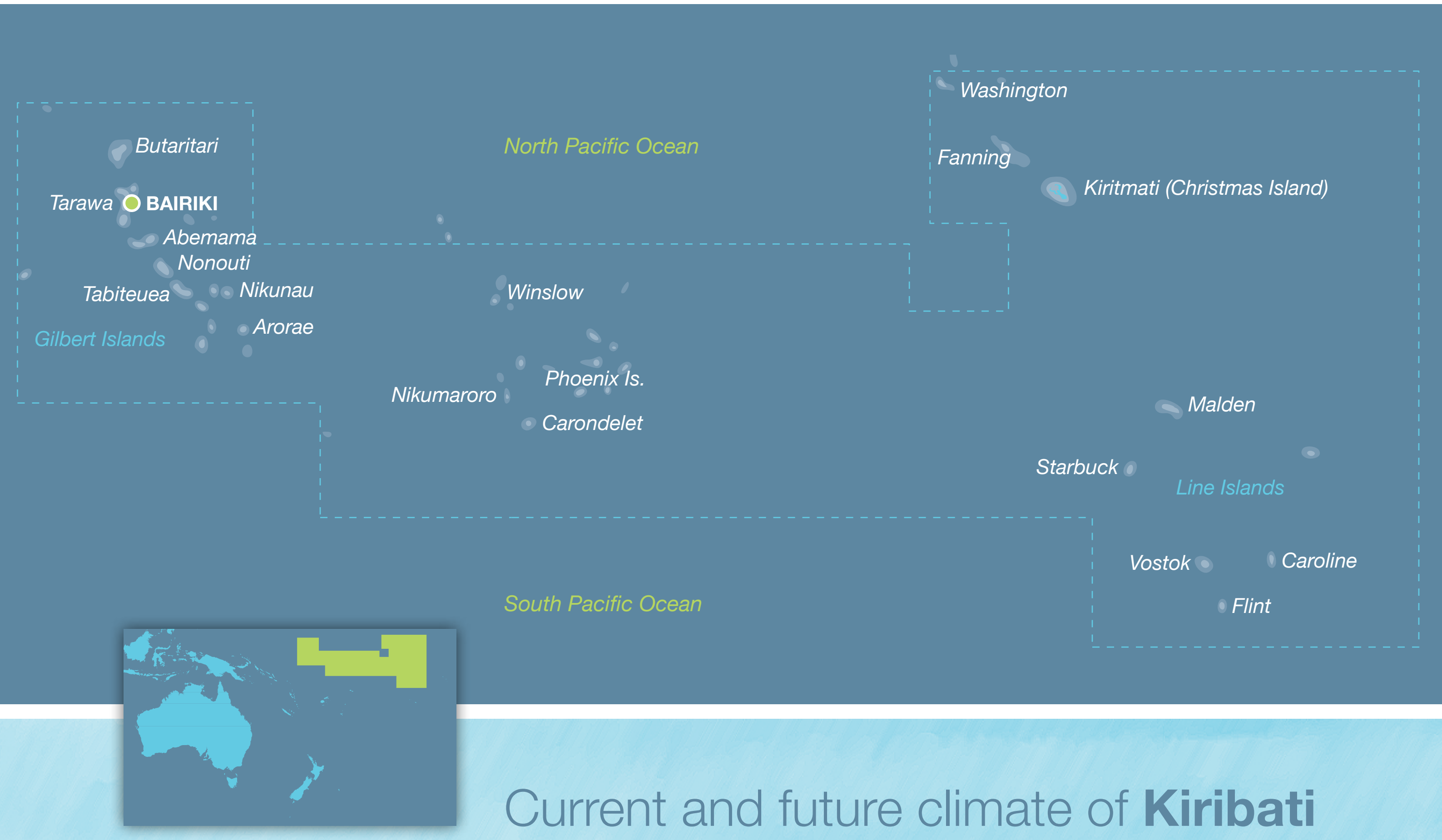
International CLIMATE CHANGE ADAPTATION Initiative

Pacific Climate Change Science 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**

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.

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 (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.

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 Kiribati 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.

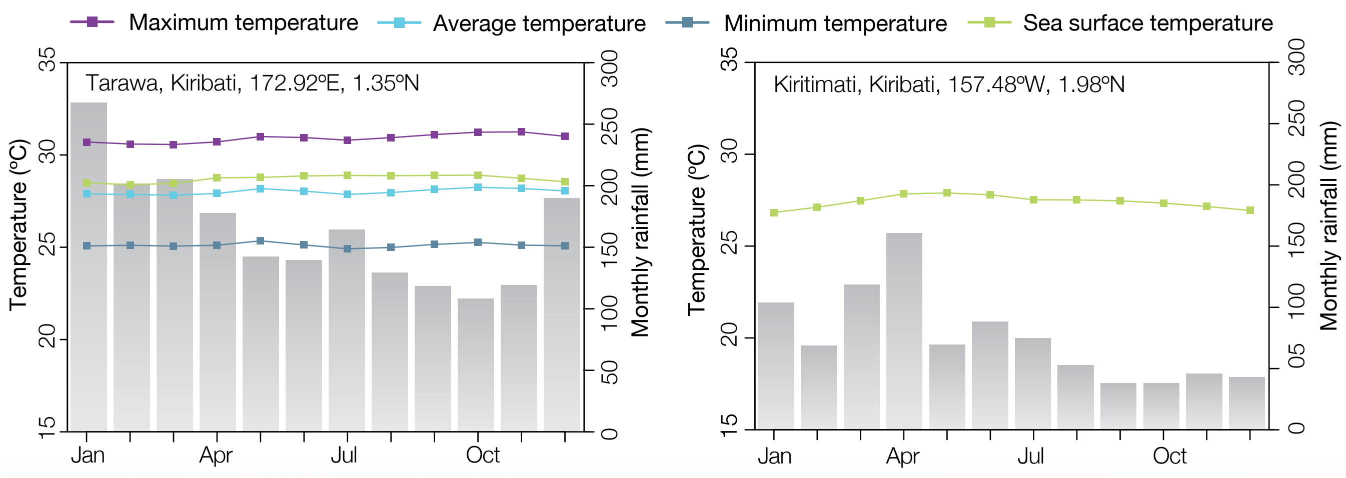


Figure 1: Seasonal rainfall and temperature at Tarawa and Kiritimati.

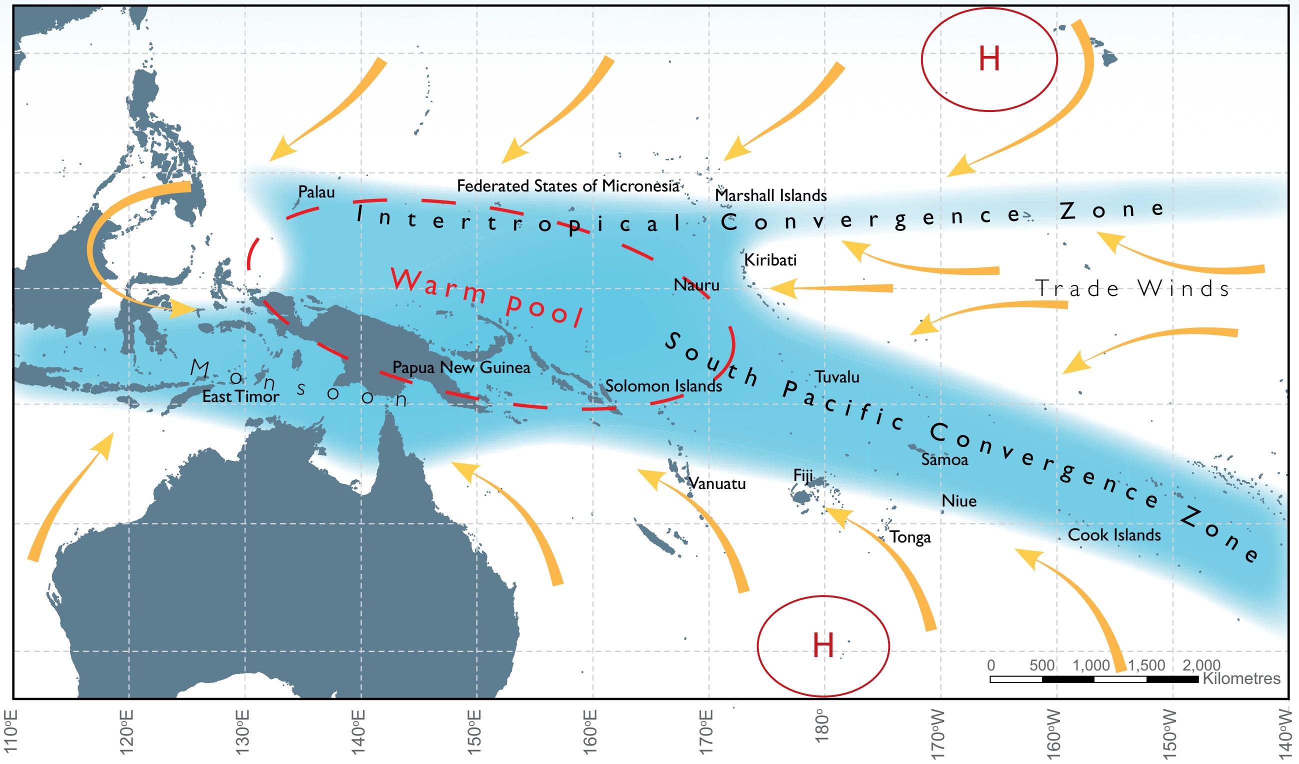


Figure 2: The average positions of the major climate features in November to April. The arrows show near surface winds, the blue shading represents the bands of rainfall convergence zones, the dashed oval shows the West Pacific Warm Pool and H represents typical positions of moving high pressure systems.

Climate data management training, Kiribati Meteorology Service.

Lagoon Beach at low tide, South Tarawa.

Kiribati's **changing climate**

Temperatures have increased

Annual and seasonal maximum and minimum temperatures have increased in Tarawa since 1950 (Figure 3). Maximum temperatures have increased at a rate of 0.18°C per decade. These temperature increases are consistent with the global pattern of warming.

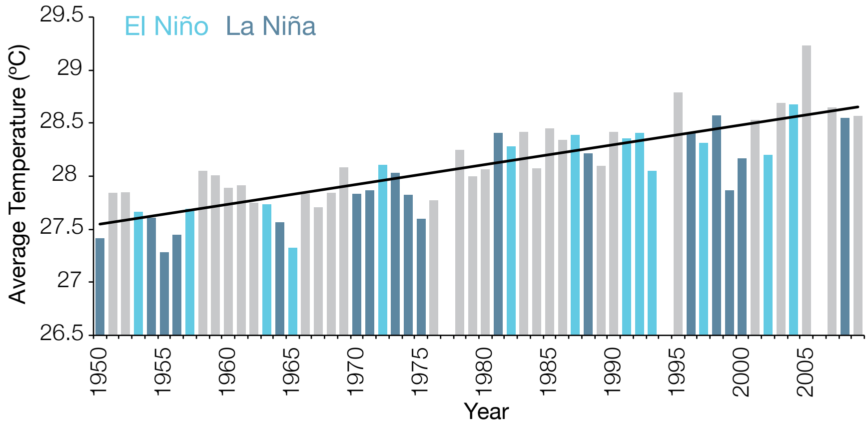


Figure 3: Annual average temperature for Tarawa. Light blue bars indicate El Niño years, dark blue bars indicate La Niña years and the grey bars indicate neutral years.

Annual rainfall has increased

Data since 1951 for Kiritimati show a clear incresing trend in annual and wet season rainfall (Figure 4), 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.

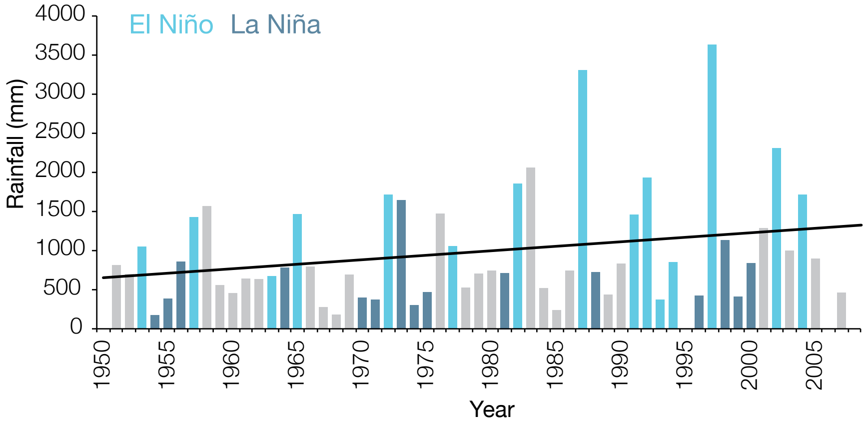


Figure 4: Annual rainfall for Kiritmati. Light blue bars indicate El Niño years, dark blue bars indicate La Niña years and the grey bars indicate neutral years.

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 6 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.

Taking temperature observations, Kiribati Meteorology Service.

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.

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 Program (PCCSP) have evaluated 24 models from around the world and found that 18 best represent the climate of the western tropical Pacific region. These 18 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. The Intergovernmental Panel on Climate Change (IPCC) developed a series of plausible scenarios based on a set of assumptions about future population changes, economic development and technological advances. For example, the A1B (or medium) emissions scenario envisages global population peaking mid-century and declining thereafter, very rapid economic growth, and rapid introduction of new and more efficient technologies. Greenhouse gas and aerosol emissions scenarios are used in climate modelling to provide projections that represent a range of possible futures.

The climate projections for Kiribati are based on three IPCC emissions scenarios: low (B1), medium (A1B) and high (A2), for time periods around 2030, 2055 and 2090 (Figure 5). Since individual models give different results, the projections are presented as a range of values.

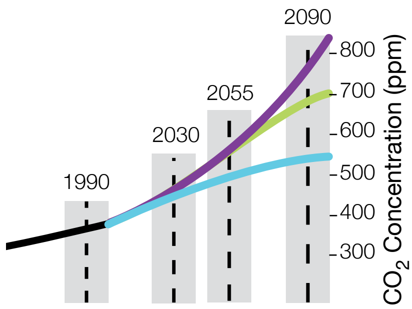


Figure 5: Carbon dioxide (CO_2) concentrations (parts per million, ppm) associated with three IPCC emissions scenarios: low emissions (B1 – blue), medium emissions (A1B – green) and high emissions (A2 – purple). The PCCSP has analysed climate model results for periods centred on 1990, 2030, 2055 and 2090 (shaded).

Aerial view, South Tarawa.

Taking temperature observations, Kiribati Meteorology Service.

Kiribati's **future climate**

This is a summary of climate projections for Kiribati. For further information refer to Volume 2 of *Climate Change in the Pacific: Scientific Assessment and New Research*, and the web-based climate projections tool – *Pacific Climate Futures* (available at www.pacificclimatefutures.net).

Temperature 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 high emissions scenario, this increase in temperature is projected to be in the range of 0.3–1.3°C for the Gilbert and 0.4–1.2°C for the Phoenix and Line Islands.

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. 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

Model projections show extreme rainfall days are likely to occur more often.

Weather balloon launch, Kiribati Meteorology Service.

Table 1: Projected annual average air temperature changes for Kiribati for three emissions scenarios and three time periods. Values represent 90% of the range of the models and changes are relative to the average of the period 1980-1999.

	2030 (°C)	2055 (°C)	2090 (°C)
Gilbert Islands			
Low emissions scenario	0.2–1.2	0.7–1.9	1.0–2.4
Medium emissions scenario	0.2–1.4	0.9–2.3	1.7–3.5
High emissions scenario	0.3–1.3	1.0–2.2	2.2–3.8
Phoenix Islands			
Low emissions scenario	0.2–1.2	0.7–1.9	1.0–2.4
Medium emissions scenario	0.4–1.4	1.0–2.2	1.7–3.5
High emissions scenario	0.4–1.2	1.1–2.1	2.3–3.7
Line Islands			
Low emissions scenario	0.2–1.2	0.6–1.8	1.0–2.4
Medium emissions scenario	0.3–1.3	1.0–2.2	1.6–3.4
High emissions scenario	0.4–1.2	1.0–2.0	2.3–3.5

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 6). By 2030, under a high emissions scenario, this rise in sea level is projected to be in the range of 5–14 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.

Table 2: Sea-level rise projections for Kiribati for three emissions scenarios and three time periods. Values represent 90% of the range of the models and changes are relative to the average of the period 1980-1999.

	2030 (cm)	2055 (cm)	2090 (cm)
Low emissions scenario	4–13	9–25	16–45
Medium emissions scenario	5–14	10–29	19–57
High emissions scenario	5–14	10–28	20–58

Ocean acidification will continue

Under all three emissions scenarios (low, medium and high) the acidity level of sea waters in the Kiribati region will continue to increase over the 21st century, with the greatest change under the 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.

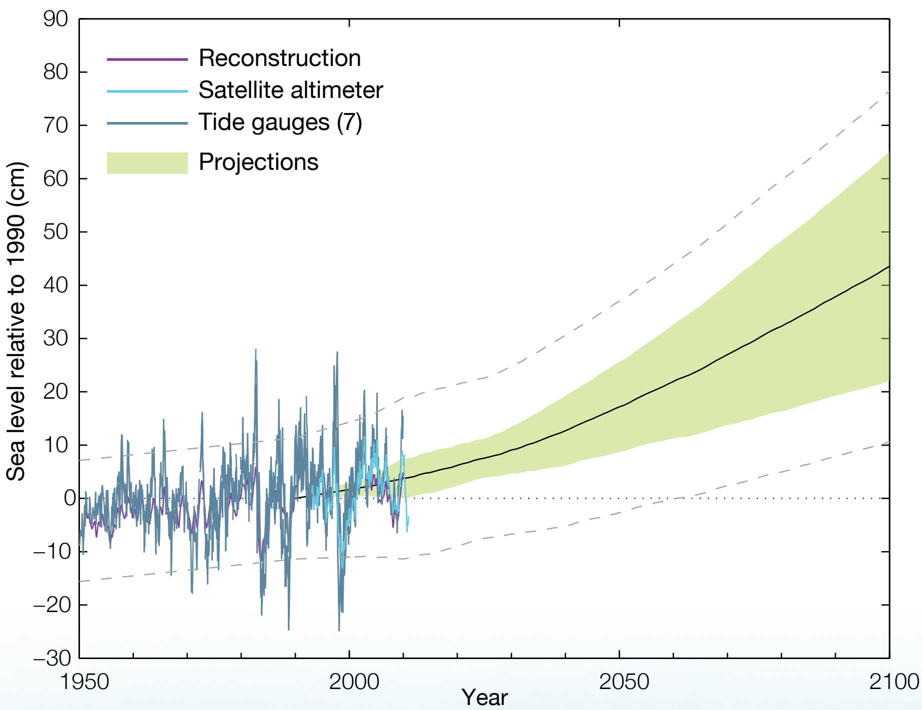


Figure 6: Observed and projected relative sea-level change in Kiribati. The observed sea-level records are indicated in dark blue (relative tide-gauge observations) and light blue (the satellite record since 1993). Reconstructed estimates of sea level near Kiribati (since 1950) are shown in purple. The projections for the A1B (medium) emissions scenario (representing 90% of the range of models) are shown by the shaded green region from 1990 to 2100. The dashed lines are an estimate of 90% of the range of natural year-to-year variability in sea level.

Changes in Kiribati's climate

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

> Annual and wet season rainfall has increased at Kiritimati since 1951. At Tarawa, there have been no clear trends in rainfall over this period. Rainfall is generally projected to increase over this century with more extreme rainfall days and less droughts.

> 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.

The content of this brochure is the result of a collaborative effort between the Kiribati Meteorology Service and the Pacific Climate Change Science Program – a component of the Australian Government's International Climate Change Adaptation Initiative. This information and research conducted by the Pacific Climate Change Science Program builds on the findings of the 2007 IPCC Fourth Assessment Report. For more detailed information on the climate of Kiribati and the Pacific see: *Climate Change in the Pacific: Scientific Assessment and New Research. Volume 1: Regional Overview. Volume 2: Country Reports.* Available from November 2011.

www.pacificclimatechangescience.org

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