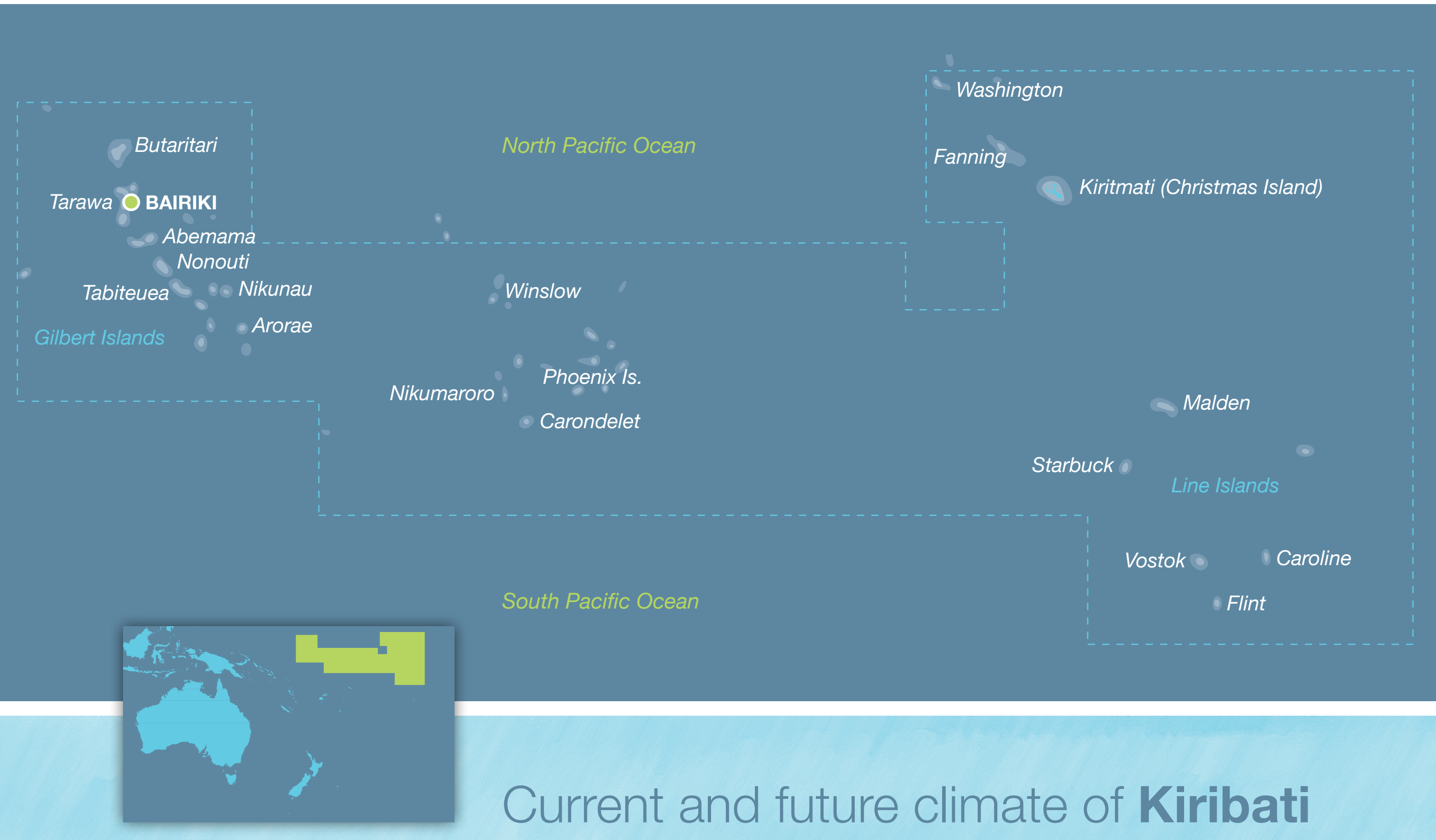
Pacific-Australia Climate Change Science and Adaptation Planning Program



Current and future climate of **Kiribati**

> Kiribati Meteorology Service
> Australian Bureau of Meteorology
> Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Australian Government

Kiribati's current climate

Temperature

Kiribati has a hot, humid tropical climate, with air temperatures very closely related to the temperature of the oceans surrounding the small islands and atolls. Across Kiribati the average temperature is relatively constant year round. Changes in the temperature from season to season are no more than about 1°C.

Rainfall

The driest and wettest periods in the year vary from location to location. At Tarawa, in the west, the driest six-month period begins in June, with the lowest mean rainfall in October. The wet season usually lasts from around November to April. At Kiritmati, 2000 km to the east, the wet season is from January to June and it is much drier than Tarawa (Figure 1).

Rainfall in Kiribati is affected by the movement of the South Pacific Convergence Zone and the Intertropical Convergence Zone. They extend across the South Pacific Ocean from the Solomon Islands to east of the Cook Islands, and across the Pacific just north of the equator, respectively (Figure 2). These bands of heavy rainfall are caused by air rising over warm water where winds converge, resulting in thunderstorm activity.

Year-to-year variability

Kiribati'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. Across Kiribati, El Niño events tend to bring wetter, warmer conditions than normal. In the wettest years Tarawa has received more than 4000 mm, while in the driest years as little as 150 mm of rain has fallen.

Droughts

Droughts can be very severe in Kiribati, and are usually associated with La Niña events. Average annual rainfall in Tarawa is approximately 2100 mm with just over 900 mm received between May and October. From July 1988 to December 1989 only 205 mm of rain fell, while from August 1998 to February 1999 total rainfall was 95 mm. The recent drought from April 2007 to early 2009 severely affected water supplies in the southern Gilbert Islands and Banaba. During this period groundwater became brackish and the leaves of most plants turned yellow.

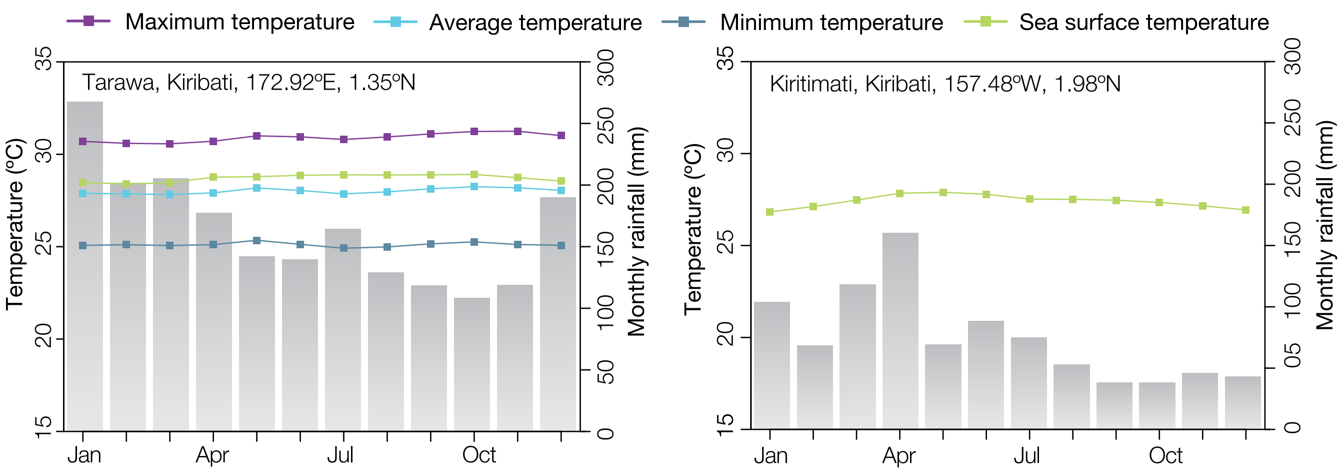


Figure 1: Seasonal rainfall and temperature at Tarawa and Kiritimati.

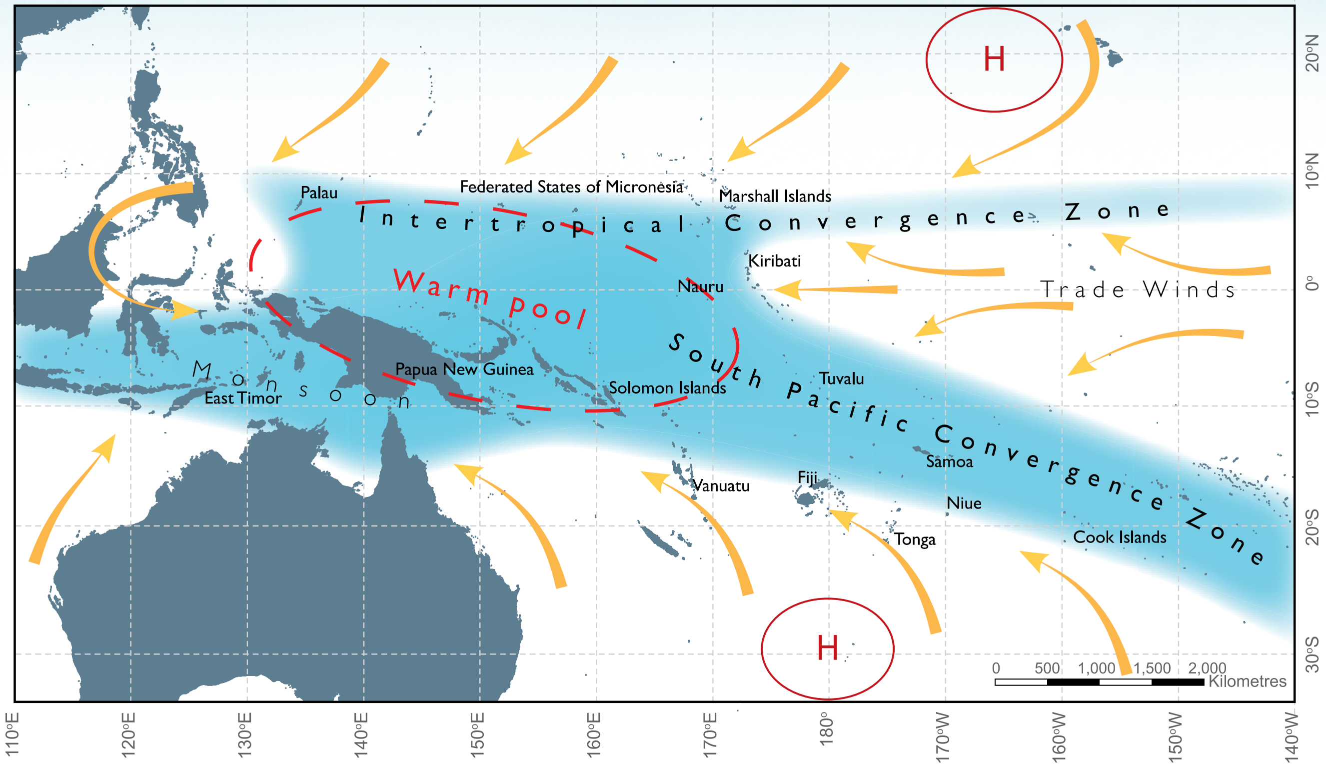


Figure 2: Average positions of the major climate features in November to April. The arrows show near surface winds, the blue shading represents the bands of rainfall convergence zones, the dashed oval shows the West Pacific Warm Pool and H represents typical positions of moving high pressure systems.

Climate data management training, Kiribati Meteorology Service.

Weather balloon launch, Kiribati Meteorology Service.

Wind-driven waves

Wind-waves in Kiribati are strongly influenced by both north-easterly and south-easterly trade winds seasonally, and the location of the South Pacific Convergence Zone, with some effect of the El Niño–Southern Oscillation from year to year. There is little variation in wave climate across the country.

In the west, waves consist of locally generated trade wind waves from the east and north-east from December to March, and from the east and south-east from June to September. In this period there is also trade wind induced swell, and some swell propagating from extra-tropical storms in the North Pacific and Southern Ocean (Figure 3, top).

In the east, waves come from the north-east during the northern trade wind season, December to March, with some small south-easterly waves, and both north-east and north-west swell from trade winds and extra-tropical storms (Figure 3, bottom). Most south-east trade wind waves from June to September are blocked by the island, with some small locally generated trade wind waves, and southerly swell from Southern Ocean storms observed.

During the northern trade wind season, waves at both Tarawa and Kiritimati have a slightly larger height and longer period than in other months.

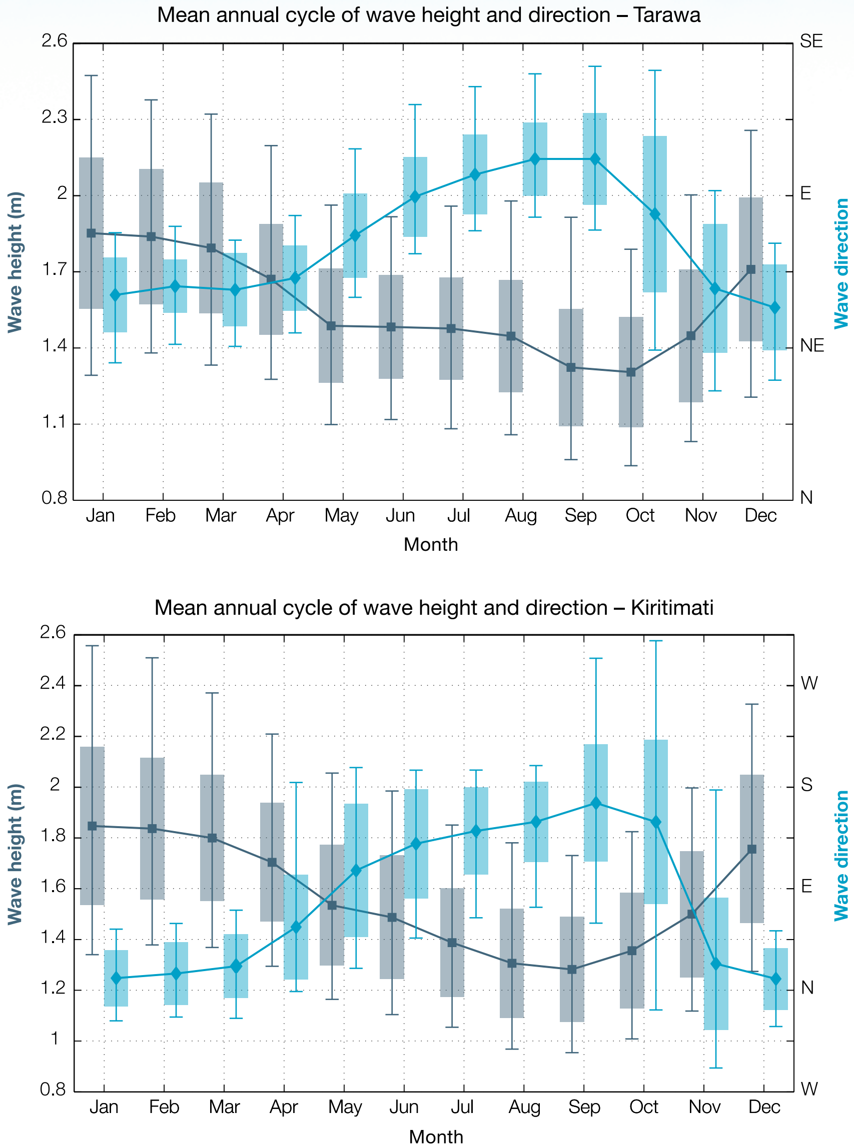


Figure 3: Annual cycle of wave height (grey) and wave direction (blue) at Tarawa (top) and Kiritimati (bottom) based on data from 1979–2009. The shaded boxes represent one standard deviation around the monthly means, and the error bars indicate the 5–95% range, showing the year-to-year variability in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

Kiribati's changing climate

Temperatures have increased

Annual and seasonal maximum and minimum temperatures have increased in Tarawa since 1950 (Figure 4). Maximum temperatures have increased at a rate of 0.13°C per decade. These temperature increases are consistent with the global pattern of warming.

Wet season rainfall has increased at Kiritimati

Data since 1946 for Kiritimati show a clear incresing trend in wet season rainfall, but no trend in the dry season. At Tarawa, rainfall data show no clear trends. Over this period, there has been substantial variation in rainfall from year to year at both sites.

Taking temperature observations, Kiribati Meteorology Service.

Aerial view, South Tarawa.

Sea level has risen

As ocean water warms it expands causing the sea level to rise. The melting of glaciers and ice sheets also contributes 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 across Kiribati by 1–4 mm per year since 1993, compared to the global average of 2.8–3.6 mm per year. Sea level rise naturally fluctuates from year to year and decade to decade as a result of phenomena such as the El Niño-Southern Oscillation. This variation in sea level can be seen in Figure 5 which includes the tide gauge record since 1950 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 Kiribati's waters.

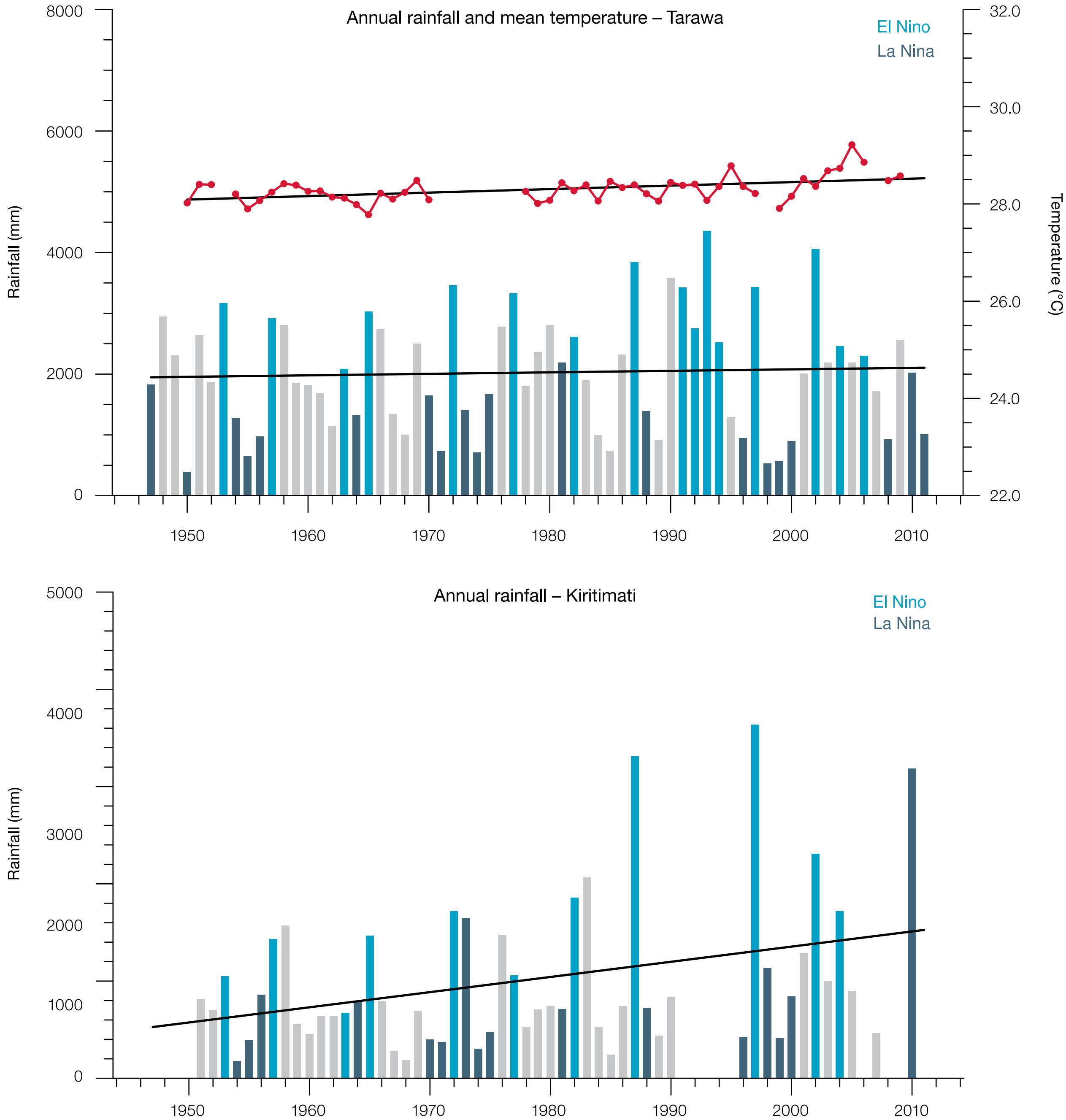


Figure 4: Annual average air temperature (red dots and line) and total rainfall (bars) at Tarawa (top) and Kiritimati (bottom). Light blue, dark blue and grey bars indicate El Niño, La Niña and neutral years respectively. No bars indicate that data is not available. Solid black lines show the trends.

Kiribati's future climate

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

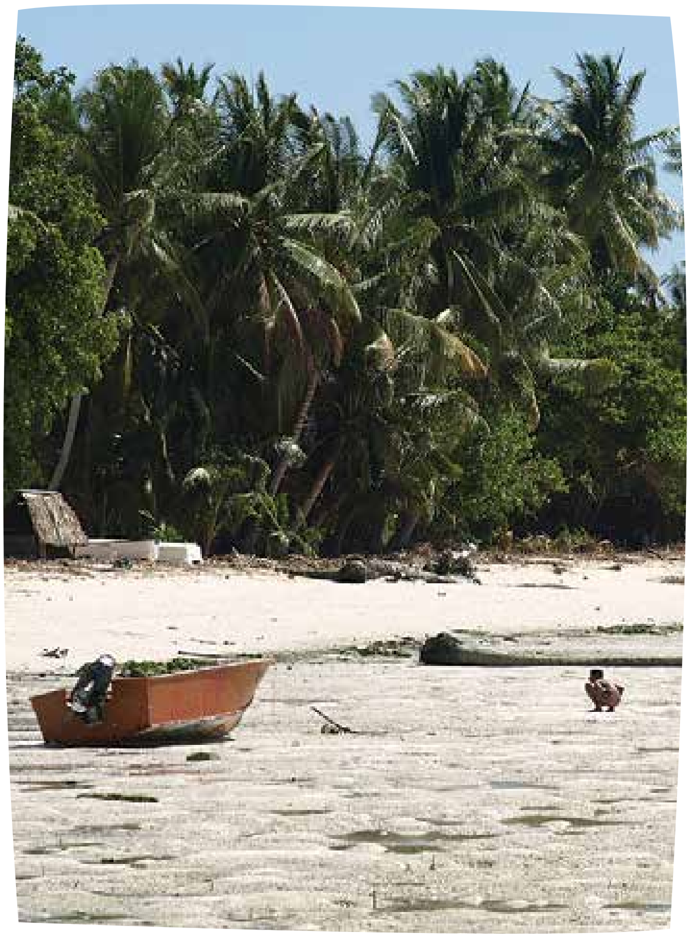
At a glance

- 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.

- Average 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 is projected to decrease in December–March, waves may be more directed from the south in October.



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 Kiribati (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 projected temperature increase under the different scenarios broadens.

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. This increase is projected to be greater in the Gilbert Islands and lower in the Line Islands. 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.

Wave climate will change

Wave height is projected to decrease in December to March. Waves may be more directed from the south in October. Wave height is projected to increase slightly in September in the Line Islands.

Table 1: Projected changes in the annual average surface air temperature for Kiribati. 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)
Gilbert Islands				
Very low emissions scenario	0.4–1.0	0.6–1.5	0.5–1.4	0.6–1.5
Low emissions scenario	0.4–1.2	0.6–1.7	0.8–2.1	1.1–2.5
Medium emissions scenario	0.4–1.0	0.7–1.6	0.9–2.3	1.1–2.9
Very high emissions scenario	0.6–1.2	1.0–2.2	1.5–3.5	2.1–4.5
Phoenix Islands				
Very low emissions scenario	0.5–1.0	0.6–1.4	0.5–1.4	0.6–1.4
Low emissions scenario	0.4–1.1	0.7–1.7	0.8–2.1	1.0–2.4
Medium emissions scenario	0.4–1.0	0.6–1.5	0.9–2.1	1.1–2.8
Very high emissions scenario	0.5–1.2	0.9–2.2	1.6–3.4	2.1–4.3
Line Islands				
Very low emissions scenario	0.5–0.9	0.6–1.3	0.5–1.3	0.5–1.3
Low emissions scenario	0.5–1.1	0.7–1.6	0.9–1.9	1.0–2.3
Medium emissions scenario	0.4–0.9	0.6–1.4	0.9–1.9	1.1–2.5
Very high emissions scenario	0.6–1.1	1.0–2.0	1.5–3.2	2.0–4.0

Coastline near Bonriki International Airport, South Tarawa.

Sea level will continue to rise

Sea level is expected to continue to rise in Kiribati (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 7–17 cm. The sea-level rise combined with natural year-to-year changes will accentuate 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 Kiribati 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.

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

	2030 (cm)	2050 (cm)	2070 (cm)	2090 (cm)
Gilbert Islands				
Very low emissions scenario	7–17	13–29	18–44	23–59
Low emissions scenario	7–16	13–30	20–47	27–66
Medium emissions scenario	7–16	13–29	19–46	28–67
Very high emissions scenario	7–17	16–33	26–56	38–87
Phoenix Islands				
Very low emissions scenario	7–17	13–29	18–44	23–59
Low emissions scenario	7–16	13–30	20–47	27–66
Medium emissions scenario	7–16	13–29	19–46	28–67
Very high emissions scenario	7–17	16–33	26–56	38–87
Line Islands				
Very low emissions scenario	7–17	13–29	18–44	23–59
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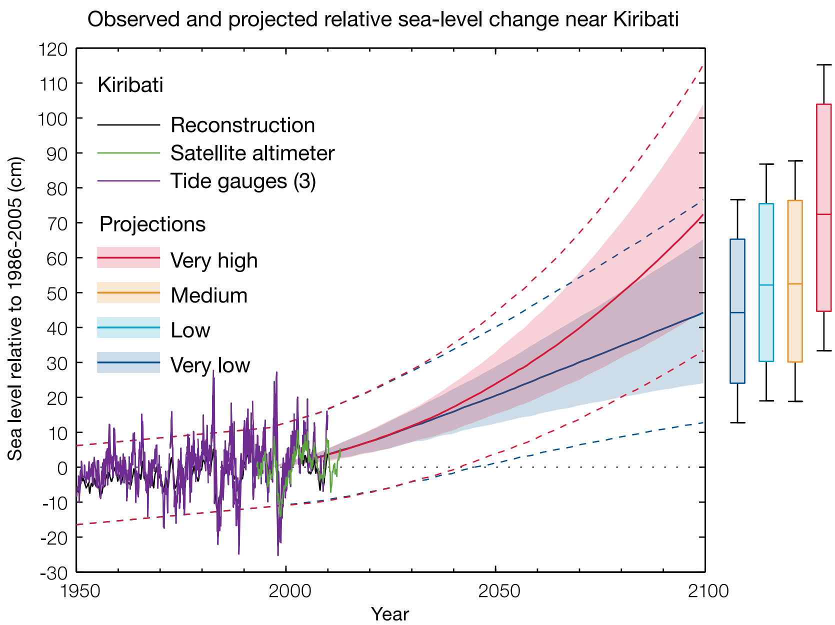

Figure 5: Tide-gauge records of relative sea level (since 1950) are indicated in purple, and the satellite record (since 1993) in green. The reconstructed sea-level data at Kiribati (since 1950) is shown in black. Multi-model mean projections from 1995–2100 are given for the very high (red solid line) 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 Kiribati region of the western tropical Pacific. These 24 models have been used to develop climate projections for Kiribati.

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 Kiribati 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.

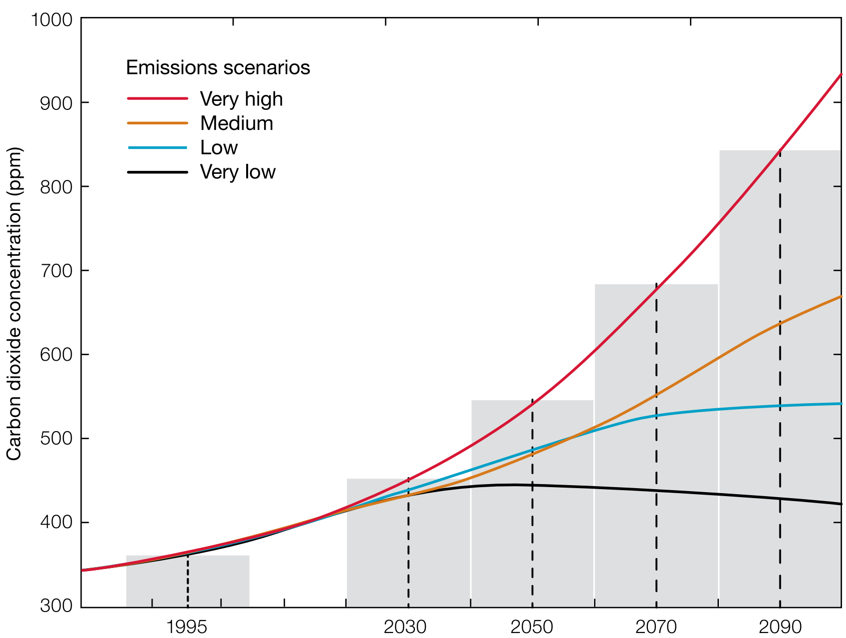

Figure 6: Carbon dioxide concentrations (parts per million, ppm) associated with the very low (RCP2.6), low (RCP4.5), medium (RCP6.0) and very high (RCP8.5) emissions scenarios for 20-year time periods (shaded) centred on 1995 (the reference period), 2030, 2050, 2070 and 2090.

This brochure contains a summary of climate projections for Kiribati. 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 Kiribati's climate

- Temperatures have warmed and will continue to warm with more very hot days in the future.
- Annual and seasonal rainfall is projected to increase. Rainfall extremes are projected to increase. The frequency of drought is projected to decrease relative to the current climate.
- Sea level near Kiribati has risen and will continue to rise throughout this century.
- Ocean acidification has been increasing in Kiribati's waters. It will continue to increase and threaten coral reef ecosystems.
- Wave height is projected to decrease in December to March. Waves may be more directed from the south in October.

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

The content of this brochure is the result of a collaborative effort between the Kiribati Meteorology Service 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 Kiribati 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).

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