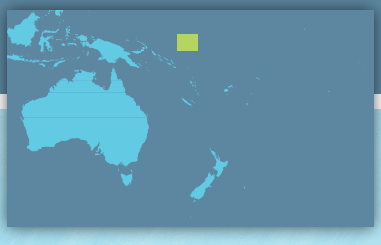
Pacific-Australia Climate Change Science and Adaptation Planning Program



Current and future climate of **Nauru**

> Nauru Department of Commerce, Industry and Environment
> Australian Bureau of Meteorology
> Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Australian Government

Nauru's current climate

Temperature

Nauru has consistent monthly average temperatures throughout the year which are strongly tied to the surrounding ocean temperature (Figure 1). The wet season usually starts in November and continues to April of the next year, while drier conditions occur from May to October.

Rainfall

Nauru's wet season is affected by the movement of the South Pacific Convergence Zone and the Intertropical Convergence Zone. These heavy bands of rainfall are caused by air rising over warm waters where winds converge, resulting in thunderstorm activity. They sit to the south and north of Nauru respectively (Figure 2).

Year-to-year variability

Nauru's climate varies considerably from year to year due to the El Niño-Southern Oscillation. This is a natural climate pattern that occurs across the tropical Pacific Ocean and affects weather around the world. There are two extreme phases of the El Niño-Southern Oscillation: El Niño and La Niña. There is also a neutral phase. In Nauru, El Niño events tend to bring warmer, wetter conditions than normal, while La Niña events are associated with a delayed onset of the wet season and drier than normal conditions, often resulting in an extended drought.

In some years Nauru's climate can be affected by the West Pacific Monsoon. This occurs when the persistent monsoon westerly winds reach as far east as western Kiribati. The West Pacific Monsoon is driven by large differences in temperature between the land and the ocean. It moves north to mainland Asia during the Northern Hemisphere summer and south to Australia in the Southern Hemisphere summer. The influence of the West Pacific Monsoon on Nauru generally varies with the phase and strength of the El Niño-Southern Oscillation and is usually associated with strong El Niño events.

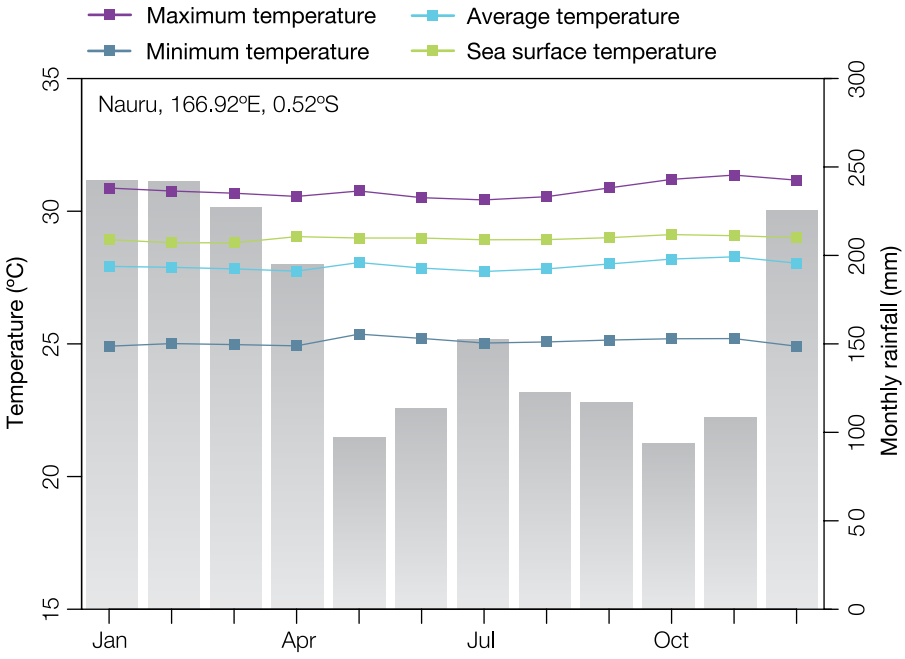


Figure 1: Seasonal rainfall and temperature at Nauru.

Extreme weather events

Being so close to the equator, Nauru does not experience tropical cyclones, although it is subject to strong winds and sea swells. The main climate extreme experienced by Nauru is drought, lasting as long as 36 months. Droughts usually occur during La Niña events when the surrounding sea temperature is lower, resulting in less cloud and rainfall. Prolonged droughts impact the underground fresh-water lens, resulting in water supply problems and severe stress on natural ecosystems.

Taking temperature observations at the Tropical Western Pacific Climate Research Station.

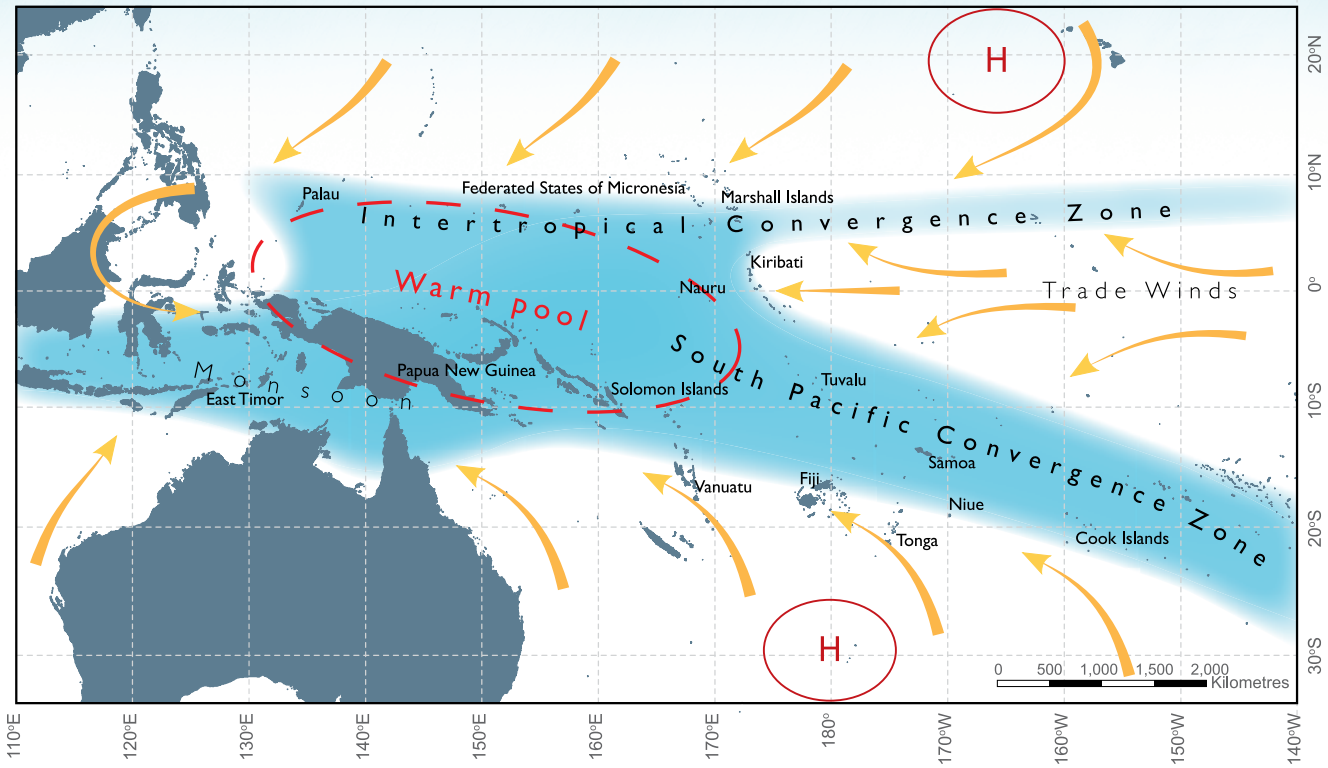


Figure 2: Average positions of the major climate features in November to April. The arrows show near surface winds, the blue shading represents the bands of rainfall convergence zones, the dashed oval shows the West Pacific Warm Pool and H represents typical positions of moving high pressure systems.

Wind-driven waves

Variability of wind-waves at Nauru is characterised by trade winds seasonally, and the El Niño–Southern Oscillation from year to year (Figure 3). In June to September, swell waves are from the south resulting from extra-tropical storms, while in December to March waves are also observed from the west due to monsoon systems and from the north due to North Pacific extra-tropical storms. Wave heights are largest during the wet season period from December to April.

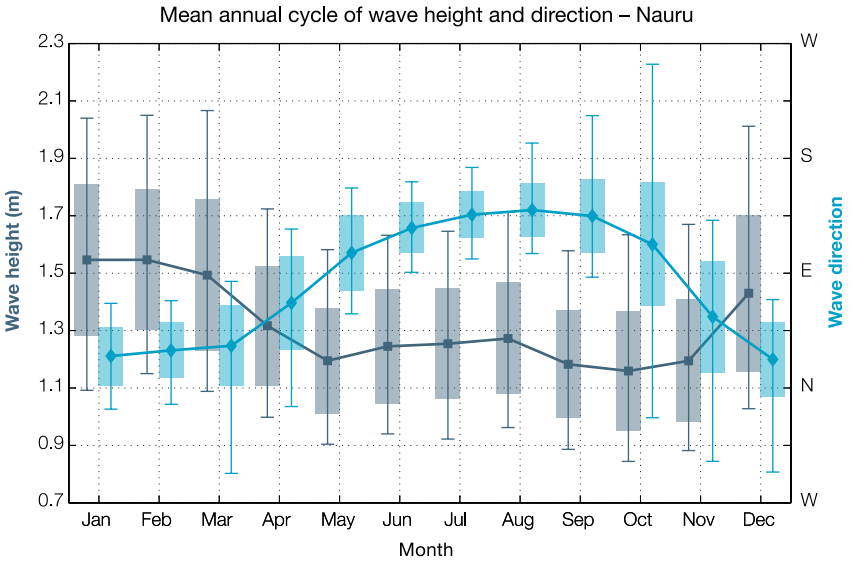


Figure 3: Annual cycle of wave height (grey) and wave direction (blue) at Nauru based on data from 1979–2009. The shaded boxes represent one standard deviation around the monthly means, and the error bars indicate the 5–95% range, showing the year-to-year variability in wave climate. The direction from which the waves are travelling is shown (not the direction towards which they are travelling).

Nauru's changing climate

Temperature and rainfall

Trends in temperature are difficult to present for Nauru because of inadequate data records. Based on nearby trends it is likely the average temperatures in Nauru have increased by around 0.15–0.25°C per decade since 1950. This is similar to the trend in sea-surface temperature for the Nauru region which shows an increase of 0.15–0.20°C per decade since 1950.

Data since 1927 show no clear trends in annual or seasonal rainfall (Figure 4), but over this period, there has been substantial variation in rainfall from year to year.

Sea level has risen

As ocean water warms it expands causing the sea level to rise. The melting of glaciers and ice sheets also contribute to sea-level rise.

Instruments mounted on satellites and tide gauges are used to measure sea level. Satellite data indicate the sea level has risen near Nauru by about 5 mm per year since 1993. This is larger than the global average of 2.8–3.6 mm per year. This higher rate of rise may be related to natural fluctuations that take place year to year or decade to decade caused by phenomena such as the El Niño-Southern Oscillation. This variation in sea level can be seen in Figure 6 which includes the tide gauge record since 1974 and satellite data since 1993.

Ocean acidification has been increasing

About one quarter of the carbon dioxide emitted from human activities each year is absorbed by the oceans. As the extra carbon dioxide reacts with sea water it causes the ocean to become slightly more acidic. This impacts the growth of corals and organisms that construct their skeletons from carbonate minerals. These species are critical to the balance of tropical reef ecosystems. Data show that since the 18th century the level of ocean acidification has been slowly increasing in Nauru's waters.

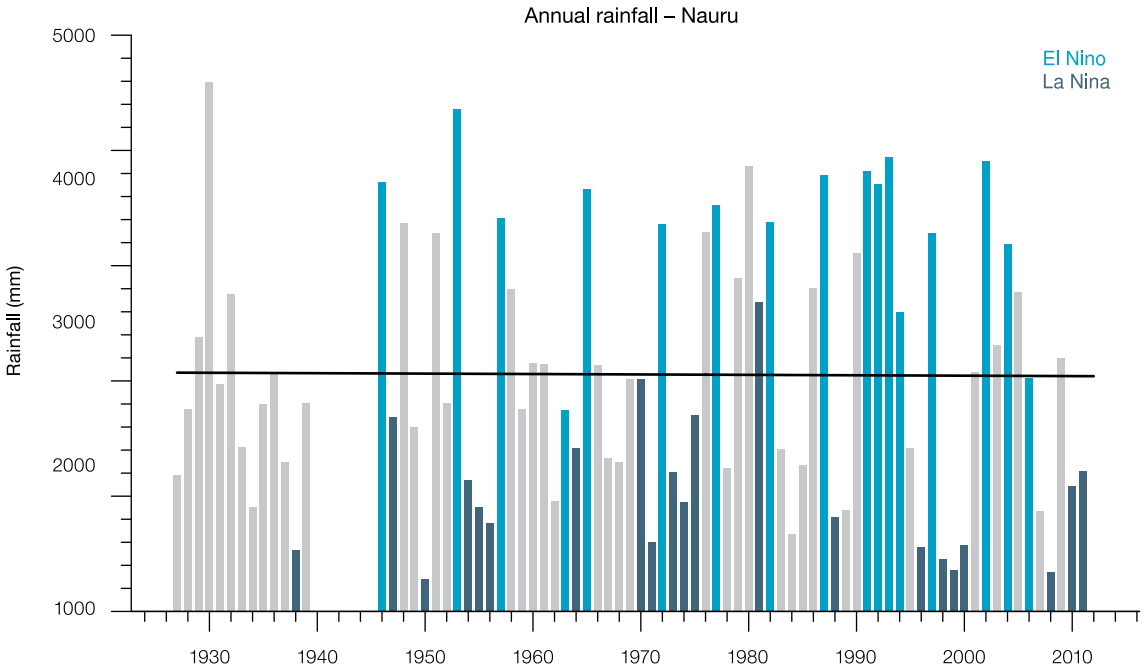


Figure 4: Annual average total rainfall at Nauru. Light blue, dark blue and grey bars indicate El Niño, La Niña and neutral years respectively. Missing bars indicate no data is available. The solid black line shows the trend.

Nauru's future climate

Climate impacts almost all aspects of life in Nauru. Understanding the possible future climate of Nauru is important so people and the government can plan for changes.

At a glance

- El Niño and La Niña events will continue to occur in the future, but there is little consensus on whether these events will change in intensity or frequency.

- Annual mean temperatures and extremely high daily temperatures will continue to rise.

- Mean rainfall is projected to increase, along with more extreme rain events.
- Droughts are projected to decline in frequency.

- Sea level will continue to rise.
- Ocean acidification is expected to continue.
- The risk of coral bleaching is expected to increase.
- Wave height and period are projected to decrease in December–March but no significant changes are projected in June–September.

Buada lagoon.

Children swimming in Anibare boat harbour.

Temperatures will continue to increase

Projections for all emissions scenarios indicate that the annual average air temperature and sea-surface temperature will increase in the future in Nauru (Table 1). By 2030, under a very high emissions scenario, this increase in temperature is projected to be in the range of 0.5–1.2°C. Later in the century the range of the projected temperature increase under the different scenarios broadens.

Table 1: Projected changes in the annual average surface air temperature for Nauru. Values represent 90% of the range of the models and are relative to the period 1986–2005.

	2030 (°C)	2050 (°C)	2070 (°C)	2090 (°C)
Very low emissions scenario	0.4–1.0	0.6–1.4	0.5–1.4	0.6–1.5
Low emissions scenario	0.4–1.2	0.6–1.5	0.8–2.1	1.1–2.5
Medium emissions scenario	0.4–1.0	0.7–1.6	0.9–2.3	1.1–3.0
Very high emissions scenario	0.5–1.2	1.0–2.2	1.5–3.5	2.0–4.5

More very hot days

Increases in average temperatures will also result in a rise in the number of hot days and warm nights, and a decline in cooler weather.

Changing rainfall patterns

Almost all of the global climate models project an increase in average annual and seasonal rainfall over the course of the 21st century. Projected increases are consistent with the expected intensification of the South Pacific Convergence Zone, the West Pacific Monsoon and Intertropical Convergence Zone. However, there is some uncertainty in the rainfall projections and not all models show consistent results. Droughts are projected to become less frequent throughout this century.

More extreme rainfall days

Projections show extreme rainfall days are likely to occur more often and be more intense.

Canoes on the beach in Nauru.

Sea level will continue to rise

Sea level is expected to continue to rise in Nauru (Table 2 and Figure 5). By 2030, under a very high emissions scenario, this rise in sea level is projected to be in the range of 8–18 cm. The sea-level rise combined with natural year-to-year changes will increase the impact of storm surges and coastal flooding. As there is still much to learn, particularly how large ice sheets such as Antarctica and Greenland contribute to sea-level rise, scientists warn larger rises than currently predicted could be possible.

Ocean acidification will continue

Under all four emissions scenarios the acidity level of sea waters in the Nauru region will continue to increase over the 21st century, with the greatest change under the very high emissions scenario. The impact of increased acidification on the health of reef ecosystems is likely to be compounded by other stressors including coral bleaching, storm damage and fishing pressure.

Wave climate will change

Wave height and period are projected to decrease in December to March; however, there is large year-to-year variability. No significant changes are projected in June to September.

Table 2: Sea-level rise projections for Nauru. Values represent 90% of the range of the model results and are relative to the period 1986–2005.

	2030 (cm)	2050 (cm)	2070 (cm)	2090 (cm)
Very low emissions scenario	8–17	14–30	19–45	24–60
Low emissions scenario	7–17	14–31	22–48	29–68
Medium emissions scenario	7–16	14–30	21–48	30–69
Very high emissions scenario	8–18	17–34	28–58	41–89

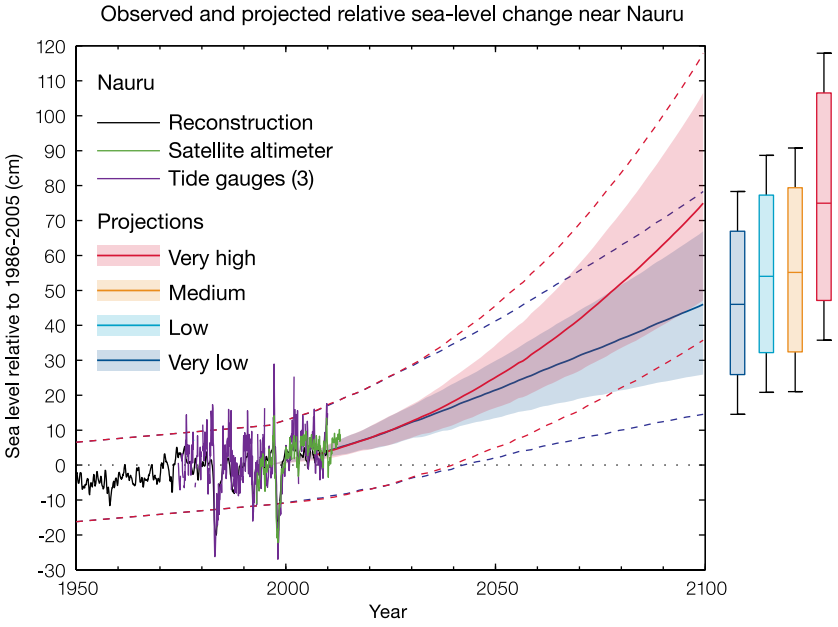


Figure 5: Tide-gauge records of relative sea level (since 1974) are indicated in purple, and the satellite record (since 1993) in green. The reconstructed sea level data at Nauru (since 1950) is shown in black. Multi-model mean projections from 1995–2100 are given for the very high (red solid line) and very low emissions scenarios (blue solid line), with the 5–95% uncertainty range shown by the red and blue shaded regions. The ranges of projections for the four emissions scenarios by 2100 are also shown by the bars on the right. The dashed lines are an estimate of year-to-year variability in sea level (5–95% uncertainty range about the projections) and indicate that individual monthly averages of sea level can be above or below longer-term averages.

How do scientists develop climate projections?

Global climate models are the best tools for understanding future climate change. Climate models are mathematical representations of the climate system that require very powerful computers. They are based on the laws of physics and include information about the atmosphere, ocean, land and ice.

There are many different global climate models and they all represent the climate slightly differently. Scientists from the Pacific Climate Change Science and Adaptation Planning Program have evaluated 26 models from around the world and found that 24 best represent the climate of the Nauru region of the western tropical Pacific. These 24 models have been used to develop climate projections for Nauru.

The future climate will be determined by a combination of natural and human factors. As we do not know what the future holds, we need to consider a range of possible future conditions, or scenarios, in climate models. Greenhouse gas and aerosol emissions scenarios are used in climate modelling to provide projections that represent a range of possible futures. The Intergovernmental Panel on Climate Change (IPCC) has developed four greenhouse gas and emissions scenarios, called Representative Concentration Pathways (RCPs). These scenarios cover a broad range of possibilities. For example, the lowest scenario shows the likely outcome if global emissions are significantly reduced, while the highest scenario shows the impact of a pathway with no policy of reducing emissions.

The climate projections for Nauru are based on the four IPCC RCPs: very low emissions (RCP2.6), low emissions (RCP4.5), medium emissions (RCP6.0) and very high emissions (RCP8.5), for four 20-year time periods centred on 2030, 2050, 2070 and 2090, relative to a 20-year period centred on 1995 (Figure 6). Since individual models give different results, the projections are presented as a range of values. When interpreting projected changes in the mean climate in the Pacific, it is important to keep in mind that natural climate variability, such as the state of the El Niño-Southern Oscillation, strongly affects the climate from one year to the next.

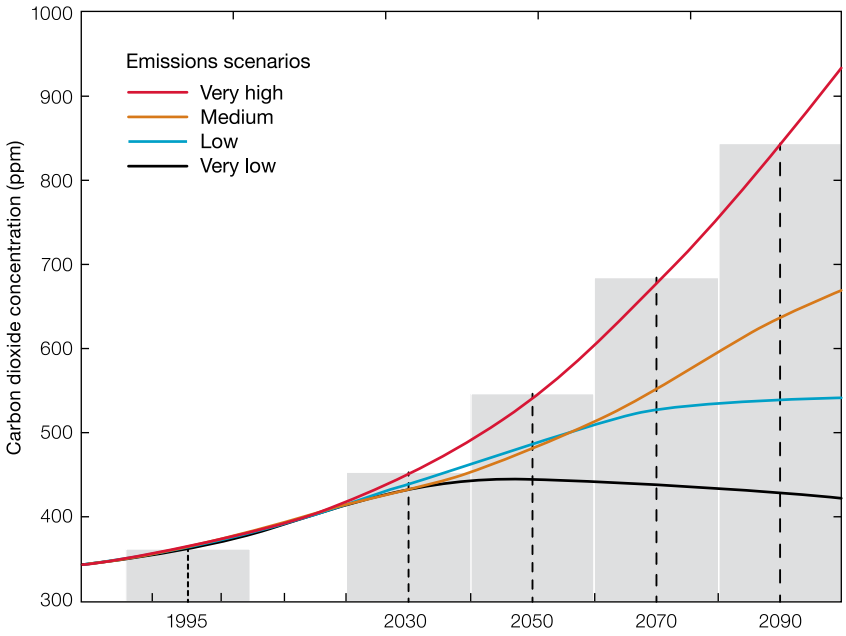


Figure 6: Carbon dioxide concentrations (parts per million, ppm) associated with the very low (RCP2.6), low (RCP4.5), medium (RCP6.0) and very high (RCP8.5) emissions scenarios for 20-year time periods (shaded) centred on 1995 (the reference period), 2030, 2050, 2070 and 2090.

This brochure contains a summary of climate projections for Nauru. For more information refer to the technical reports *Climate Change in the Pacific: Scientific Assessment and New Research (Volume 2)* and *Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports.*

These reports are available at **www.pacificclimatechangescience.org**.

Climate projections are also available through the web-based Pacific Climate Futures tool at **www.pacificclimatefutures.net**.

Changes in Nauru's climate

> Temperatures have warmed and will continue to warm with more very hot days in the future.

> Rainfall shows no clear trend since 1950. Rainfall is generally projected to increase over this century with more extreme rainfall days and less droughts.

> Sea level near Nauru has risen and will continue to rise throughout this century.

> Ocean acidification has been increasing in Nauru's waters. It will continue to increase and threaten coral reef ecosystems.

> Wave height and period are projected to decrease in December to March.

This publication updates the original *Current and future climate of Nauru* brochure published in 2011.

The content of this brochure is the result of a collaborative effort between the Nauru Department of Commerce, Industry and Environment and the Pacific-Australia Climate Change Science and Adaptation Planning (PACCSAP) Program – a component of the Australian Government's International Climate Change Adaptation Initiative. The information in this publication, and research conducted by PACCSAP, builds on the findings of the 2013 IPCC Fifth Assessment Report, and uses new emissions scenarios and climate models.

For more detailed information on the climate of Nauru and the Pacific see *Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports* (2014) and *Climate Change in the Pacific: Scientific Assessment and New Research. Volume 1: Regional Overview. Volume 2: Country Reports* (2011).

www.pacificclimatechangescience.org

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