NARCliM

North Coast

Climate Change Snapshot

NSW GOVERNMENT

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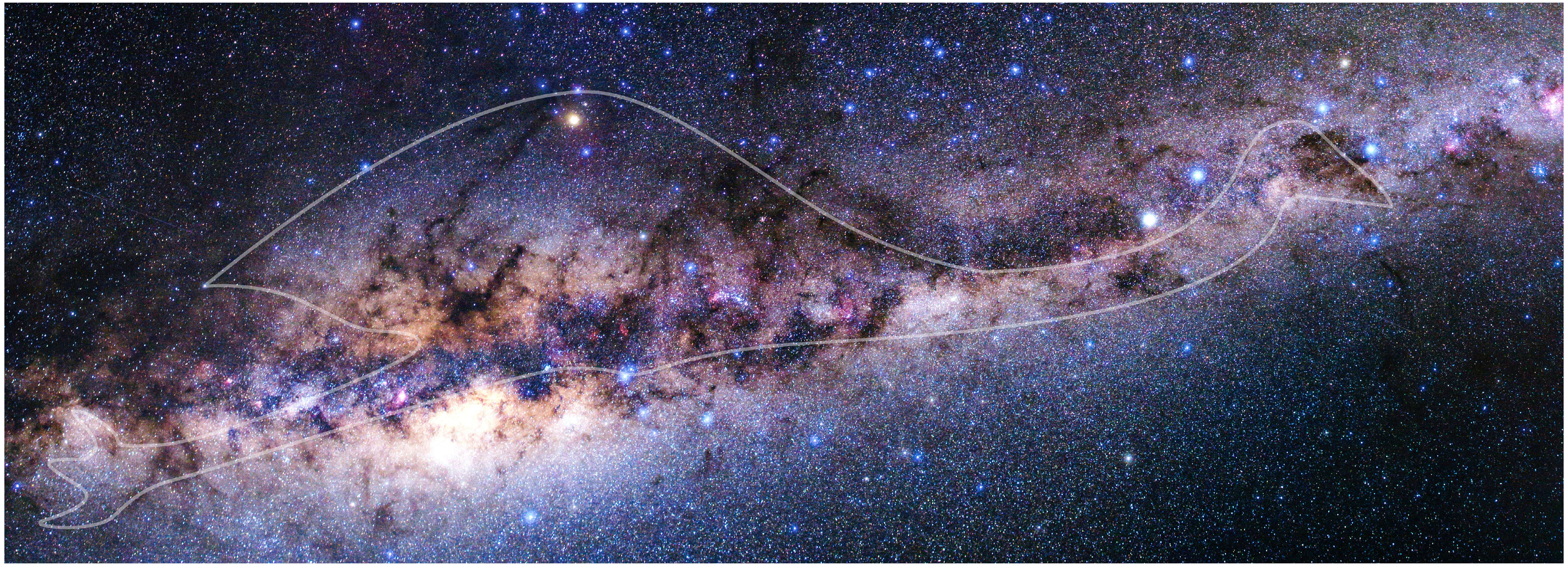

Photo caption:

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.

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 North Coast region encompasses the traditional lands of the Bundjalung, Gumbaynggirr, Dunghutti, Nganyaywana, Biripi and Yaegl 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.

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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 North Coast 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 ≥35°C), cold nights (<2°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 North Coast 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.

Low-emissions future

SSP 1–2.6

SSP1–2.6 describes a **low-emissions future** with a global transition towards sustainable and equitable development.

Medium-emissions future

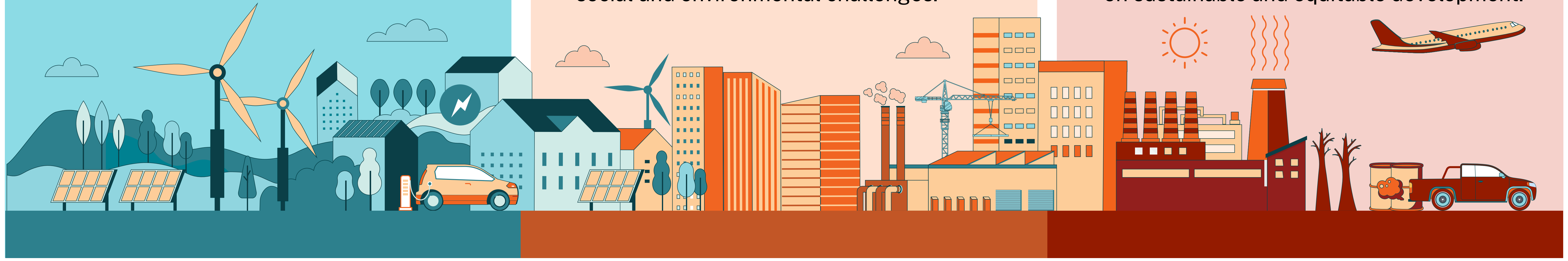
SSP 2–4.5

SSP2–4.5 describes a **medium-emissions future** with uneven economic growth, slow sustainability progress, ongoing environmental degradation, and persistent social and environmental challenges.

High-emissions future

SSP 3–7.0

SSP3–7.0 describes a **high-emissions future** of regional conflict and development where countries do not collaborate on tackling climate change and do not focus on sustainable and equitable development.



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

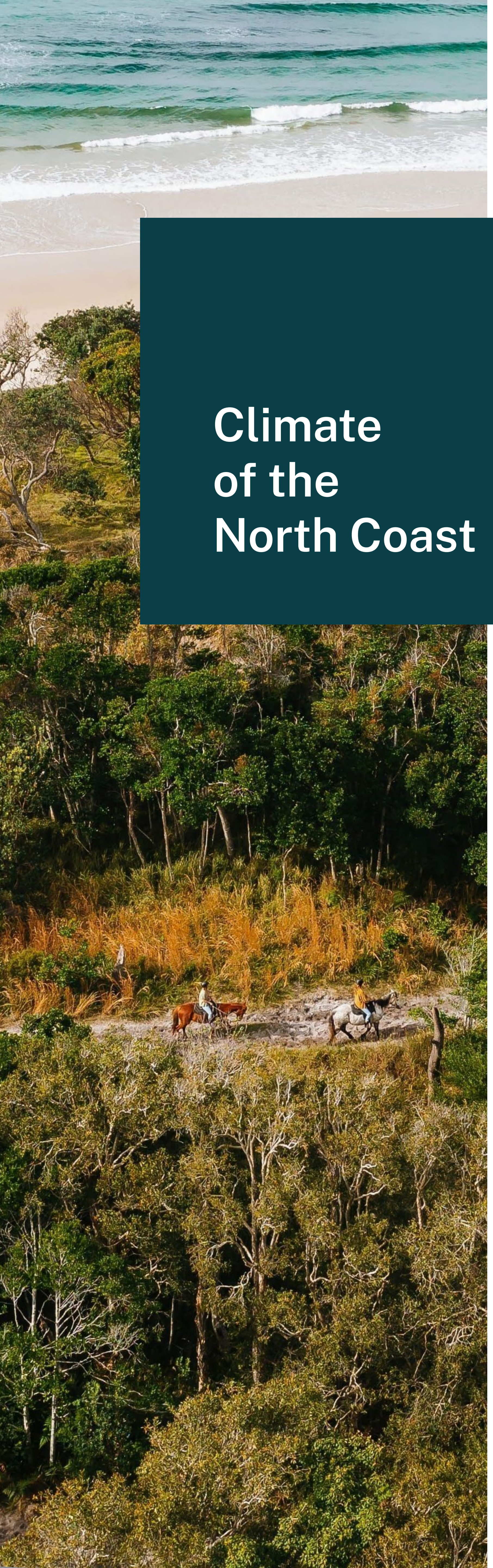
Use the historical model values in Table 1 as the baseline when interpreting both middle of the century and end of the century climate projections in this snapshot.

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 North Coast

	Average temperature	Average maximum temperature	Average minimum temperature	Hot days	Cold nights	Rainfall	Severe fire weather days
Observed	18.3°C	24.4°C	12.1°C	4.4 days	14.9 days	1,238 mm	0.6 days
Historical model	17.6°C	23.8°C	12.9°C	6.3 days	12.2 days	1,175 mm	0.9 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 North Coast

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

The North Coast region encompasses the traditional lands of the Bundjalung, Gumbayngirr, Dunghutti, Nganyaywana, Biripi and Yaegl peoples.

The North Coast region of NSW extends from Port Macquarie to the Queensland border, and west to the Great Dividing Range and hinterland. It includes the regional centres of Coffs Harbour, Grafton and Lismore; and the towns of Ballina, Byron Bay and Tweed Heads.

The North Coast region is characterised by its subtropical to temperate climate, influenced by its proximity to the coast and surrounding geographical features. The topography of the region and its coastal setting result in climate conditions that vary across the region. The area experiences warm humid summers and mild winters, with much of the rainfall generally falling in summer and autumn. It is very wet along the coast, especially in the north, but drier inland. Summers are warm across the region, with cool winters in the foothills and along the Great Dividing Range.

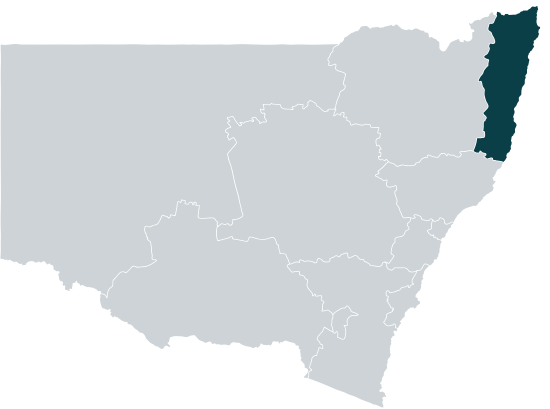
People aged 65 and over make up 25.7% of the population (notably higher than the NSW and ACT average of 17.4%), while people aged 0–14 years represent 16.6% and working-aged people (15–64 years) represent 57.7% of the region's population.[5]

The North Coast supports a diverse range of industries that are vital for NSW's economy, with the highest number of businesses in construction, agribusiness (agriculture, forestry and fishing), specialised services (professional, scientific and technical), health care and social assistance as well as property and rental services. The largest industries of employment for the region are health care and social assistance (18.1%), retail trade (10.3%), construction (9.7%), education and training (9.5%) and accommodation and food services (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 frequent hot days, a reduction in cold nights, greater fire danger and higher rainfall variability.

The following pages outline the projected changes in these key climate variables across the North Coast.

PROJECTED CHANGES



	Low-emissions scenario 2050	Low-emissions scenario 2090	Medium-emissions scenario 2050	Medium-emissions scenario 2090	High-emissions scenario 2050	High-emissions scenario 2090
Increase in average temperature	+1.1˚C	+1.2˚C	+1.4˚C	+2.3˚C	+1.7˚C	+3.4˚C
Increase in hot days per year	+5.9	+6.0	+5.7	+12.3	+8.6	+19.4
Decrease in average winter rainfall	–15.8%	–13.3%	–23.9%	–19.1%	–22.1%	–18.2%
Increase in severe fire weather days per year	+0.4	+0.2	+0.2	+0.8	+0.5	+0.7

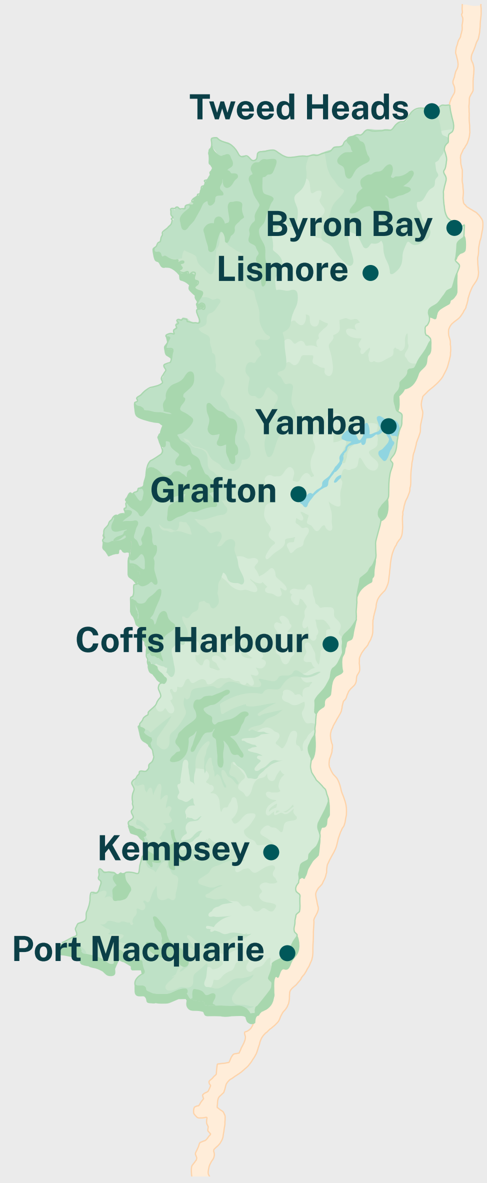
REGIONAL IMPACTS

Rainforest

Changes to rainfall

Agriculture

Increased extreme heat



Increased severe fire weather

Isolated coastal towns

Increased extreme heat

Regional town

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.

3.4°C

rise in average temperature across the North Coast 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 North Coast 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 mean temperature and maximum temperature in the North Coast region was 2019, when the average temperature was 1.0°C above the 1990–2009 baseline average.

Projections

Across the North Coast 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 less than 0.1°C between 2050 and 2090. However, major temperature increases of 0.9°C under a medium-emissions scenario and 1.7°C under a high-emissions scenario are projected during the same period. Notably, the temperature projections for 2050 under a high-emissions scenario are expected to exceed the projections for 2090 under a low-emissions scenario (Table 2).

Temperature increases are expected in all parts of the region (Figure 2) and across all seasons. The ocean's moderating influence results in somewhat lower temperature increases along the coast compared to inland areas. Inland areas of the region, including towns such as Grafton and Casino, will experience the greatest increases in temperature. By 2090, Grafton is likely to experience an increase in temperature of 1.3°C under a low-emissions scenario, 2.5°C under a medium-emissions scenario and 3.5°C under a high-emissions scenario. Comparatively, on the coast, Byron Bay is likely to experience an increase in temperature of 1.1°C under a low-emissions scenario, 2.1°C under a medium-emissions scenario and 3.2°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.

Table 2. Projected annual average temperature increase – North Coast

2050

	Low-emissions	Medium-emissions	High-emissions
Temperature	**1.1°C** (0.6°C to 1.7°C)	**1.4°C** (0.9°C to 1.9°C)	**1.7°C** (1.1°C to 2.8°C)
Maximum temperature	**1.2°C** (0.6°C to 1.9°C)	**1.4°C** (0.8°C to 2.0°C)	**1.9°C** (1.1°C to 3.1°C)
Minimum temperature	**1.1°C** (0.6°C to 1.6°C)	**1.4°C** (0.9°C to 1.9°C)	**1.7°C** (1.1°C to 2.6°C)

2090

	Low-emissions	Medium-emissions	High-emissions
Temperature	**1.2°C** (0.5°C to 2.0°C)	**2.3°C** (1.8°C to 3.4°C)	**3.4°C** (2.4°C to 4.8°C)
Maximum temperature	**1.3°C** (0.5°C to 2.3°C)	**2.4°C** (1.7°C to 3.6°C)	**3.4°C** (2.3°C to 4.9°C)
Minimum temperature	**1.2°C** (0.6°C to 1.9°C)	**2.4°C** (1.7°C to 3.5°C)	**3.5°C** (2.5°C to 4.9°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 17.6℃ for average temperature, 23.8℃ for average maximum temperature and 12.9℃ for average minimum temperature.

Figure 1. Historical and projected average temperature change – North Coast

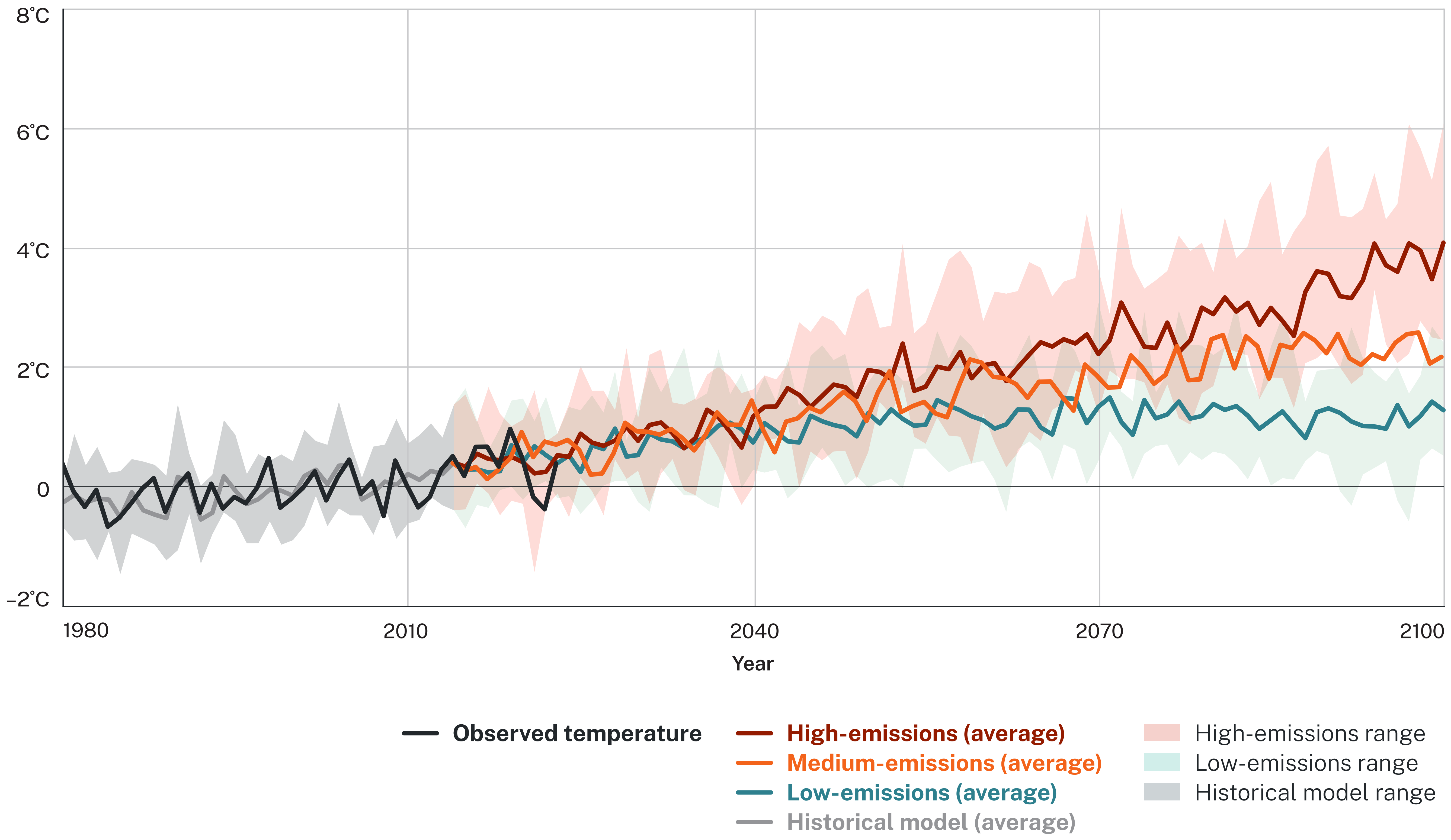
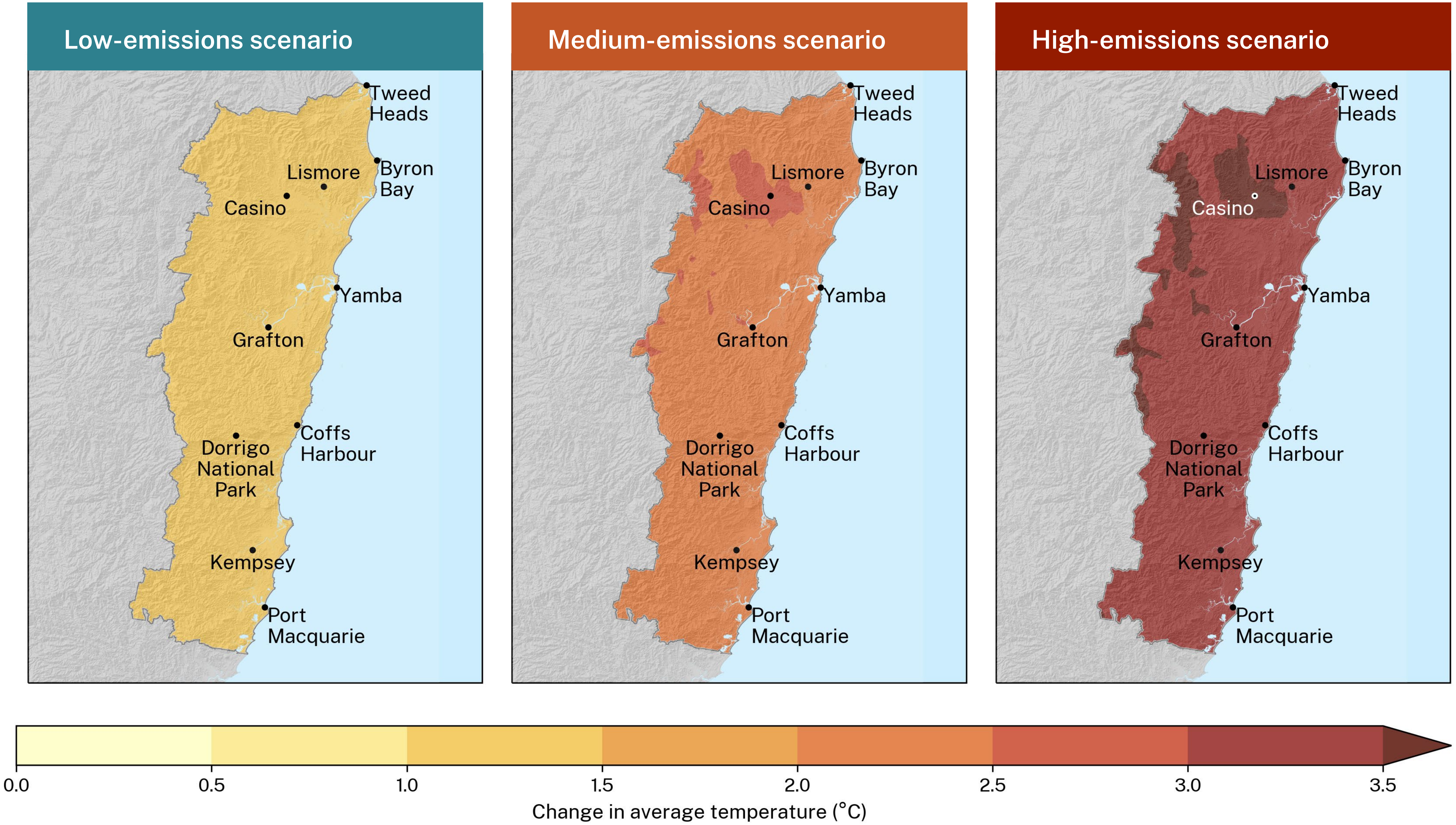


Figure 2. Projected change in average temperature by 2090 for the North Coast



Hot days

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

3x

The number of hot days across the North Coast region is projected to approximately triple by 2090 under a high-emissions scenario.

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

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 the number of hot days could have significant impacts on bushfire danger, infrastructure and native species.

Generally, the number of hot days in the North Coast region increases further inland. During the baseline period, areas near the coast had on average 1–2 hot days per year. Inland areas such as Grafton had on average 10 hot days per year, whereas higher elevation inland areas such as Dorrigo National Park averaged 1.6 hot days per year.

Projections

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

The number of hot days will increase for the region by 2050 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 across spring, summer and autumn, with the largest increase in summer.

Under a low-emissions scenario, there is a minimal increase in the number of hot days between 2050 and 2090, with less than 1.0 additional hot day projected across the region. However, increases of 6.6 additional hot days under a medium-emissions scenario and 10.9 additional hot days under a high-emissions scenario are projected during the same period (Table 3).

The changes will occur across all of the region. Low-lying inland areas, including Casino and Grafton, are projected to experience the greatest increases in the number of hot days (Figure 4.) Coastal areas will experience a relatively lower increase due to the moderating influence of the ocean. By 2090, Grafton is projected to experience 8.7 additional hot days per year under a low-emissions scenario, 17.7 under a medium-emissions scenario and 26.4 under a high-emissions scenario. A medium-emissions scenario is projected to nearly double Grafton's baseline period average of 10.3 hot days per year, while a high-emissions scenario is projected to more than triple Grafton's baseline average of hot days.

Comparatively, on the coast, Byron Bay's baseline period average is 1.7 hot days per year. By 2090, Byron Bay is projected to experience an additional 1.1 hot days per year under a low-emissions scenario, 2.4 additional hot days per year under a medium-emissions scenario and 5.2 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.

Table 3. Projected increase in average annual number of hot days – North Coast

2050

Low-emissions	Medium-emissions	High-emissions
5.9 days (3.1 to 9.4 days)	**5.7 days** (3.4 to 8.2 days)	**8.6 days** (3.4 to 16.9 days)

2090

Low-emissions	Medium-emissions	High-emissions
6.0 days (1.2 to 13.0 days)	**12.3 days** (6.2 to 22.3 days)	**19.4 days** (10.2 to 32.0 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 6.3 hot days.

Figure 3. Historical and projected average annual number of hot days – North Coast

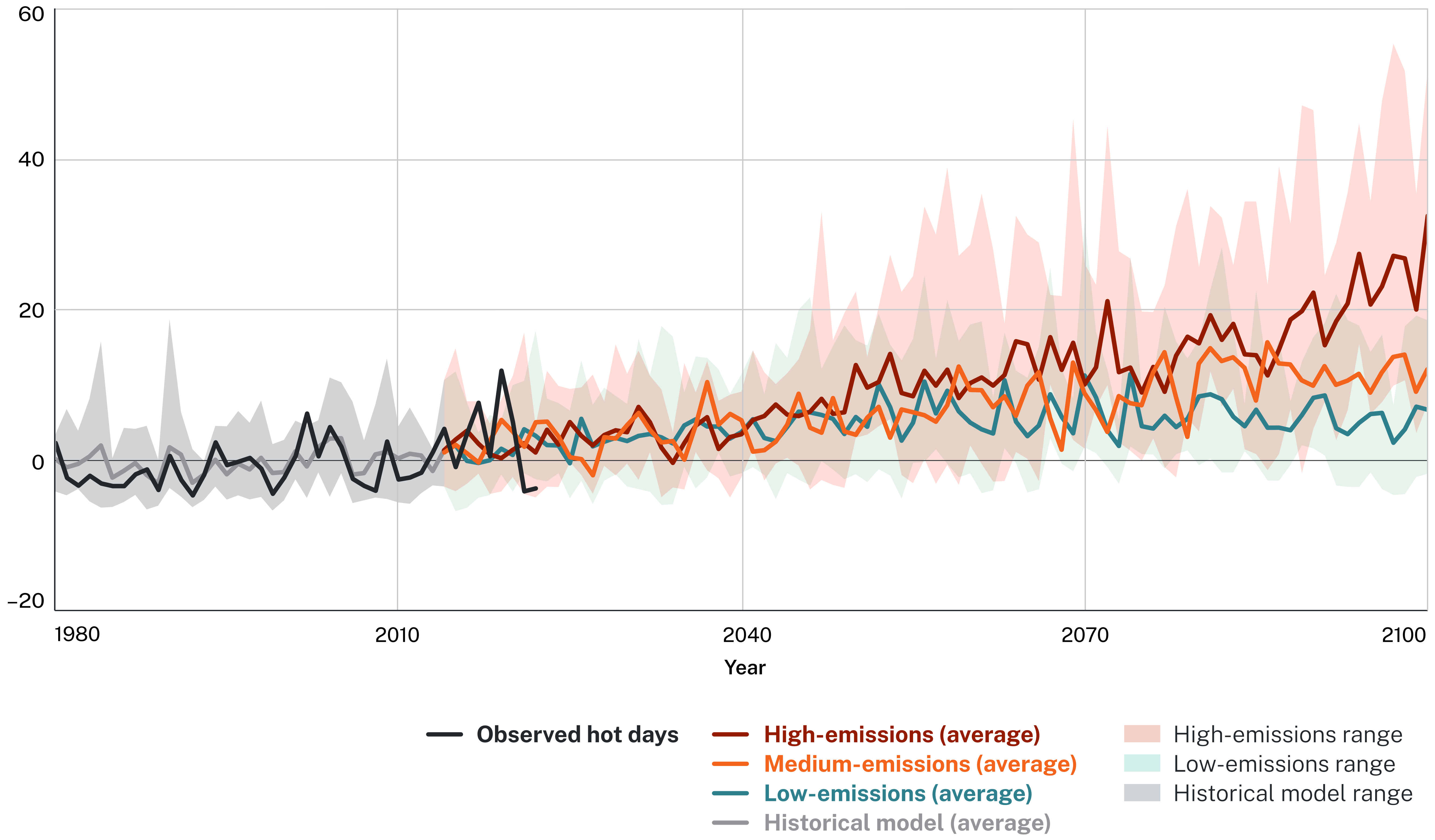
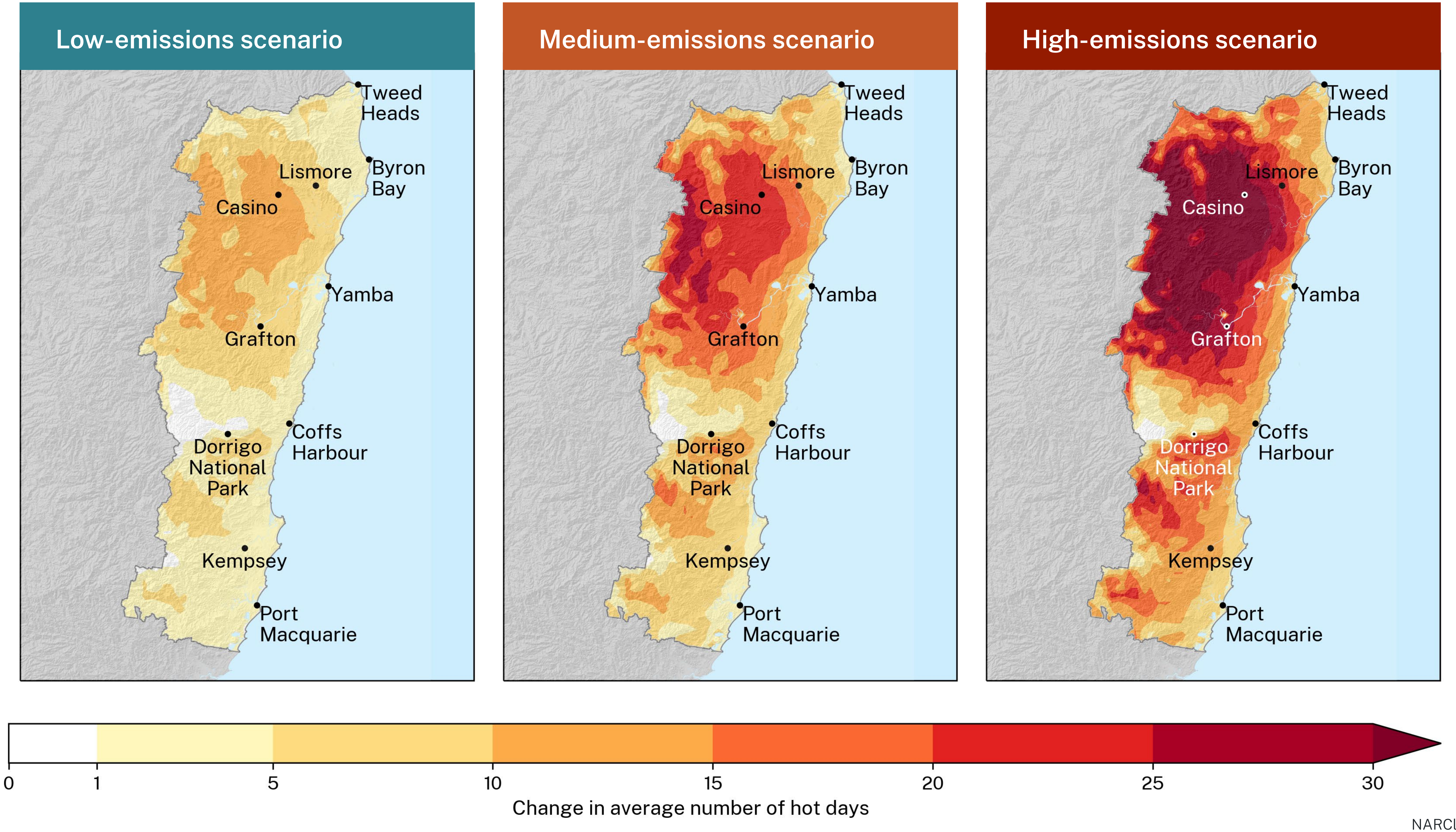


Figure 4. Projected change in annual number of hot days by 2090 for the North Coast



Increased heat stress

Heatwaves have been responsible for more human deaths than any other natural hazard, including bushfires and floods.[6] Heatwaves occur when both maximum and minimum temperatures are unusually hot over 3 days, compared to the previous month and historical weather. Heatwaves in 2011 and 2019 led to a 14% rise in NSW hospital admissions. In 2009, the heatwave in Victoria preceding the 2009 bushfires led to 374 deaths, with the bushfires directly responsible for 173 deaths.[6]

Low-lying inland areas including Casino and Grafton are projected to experience the greatest increases in the number of hot days (Figure 4).

Coastal areas will experience a relatively lower increase due to the moderating influence of the ocean.

The North Coast region, with its aging population, faces significant impacts from an increase in the number of hot days. Older people have less ability to handle hot days, due to factors often associated with aging, such as poor fitness, body changes and long-term health problems.[7] This makes them more likely to suffer from symptoms of heat strain, such as a faster heart rate, higher body temperature and laboured breathing.[8]

Cold nights

Cold nights are important for biodiversity in higher-elevation areas and the viability of important plant species, including some temperate fruits.

Under a high-emissions scenario, the number of cold nights across the North Coast could reduce by 90% by 2090.

Under a low-emissions scenario, the number of cold nights across the North Coast could reduce by less than 50% 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.

Cold nights in the North Coast region generally occur in inland areas. During the baseline period, areas such as Casino and Grafton had on average 2 cold nights per year. Higher elevation areas near Dorrigo National Park had on average more than 31 cold nights per year. Areas along the coast do not typically experience cold nights, except for some of the coast near Coffs Harbour, which had on average 2 cold nights per year.

Projections

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

The number of cold nights will decrease for the North Coast region by 2050 for all emissions scenarios, with an even greater decrease by 2090 under a medium-emissions scenario and a high-emissions scenario (Table 4). The number of cold nights is projected to decrease across autumn, winter and spring, with the largest decreases in winter.

The number of cold nights will particularly decrease in the hinterland west of Coffs Harbour (Figure 6). The greatest decreases are projected to occur for Dorrigo National Park and Guy Fawkes River National Park. By 2090, Dorrigo National Park is projected to have 13.5 fewer cold nights per year under a low-emissions scenario, 23.4 fewer cold nights per year under a medium-emissions scenario and 27.6 fewer cold nights per year under a high-emissions scenario. A medium-emissions scenario is projected to reduce Dorrigo National Park's baseline period average of 31.3 cold nights per year by nearly 75%, while a high-emissions scenario is projected to reduce the baseline period 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.

Table 4. Projected decrease in average annual number of cold nights – North Coast

2050

Low-emissions	Medium-emissions	High-emissions
5.0 days (2.4 to 7.4 days)	**6.3 days** (4.0 to 8.5 days)	**7.6 days** (5.2 to 9.8 days)

2090

Low-emissions	Medium-emissions	High-emissions
5.6 days (2.8 to 7.6 days)	**9.4 days** (7.7 to 11.4 days)	**11.0 days** (9.2 to 13.4 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 12.2 cold nights.

Figure 5. Historical and projected change in annual number of cold nights – North Coast

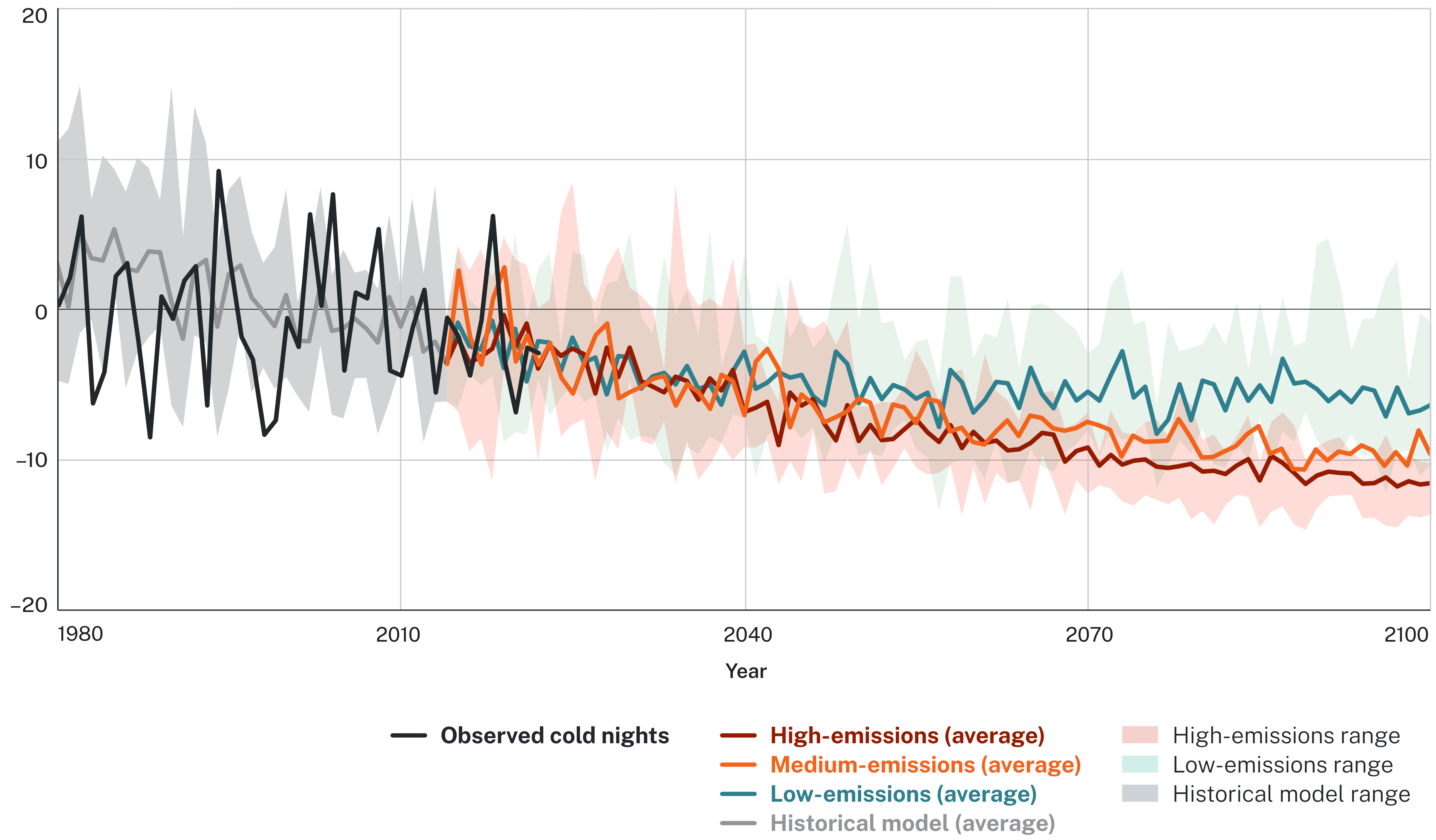
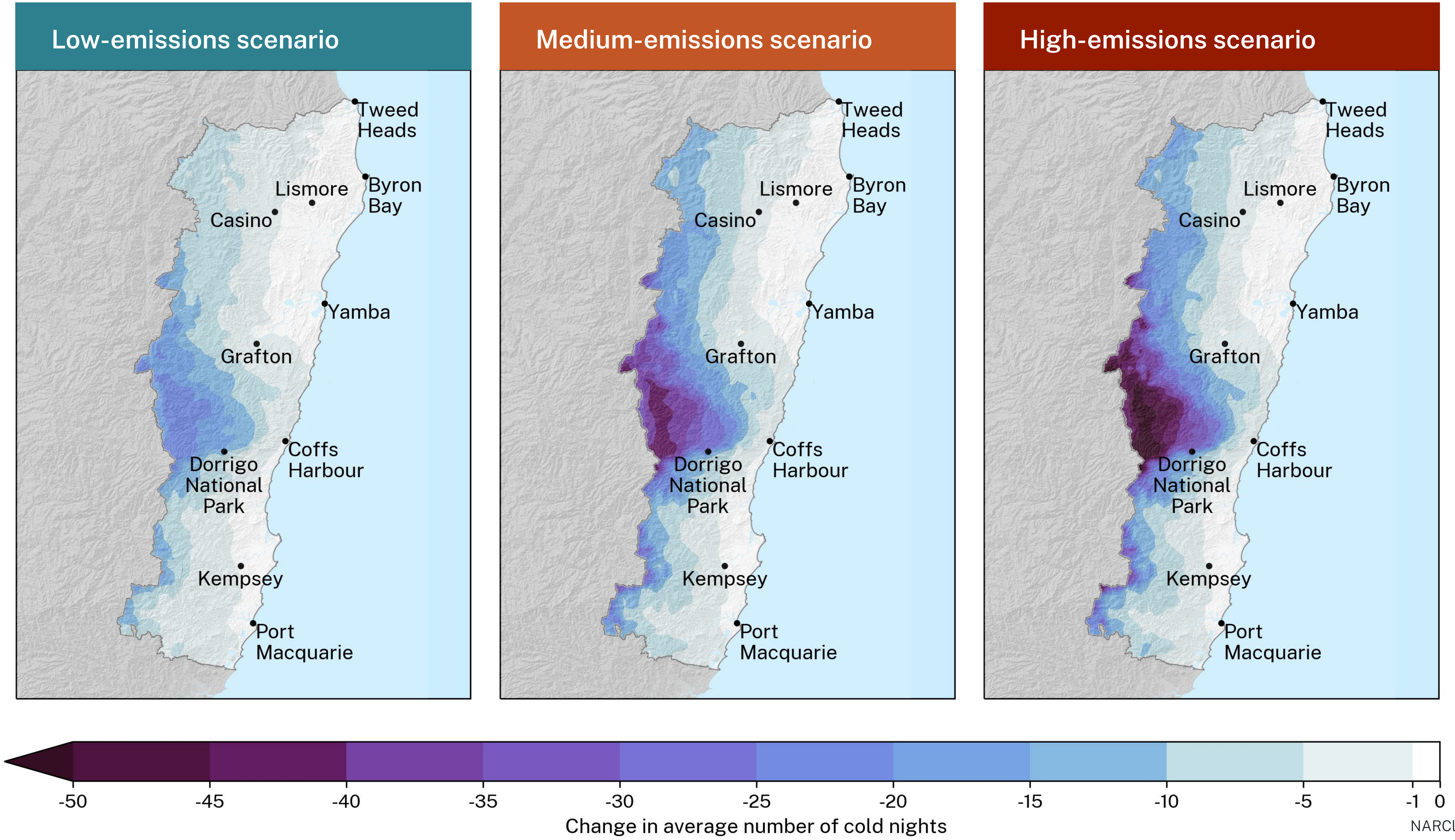
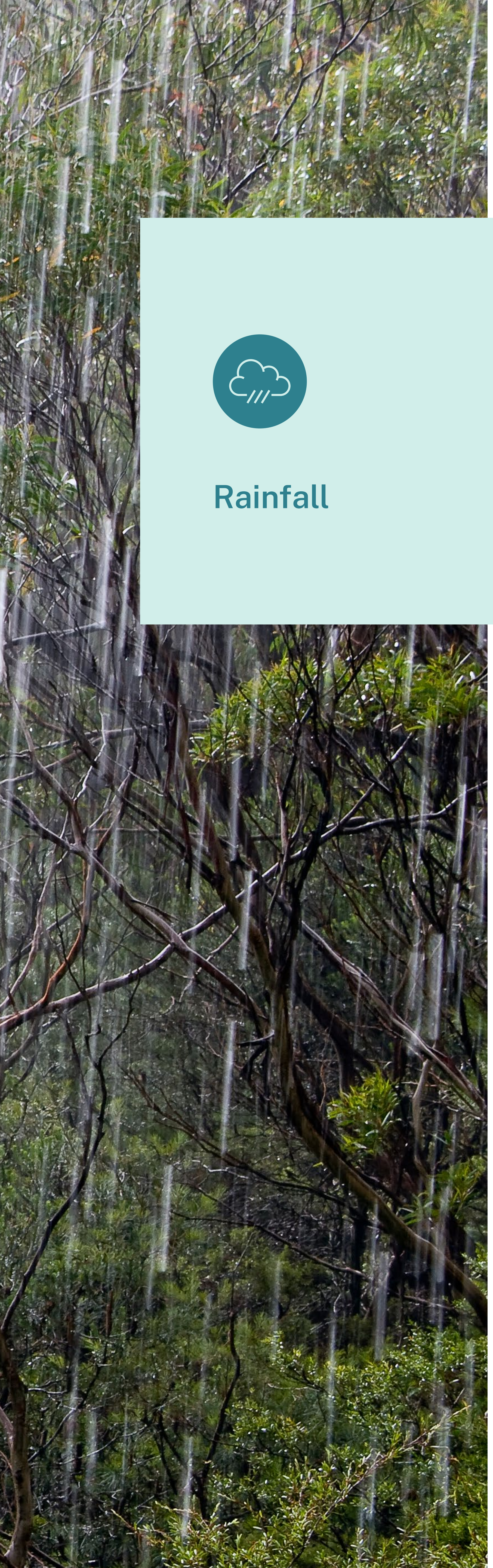


Figure 6. Projected change in annual number of cold nights by 2090 for the North Coast





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, subtropical rainforest communities in the north may contract due to more variable rainfall and changes to humidity and evapotranspiration.

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 North Coast region averages about 1,240 mm.[4] Rainfall is highest in the far north of the region. Higher elevation areas of the region and other areas of the coast also experience high rainfall. Lower elevation inland areas such as Casino experience relatively lower rainfall. Annual rainfall occurs mostly in summer and autumn, with winter and spring typically being drier. The driest year on record was 2019, with an average of only 570 mm across the region.[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.

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 6% under a low-emissions scenario, by 9% under a medium-emissions scenario and by 3% under a high-emissions scenario (Table 5). Changes to average rainfall will occur in all seasons, with the largest decreases occurring in winter (Table 5).

> A decrease in average winter rainfall of 18% by 2090 under a high-emissions scenario is projected for the North Coast.

> Subtropical rainforest communities in the north could contract due to more variable rainfall and changes to humidity and evapotranspiration.

Average winter rainfall is projected to decrease for the North Coast under all emissions scenarios. By 2090, on average, winter rainfall is expected to decrease by 13% under a low-emissions scenario, by 19% under a medium-emissions scenario and by 18% under a high-emissions scenario, with areas in the west of the region expected to experience greater decreases. For average winter rainfall, Kempsey is expected to experience a decrease of 16% under a low-emissions scenario, 20% under a medium-emissions scenario and by 18% under a high-emissions scenario. Comparatively, Byron Bay is expected to experience a decrease of 5% under a low-emissions scenario, 8% under a medium-emissions scenario and 10% under a high-emissions scenario.

On average, summer, spring and autumn rainfall is projected to change by 10% or less across the region by 2090 under all emissions scenarios (Table 5). 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.

Table 5. Projected change to average rainfall – North Coast

2050

	Low-emissions	Medium-emissions	High-emissions
Annual	**–6.0%** (–12.1% to +10.9%)	**–6.5%** (–20.7% to +21.2%)	**–11.5%** (–26.1% to +11.9%)
Summer	**–5.3%** (–18.3% to +9.2%)	**–3.2%** (–17.3% to +30.4%)	**–13.4%** (–34.1% to +8.3%)
Autumn	**–5.6%** (–28.6% to +22.2%)	**–7.3%** (–28.5% to +28.2%)	**–11.5%** (–31.7% to +13.1%)
Winter	**–15.8%** (–30.4% to +5.2%)	**–23.9%** (–52.3% to +17.7%)	**–22.1%** (–41.4% to +7.8%)
Spring	**+0.2%** (–14.2% to +14.1%)	**2.4%** (–29.4% to +36.0%)	**+1.5%** (–27.8% to +36.7%)

2090

	Low-emissions	Medium-emissions	High-emissions
Annual	**–6.0%** (–18.3% to +5.9%)	**–9.2%** (–24.5% to +3.1%)	**–3.0%** (–25.6% to +19.6%)
Summer	**–8.7%** (–20.8% to +10.3%)	**–10.1%** (–22.7% to +26.7%)	**+1.4%** (–23.5% to +33.2%)
Autumn	**–2.1%** (–21.1% to +18.1%)	**–7.5%** (–32.2% to +17.2%)	**–3.4%** (–25.4% to +32.1%)
Winter	**–13.3%** (–35.1% to +11.6%)	**–19.1%** (–40.8% to +26.0%)	**–18.2%** (–54.4% to +23.1%)
Spring	**–1.0%** (–19.9% to +18.7%)	**–1.7%** (–28.6% to +33.4%)	**+0.9%** (–33.3% to +29.1%)

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 1,175 mm. Average summer rainfall is relative to a baseline of 444 mm, average autumn rainfall is relative to a baseline of 353 mm, average winter rainfall is relative to a baseline of 174 mm and average spring rainfall is relative to a baseline of 205 mm.

Figure 7. Historical and projected change in average rainfall – North Coast

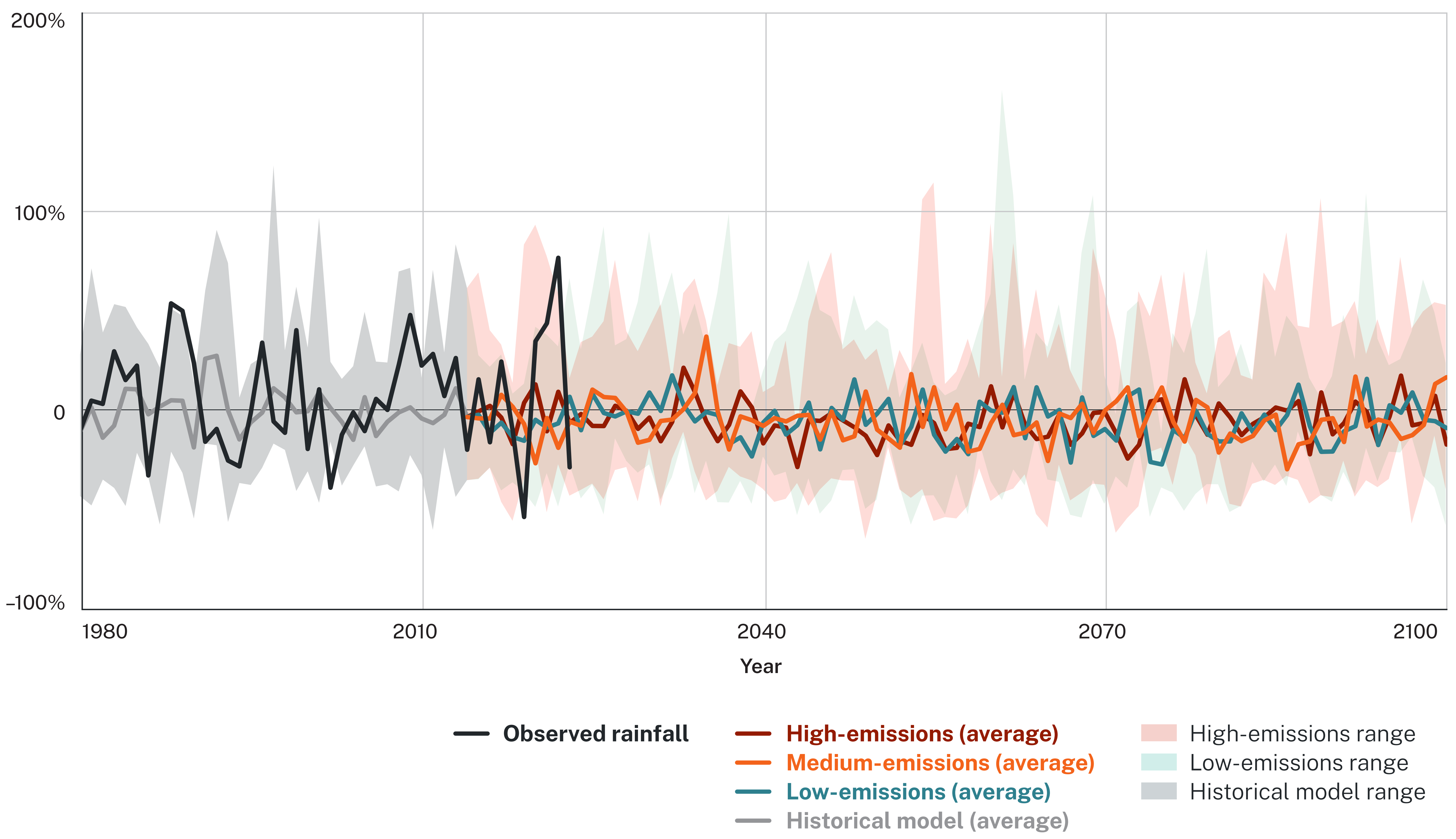


Figure 8. Projected change to average annual rainfall by 2090 for the North Coast

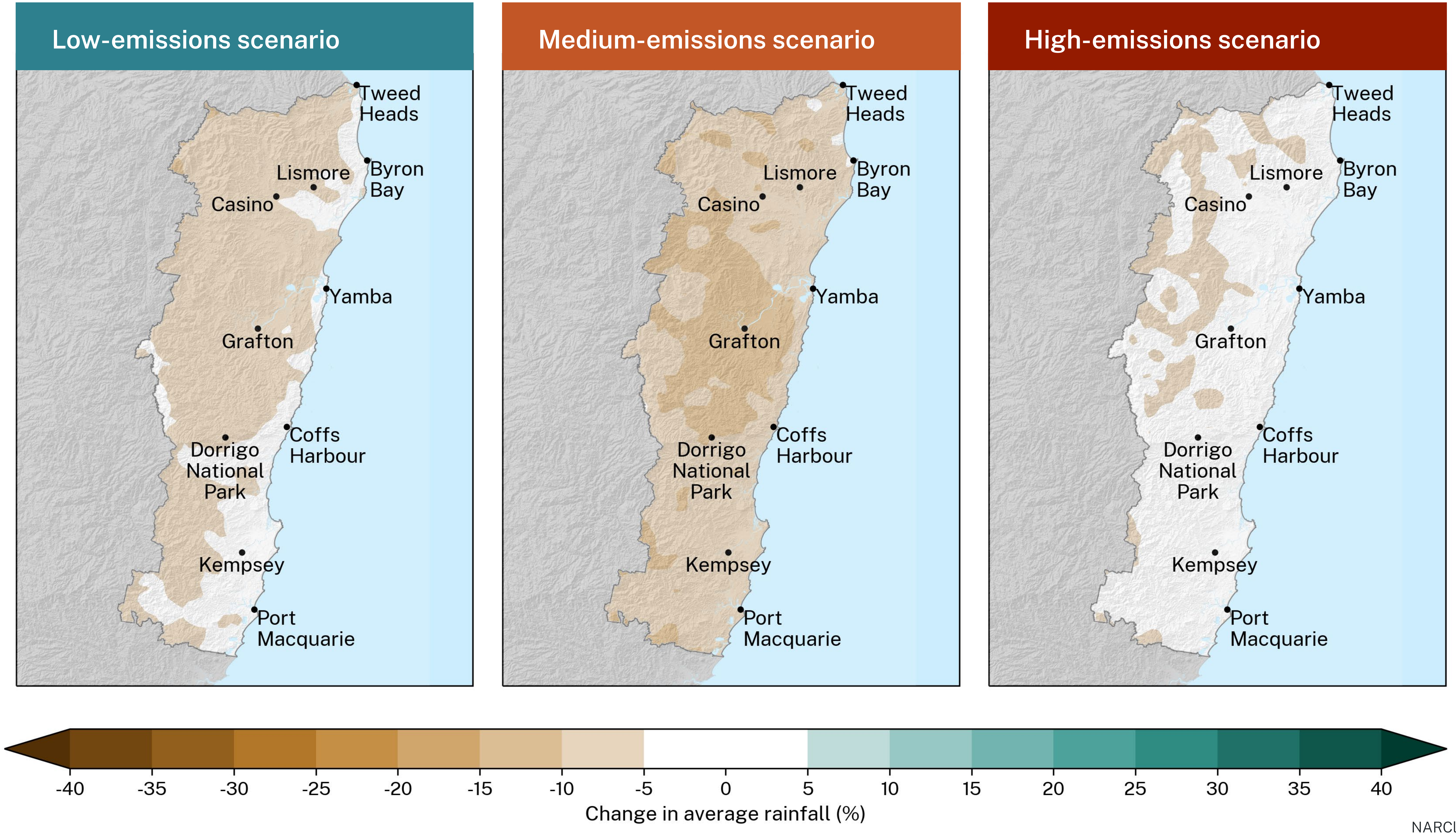


Figure 9. Projected change to average summer rainfall by 2090 for the North Coast

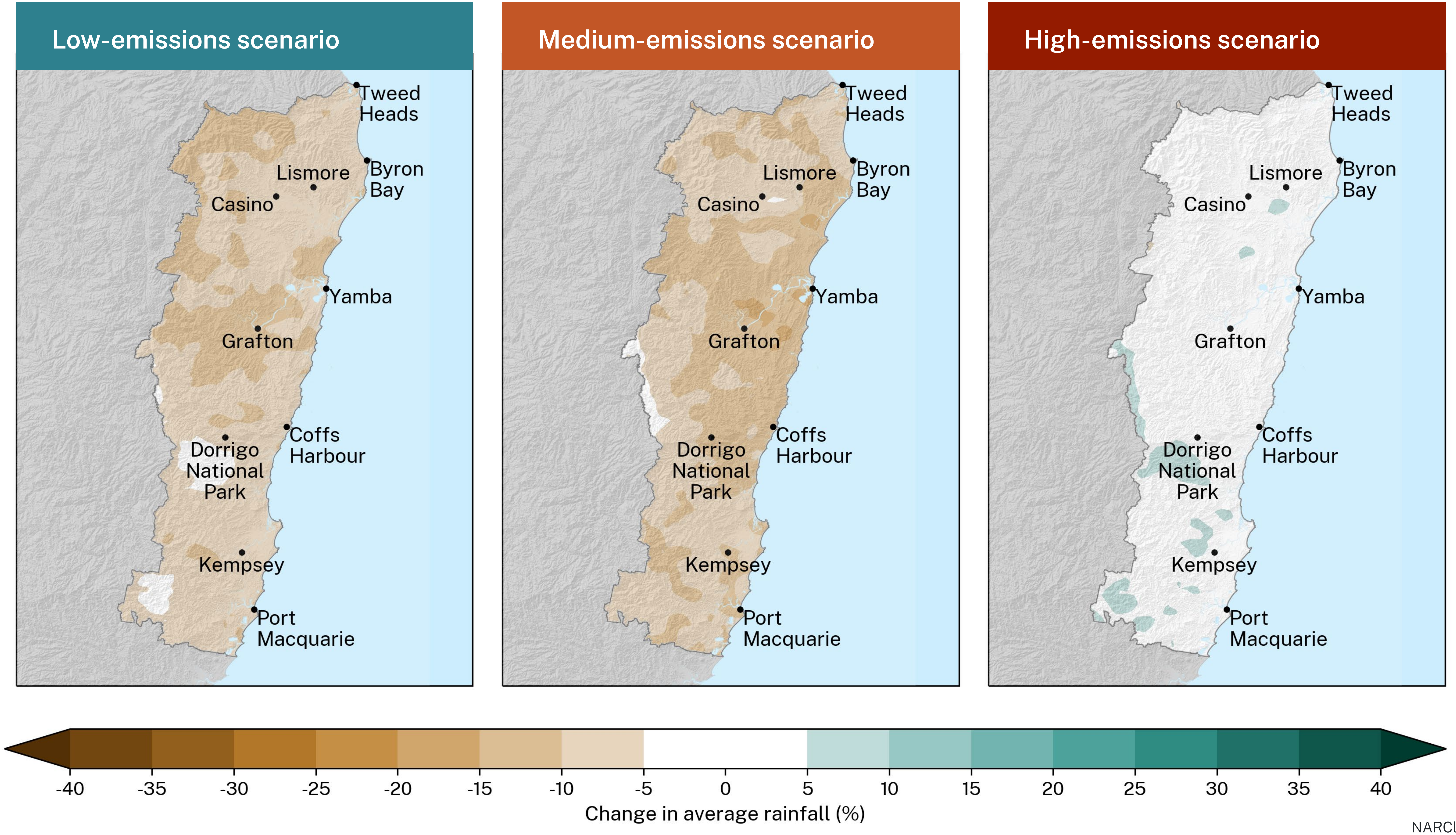


Figure 10. Projected change to average autumn rainfall by 2090 for the North Coast

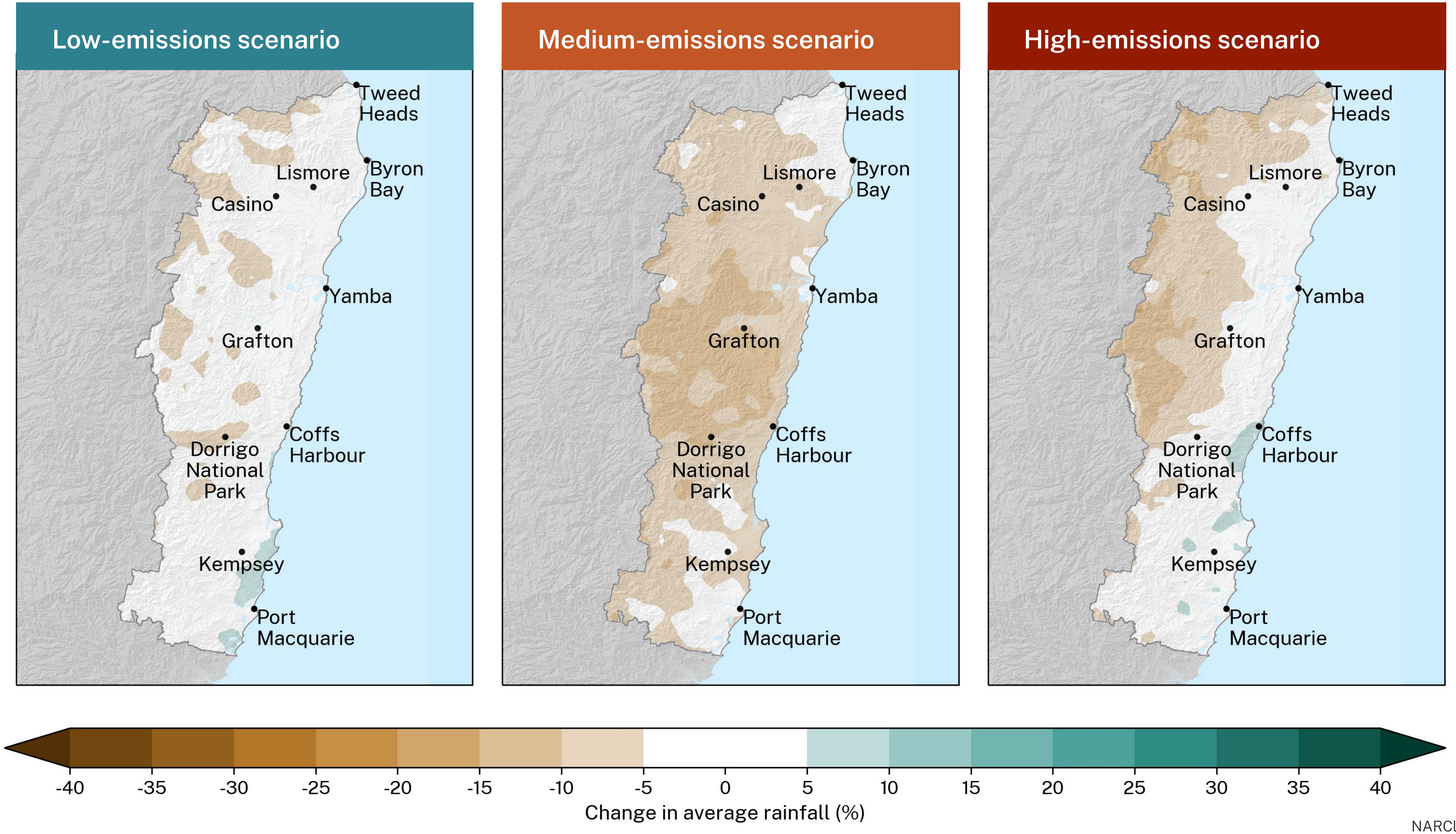


Figure 11. Projected change to average winter rainfall by 2090 for the North Coast

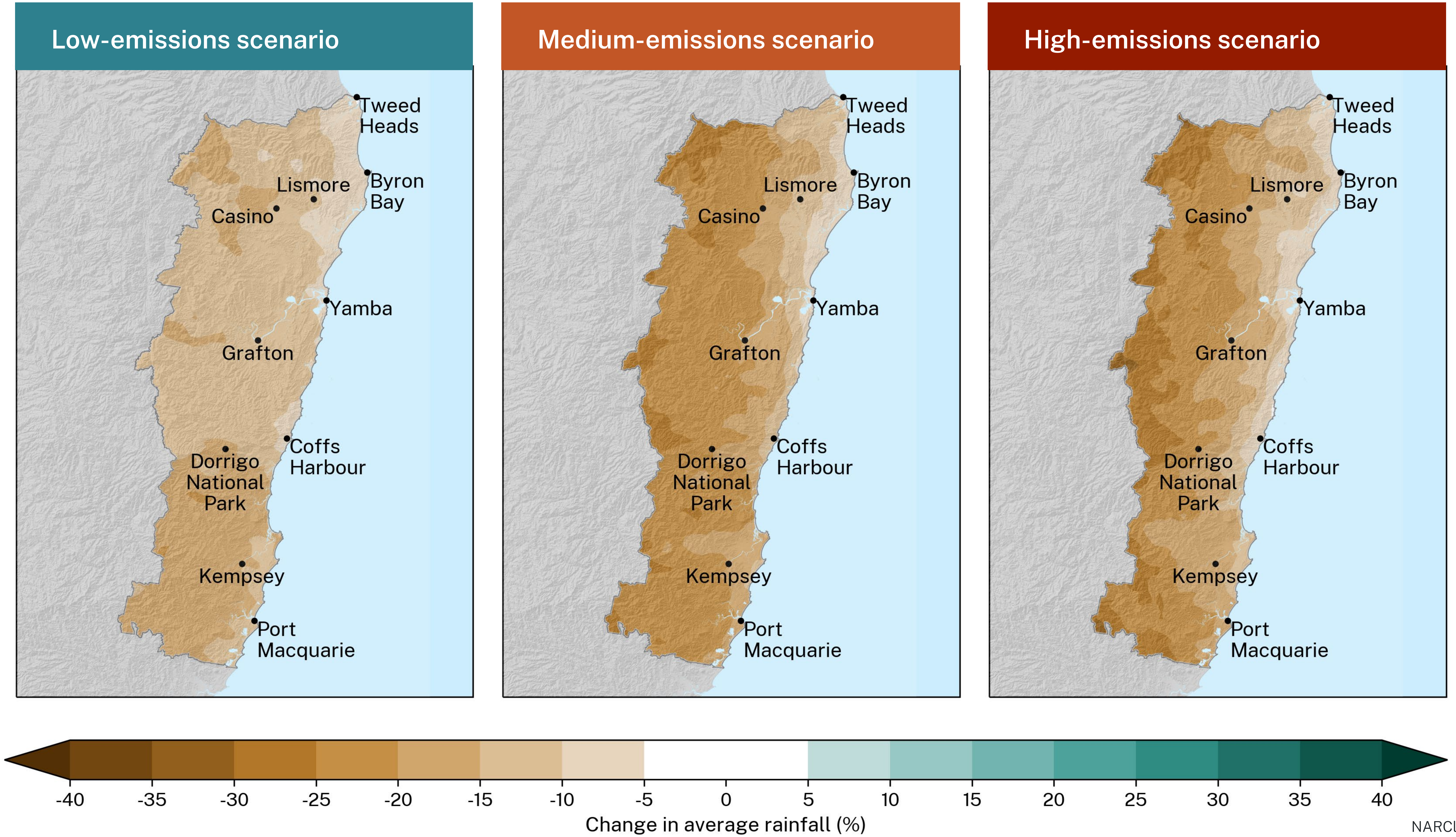
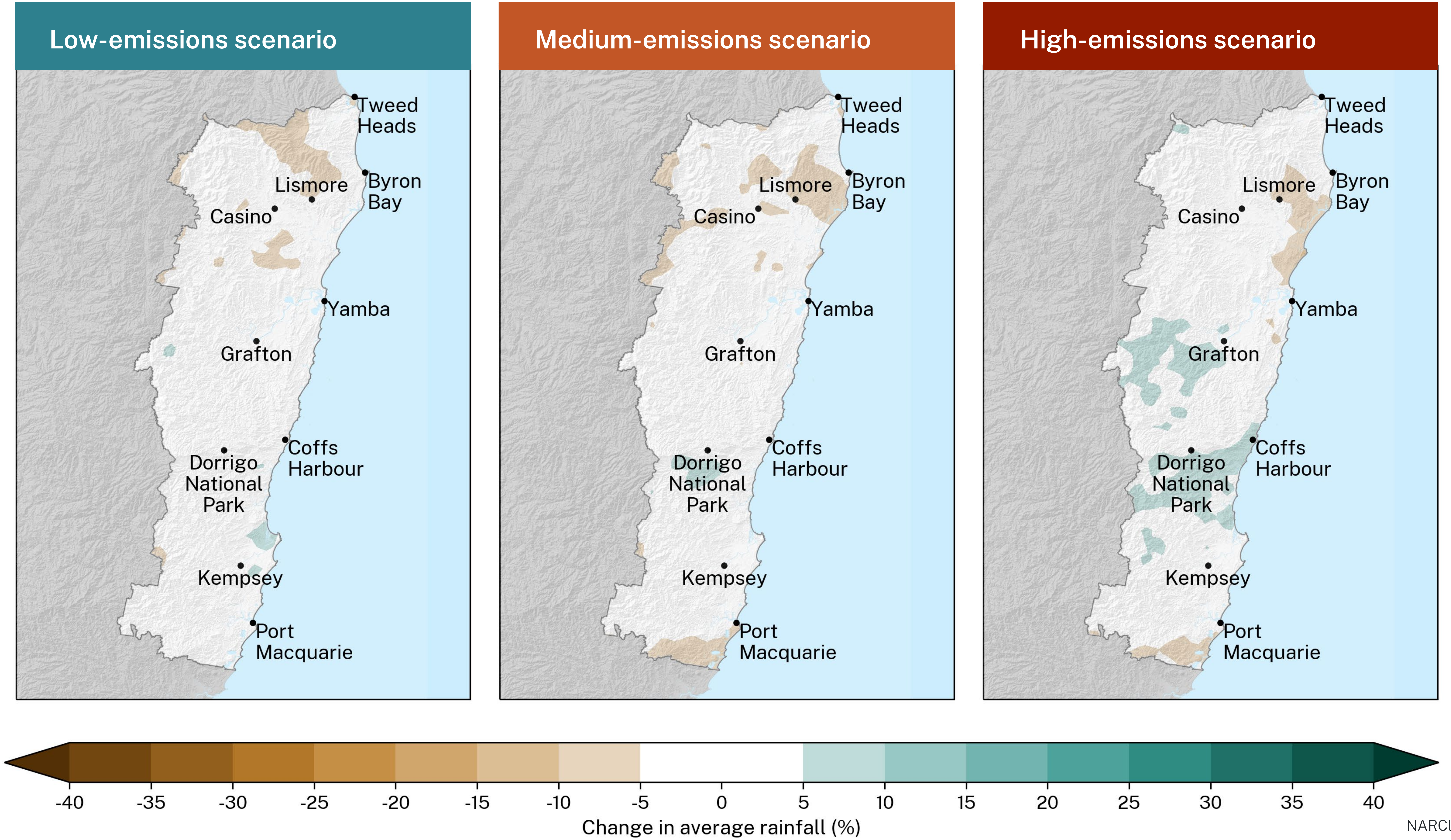


Figure 12. Projected change to average spring rainfall by 2090 for the North Coast



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.[9] FFDI was monitored by weather stations across NSW and the ACT 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 cannot. FFDI also provides a long history of data and gives context to the NARCliM projections.

Projections

Across the North Coast, 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 slightly increase for the North Coast 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 spring.

Increases to severe fire weather days are projected to occur across some of the region. The greatest increases are projected to occur in inland areas in the north of the region including Grafton (Figure 14). By 2090, Grafton is projected to experience 0.4 additional severe fire weather days per year under a low-emissions scenario, 1.3 additional severe fire weather days under a medium-emissions scenario and 1.3 additional severe fire weather days per year under a high-emissions scenario. Grafton's number of severe fire weather days per year is projected to notably increase under a both a medium-emissions scenario and a high-emissions scenario, compared with the baseline period average of 2.5 severe fire weather days per year.

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.

2x

Under a high-emissions scenario, the number of severe fire weather days per year across the North Coast could nearly double by 2090.

Fire weather was the strongest determining factor of house loss during the Black Summer bushfires.[9]

Table 6. Projected increase in average annual number of severe fire weather days – North Coast

2050

Low-emissions	Medium-emissions	High-emissions
0.4 days (–0.1 to 1.3 days)	**0.2 days** (–0.4 to 1.1 days)	**0.5 days** (–0.3 to 1.8 days)

2090

Low-emissions	Medium-emissions	High-emissions
0.2 days (–0.7 to 0.9 days)	**0.8 days** (0.2 to 2.1 days)	**0.7 days** (–0.1 to 2.7 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 0.9 severe fire weather days.

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

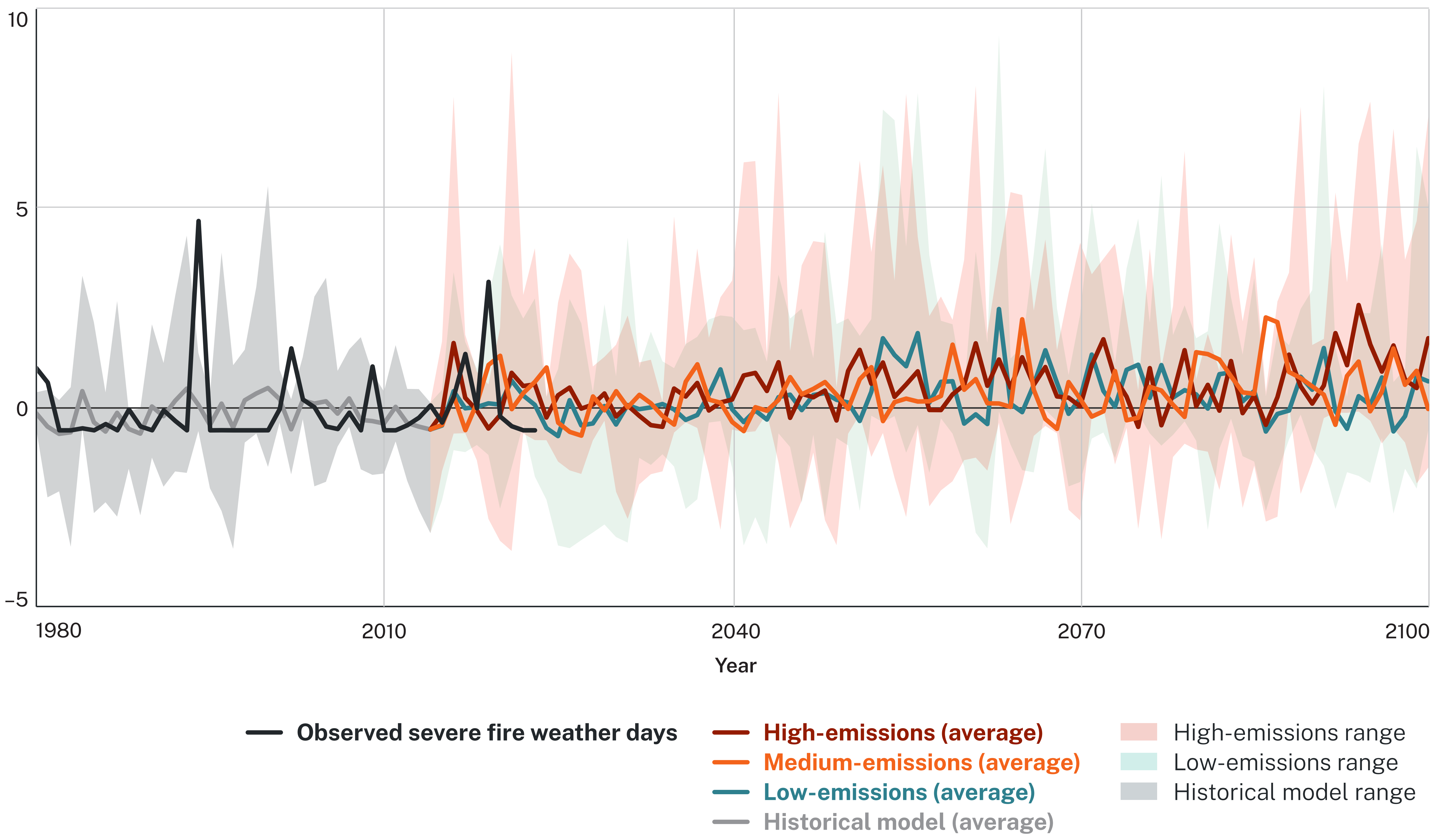
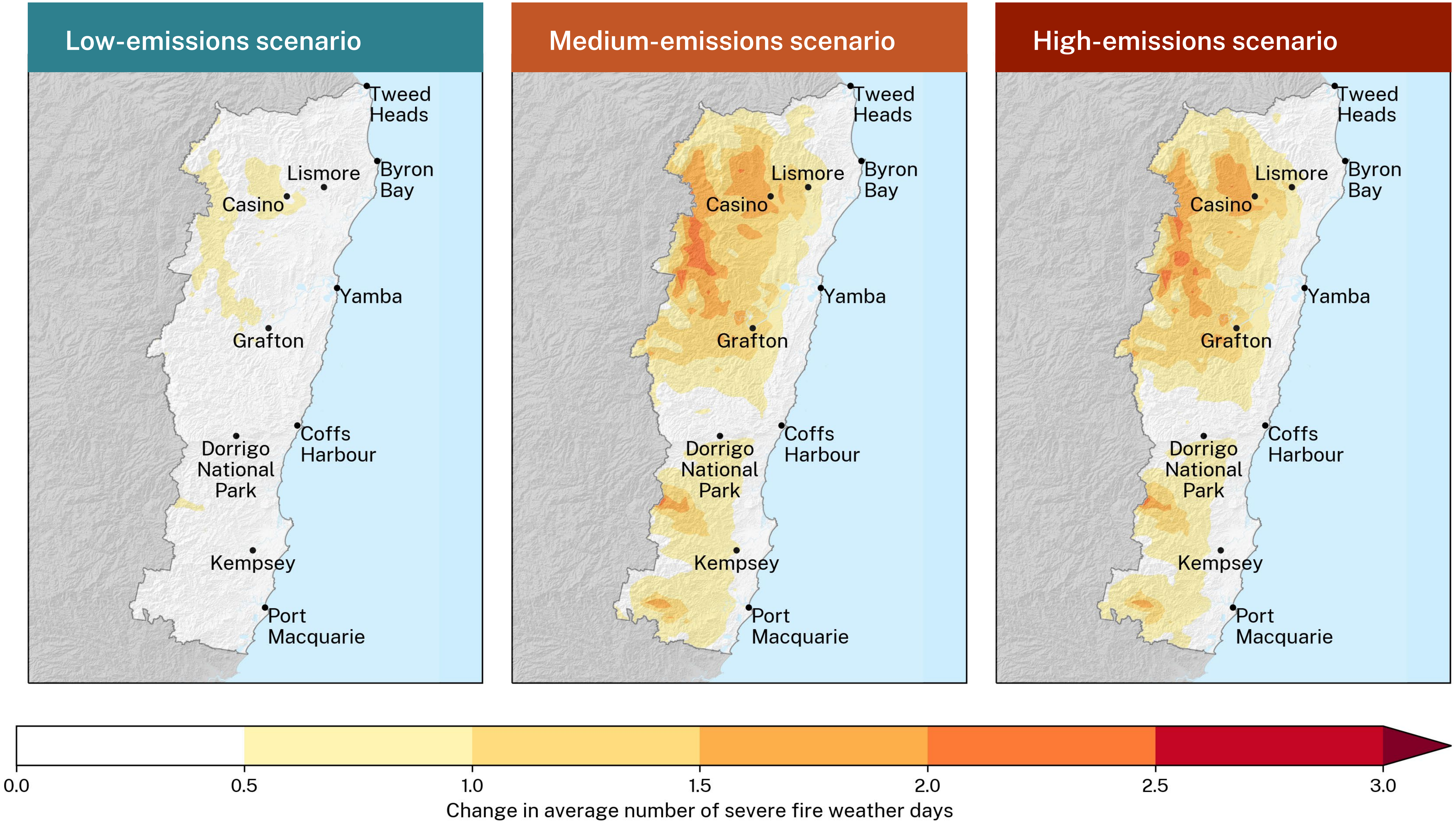


Figure 14. Projected change to average annual number of severe fire weather days by 2090 for the North Coast

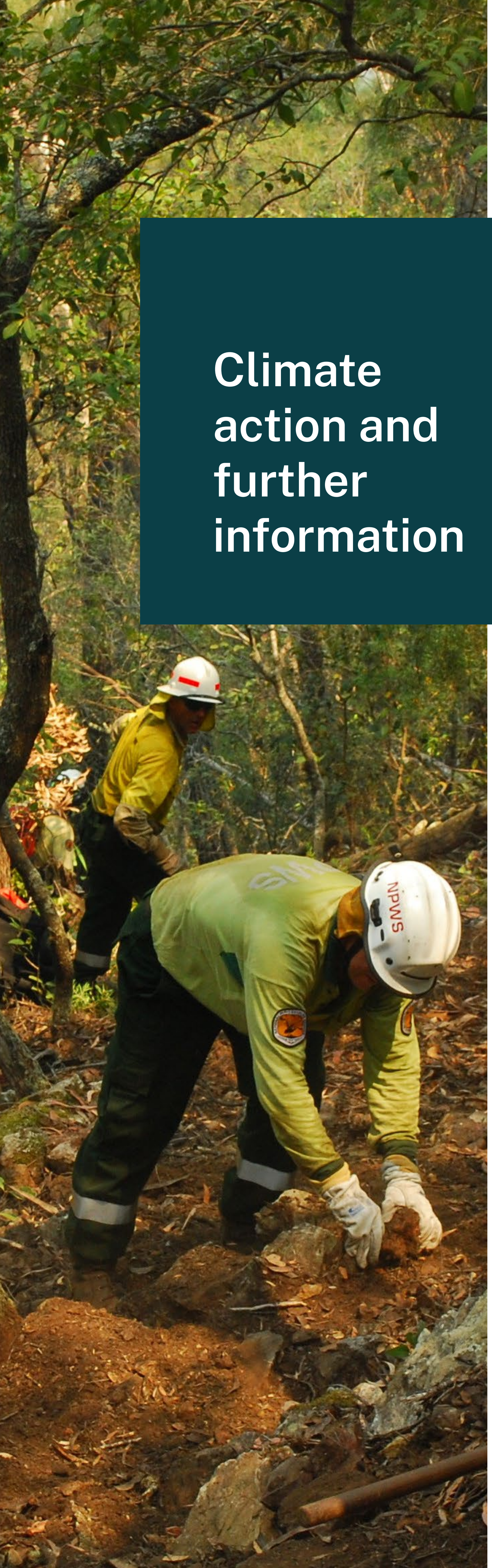


Bushfires

The region experienced significant impacts during the 2019–20 bushfire season with extensive impacts to communities, infrastructure and natural ecosystems. Over 880,000 hectares of the region were burnt and 10,706 buildings were impacted, including 414 homes which were destroyed.[10] There were 36 premature deaths, as well as 48 cardiovascular disease and 146 respiratory disease hospitalisations across the region from poor air quality caused by the bushfires.[11]

Large areas of bushland experienced extreme fire severity, including the Nymboi-Binderay, New England, Guy Fawkes River, Werrikimbe and Willi Willi national parks.[12] Significant areas of previously unburnt rainforest that form part of the Gondwana Rainforests of Australia World Heritage Area were burnt. There were also significant impacts on biodiversity, including 71 plant species, 4 threatened ecological communities and over 100 animal species. Many threatened species were impacted, such as the brush-tailed rock-wallaby, rufous scrub-bird and parma wallaby.[12]

The North Coast, with its isolated coastal towns near bushland, is highly vulnerable to the impacts of increasing number of severe fire weather. 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 also expected to reduce the interval between fires, increase fire intensity, and shorten the window for safe fire management.[13] For communities on the bushland-urban interface, the increased fire occurrence heightens risks to people, homes and infrastructure.[14]



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 AdaptNSW
- 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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