12 Solomon Islands

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12.1 Summary

12.1.1 Climate

- Changes in air temperature from season to season are relatively small and strongly linked to changes in the surrounding ocean temperature. The Solomon Islands have two distinct seasons – a warm wet season from November to April and a cooler dry season from May to October.
- The seasonal cycle of rainfall is affected by the South Pacific Convergence Zone (SPCZ) and the West Pacific Monsoon (WPM) during the wet season months, with additional influence from the Intertropical Convergence Zone (ITCZ) over the northern islands throughout the year.
- Annual and seasonal air temperatures at Honiara increased over the period 1951–2020. The number of cold nights has decreased.
- Annual maximum daily rainfall has increased at Honiara and Munda (New Georgia). Conversely, the number of rainy days each year has decreased at Honiara.
- Tropical cyclones usually affect the Solomon Islands between November and April. Over the period 1969–2018, an average of 28 cyclones passed within the Solomon Islands exclusive economic zone (EEZ) per decade. Tropical cyclones were most frequent in El Niño years and least frequent in La Niña years. Year-to-year variability is large, ranging from no tropical cyclones in some seasons to eight in 1997/98.
- There has been little change in the total number of tropical cyclones in the Southwest Pacific since 1981/82. The number of severe tropical cyclones has declined over the same period/region.

12.1.2 Ocean

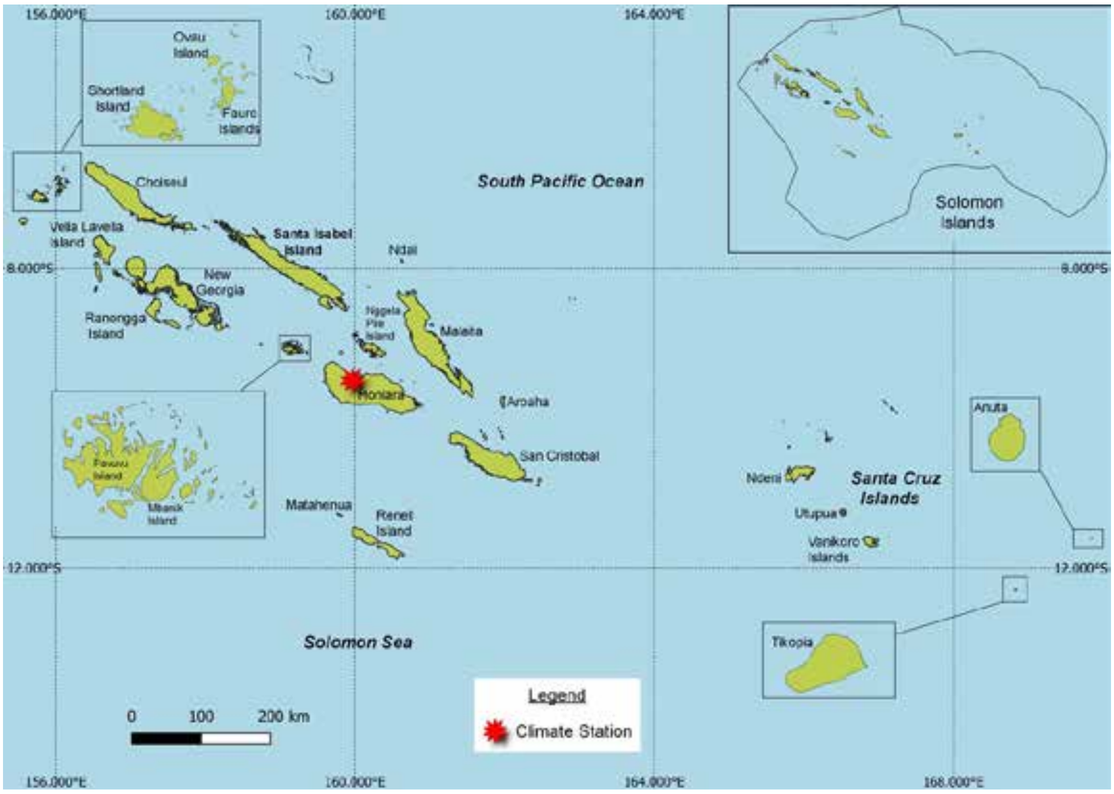
- Highest sea levels typically occur in the months November–January and March/April.
- Sea-level rise within the EEZ, measured by satellite altimeters from 1993 to mid-2020, ranges from about 3.5 and 5.5 mm per year.
- Monthly average ocean temperature, as measured by the Honiara tide-gauge, ranges from 28.7 °C in August to approximately 30 °C in the months December/January and again in April, exhibiting a bimodal peak. Monthly temperatures in any given year can be ±2 °C of these averages.
- The sea surface temperature (SST) trend in the EEZ is 0.26 °C per decade from 1981 to 2021.
- Dominant wave direction is from 17° (NNE), with an average significant wave height of 0.11 m and average wave period of 9.86 s.
- Severe wave height was defined as 1.00 m, with an average of 1.7 severe events every two years.
- Peak average significant wave height occurs in January–March, with associated high wave periods driven by swell from the north.

12.2 Country description

The Solomon Islands are located in the tropical South Pacific Ocean between latitudes 5°S and 13°S, and longitudes 155°E and 169°E (Figure 12.1). The nation consists of six major islands and over 900 smaller islands. The Solomon Islands have a total land area of 28,896 km^2 and an EEZ of 1.6 million km^2. The archipelago includes Choiseul, the Shortland Islands, the New Georgia Islands, Santa Isabel, the Russell Islands, the Florida Islands, Tulagi, Malaita, Maramasike, Ulawa, Owaraha (Santa Ana), Makira (San Cristobal) and the main island of Guadalcanal. The highest elevation is 2330 m, at Mt Popomanaseu.

The population is approximately 653,000. About 24% live on Guadalcanal, which includes the capital Honiara. Guadalcanal is the second-most populous island in the country after Malaita (approximately 25%).

Figure 12.1:
Solomon Islands and the location of the climate station used in this report



12.3 Data

Daily historical rainfall and air temperature records for a Honiara–Henderson Airport composite and Munda (New Georgia) from 1951 were obtained from the Solomon Islands Meteorological Service. These records have undergone data quality and homogeneity assessment. Where the maximum or minimum air temperature records were found to have discontinuities, these records have been adjusted to make them homogeneous (further information is provided in Chapter 1). Additional information on historical climate trends for the Solomon Islands can be found in the Pacific Climate Change Data Portal http://www.bom.gov.au/climate/pccsp.

Tropical cyclone data and historical tracks starting from the 1969/70 season are available from the SHTC Data Portal http://www.bom.gov.au/cyclone/history/tracks/index.shtml.

SST covering the EEZ was obtained via the daily Optimum Interpolation SST version 2.1 (OISST v2.1) dataset from NOAA (Reynolds et al. 2007; Banzon et al. 2016). In situ ocean temperature data were obtained from the PSLGM Project tide-gauge located at Honiara, with data spanning from 1994 to 2021.

Wave data were obtained from the PACCSAP wave hindcast (Smith et al. 2021), available hourly from 1979 to 2021, with a grid resolution near the Solomon Islands of 7 km.

Regional sea level data were obtained from CSIRO satellite altimetry (updated by Benoit Legresy, Church and White 2011), with correction for seasonal signals, inverse barometer effect and glacial isostatic adjustment. Tide-gauge data were sourced from the Honiara tide-gauge station, spanning from 1994 to 2021 at hourly intervals.

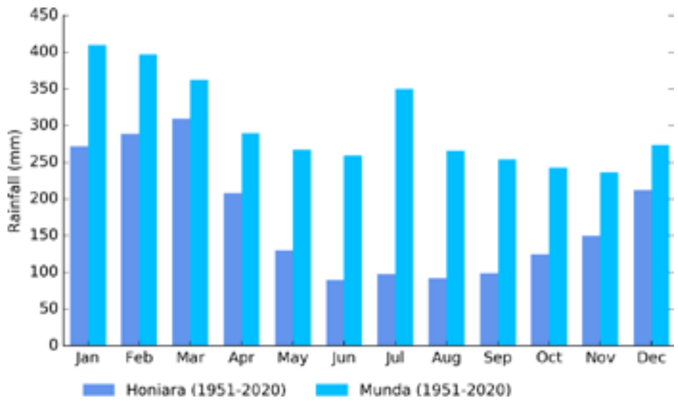
12.4 Rainfall

12.4.1 Seasonal cycle

Rainfall in the Solomon Islands is strongly affected by the SPCZ. The SPCZ contributes to the high rainfall during the wet season from December to April at both Honiara and Munda. The wet season at Honiara is more pronounced than at Munda, with 69% of the annual rainfall during this time and a peak in March of 310 mm on average (Figure 12.2). The highest rainfall months at Honiara are during January–March when the WPM is most active in the region. This feeds moisture into the SPCZ, which is strongest in the wet season.

Munda has a more even distribution of rainfall during the year, with the wettest months being January–March and a second peak in rainfall in July. Located closer to the western Warm Pool and the normal location of the SPCZ, Munda averages between 410 mm of rainfall in January and 260 mm in June.

Figure 12.2:
Mean annual rainfall at Honiara and Munda



12.4.2 Trends

Trends in annual and seasonal rainfall are not statistically significant at Honiara and Munda (Figure 12.3, Table 12.1). Trends indicate little change in annual and seasonal rainfall at these sites. However, the number of wet days has been decreasing at Honiara. Annual rainfall varies from approximately 1300 to 3000 mm at Honiara and from approximately 2600 to 4400 mm at Munda.

Figure 12.3:
Annual rainfall (bar graph) and number of wet days (where rainfall is at least 1 mm; line graph) at Honiara (left) and Munda (right). Straight lines indicate linear trends for annual rainfall (in black) and number of wet days (in blue). The magnitudes of the trends are presented in Table 12.1. Diamonds indicate years with insufficient data for one or both variables.

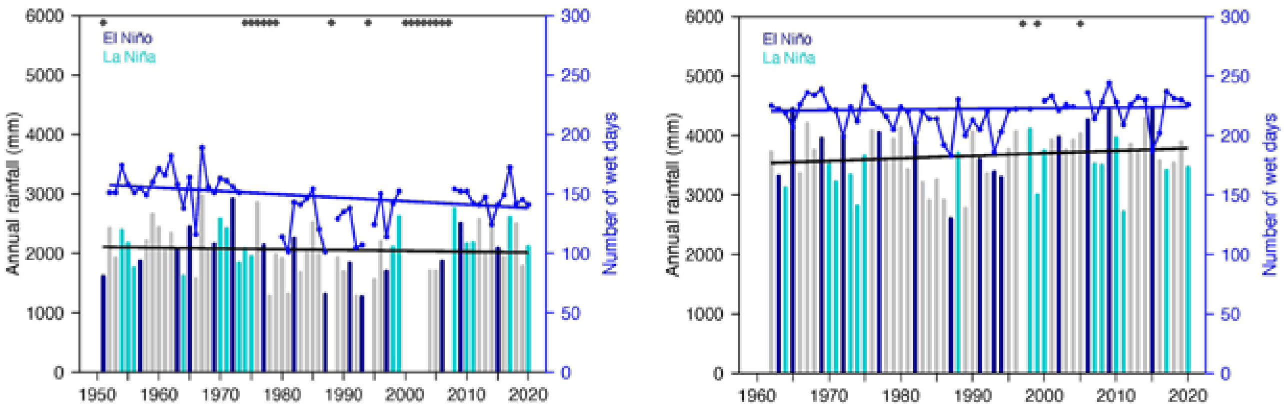
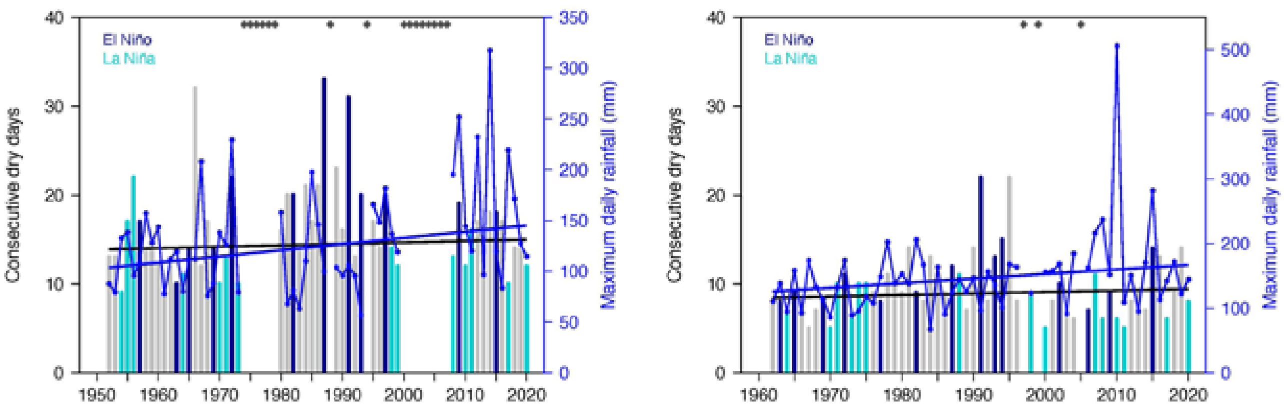


Table 12.1:
Trends in annual, seasonal and extreme rainfall at Honiara (left) and Munda (right). The 95% confidence intervals are shown in parentheses, and trends significant at the 95% level are shown in bold. The contribution to total rainfall from extreme events and the standardised rainfall evapotranspiration index are measured relative to 1961–1990 (see Chapter 1 for details). The standardised rainfall evapotranspiration index is not available for Munda due to the lack of daily temperature observations at this site.

	Honiara	Munda
	1951–2020	1962–2020
Annual rainfall (mm/decade)	-13.59 (-78.68, +38.86)	+42.63 (-44.52, +114.27)
November–April (mm/decade)	+0.72 (-46.92, +56.00)	+14.79 (-49.29, +73.05)
May–October (mm/decade)	-11.03 (-32.39, +12.25)	+29.69 (-31.02, +86.96)
Number of wet days (days/decade)	**-2.82** (-5.37, 0.49)	+0.59 (-2.42, +3.2)
Contribution to total rainfall from extreme events (%/decade)	+0.72 (-0.56, +2.08)	+1.42 (-0.04, +2.57)
Consecutive dry days (days/decade)	+0.17 (-0.22, +0.79)	+0.18 (-0.43, +0.77)
Maximum one-day rainfall (mm/decade)	**+6.08** (0.00, +12.16)	**+7.08** (+1.17, +13.13)
Standardised rainfall evapotranspiration index (November–April)	-0.03 (-0.15, +0.11)	-
Standardised rainfall evapotranspiration index (May–October)	-0.08 (-0.20, +0.05)	-

There has been a significant increase in maximum daily rainfall at Honiara and Munda (Table 12.1, Figure 12.4). The longest run of days without any rain has not been changing and rarely exceeds three weeks at Honiara and two weeks at Munda (Figure 12.4). At Honiara, variability associated with ENSO is evident, with El Niño years generally experiencing longer dry spells. In 2010, a maximum daily rainfall of over 500 mm at Munda was associated with a tropical depression that brought heavy flooding to several islands.

Figure 12.4:
Annual longest run of consecutive dry days (bar graph) and maximum daily rainfall (line graph) at Honiara (left) and Munda (right). Straight lines indicate linear trends for dry days (in black) and maximum daily rainfall (in blue). The magnitudes of the trends are presented in Table 12.1. Diamonds indicate years with insufficient data for one or both variables.



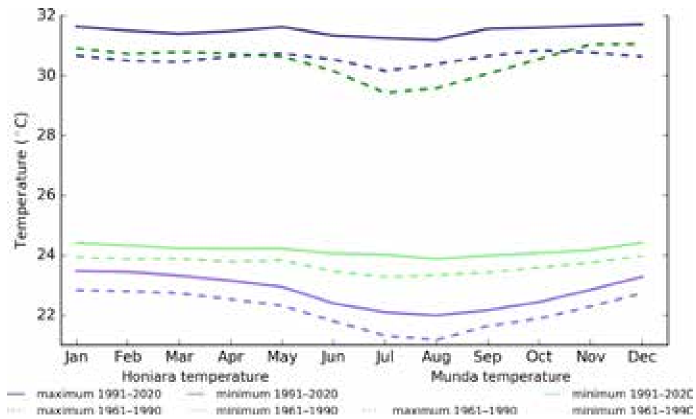
12.5 Air temperature

12.5.1 Seasonal cycle

Air temperatures throughout the year show only small seasonal variations (Figure 12.5) as they are strongly linked to the surrounding ocean temperatures. The most significant variation in air temperatures is in July and August, when cooler air blows in from the south. This change is most evident in the average minimum temperatures at Munda, which has a minimum temperature range of 1.6 °C for the 1961–1990 climatology period. Honiara has a maximum and minimum temperature range of less than 1 °C.

Both Honiara and Munda display a clear warming of average minimum temperatures between the 1991–2020 climatology period and the 1961–1990 period for all months throughout the year. Honiara also warms across all months for maximum temperature (maximum temperature data for Munda for the 1991–2020 period is not available).

Figure 12.5:
Maximum and minimum air temperature seasonal cycle for Honiara (purple) and Munda (green), and for the periods 1961–1990 (dotted lines) and 1991–2020 (solid lines)



12.5.2 Trends

Average annual and seasonal temperatures have increased significantly at Honiara (Figure 12.6, Table 12.2). The relatively small year-to-year fluctuations in temperature can be attributed to Honiara's tropical location.

Figure 12.6:
Average annual, November–April and May–October temperatures for Honiara. Straight line indicates linear trend. The magnitudes of the trends are presented in Table 12.2. Diamonds indicate years with insufficient data for one or more variables.

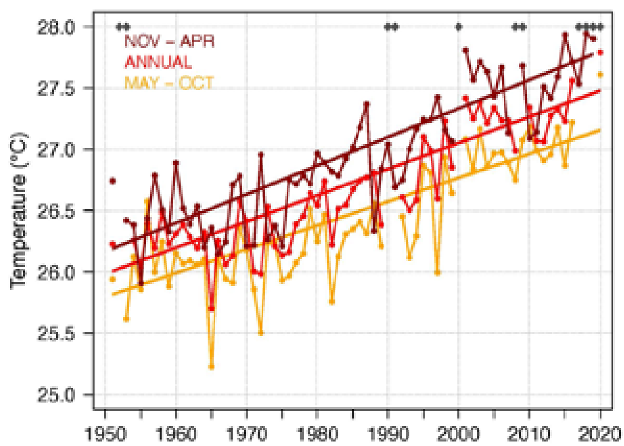
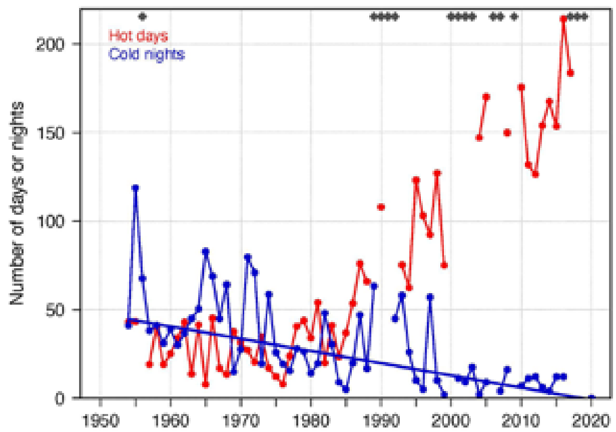


Table 12.2:
Trends in annual and seasonal air temperatures at Honiara. The 95% confidence intervals are shown in parentheses, and trends significant at the 95% level are shown in bold.

	Honiara Tmax (°C/decade)	Honiara Tmin (°C/decade)	Honiara Tmean (°C/decade)
		1951–2020	
Annual	**+0.23** (+0.17, +0.28)	**+0.19** (+0.14, +0.24)	**+0.21** (+0.17, +0.25)
November–April	**+0.26** (+0.19, +0.31)	**+0.20** (+0.15, +0.27)	**+0.23** (+0.19, +0.27)
May–October	**+0.22** (+0.16, +0.27)	**+0.18** (+0.13, +0.22)	**+0.19** (+0.16, +0.23)

Numerous gaps exist in the daily temperature record at Honiara, which prevents the robust calculation of trends in many temperature extremes. Despite this, the number of cold nights has decreased significantly and available data suggest Honiara now experiences more than three times as many hot days compared to the 1950s (Figure 12.7). However, it is possible that some of this warming trend is due to increased urban density at Honiara or unresolved data homogeneity issues in the Honiara–Henderson Airport composite.

Figure 12.7:
Annual number of hot days and cold nights at Honiara. The straight line indicates the linear trend. Criteria for statistical robustness were not met for determining a linear trend for hot days. Diamonds indicate years with insufficient data for one or both variables.



12.6 Tropical cyclones

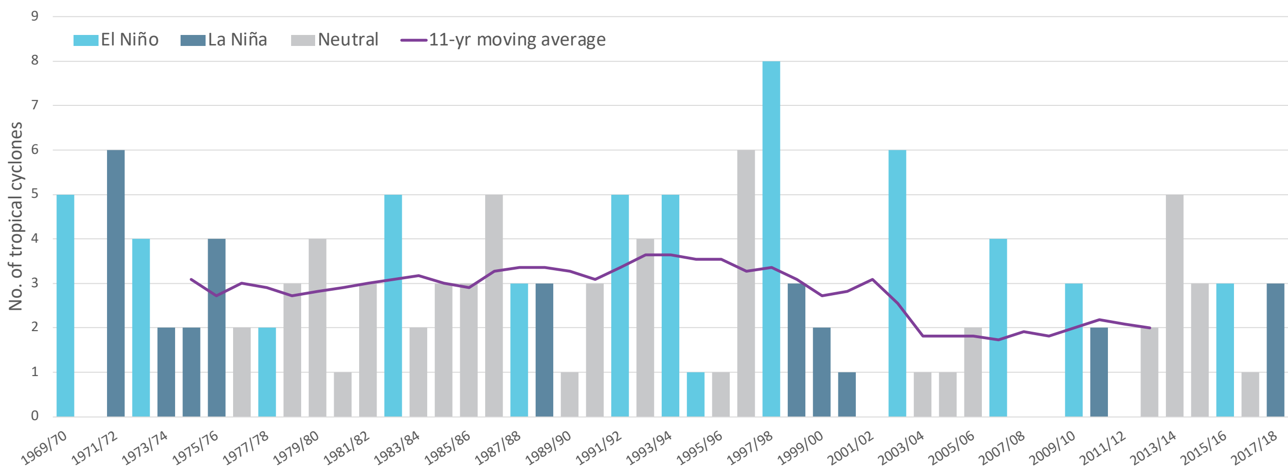
16.6.1 Seasonal cycle

Tropical cyclones usually affect Solomon Islands during the southern hemisphere tropical cyclone season, which is from November to April, but also occasionally occur outside the tropical cyclone season. The Southern Hemisphere Tropical Cyclone Archive indicates that between the 1969/70 and 2017/18 seasons, 138 tropical cyclones (Figure 12.8) passed within the EEZ. This represents an average of 28 cyclones per decade. Tropical cyclones were most frequent in El Niño years (42 cyclones per decade), followed by neutral years (25 cyclones per decade) and least frequent in La Niña years (20 cyclones per decade).

Interannual variability in the number of tropical cyclones in the EEZ is large, ranging from zero in some seasons to eight in 1997/98 and six in 1971/72, 1996/97 and 2002/03 (Figure 12.8). High interannual variability and the small number of tropical cyclones occurring in the EEZ make reliable identification of long-term trends in frequency and intensity difficult.

Some tropical cyclone tracks analysed in this section include the tropical depression stage (sustained winds ≤34 knots) before and/or after tropical cyclone formation.

Figure 12.8:
Number of tropical cyclones passing within the Solomon Islands EEZ per season. Each season is defined by the ENSO status, with light blue being an El Niño year, dark blue a La Niña year and grey showing a neutral ENSO year. The 11-year moving average is presented as a purple line and considers all years.



12.6.2 Trends

Trends in total number of tropical cyclones (<995 hPa) and severe tropical cyclones (<970 hPa) are presented for the period 1981/82–2020/21 for the greater Southwest Pacific (135°E–120°W; 0–50°S). Trends are presented at a regional scale as the number of tropical cyclones occurring within Pacific Island EEZs is insufficient for reliable long-term trend analysis.

For the total number of tropical cyclones, the trend (and 95% confidence interval) is -0.92 (-1.85, 0.01) tropical cyclones/ decade. There has been little change/marginal decline in the total number of tropical cyclones over the last 40 seasons. This trend is not statistically significant.

For the total number of severe tropical cyclones, the trend is -0.80 (-1.32, -0.29) tropical cyclones/decade. There is a negative trend in the number of severe tropical cyclones over the last 40 seasons. There has been little change/marginal decline in the proportion of tropical cyclones reaching severe status. The trend is -0.04(-0.08, 0.00) tropical cyclones/decade. The negative trend is statistically significant.

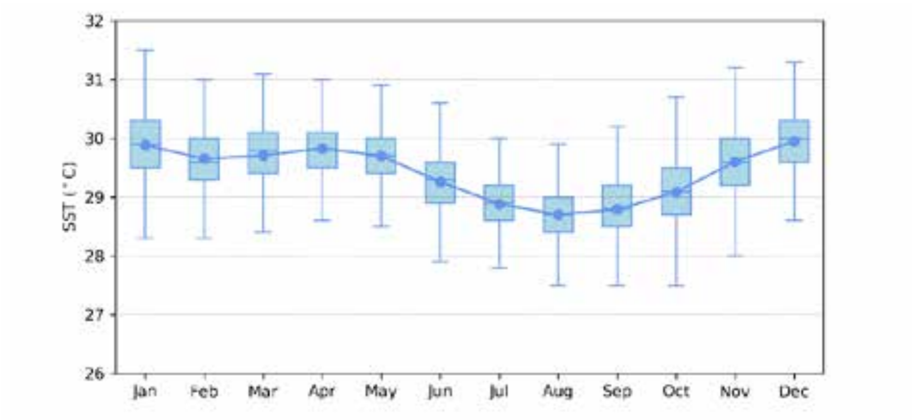
Records of tropical cyclones exist from the late 1800s in some countries in the Southwest Pacific, but trends in tropical cyclones have only been presented from 1981/82. Satellite-based observations began in the Southwest Pacific in the early 1970s, but consistent coverage and reliable intensity estimates have only been available since the early 1980s. Confidence in tropical cyclone trends is moderate as the definition of a tropical cyclone has changed and satellite observation methods have continued to improve over the last 40 years.

12.7 Sea surface temperature

12.7.1 Seasonal cycle

Ocean temperature, as measured by the Honiara tide-gauge from 1994 to 2021, reaches on average a maximum of almost 30 °C in December/January and again in April, exhibiting a unique bimodal peak during the wet season (Figure 12.9). However, maximum temperatures in individual months can get as high as 31.5 °C in January. Minimum average temperature is 28.7 °C in August. Temperatures can be up to 2 °C higher or lower than these averages, although 50% of observations fall within 1 °C of the average.

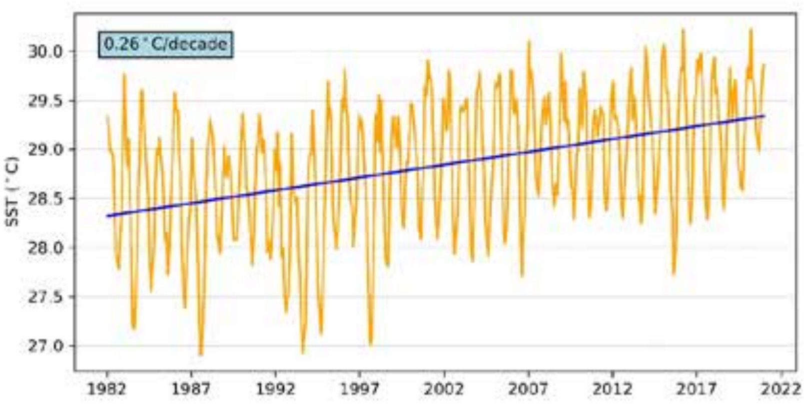
Figure 12.9:
Annual temperatures measured at the Honiara tide-gauge. Blue dots show the monthly average, and shaded boxes show the middle 50% of observations. Lines show the top and bottom 25% of observations.



12.7.2 Trends

Figure 12.10 shows the 1981–2021 SST from satellite observations averaged over the EEZ. The data show a trend of 0.26 °C per decade, with a 95% confidence interval of ±0.05 °C.

Figure 12.10:
Sea surface temperature from satellite observations averaged across the Solomon Islands EEZ, shown as the orange line. The blue line shows the linear regression trend.



12.8 Sea level

12.8.1 Seasonal cycle

Honiara experiences a mixed tidal cycle, meaning it can be both diurnal and semidiurnal depending on the time of month. Sometimes there are two high and two low tides a day, and sometimes there is only one high and one low tide per day. The highest predicted tides of the year typically occur during the wet season months of November–January and also April/May. Figure 12.11 shows the number of hours the 99th percentile (1.27 m) sea level threshold is exceeded per month across the entire sea level record at Honiara. Blue shading indicates the number of hours, and the final row provides a summary of all the years. Peak sea levels typically occur in November to January and March/April.

Figure 12.11: Number of hours exceeding 99th percentile sea level threshold per month from 1994 to 2021 at the Honiara tide-gauge. Blue shading indicates the number of hours, and the final row provides a percentage summary of all the years.

Number of hours exceeding 1.27 m (Honiara, Solomon Islands)

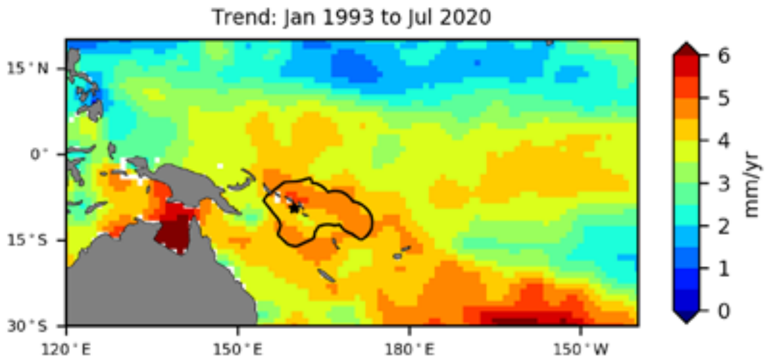
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1994	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	1	0	0	0	0	0	0	0	0	1
2002	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	4	5	0	0	0	0	0	0	0	0	9
2007	0	0	0	0	0	0	0	0	0	0	18	8	26
2008	0	0	15	15	11	0	0	0	0	0	0	1	42
2009	2	0	5	2	0	0	0	0	0	0	0	0	9
2010	0	0	0	0	0	0	0	0	0	0	0	6	6
2011	0	0	0	0	0	0	0	0	0	0	0	6	6
2012	0	2	9	0	0	0	0	0	0	0	0	0	11
2013	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	1	1	0	0	0	0	0	0	0	0	2
2018	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	3	0	0	0	0	0	0	0	6	9
2021	25	0	0	12	1	0	0	0	0	0	17	35	90
Monthly Totals (%)	13	1	16	18	6	0	0	0	0	0	17	29	

12.8.2 Trends

Sea level within the EEZ, measured by satellite altimeters (Figure 12.12) since 1993, has risen between 3.5 and 5.5 mm per year, with a confidence interval of up to ±1.2 mm across the islands. This rise is partly linked to a pattern related to climate variability from year to year and decade to decade. Although these trend estimates are larger than the global average of 3.1 ± 0.4 mm per year (von Schuckmann et al. 2021), the high uncertainty estimate means the trend could be as low as 2.3 mm/year or as high as 6.7 mm/year.

Trend estimates at the Honiara tide-gauge over a shorter time span than the altimetry observations (July 1994 to July 2020) are provided in the PSLGM Monthly Data Report for July 2020 (http://www.bom.gov.au/ntc/IDO60101/IDO60101.202007.pdf). For Honiara, the trend is reported as 3.7 mm per year, which is similar to the altimetry trends seen near Honiara (3.5 to 4.0 mm/year) shown in Figure 12.12 (tide-gauge indicated by star symbol).

Figure 12.12:
Satellite altimetry annual trend for the Pacific from 1993 to 2020, with the Solomon Islands EEZ highlighted. The star symbol indicates the location of the tide-gauge at Honiara.



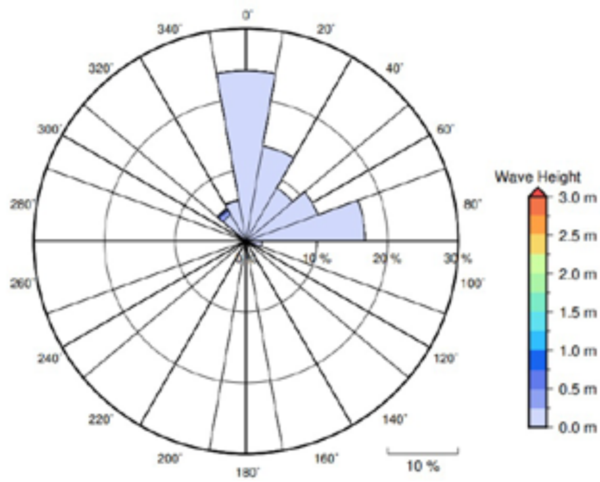
12.9 Waves

12.9.1 Seasonal cycle

The average wave climate in Honiara is defined by the significant wave height, peak period and peak direction. The significant wave height is the mean wave height (from trough to crest) of the highest one third of waves and corresponds to the wave height that would be reported by an experienced observer. Peak period is the time interval between two waves of the dominant wave period. Peak direction is the direction from which the dominant waves are coming.

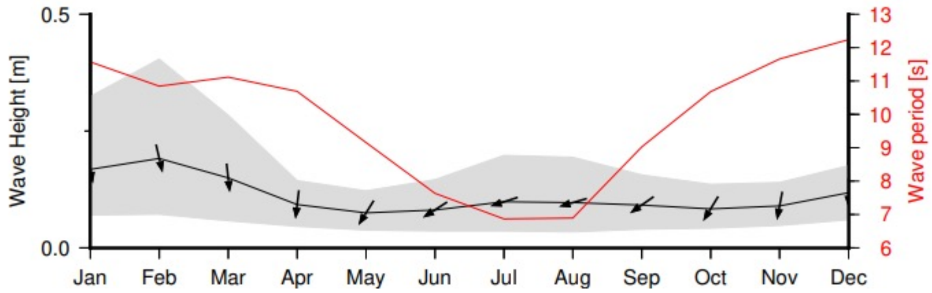
The average sea state is dominated by wind seas from the northeast. The annual mean wave height is 0.11 m, the annual mean wave direction is 17° and the annual mean wave period is 9.86 s. In the Pacific, waves often come from multiple directions and for different periods at a time. In Honiara, there are often more than one different wave direction/period components coming from the southeast to southwest (Figure 12.13).

Figure 12.13:
Annual wave rose for Honiara. Note that direction is where the wave is coming from.



The significant wave height peaks around February, with the period also highest between October and April, but is significantly less in July/August (Figure 12.14) This shows that waves at Solomon Islands are predominantly driven by easterly local winds from June to September, which changes to a dominant northerly swell over the remainder of the year.

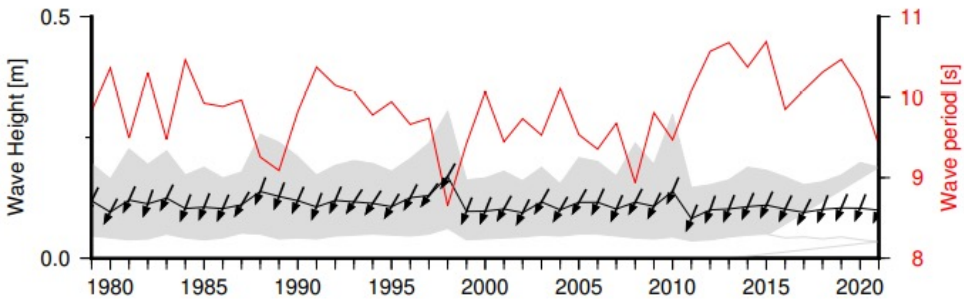
Figure 12.14:
Monthly wave height (black line), wave period (red line) and wave direction (arrows). The grey area represents the range of wave height between calm periods (10% of lowest wave height) and large wave events (10% of highest wave height).



12.9.2 Trends

Waves change from month to month with the seasons, but they also change from year to year with climate oscillations. Typically, these changes are smaller than the seasonal changes but can be important during phenomena such as ENSO. In Honiara, the mean annual wave height has remained unchanged since 1979 (Figure 12.15). The mean annual wave height in Honiara is not significantly correlated with the main climate indicators of the region.

Figure 12.15.
Annual wave height (black line), wave period (red line) and wave direction (arrows). The grey area represents the range of wave height between calm periods (10% of lowest wave height) and large wave events (10% of highest wave height).



12.9.3 Extreme waves

Extreme wave analysis completed for Honiara was done by defining a severe height threshold and fitting a generalized Pareto distribution (GPD). The optimum threshold selected was 1.00 m. In the 42-year wave hindcast, 35 wave events reached or exceeded this threshold, averaging 1.7 events every two years. The GPD was fitted to the largest wave height reached during each of these events (Figure 12.16, Table 12.4). Extreme wave analysis is a very useful tool but is not always accurate because the analysis is very sensitive to the data available, the type of distribution fitted and the threshold used. For example, this analysis does not accurately account for tropical cyclone waves. More in-depth analysis is required to obtain results appropriate for designing coastal infrastructure and coastal hazard planning.

Figure 12.16:
Extreme wave distribution for Honiara. The crosses represent the wave events that have occurred since 1979. The solid line is the statistical distribution that best fits past wave events. The dashed lines show the upper and lower confidence limits of the fit. There is a 95% chance that the fitted distribution lies between the two dashed lines. Note that the annual return interval is in logarithmic scale.

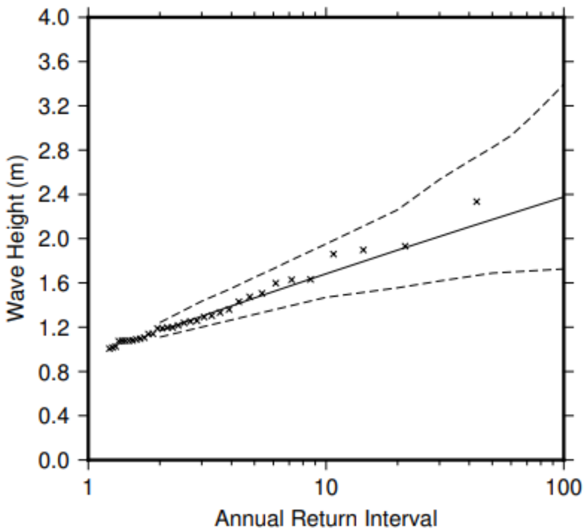


Table 12.4:
Summary of the results from extreme wave analysis in Honiara

Large wave height (90th percentile)	0.19 m
Severe wave height (99th percentile)	0.56 m
1-year ARI wave height	1.0 m
10-year ARI wave height	1.68 m
20-year ARI wave height	1.90 m
50-year ARI wave height	2.17 m
100-year ARI wave height	2.38 m