

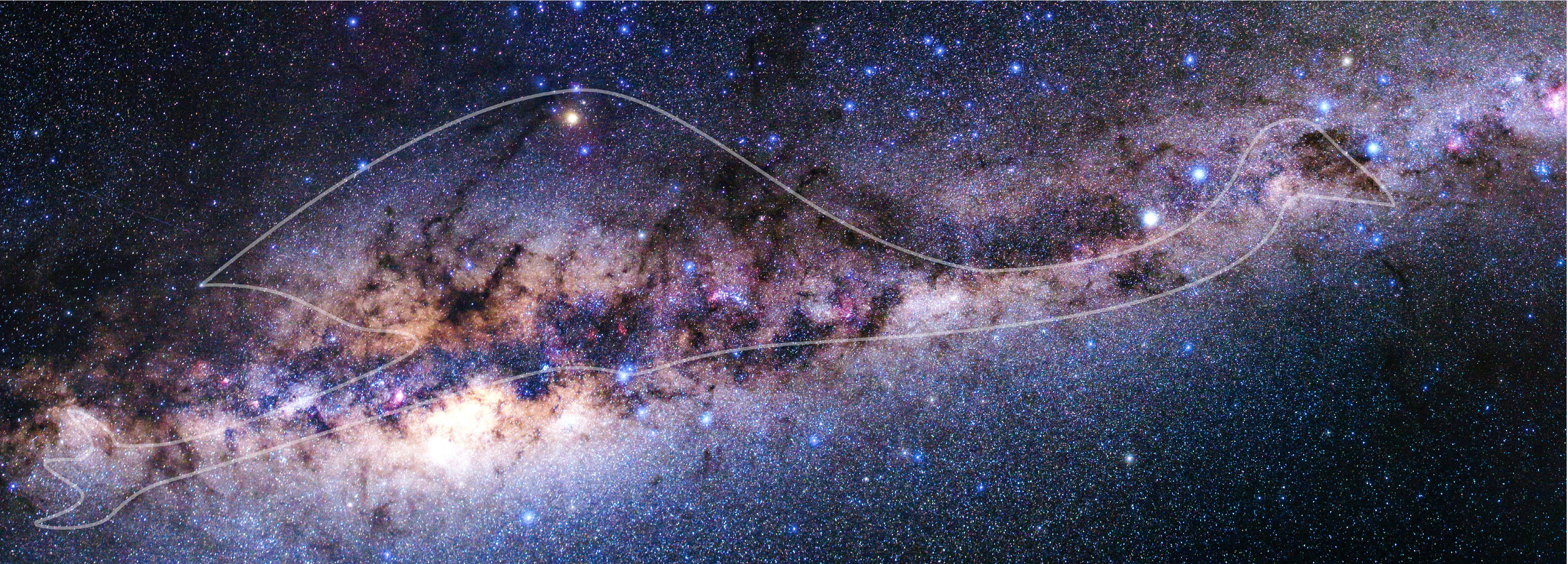
Riverina Murray

Climate Change Snapshot



Photo caption:

The Emu in the Sky is an Aboriginal constellation that is made up of the dark clouds of the Milky Way. With the movement of the Earth, the position of the Emu in the Sky changes throughout the year. Aboriginal people in some nations across NSW and Australia relate the position of the Emu in the Sky to the breeding behaviour of the emu on the land. Cultural astronomy teaches us about the relationship between the sky and land; and that we are all interconnected.



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Acknowledgement of Country

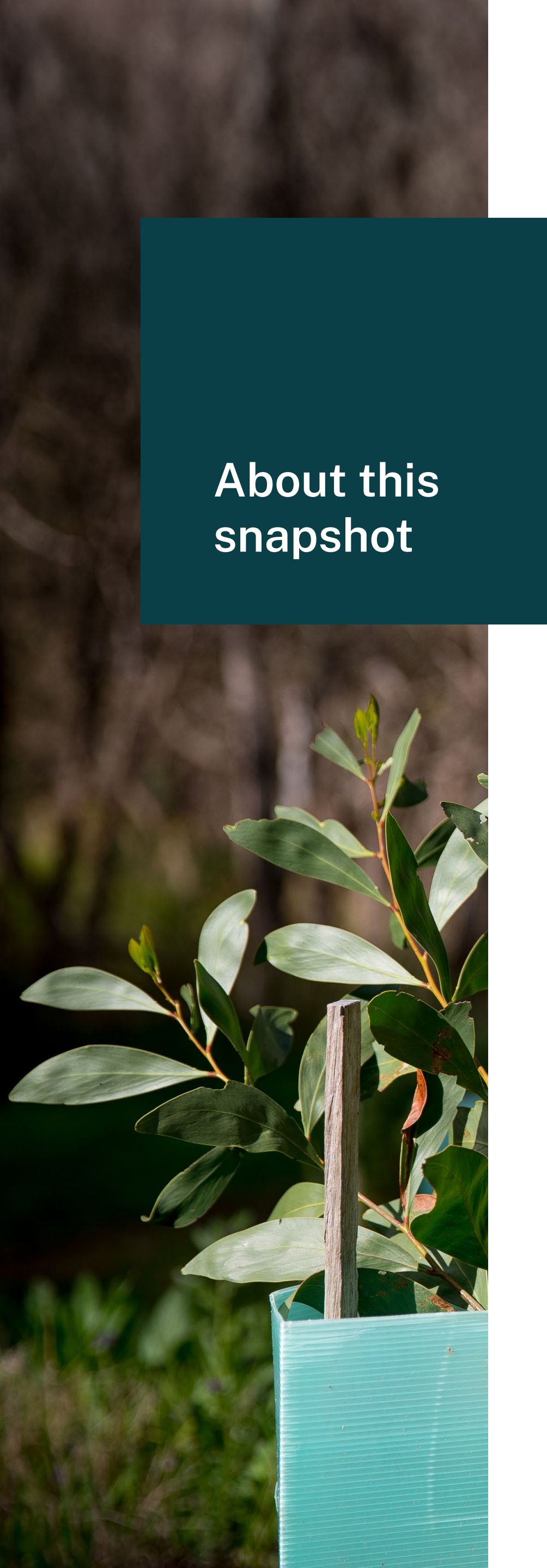
The NSW Government acknowledges First Nations people as the first Australian people and the traditional owners and custodians of the country's lands and water. Australia's First Nations people have lived in NSW for over 60,000 years and have significant spiritual, cultural and economic connections with its lands, waters, seas and skies.

The Riverina Murray region encompasses the traditional lands of the Barapa Barapa, Nari Nari, Ngarigu, Ngunawal, Wolgalu, Wemba Wemba, Wiradjuri, Yita Yita and Yorta Yorta peoples.

They are the first astronomers and scientists who have been listening, reading and understanding natural processes and caring for Country for generations.

We pay respects to Elders past and present and acknowledge the significance of their traditional knowledge in adapting to changes in climate over tens of thousands of years.

We recognise the importance of their cultural knowledge and guidance at this pivotal moment in time.



About this snapshot

The New South Wales (NSW) and Australian Regional Climate Modelling (NARClIM) project delivers high-resolution climate change projections for NSW and south-east Australia.

This snapshot provides the latest NARClIM2.0 climate projections for the Riverina Murray under low, medium and high emissions scenarios for the middle of the century (2050) and end of the century (2090). It includes projections for key climate variables including temperature, average rainfall, hot days (days $\geq 35^{\circ}\text{C}$), cold nights ($< 2^{\circ}\text{C}$), and severe fire weather days (Forest Fire Danger Index > 50). The projections help illustrate potential climate changes and their impacts, as well as associated climate risks.

NSW is already experiencing climate change. This document provides local-scale climate modelling insights to help the Riverina Murray communities understand and plan for the impacts of climate change on their infrastructure, environment and way of life; and to support informed planning, risk assessment and action.

This snapshot offers a high-level overview, with more detailed data available through the [AdaptNSW Interactive Map](#), [Climate Data Portal](#) and [AdaptNSW](#).

How to use this snapshot

While there are several different ways to engage with the information in this snapshot, here are some key things to consider:

- **Explore each climate variable across scenarios** – review projections under low (SSP1–2.6), medium (SSP2–4.5), and high (SSP3–7.0) emissions scenarios to understand how climate risk differs depending on emissions pathways (Shared Socioeconomic Pathways, SSPs).
- **Compare scenario-based changes over time** – examine how each climate variable responds to different emissions scenarios for the middle of the century (2050) and the end of the century (2090) to understand how risks may evolve.
- **Identify where projections of climate variables align or diverge** – look for patterns across emissions scenarios and timeframes to see where risks remain consistent and where they escalate or diverge significantly.

Time periods in this snapshot

The projections for each time period represent averaged data across all climate models used for NARClIM for a 20-year period:

- **Baseline period: baseline** → The modelled average for each climate variable from 1990–2009, used for comparison with future projections.
- **Middle of the century: ‘2050’ projection** → The projected average for each climate variable for 2040–2059.
- **End of the century: ‘2090’ projection** → The projected average for each climate variable for 2080–2099.



About this snapshot

NARClIM climate projections

NARClIM is NSW's regional climate modelling project. NARClIM combines carefully selected global and regional climate models through a process known as dynamical downscaling, to generate detailed, locally relevant climate projections. These simulate a range of plausible future climates, helping to inform climate risk assessments and support planning at local and regional levels.

Launched in 2024, NARClIM2.0 provides nation-leading climate model data that span the range of plausible future changes in climate. It offers:

- climate projections out to the year 2100, and simulations of the past climate from 1951 to 2014
- 4-km scale projections for south-east Australia
- 20-km scale projections for the broader Australasian region
- projections for key climate variables and extremes.

There is more information [About NARClIM](#), as well as specific information on [Downscaling in NARClIM](#) and [Global and regional climate models used by NARClIM](#) at AdaptNSW.

Methods and uncertainty

To help address future uncertainty, NARClIM2.0 is built on a selection of emissions scenarios, global climate models and regional climate models that, together, capture a range of climates that could occur. This is referred to as the NARClIM model ensemble. The NARClIM2.0 model ensemble is made up of different combinations of 5 global climate models and 2 regional climate models, giving 10 model combinations in total.

The data presented in this snapshot is generally an average for different 20-year time periods (e.g. the 2050 projection is the average for the 2040–2059 time period). Time series data are presented as annual averages. Combining multiple models through averaging and other statistical methods produces better projections by providing a comprehensive representation of possible future climate scenarios.

To ensure that NARClIM models adequately simulate regional climate, scientists use them to simulate the past climate and compare the results with actual observations. Outputs undergo rigorous quality control and scientific technical peer review.

There is more information on [The NARClIM modelling methodology](#) and [NARClIM data processing, testing and validation](#) at AdaptNSW.

Mental health support

Climate change information can be distressing for some readers, with many Australians of all ages experiencing significant eco-anxiety. For supporting information, please visit the [Black Dog Institute](#) or [Australian Psychological Society](#) or speak with your local healthcare provider.

About this snapshot

Shared Socioeconomic Pathways

NARClIM2.0 uses Shared Socioeconomic Pathways (SSPs), which are the most recent emissions scenarios adopted in Coupled Model Intercomparison Project Phase 6 (CMIP6) models and used in the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report.

The SSPs are a type of storyline-based emission scenario that estimate the world’s future emissions and how these will affect the climate. SSPs outline different global development trajectories based on factors such as population, economic growth, education, urbanisation and land use, and technological advancement.¹ By analysing SSPs, we can better understand the long-term consequences of today’s decisions and determine if we are heading toward higher-risk scenarios.²

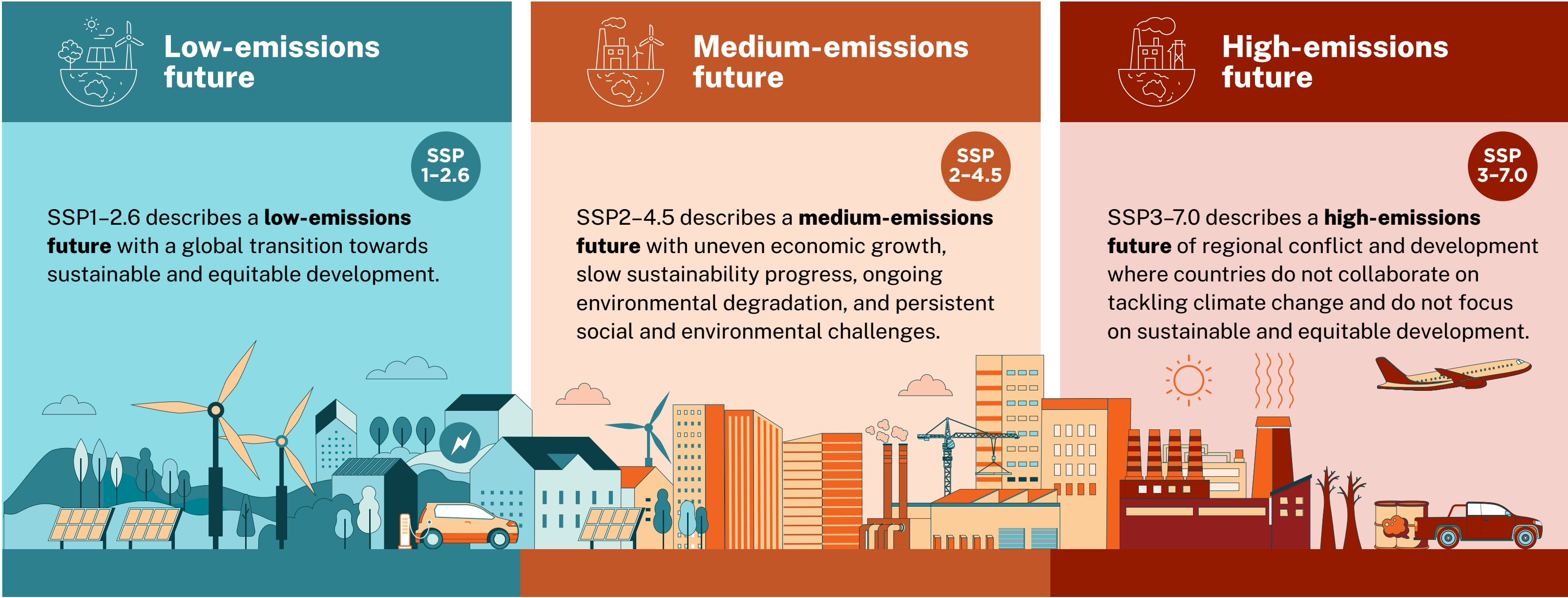
For more information on emissions scenarios visit Emissions scenarios used by NARClIM on AdaptNSW and Summary for policymakers report by the IPCC.

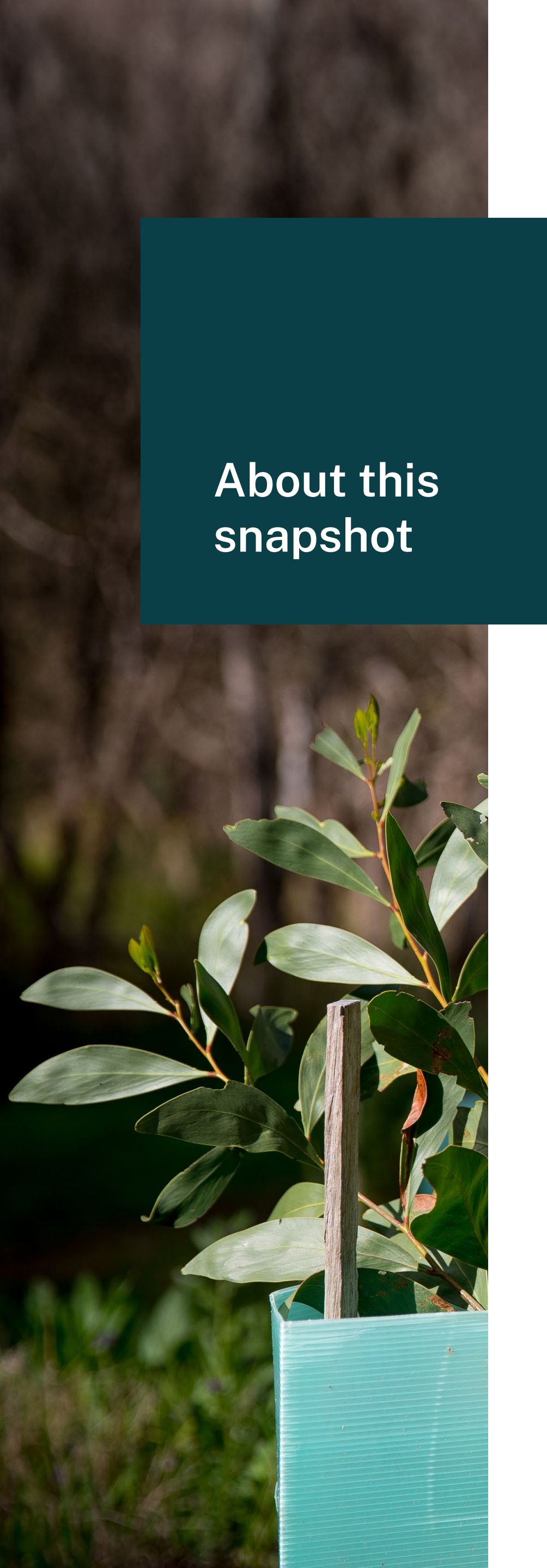
Why do we use 3 SSPs?

The future is uncertain. There are many plausible futures on the horizon, and the one we reach depends on the path we take to get there. NARClIM provides projections for 3 SSPs (low-, medium- and high-emissions), each representing a distinct future with varying levels of climate risk.

Considering a range of SSPs and understanding where these scenarios align or diverge – in both the middle of the century (2050) and the end of the century (2090) – helps inform better planning and decision-making. NARClIM data highlights just how stark the differences between futures can be.

For more information about how to integrate this information into your risk assessments see Climate risk ready guide and Limitations and appropriate use on AdaptNSW.





About this snapshot

Understanding the baseline period

To assess future climate projections, a climate baseline is used. This is a reference point which future change is relative to. In this snapshot, the baseline is the 20-year period from 1990 to 2009. This period is termed the baseline period to represent the average climate across those 2 decades.

A 20-year baseline averages out natural climate variability and avoids misleading comparisons with unusually hot, cold, wet or dry years. Using a fixed reference point prevents issues that may arise from using shifting reference points to compare future change against.

Climate during the baseline period is described in 2 ways in this snapshot:

- **Historical model:** The NARClIM2.0 simulation of past climate conditions.
- **Observed:** What was actually measured using weather station data during this period.

These 2 values are similar but not the same. Climate models aim to capture long-term patterns and trends, rather than matching observations perfectly. Observed values give context for comparison of the historical model with what it was in reality.

Looking backwards from the baseline

Before the baseline period, +0.84°C of observed warming had already occurred across NSW and the Australian Capital Territory (ACT) since records began. This is the difference between the 20-year average temperature of the 2 periods centred on 1920 (1910–1929) and 2000 (1990–2009). The Bureau of Meteorology’s national climate records for temperature begin in 1910, making 1910–1929 the first available 20-year average for comparison with the baseline.

Consider the following when incorporating past warming into future projections:

- Warming before the baseline (+0.84°C) is not included in projections of future change.
- Warming after the baseline period is already included in future projections and should not be added again.

Looking forwards from the baseline

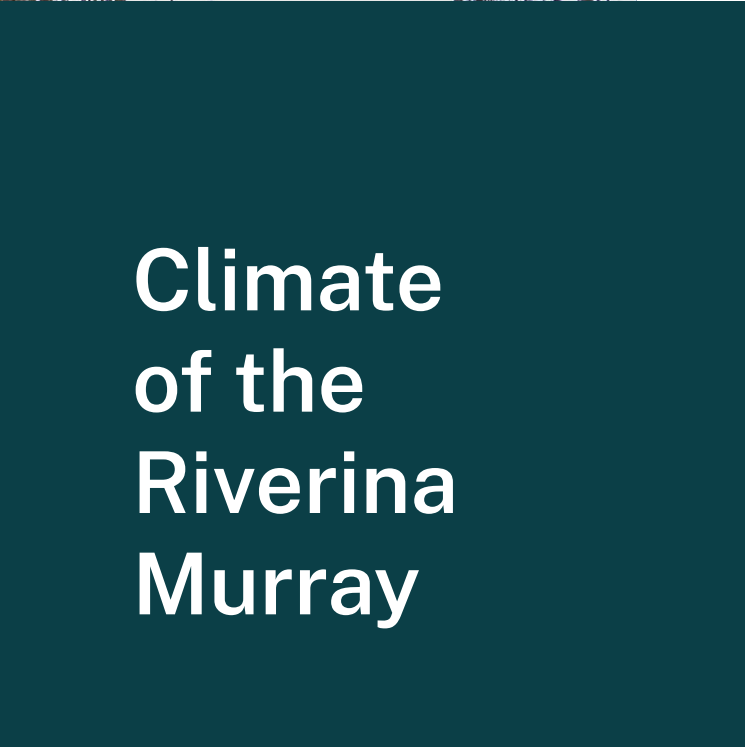
Use the historical model values in Table 1 as the baseline when interpreting both middle of the century and end of the century climate projections in this snapshot.

By comparing future projections to the historical model baseline values, we ensure the projected changes reflect genuine shifts, instead of also including the small differences between the modelled and observed data.

Table 1. Baseline climate for the Riverina Murray

	Average temperature	Average maximum temperature	Average minimum temperature	Hot days	Cold nights	Rainfall	Severe fire weather days
Observed	16.3°C	23.2°C	9.5°C	29.0 days	41.7 days	462 mm	7.4 days
Historical model	16.9°C	22.4°C	11.3°C	28.2 days	39.7 days	415 mm	7.9 days

Table 1 outlines the annual average values for the baseline period in this snapshot. All observed data is calculated from Bureau of Meteorology products. Long-term temperature change data is from the long-term temperature record.³ Observed information and data in graphs come from Australian Gridded Climate Data (AGCD).⁴



Climate of the Riverina Murray

The climate of the Riverina Murray underpins a diverse array of important lifestyles, industries and natural ecosystems. A stable climate is critical to support a range of values in the Riverina Murray, including our unique biodiversity, recreational activities and food systems.

The Riverina Murray region encompasses the traditional lands of the Barapa Barapa, Nari Nari, Ngarigu, Ngunawal, Wolgalu, Wemba Wemba, Wiradjuri, Yita Yita and Yorta Yorta peoples.

The Riverina Murray region spans approximately 76,000 km². It includes the major regional cities of Albury, Wagga Wagga and Griffith, which are home to more than 50% of the region's population. Known as Australia's food bowl, the region supports diverse industries including farming, viticulture and tourism.

The region features large floodplains and relatively flat river valleys, including some of the longest rivers in Australia such as the Murray, Murrumbidgee and Lachlan rivers. The region's climate varies widely due to its topography, with wetter conditions near the Snowy Mountains and drier climates in the west. Summers tend to be warm to hot in the north-west and cooler in the mountains. Milder temperatures prevail in central areas along the south-west slopes, featuring cooler summers and warmer winters than surrounding areas. The range of altitude, rainfall and temperature in the region give rise to great diversity in natural environments.

The region includes some of Australia's rarest and most significant natural ecosystems, which range from the highest altitudes of the Australian continent to semi-arid ecosystems in south-west NSW and on the Hay Plains. In the west of the region, wetland communities associated with the major rivers rely on the snowmelt and rainfall from the highest peaks, including 2 internationally significant Ramsar sites (NSW Central Murray forests and Fivebough and Tuckerbil Swamps).

Children and adolescents (0–14 years) make up 18.9% of the population, slightly higher than the NSW and ACT average of 18.2%, while people aged 65 and over represent 21.0% and the working-age population (15–64) represent 60.1% of the region's total.⁵

The Riverina Murray supports a diverse range of industries that are vital for NSW's economy, with the highest number of businesses in agribusiness (agriculture, forestry and fishing), construction as well as property and rental services. The largest industries of employment for the region are health care and social assistance (14.2%), agribusiness (10.6%), retail trade (8.9%), education and training (8.9%) and manufacturing (8.8%).⁵

The region's climate has provided the foundation for many of the region's current social, economic and ecological systems. These systems will be impacted by increased temperatures, more hot days, fewer cold nights, greater fire danger and higher rainfall variability.

The following pages outline the projected changes in these key climate variables across the Riverina Murray region.





PROJECTED CHANGES





Increase in average temperature



Increase in hot days per year



Decrease in cold nights per year



Increase in severe fire weather days per year

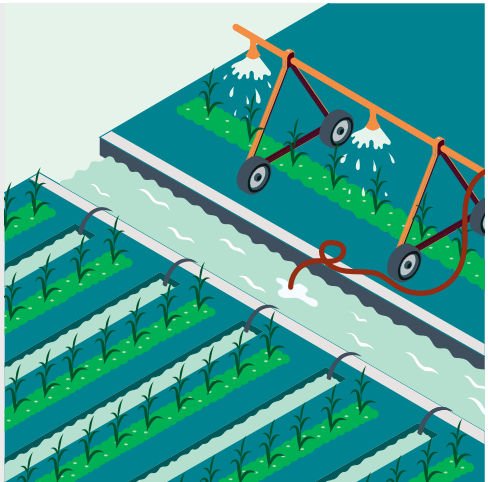
 Low-emissions scenario	2050		2090	
	2050	2090	2050	2090
	+1.1°C	+1.2°C	+1.5°C	+2.5°C
	+1.5°C	+2.5°C	+1.9°C	+3.7°C
	+13.0	+13.8	+16.1	+28.3
	+20.8	+41.9	+20.8	+41.9
	-12.3	-13.5	-15.5	-24.7
	-15.5	-24.7	-18.7	-31.7
	-18.7	-31.7	-18.7	-31.7
	-31.7	-31.7	-31.7	-31.7
	+2.6	+3.1	+2.8	+6.1
	+2.8	+6.1	+4.8	+8.0
	+4.8	+8.0	+4.8	+8.0
	+8.0	+8.0	+8.0	+8.0

REGIONAL IMPACTS



Alpine ecosystems

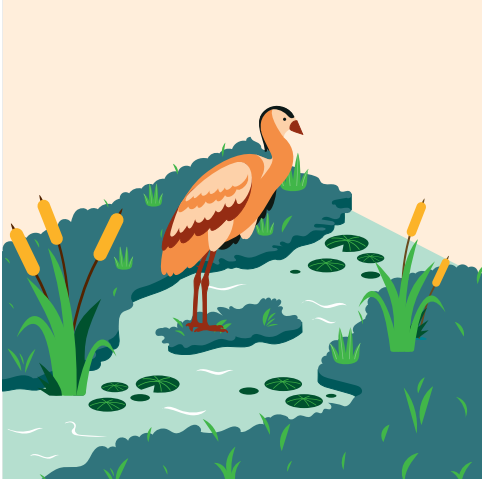
Decrease in cold nights



Irrigated horticulture

Changes to rainfall





Inland wetlands

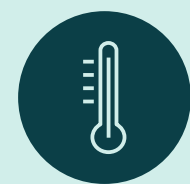
Changes to rainfall



Viticulture

Increased extreme heat

Data is based on NARcliM2.0 projections for SSP1–2.6 (low-emissions), SSP2–4.5 (medium-emissions) and SSP3–7.0 (high-emissions) and is presented relative to the baseline period of 1990–2009. Values presented are averages across the NARcliM2.0 model ensemble, and do not represent the full range of plausible climate futures. Regional climate change impacts are used to highlight how the region is likely to be affected by climate change, and impacts are not limited to the examples provided.



Temperature

In NSW, 8 of the 10 warmest years on record since 1910 have occurred since 2013.



3.7°C

rise in average temperature across the Riverina Murray by 2090 under a high-emissions scenario.

Temperatures are projected to be higher by 2050 under a high-emissions scenario than by 2090 under a low-emissions scenario.

The Riverina Murray is getting warmer

Temperature is the most robust indicator of climate change. In NSW, 8 of the 10 warmest years on record since 1910 have occurred since 2013. The warmest year on record for both average temperature and maximum temperature in the Riverina Murray region was 2009, when the average temperature was 1.1°C above the 1990–2009 baseline average.⁴

Projections

Across the the Riverina Murray region, average temperatures will increase throughout this century (Figure 1).

Under a low-emissions scenario, the average temperature increase across the region is projected to be 0.1°C between 2050 and 2090 (Table 2). However, major temperature increases of 1.0°C under a medium-emissions scenario and 1.8°C under a high-emissions scenario are expected during the same period. Notably, the temperature

projections for 2050 under both a medium-emissions scenario and a high-emissions scenario are expected to exceed the projections for 2090 under a low-emissions scenario.

Temperature increases are expected in all parts of the region (Figure 2) and across all seasons. The temperature increase is likely to be uniform throughout the region, with a slightly larger increase in the north of the region. By 2090, Wagga Wagga is likely to experience an increase in temperature of 1.2°C under a low-emissions scenario, 2.5°C under a medium-emissions scenario and 3.7°C under a high-emissions scenario.

Table 2 and Figure 1 provide more information on how the projections differ across the 3 scenarios, and Figure 2 provides information on regional differences by 2090 across the 3 scenarios.



Temperature

Table 2. Projected annual average temperature increase – Riverina Murray

2050

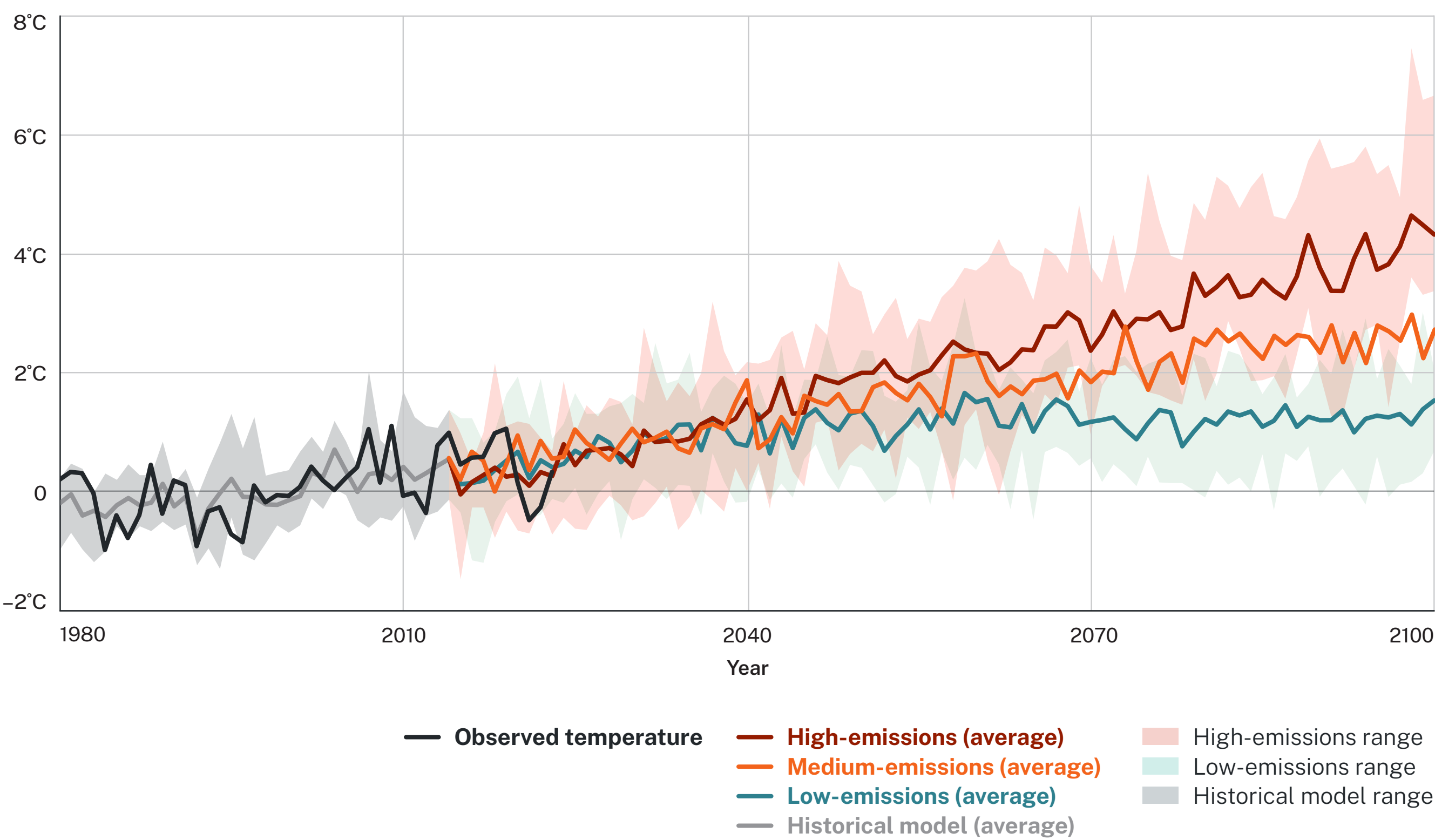
	Low-emissions	Medium-emissions	High-emissions
Temperature	1.1°C (0.6°C to 1.6°C)	1.5°C (1.0°C to 1.9°C)	1.9°C (0.8°C to 2.6°C)
Maximum temperature	1.2°C (0.6°C to 1.7°C)	1.6°C (1.1°C to 1.9°C)	2.0°C (0.9°C to 2.8°C)
Minimum temperature	1.0°C (0.5°C to 1.4°C)	1.4°C (0.8°C to 1.9°C)	1.7°C (0.8°C to 2.3°C)

2090

	Low-emissions	Medium-emissions	High-emissions
Temperature	1.2°C (0.7°C to 1.9°C)	2.5°C (1.8°C to 3.5°C)	3.7°C (2.5°C to 5.3°C)
Maximum temperature	1.3°C (0.7°C to 2.0°C)	2.7°C (1.8°C to 3.7°C)	3.9°C (2.6°C to 5.5°C)
Minimum temperature	1.1°C (0.6°C to 1.7°C)	2.3°C (1.7°C to 3.3°C)	3.6°C (2.3°C to 5.1°C)

The bold number is the ensemble average for the period. Underneath the average is the ensemble range. Temperature increases are additional to the historical model baselines of 16.9°C for average temperature, 22.4°C for average maximum temperature and 11.3°C for average minimum temperature.

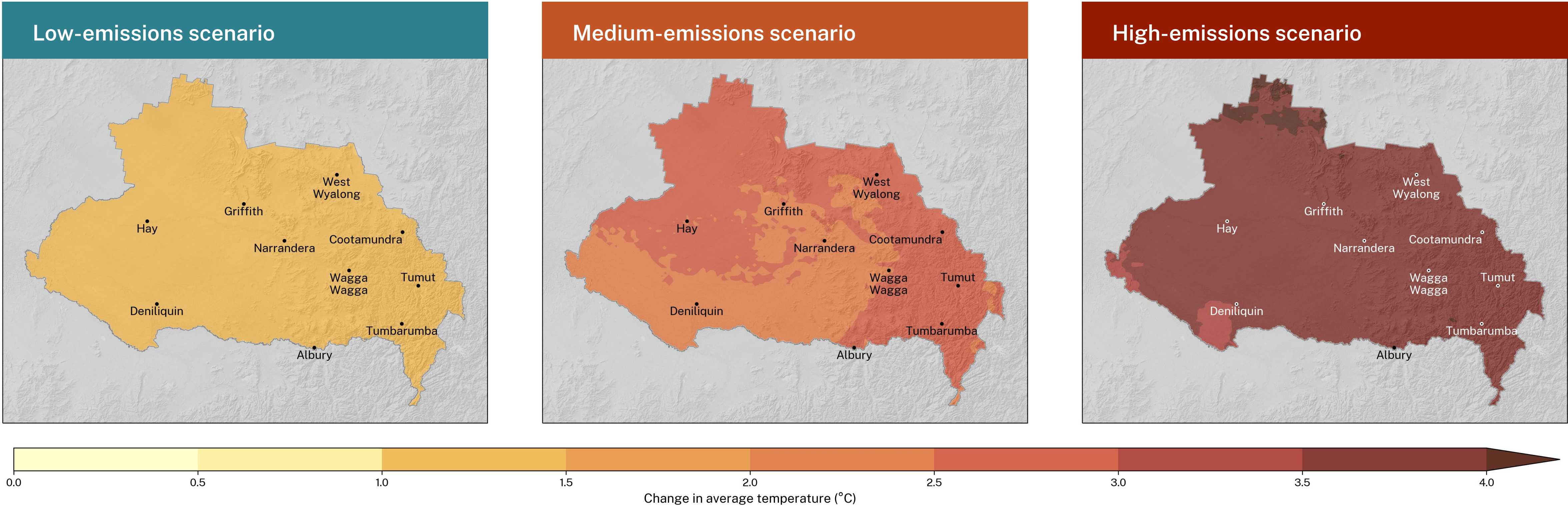
Figure 1. Historical and projected average temperature change – Riverina Murray

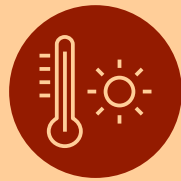




Temperature

Figure 2. Projected change in average temperature by 2090 for the Riverina Murray





Hot days

Changes to temperature extremes often have more pronounced impacts than changes in average temperatures.

Hot days will become more frequent

Prolonged hot days where maximum daily temperatures are equal to or above 35°C increase the incidence of illness and death – particularly among vulnerable people. Seasonal changes in hot days could have significant impacts on bushfire danger, infrastructure and native species.

The number of hot days varies widely across the Riverina Murray region. During the baseline period, higher elevation areas such as Tumbarumba had on average fewer than 5 hot days per year. Lower elevation areas in the east of the region such as Tumut, Wagga Wagga and Cootamundra had on average 10–20 hot days per year, while further inland, areas such as Griffith, Hay and West Wyalong had on average 25–35 hot days per year.

Projections

Across the Riverina Murray, the average number of hot days per year will increase throughout this century (Figure 3).

The number of hot days will increase for all emissions scenarios, with an even greater increase by 2090 under a medium-emissions scenario and a high-emissions scenario (Table 3). The number of hot days is projected to increase during spring, summer and autumn, with the largest increase in summer.

2x

The number of hot days across the Riverina Murray region is expected to more double by 2090 under a medium-emissions scenario and a high-emissions scenario.

Higher maximum temperatures affect health through heat stress and exacerbate existing health conditions.

Under a low-emissions scenario, there is a minimal increase of less than 1.0 additional hot day projected across the region between 2050 and 2090 (Table 3). However, increases of 12.2 additional hot days under a medium-emissions scenario and 21.1 additional hot days under a high-emissions scenario are projected during the same period.

Increases to hot days will occur across all of the region (Figure 4). Northern areas of the region, including Griffith and Hay, are projected to experience pronounced increases in the number of hot days. By 2090, Griffith is projected to experience 15.0 additional hot days per year under a low-emissions scenario, 31.0 additional hot days per year under a medium-emissions scenario and 45.1 additional hot days per year under a high-emissions scenario. A medium-emissions scenario is projected to more than double Griffith's baseline period average of 30.4 hot days per year, while a high-emissions scenario is projected to more than double Griffith's baseline average of hot days. Comparatively, in the east of the region, Tumut's baseline period average is 10.9 hot days per year. By 2090, Tumut is also projected to experience an additional 9.0 hot days per year under a low-emissions scenario, 20.4 additional hot days under a medium-emissions scenario and 31.1 additional hot days per year under a high-emissions scenario.

Table 3 and Figure 3 provide more information on how the projections differ across the 3 scenarios, and Figure 4 provides information on regional differences by 2090 across the 3 scenarios.



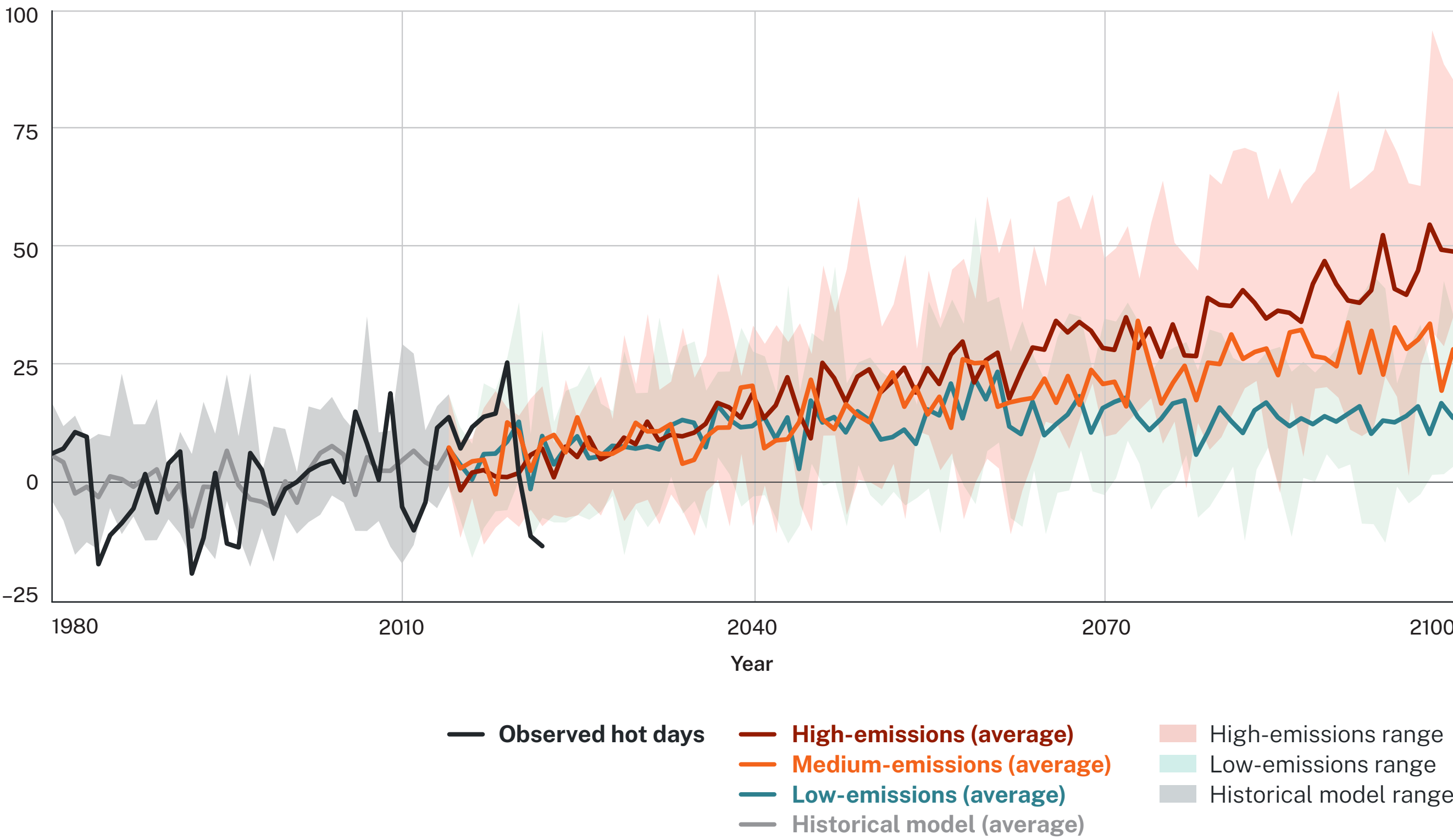
Hot days

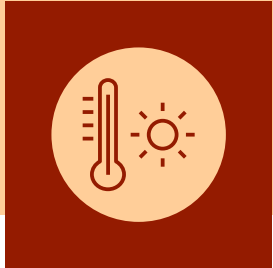
Table 3. Projected increase in average annual number of hot days – Riverina Murray

2050		
Low-emissions	Medium-emissions	High-emissions
13.0 days (2.1 to 23.2 days)	16.1 days (7.8 to 23.0 days)	20.8 days (3.3 to 33.7 days)
2090		
Low-emissions	Medium-emissions	High-emissions
13.8 days (5.7 to 23.9 days)	28.3 days (13.6 to 43.6 days)	41.9 days (22.7 to 67.3 days)

The bold number is the ensemble average for the period. Underneath the average is the ensemble range. Hot day increases are additional to the historical model baseline of 28.2 hot days.

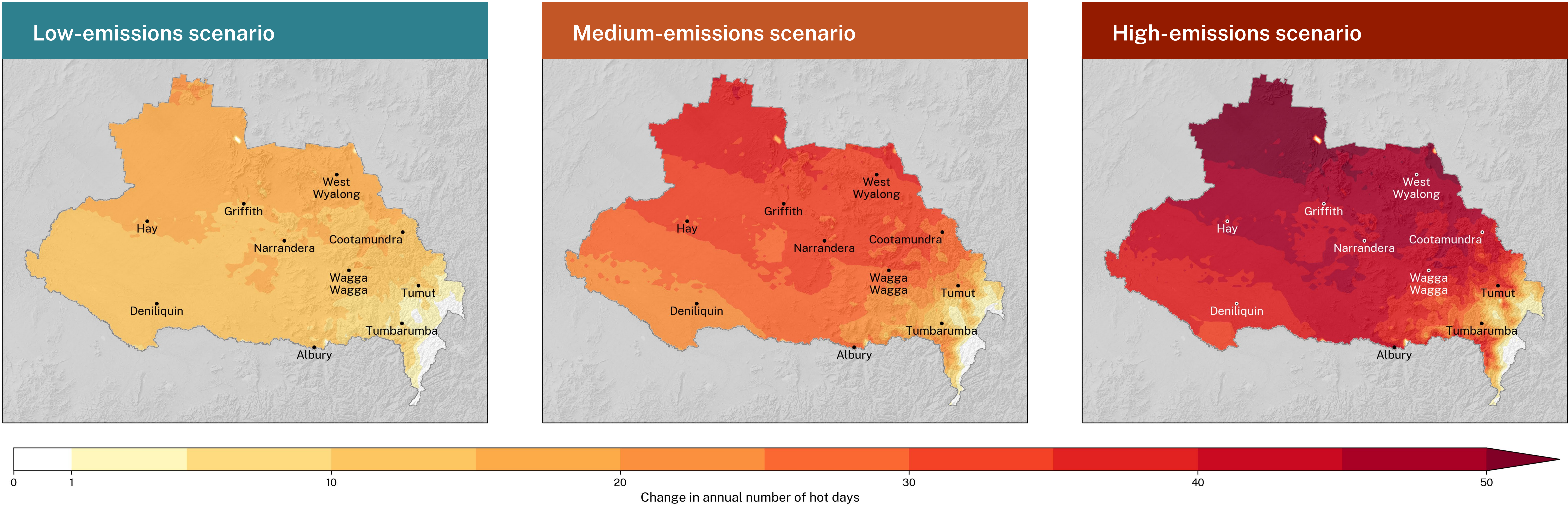
Figure 3. Historical and projected average annual number of hot days – Riverina Murray





Hot days

Figure 4. Projected change in annual number of hot days by 2090 for the Riverina Murray





Cold nights

High-elevation areas of the region such as Tumbarumba could experience a greater than 60% reduction in the annual number of cold nights.

Under a high-emissions scenario, alpine areas of the region could experience half the number of cold nights by 2090.

Under a low-emissions scenario, the number of cold nights across the Riverina Murray could reduce by less than 35% by 2090.

Cold nights will decrease

Cold nights are those where the minimum temperature drops below 2°C. These are important for the viability of some important plant species. For example, some common temperate fruit species require sufficiently cold winters to produce flower buds.

The number of cold nights varies widely across the Riverina Murray region, but generally decreases from east to west. During the baseline period, areas of higher elevation in the east of the region had on average more than 110 cold nights per year. Areas near the centre of the region such as Wagga Wagga and Griffith had on average 30–40 cold nights per year, while western areas such as Hay had on average 20 cold nights per year.

Projections

Across the Riverina Murray, the average number of cold nights per year will decrease throughout this century (Figure 5).

Under a low-emissions scenario, there is a small decrease of 1.2 fewer cold nights per year projected across the region between 2050 and 2090 (Table 4). However, decreases of 9.2 fewer cold nights per year under a medium-emissions scenario and 13.0 fewer cold nights per year under a high-emissions scenario are projected during the same period.

The greatest decreases are projected to occur along the western edge of the Snowy Mountains including Tumbarumba and Tumut. By 2090, Tumbarumba is projected to have 22.0 fewer cold nights per year under a low-emissions scenario, 47.0 fewer cold nights per year under a medium-emissions scenario and 67.6 fewer cold nights per year under a high-emissions scenario. A medium-emissions scenario is projected to reduce Tumbarumba's 108.1 cold nights per year baseline period average by more than 40%, while a high-emissions scenario is projected to reduce the baseline average by more than 60%.

Cold nights will decrease across all of the region, particularly in higher elevation areas in the east of the region (Figure 6). By 2090, Wagga Wagga is projected to have 13.0 fewer cold nights per year under a low-emissions scenario, 24.3 fewer cold nights per year under a medium-emissions scenario and 31.0 fewer cold nights per year under a high-emissions scenario. A medium-emissions scenario is projected to reduce Wagga Wagga's 35.9 cold nights per year baseline period average by more than 65%, while a high-emissions scenario is projected to reduce Wagga Wagga's baseline average by more than 85%.

Table 4 and Figure 5 provide more information on how the projections differ across the 3 scenarios, and Figure 6 provides information on regional differences by 2090 across the 3 scenarios.



Cold nights

Table 4. Projected decrease in average annual number of cold nights – Riverina Murray

2050

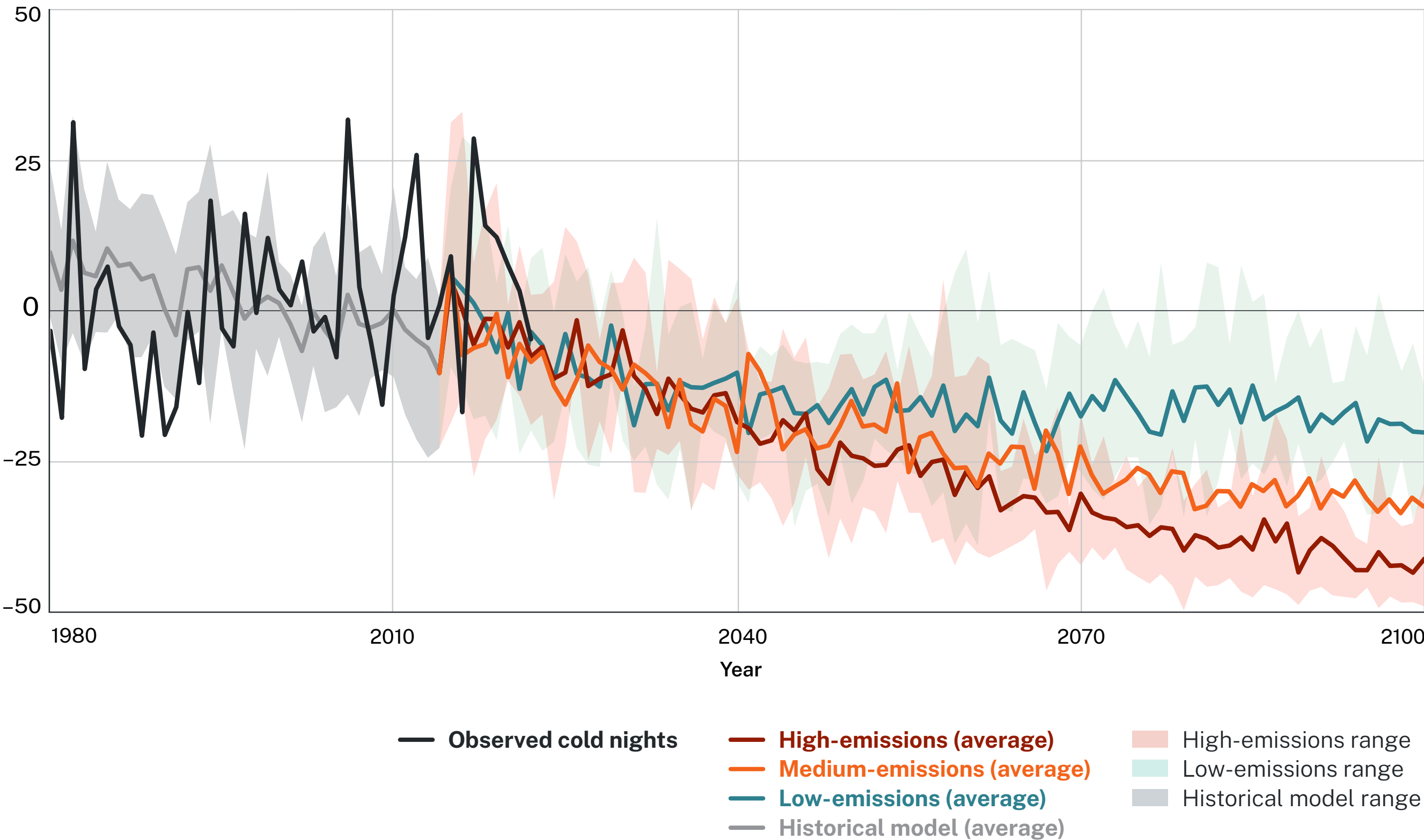
Low-emissions	Medium-emissions	High-emissions
12.3 days (7.7 to 17.9 days)	15.5 days (9.5 to 19.2 days)	18.7 days (8.7 to 23.3 days)

2090

Low-emissions	Medium-emissions	High-emissions
13.5 days (5.5 to 18.4 days)	24.7 days (18.0 to 30.4 days)	31.7 days (24.4 to 36.5 days)

The bold number is the ensemble average for the period. Underneath the average is the ensemble range. Cold night decreases are relative to the historical model baseline of 39.7 cold nights.

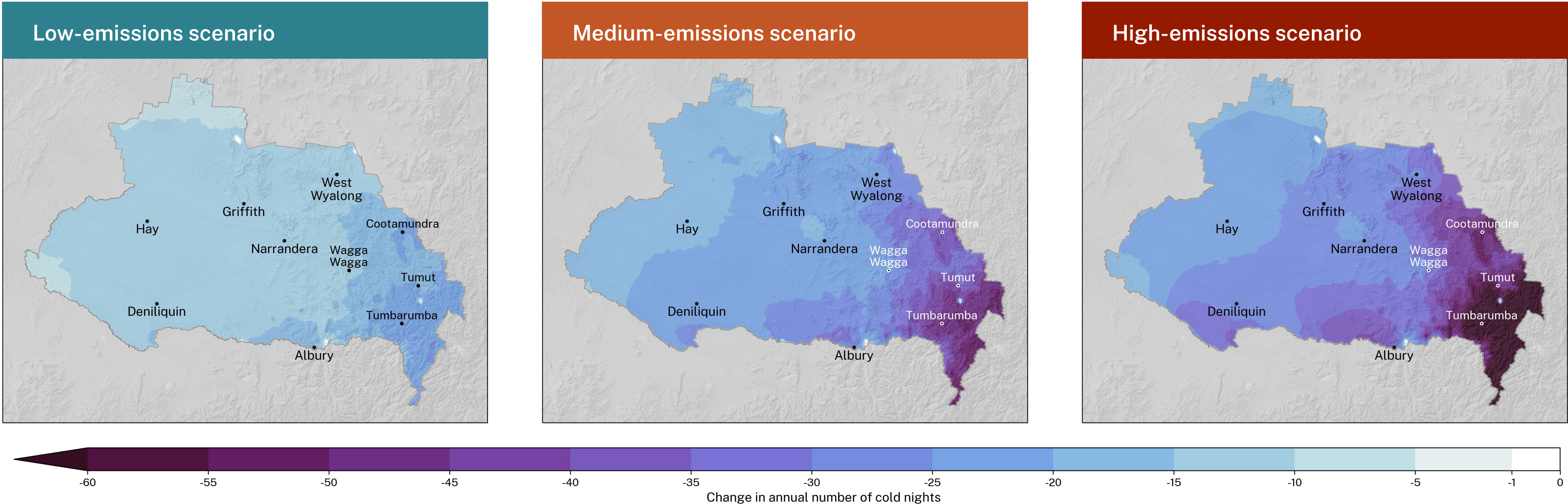
Figure 5. Historical and projected change in annual number of cold nights – Riverina Murray





Cold nights

Figure 6. Projected change in annual number of cold nights by 2090 for the Riverina Murray





Rainfall

Rainfall is projected to remain variable

Climate change will influence rainfall patterns and the total amount of rainfall that NSW receives. These changes may have widespread impacts on water security, agricultural productivity and native species' reproductive cycles. For example, eucalypt woodlands and riverine plains in the interior west could struggle to cope with drier conditions.

Modelling rainfall is more difficult than modelling temperature due to the complexities of the weather systems that generate rain. NARcliM projections capture a range of plausible climate futures under the 3 emissions scenarios, including wet and dry outcomes. This means that rainfall is inherently more variable in the NARcliM projections than temperature, and the full range of rainfall projections should be taken into account. This can be explored further on the [AdaptNSW Interactive Map](#).

Observed annual rainfall across the Riverina Murray region averages about 460 mm.⁴ Rainfall is highest in the Snowy Mountains and rainfall generally decreases from the east to the west of the region. Rainfall is nearly uniformly distributed throughout the year across most of the region, with slightly higher rainfall in winter and spring, particularly in the Snowy Mountains. The driest year on record was 1967, with an average rainfall of only 210 mm. Notably dry years were also experienced in 2018 and 2019, with approximately 290 mm of rainfall across the region in each year.⁴

This snapshot provides data on average rainfall change and does not provide data on rainfall extremes or the impacts of climate change on flooding.

A decrease in average spring rainfall of approximately 25% by 2090 is projected for the Riverina Murray under both medium-emissions and high-emissions scenarios.

Projections

Annual average rainfall in the region is projected to remain variable throughout this century (Figure 7). By 2090, on average, annual rainfall is projected to decrease by 10% under a low-emissions scenario, by 19% under a medium-emissions scenario and by 15% under a high-emissions scenario (Table 5). Changes to average rainfall will occur in all seasons, with the largest changes expected in spring and summer.

By 2090, average summer rainfall is projected to decrease across the region, under all emissions scenarios (Figure 9), with areas in the west of the region such as Deniliquin and Hay, projected to experience a decrease in rainfall of approximately 20%.

On average, autumn and winter rainfall is projected to change by 12% or less across the region by 2090 under all emissions scenarios, except a 19% decrease in average winter rainfall under a medium-emissions scenario.

By 2090, average spring rainfall is projected to decrease across the region by 20% under a low-emissions scenario, by 25% under a medium-emissions scenario and by 26% under a high-emissions scenario. There are some minor variations across the region (Figure 12).

Refer to the [Interactive Map](#) for further seasonal information.

Table 5 and Figure 7 provide more information on how the projections differ across the 3 scenarios, and Figures 8 to 12 provide information on regional differences by 2090 across the 3 scenarios by season.



Rainfall

Table 5. Projected change to average rainfall – Riverina Murray

2050

	Low-emissions	Medium-emissions	High-emissions
Annual	-11.8% (-24.1% to +5.9%)	-8.8% (-25.0% to +10.6%)	-16.1% (-38.7% to -1.4%)
Summer	-14.1% (-35.4% to +50.6%)	-11.0% (-32.1% to +74.3%)	-23.8% (-48.2% to +52.3%)
Autumn	-13.6% (-34.0% to +10.3%)	-2.6% (-33.9% to +29.0%)	-12.9% (-46.4% to +38.8%)
Winter	-5.4% (-26.6% to +19.0%)	-6.8% (-22.1% to +37.1%)	-10.6% (-33.5% to +22.4%)
Spring	-15.7% (-39.1% to +13.3%)	-14.7% (-40.7% to +32.7%)	-18.4% (-40.7% to -4.4%)

2090

	Low-emissions	Medium-emissions	High-emissions
Annual	-10.3% (-24.6% to +28.2%)	-19.1% (-37.6% to +14.1%)	-15.2% (-44.6% to +35.4%)
Summer	-18.0% (-47.4% to +57.8%)	-22.6% (-43.9% to +49.2%)	-15.1% (-53.1% to +68.0%)
Autumn	-5.5% (-27.9% to +25.7%)	-10.0% (-40.2% to +18.0%)	-12.2% (-44.0% to +50.2%)
Winter	0.0% (-26.9% to +51.4%)	-18.5% (-42.9% to +34.0%)	-8.2% (-39.7% to +56.7%)
Spring	-19.7% (-35.0% to +14.8%)	-24.8% (-41.7% to +8.5%)	-26.3% (-53.0% to +22.4%)

The bold number is the ensemble average for the period. Underneath the average is the ensemble range. Percentages changes in annual average rainfall are relative to the historical model baseline of 415 mm. Average summer rainfall is relative to a baseline of 97 mm, average autumn rainfall is relative to a baseline of 92 mm, average winter rainfall is relative to a baseline of 124 mm and average spring rainfall is relative to a baseline of 102 mm.

Figure 7. Historical and projected change in average rainfall – Riverina Murray

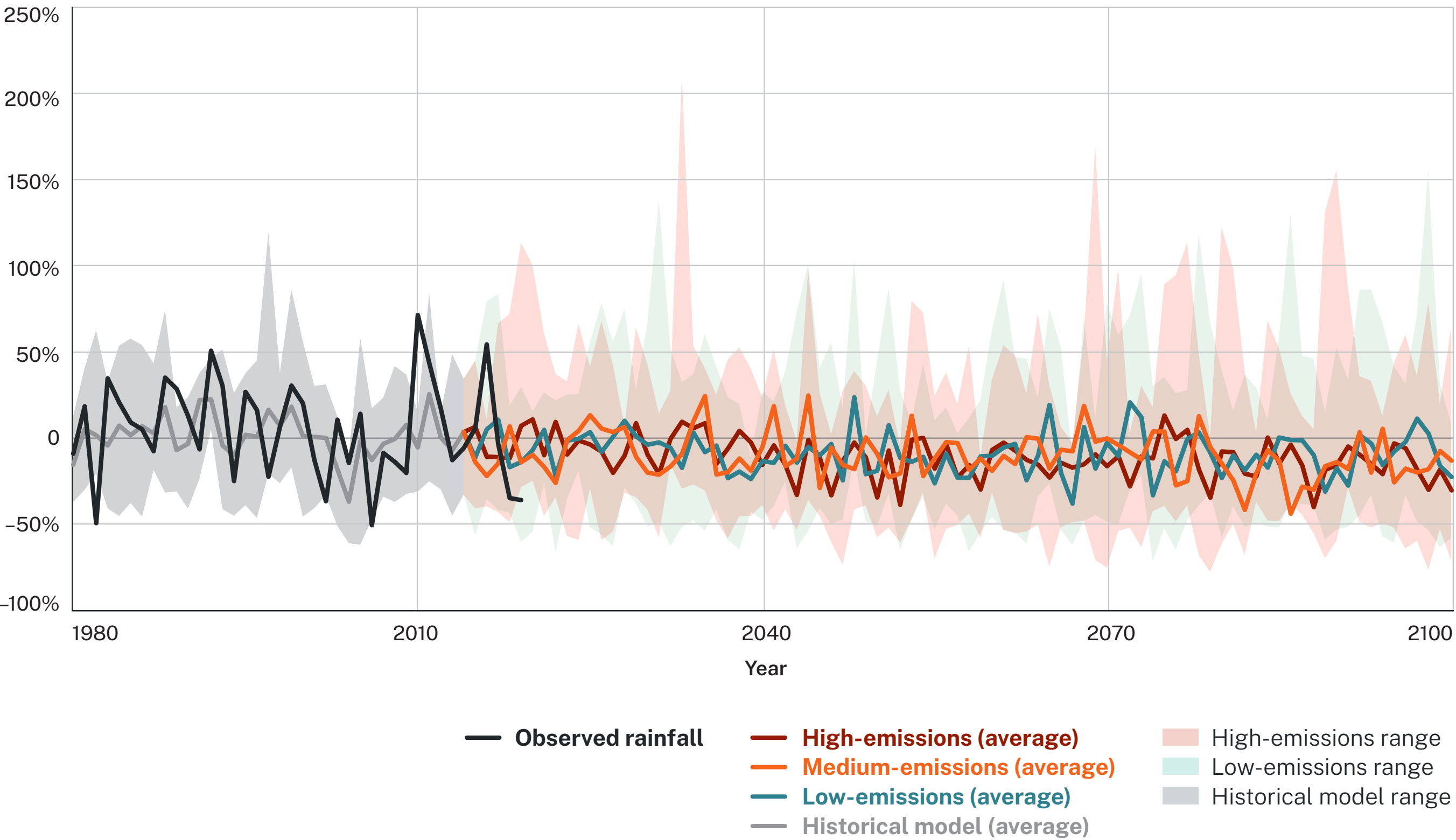




Figure 8. Projected change to average annual rainfall by 2090 for the Riverina Murray

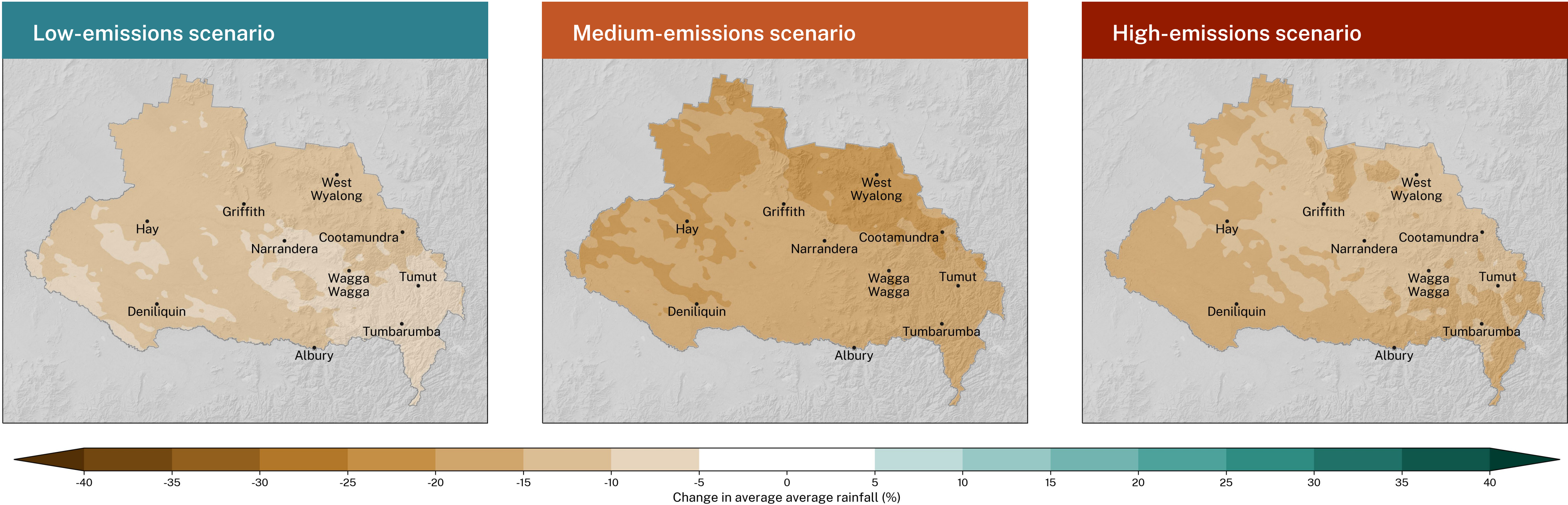




Figure 9. Projected change to average summer rainfall by 2090 for the Riverina Murray

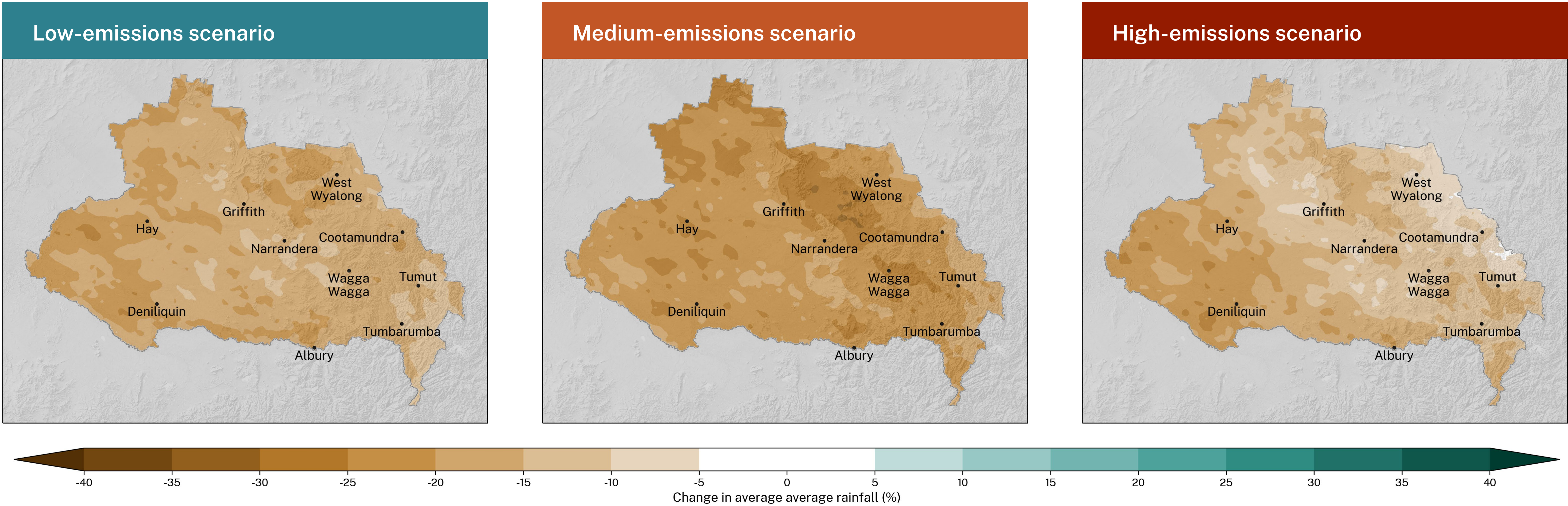




Figure 10. Projected change to average autumn rainfall by 2090 for the Riverina Murray

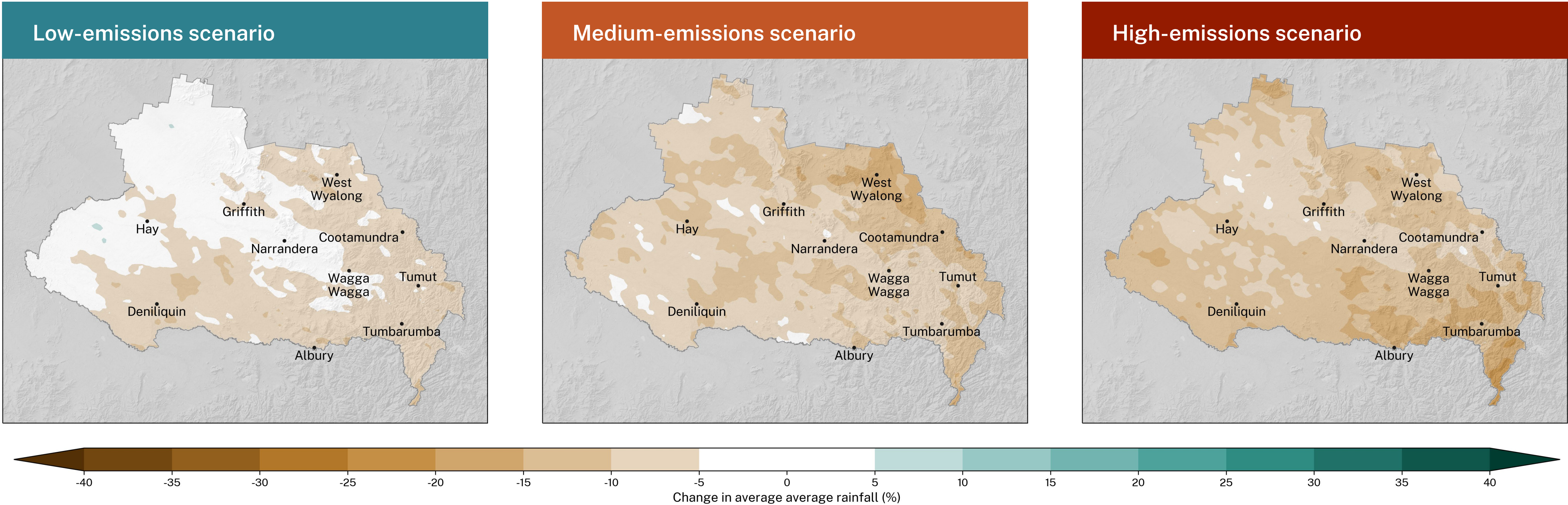




Figure 11. Projected change to average winter rainfall by 2090 for the Riverina Murray

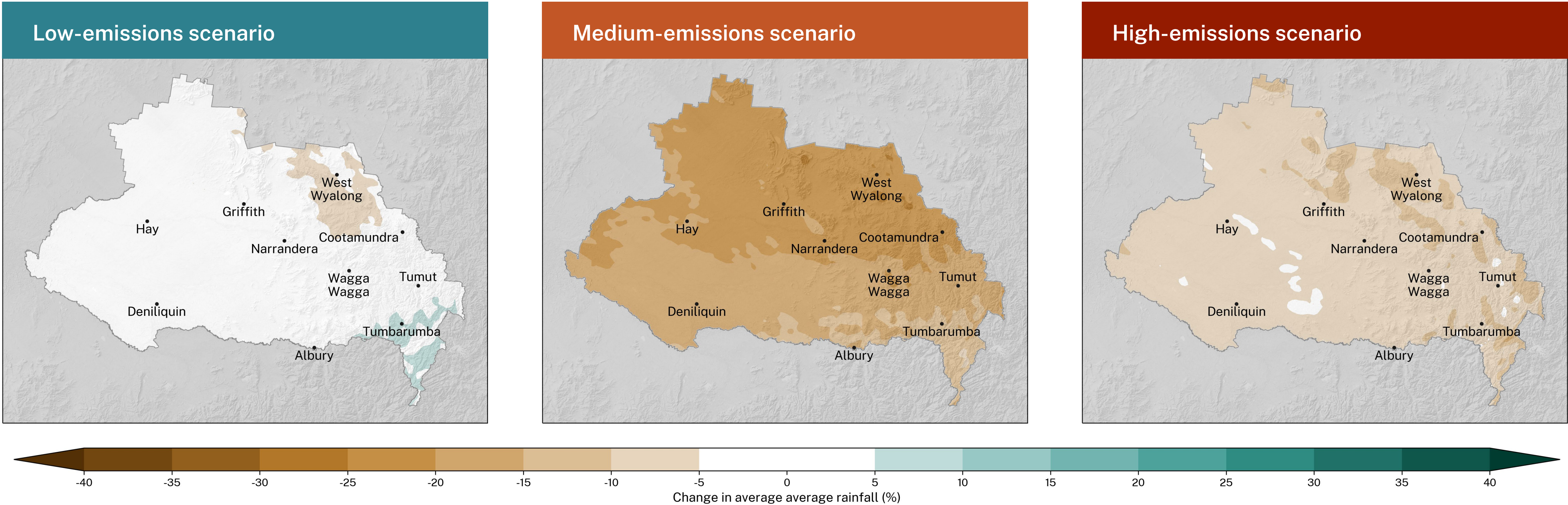
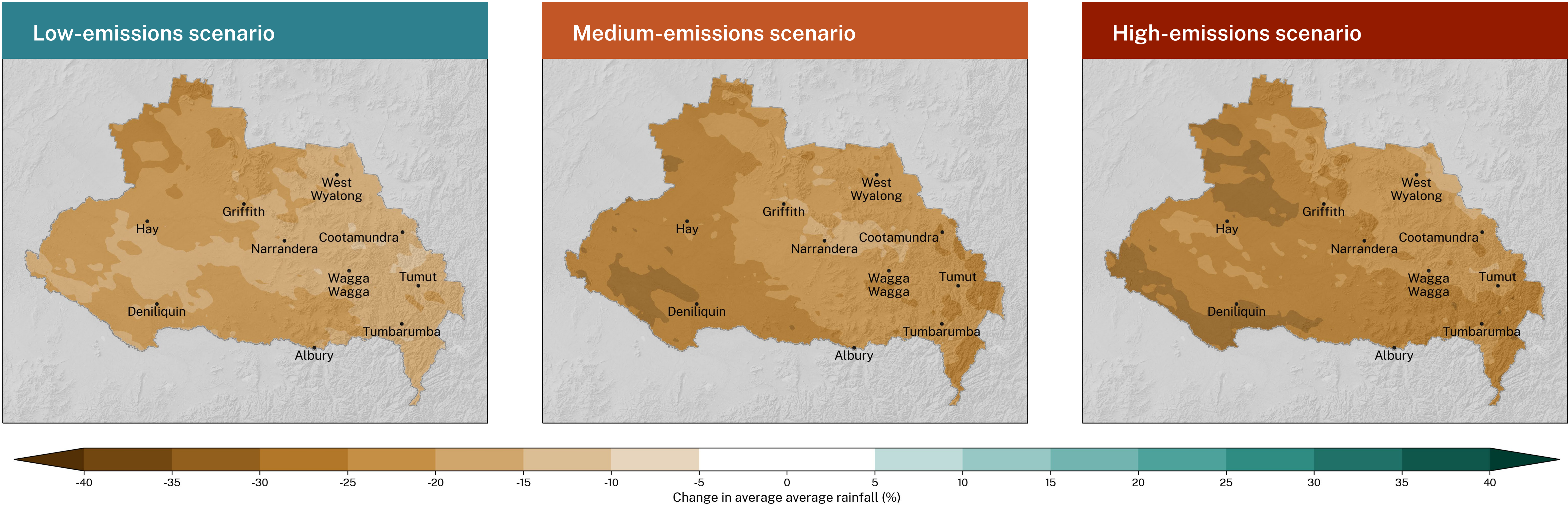




Figure 12. Projected change to average spring rainfall by 2090 for the Riverina Murray





Changes to rainfall

Changes to rainfall and increased temperatures from climate change are expected to have significant impacts on the region. There is the potential for an increased risk of lower median inflows in key river catchments such as the Murray and Murrumbidgee rivers. For the NSW Central Murray Forests, the reduced frequency, extent and duration of spring floods from water extraction and climate change have already impacted the ecological character of the Ramsar site and caused a significant decrease in waterbird breeding.⁶



Changes to spring rainfall could affect agricultural operations and crop selection, and the ability to optimally manage environmental releases and inflows to dams during their traditional filling period.¹²



Changes in water availability affect the wetland inundation patterns that support vegetation. These may cause significant contraction of inland wetlands and change their ecological functions.¹³



Increased rainfall variability, increased evapotranspiration and a shift in seasonal patterns will impact town water supplies, agriculture and internationally significant wetlands in the region.⁷





Severe fire weather

Severe fire weather will increase

The Forest Fire Danger Index (FFDI) represents an estimate of fire weather risk. The FFDI is calculated from temperature, relative humidity and wind speed, as well as an index representing fuel dryness.

Severe fire weather (FFDI greater than 50) is most likely in summer and spring. Fire weather was the strongest determining factor of house loss during the Black Summer bushfires.⁸ FFDI was monitored by weather stations across NSW until the introduction in 2022 of the Australian Fire Danger Rating System. FFDI is used in this snapshot as it can be simulated using the NARClIM projections, whereas data used by the Australian Fire Danger Rating System currently cannot. FFDI also provides a long history of data and gives context to the NARClIM projections.

Projections

Across the Riverina Murray, the average number of severe fire weather days per year will increase throughout this century (Figure 13).

The number of severe fire weather days will increase for the Riverina Murray region by 2050 for all emissions scenarios, with an even greater increase projected by 2090 under a medium-emissions scenario and a high-emissions scenario (Table 6). The number of severe fire weather days is projected to increase during spring and summer, with the largest increase in summer.

Increases to severe fire weather days are projected to occur across most of the region (Figure 14). The greatest increases will occur in northern areas of the region including Hay and Griffith. By 2090, Griffith is projected to experience 3.7 additional severe fire weather days per year under a low-emissions scenario, 6.9 additional severe fire weather days under a medium-emissions scenario and 8.7 additional severe fire weather days per year under a high-emissions scenario. A high-emissions scenario is projected to nearly double Griffith's baseline period average of 9.0 severe fire weather days per year.

2x

Under a high-emissions scenario, the number of severe fire weather days per year across the Riverina Murray could more than double by 2090.

Fire weather was the strongest determining factor of house loss during the Black Summer bushfires.⁸

Comparatively, in the east of the region, Tumut's baseline period average is 4.0 severe fire weather days. By 2090, Tumut is projected to experience 2.1 additional severe fire weather days per year under a low-emissions scenario, 4.4 additional severe fire weather days under a medium-emissions scenario and 6.0 additional severe fire weather days per year under a high-emissions scenario.

Table 6 and Figure 13 provide more information on how the projections differ across the 3 scenarios, and Figure 14 provides information on regional differences by 2090 across the 3 scenarios.



Table 6. Projected increase in average annual number of severe fire weather days – Riverina Murray

2050

Low-emissions	Medium-emissions	High-emissions
2.6 days (-1.3 to 6.3 days)	2.8 days (-0.5 to 6.2 days)	4.8 days (0.2 to 10.9 days)

2090

Low-emissions	Medium-emissions	High-emissions
3.1 days (0.5 to 8.2 days)	6.1 days (3.3 to 11.1 days)	8.0 days (1.7 to 15.9 days)

The bold number is the ensemble average for the period. Underneath the average is the ensemble range. Severe fire weather increases are additional to the historical model baseline of 7.9 severe fire weather days.

Figure 13. Historical and projected change in annual number of severe fire weather days – Riverina Murray

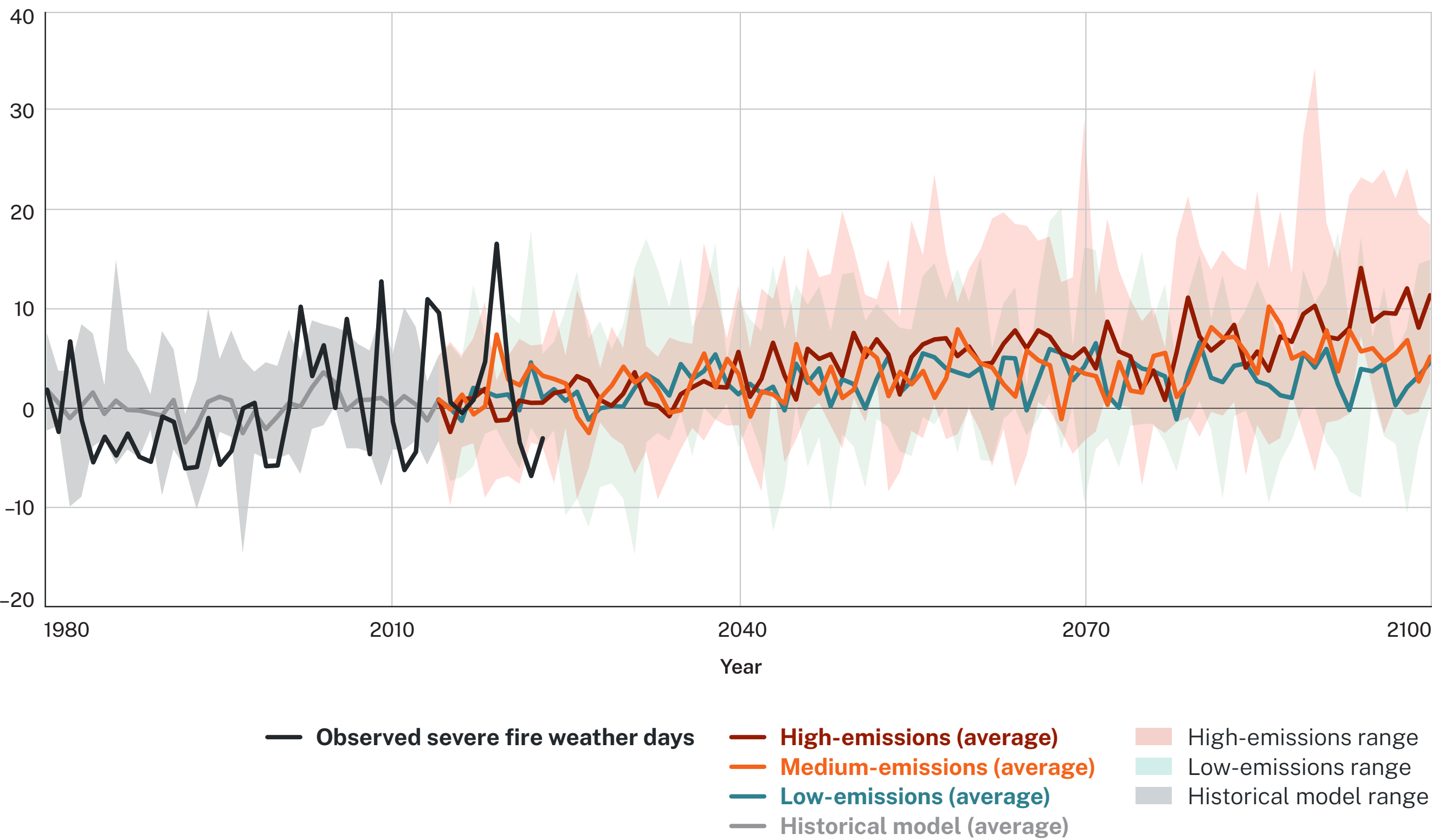
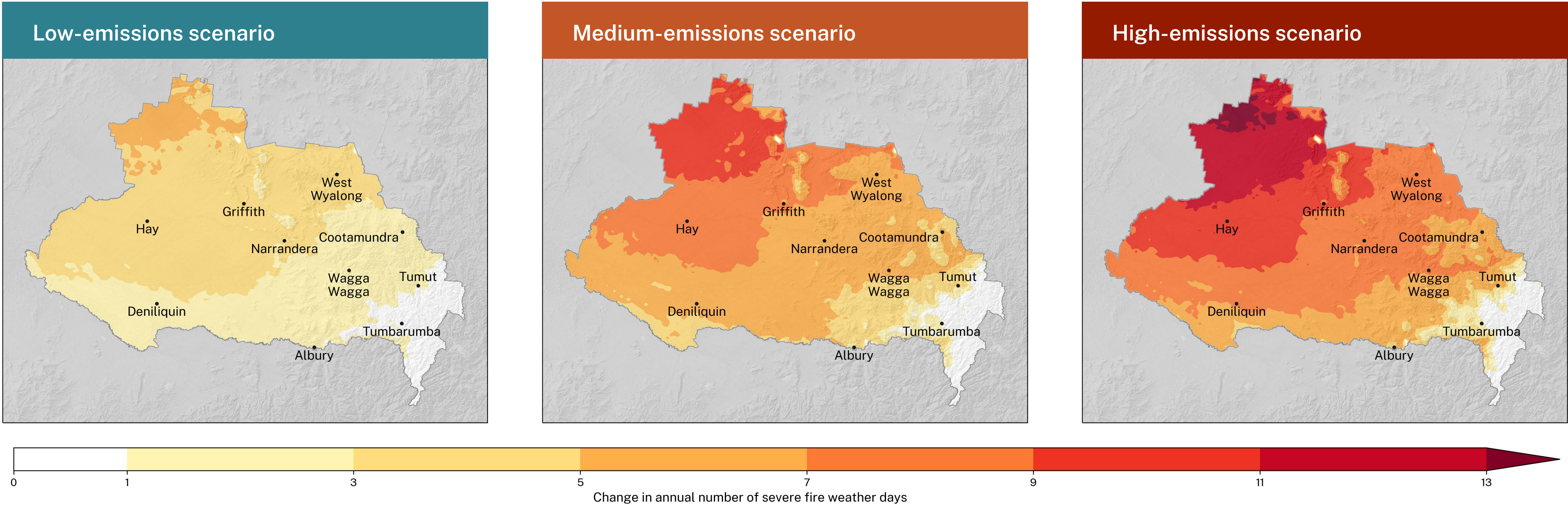




Figure 14. Projected change to annual average number of severe fire weather days by 2090 for the Riverina Murray





Bushfires

The Riverina Murray region experienced significant impacts during the 2019–20 bushfire season with extensive impacts on communities, infrastructure and natural ecosystems. Over 500,000 hectares of the region were burnt and 4,961 buildings were impacted, including 201 homes which were destroyed.⁹ Large areas of bushland experienced extreme fire severity, including Kosciuszko and Woomargama national parks. Over 27,000 hectares or 21% of NSW alpine vegetation was burnt, adding to extensive areas of alpine vegetation still recovering from severe fires that occurred in 2002–03.¹⁰



Increases to severe fire weather are expected to be greater in the north-west of the region.

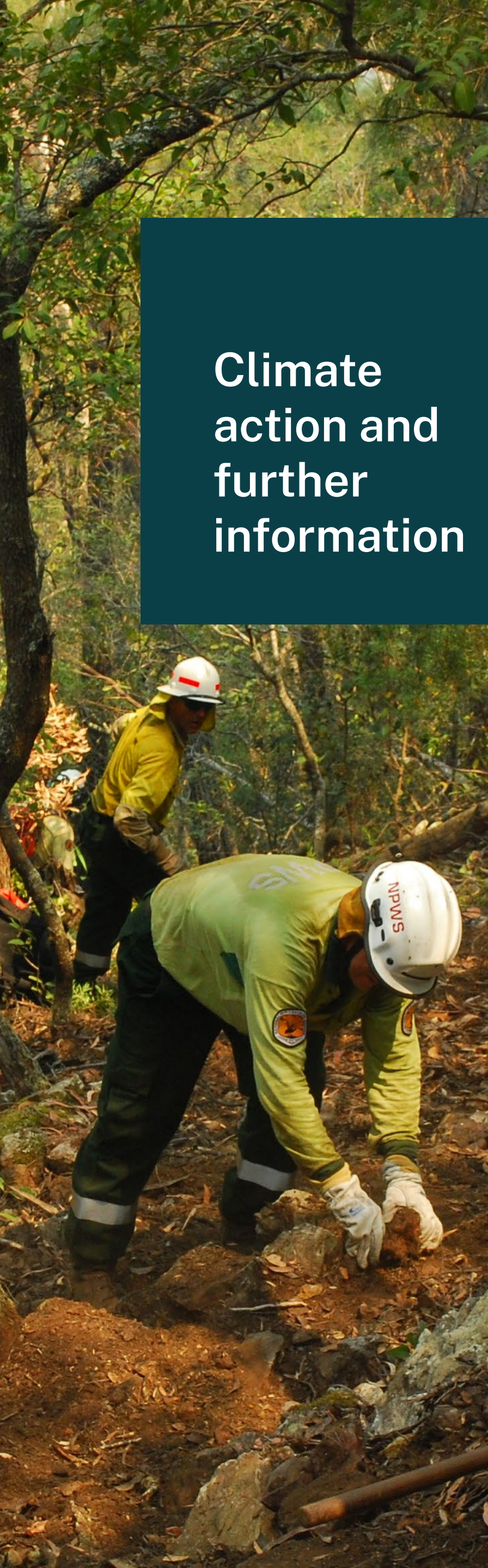


Although bushfires are a natural part of the Australian environment, climate change is increasing the frequency, duration, extent and intensity of ‘fire weather’ in south-east Australia.^{14,15}



Severe fire danger days, which create the underlying conditions for large-scale bushfires, are expected to become more common in the future, particularly under a high-emissions scenario. Climate change is expected to reduce the interval between fires, increase fire intensity, and shorten the window for safe fire management activities.¹¹





Climate action and further information

Climate action

The NARClIM projections for the low-, medium- and high-emissions scenarios highlight the stark difference in climate change impacts that will be experienced under each scenario. The differences provide a reminder of the required action across the world to reduce emissions, and specifically within NSW to meet our legislated Net Zero by 2050 emissions reduction targets. This is our best chance at ensuring the future projections under the high-emissions scenario are avoided. The NARClIM projections highlight the importance of taking action to adapt to the impacts of climate change. For more resources on reducing emissions and adapting to the impacts of climate change, visit [AdaptNSW](#).

Additional resources

- For information on other climate change impacts, including sea level rise, visit [AdaptNSW](#)
- [Climate change resources for local government on Adapt NSW](#)
- Generate detailed climate information based on your local government area using [SEED](#)
- [Climate Data Portal](#)
- [NARClIM case studies](#)
- [Climate risk ready NSW guide](#)
- [Local government climate change action in NSW: a guide to leadership](#)

Further information

NARClIM projections are delivered with support from: the ACT, South Australian, Victorian and Western Australian governments; National Computational Infrastructure; Murdoch University; and the University of New South Wales. Detailed information on the methodology and application of the projections can be found on the AdaptNSW website. Climate change information in this snapshot is delivered as part of the NSW Government's commitment to 'Publish regularly updated and improved local level climate change projections' under Action 3 of the [NSW climate change adaptation strategy](#).

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