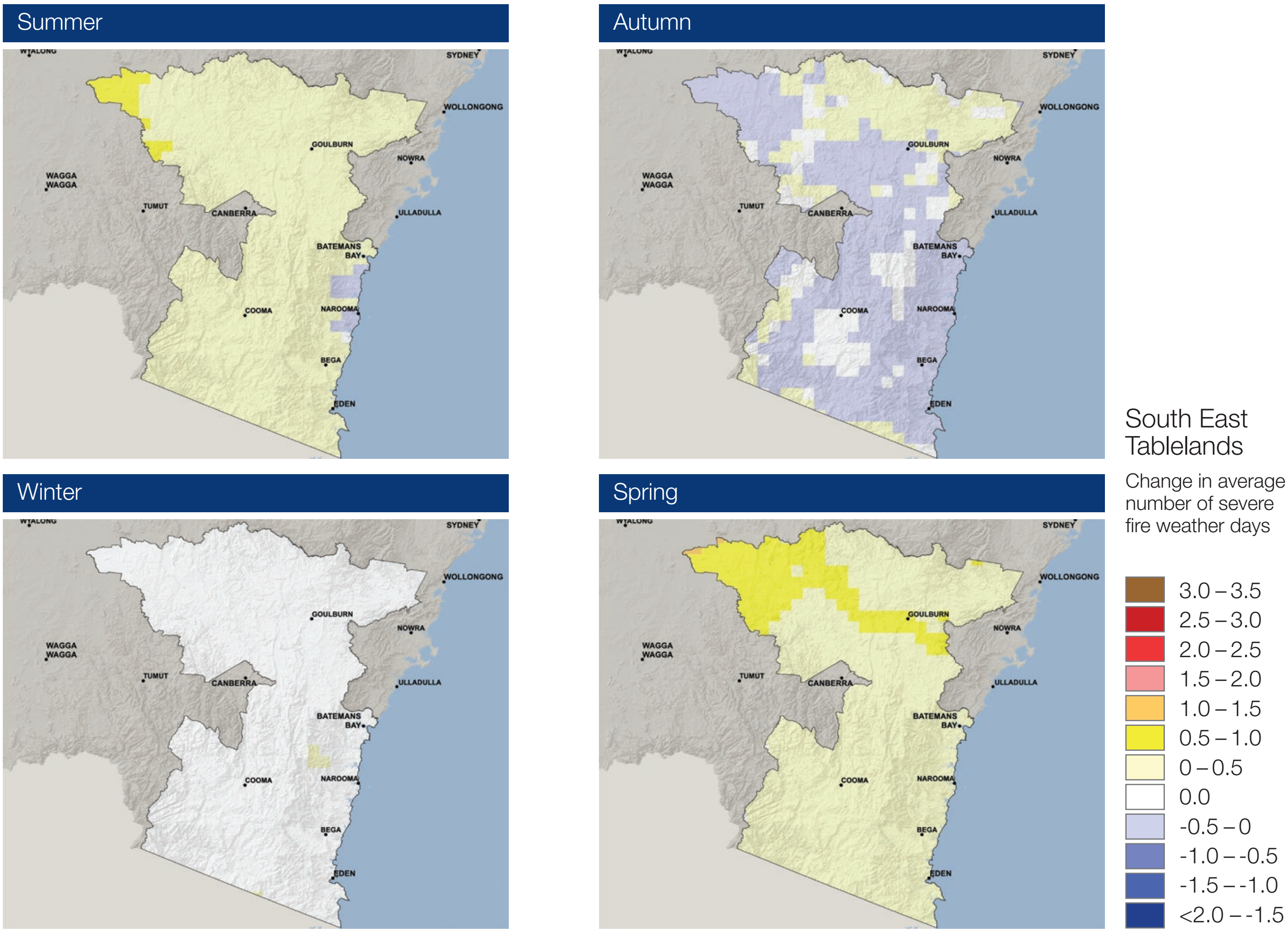


Figure 19: Far future (2060–2079) projected changes in average number of days with a FFDI greater than 50, compared to the baseline period (1990–2009).

Appendix 1 Guide to reading the maps and graphs

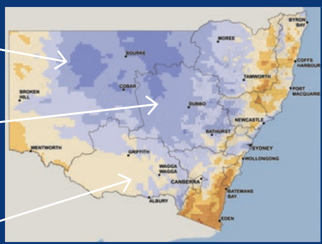
This document contains maps and bar graphs of the climate change projections. The maps present the results of the twelve models as an average of all twelve models. The bar graphs show projections averaged across the entire state and do not represent any particular location within the state. The bar graphs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



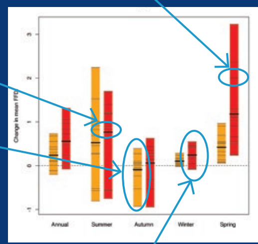
How to read the bar graphs

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

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