

The Island Climate Update

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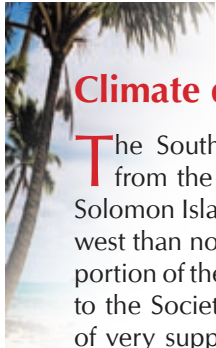
December's climate

- South Pacific Convergence Zone (SPCZ) extends from Papua New Guinea toward Fiji, and from Samoa to the Society Islands
- Tropical cyclone Daman (Category 4) brings high rainfall and winds to parts of northern Fiji; initial damage costs exceed US\$0.4 million
- Suppressed convection intensifies over Kiribati, and spreads west, bringing low rainfall
- Above average temperatures in Western Kiribati, New Caledonia and Tonga; below average temperatures in the Southern Cook Islands and parts of Southern French Polynesia

El Niño/Southern Oscillation (ENSO) and seasonal rainfall forecasts

- A moderate to strong La Niña episode is now in progress across the entire equatorial Pacific, and the event is expected to persist into the Southern Hemisphere autumn
- A large area of suppressed convection and below average rainfall is very likely along the equatorial Pacific from Western to Eastern Kiribati, including the Solomon Islands, Tuvalu, Tokelau, Northern Cooks, and the Marquesas Islands
- Enhanced convection is likely to continue along a southwest displaced SPCZ with above average rainfall from Vanuatu to Pitcairn Island, including New Caledonia, Fiji, Wallis & Futuna, Tonga, Niue, and the Southern Cook Islands





Climate developments in December 2007

The South Pacific Convergence Zone (SPCZ) extended from the monsoon trough over Papua New Guinea, the Solomon Islands, and toward Fiji, displaced further south and west than normal for the time of year in that region. Another portion of the SPCZ extended from the region north of Samoa to the Society Islands and further southeast. A large region of very suppressed convection persisted along the equator, extending much further west than in November, affecting the region north of Papua New Guinea, Nauru, Kiribati, and the regions further east (both north and south of the Equator) including the Northern Cook Islands.

Rainfall was well above average in parts of Fiji (especially in the north; Udu Point recording 630 mm) and the Society Islands, as well as Norfolk Island in the North Tasman Sea, and the north of New Zealand. Heavy rainfall, exceeding 100 mm, occurred at Rotuma, Fiji, with the passage of tropical cyclone Daman early in the month. Rainfall was also above average over much of Samoa and New Caledonia.

In contrast December rainfall was 25% or less of normal over much of Kiribati, and the parts of the Cook Islands.

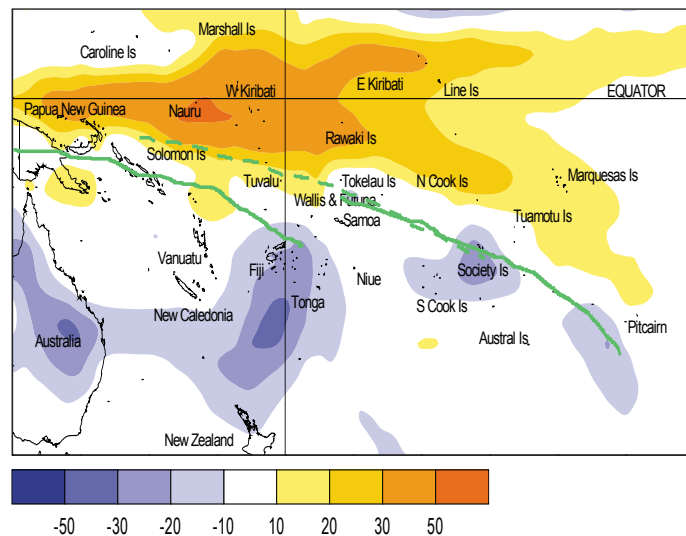
Rainfall has been below average for each of the past 7 months in Kiribati, and above average for each of the past 4 months in Fiji.

Country	Location	Rainfall (mm)	% of avg	Comments
Cook Islands	Penrhyn	31	10	Extremely low
Fiji	Nadi Airport	335	188	Well above normal
Fiji	Udu Point	630	239	Record high
New Zealand	Whangarei	175	192	Well above normal
Australia	Norfolk Island	306	373	Extremely high

December mean air temperatures were about 1.0 °C below normal in the Southern Cook Islands and parts of southern French Polynesia, and 0.5°C or more above normal in Western Kiribati, New Caledonia, and Tonga.

Tropical Southwest Pacific mean sea-level pressures were below average over New Caledonia and Papua New Guinea. Higher than normal pressures occurred southeast of New Zealand toward the region south of the Cook Islands, and over all of French Polynesia.

Equatorial surface easterlies remained persistent at Tarawa, occurring in almost all observations.



Outgoing Long-wave Radiation (OLR) anomalies, in Wm^2 are represented by hatched areas. High radiation levels (yellow) are typically associated with clearer skies and lower rainfall, while cloudy conditions lower the OLR (blue) and typically mean higher rainfalls. The December 2007 position of the South Pacific Convergence Zone (SPCZ), as identified from total rainfall, is indicated by the solid green line. The average position of the SPCZ is identified by the dashed green line.

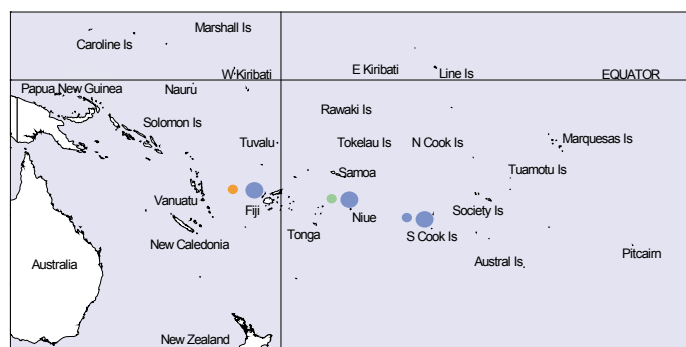
Soil moisture in December 2007

Estimates of soil moisture shown in the map (right) are based on monthly rainfall for one station in each country. Currently there are not many sites in the water balance model, but it is planned to include more stations in the future.

The information displayed is based on a simple water balance technique to determine soil moisture levels. Addition of moisture to the available water already in the soil comes from rainfall, with losses via evapotranspiration. Monthly rainfall and evapotranspiration are used to determine the soil moisture level and its changes.

Please note that these soil moisture calculations were made at the end of the month, and for practical purposes, generalisations were made about the available water capacity of the soils at each site.

Soils continued to be moist (at field capacity) for the time of year at Nadi (Fiji), Hanan Airport (Niue), and Rarotonga (Cook Islands).



December 2007 December 2006

- Wet
- Moderate
- Dry

Estimated soil moisture conditions at the end of December 2007, using monthly rainfall data.

El Niño/Southern Oscillation (ENSO)

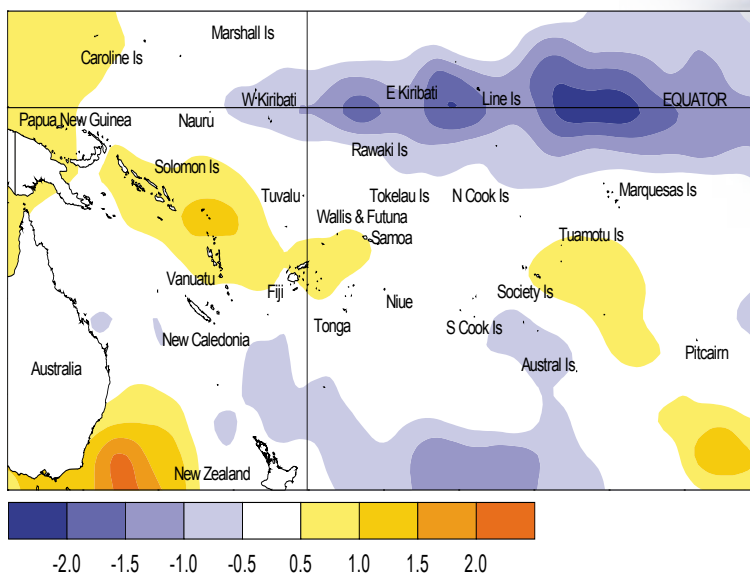
During December La Niña conditions strengthened into a moderate – strong event. La Niña conditions spread into the western tropical Pacific. The Southern Oscillation Index (SOI) continued its strong movement upwards, indicating a further strengthening of the ocean-atmosphere coupling.

Below normal sea surface temperature (SST) anomalies stabilised across the tropical Pacific from South America to west of the Date Line during December, while a warm “horseshoe” continues in the extratropics of both hemispheres. The NINO3 anomaly was $-1.3\text{ }^{\circ}\text{C}$ for December (OND average $-1.4\text{ }^{\circ}\text{C}$), while NINO4 strengthened to $-0.9\text{ }^{\circ}\text{C}$ (OND average $-0.7\text{ }^{\circ}\text{C}$). The subsurface temperature anomalies have strengthened again: the largest anomalies near 100m depth over $120\text{-}100^{\circ}\text{W}$ during December were about $-4\text{ }^{\circ}\text{C}$ ($-2\text{ }^{\circ}\text{C}$ in November).

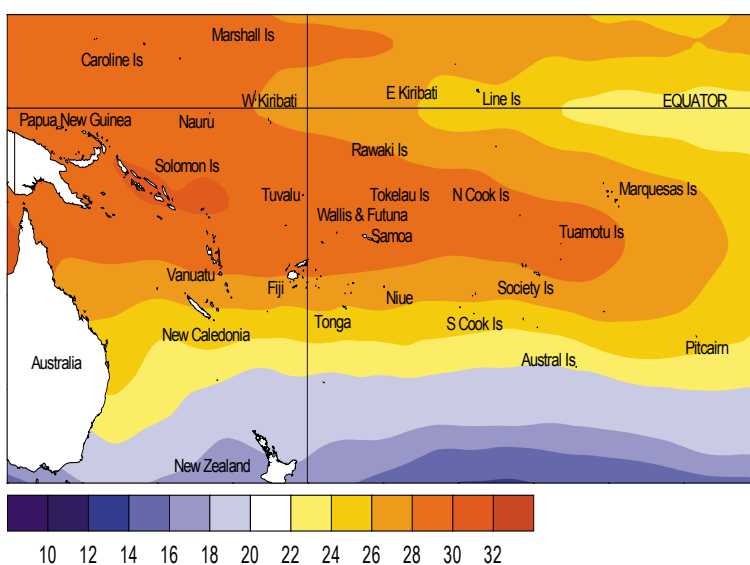
The easterly trade winds were also strong and persistent during December over a wide longitude band, and spread west of the Date Line. The SOI was $+1.4$ for December ($+1.1$ November), with the OND average of $+1.0$.

Tropical OLR anomalies show suppressed convection in the equatorial region from west of the Date Line (140°E) eastwards. Enhanced convection occurred over Indonesia and parts of northern Australia, and the South Pacific Convergence Zone is prominent between New Caledonia and Tonga. The TRMM-based ENSO precipitation index was -1.35 in December, well into the moderate range. The Madden-Julian Oscillation has displayed a fairly regular periodicity of 40-50 days in recent months, and the current active phase has initiated monsoon development over northern Australia, which should spread into the Pacific in early January, then dissipate.

All models now clearly indicate La Niña conditions. Most models indicate La Niña conditions continuing through the southern summer and autumn, before easing to neutral conditions in winter 2008. The NCEP synopsis (of 6 December) indicates La Niña



Sea surface temperature anomalies ($^{\circ}\text{C}$) for December 2007



Mean sea surface temperatures ($^{\circ}\text{C}$) for December 2007

has reached moderate strength (Niño3.4 index below -1.0°C), and likely to continue into the austral autumn. The IRI synthesis shows that moderately strong La Niña conditions exist presently, with more than a 97% probability of La Niña conditions through the next three months.

Forecast validation: October to December 2007

A La Niña-like pattern, with a large region of enhanced convection and above average rainfall, was expected from the Solomon Islands southeast to Niue, including Vanuatu, New Caledonia, Fiji, Tonga, and Samoa, with average or above average rainfall in Papua New Guinea, the Southern Cook Islands, and the Society and Austral Islands. Suppressed convection with below average rainfall was expected over Kiribati, with average or below average rainfall in Tuvalu, Tokelau, and the Northern Cook Islands. Rainfall was lower than expected in the Marquesas Islands.

The rainfall outlook for the October – December 2007 period was very similar to what was forecast, the ‘hit’ rate being 77%.

Tropical Pacific rainfall – December 2007

Territory and station name	December 2007 rainfall total (mm)	December 2007 percent of average
Australia		
Cairns Airport	321.2	175
Townsville Airport	137.6	105
Brisbane Airport	36.2	29
Sydney Airport	74.8	98
Cook Islands		
Penrhyn	31.2	10
Aitutaki		
Rarotonga Airport	228.9	122
Rarotonga EWS	211.2	112
Fiji		
Rotuma Island	236.4	83
Udu Point	629.7	239
Nadi Airport	310.6	174
Nausori	279.9	105
French Polynesia		
Hiva Hoa, Atuona	49.2	49
Bora Bora	464.6	171
Tahiti – Faa'a	439.8	124
Tuamotu, Takaroa	200.6	92
Gambier, Rikitea	257.4	124
Tubuai	91.0	50
Rapa	114.2	54
Kiribati		
Tarawa*	6.0	3
Kanton*	0.4	0
New Zealand		
Kaitia	159.7	165
Whangarei Airport	175.0	192
Auckland Airport	65.2	79
New Caledonia		
Ile Art, Belep	165.8	126
Koumac	129.6	130
Ouloup	130.2	92
Ouanaham	122.6	70
Poindimie	449.0	200
La Roche	109.9	61
La Tontouta	96.8	133
Noumea	64.6	82
Moue	92.4	63

Territory and station name	December 2007 rainfall total (mm)	December 2007 percent of average
Niue		
Hanan Airport	149.5	88
Liku	93.6	58
North Tasman		
Lord Howe Island	77.6	64
Norfolk Island	306.0	373
Raoul Island	221.8	164
Samoa		
Apia	520	141
Faleolo Airport	308	119
Nafanua	523	150
Afimalu	657	113
Maota	424	86
Tonga		
Mata'aho Airport	141.7	52
Lupepau'u	184.8	70
Salote Airport	148.8	61
Nuku'alofa	139.0	90
Fua'motu Airport	250.9	158
Tuvalu		
Nanumea*	105.6	31
Nui Island*	186.3	48
Funafuti*	310.7	79
Nuilakita*	227.6	75
Vanuatu		
Sola		
Pekoa	185.8	69
Lamap	75.6	49
Port Vila		
Tanna/Whitegrass		-
Bauerfield	49.3	48
Aneityum	104.6	62

Rainfall totalling 200% or more is considered well above average. Totals of 40% or less are normally well below average. **Highlighted values are new records.**

Data are published as received and may be subject to change after undergoing quality control checks. * denotes synoptic values.

Tropical rainfall outlook: January 2008 to March 2008

La Niña conditions are still very likely to influence rainfall patterns during this period, with a large area of suppressed convection very likely along the equatorial Pacific from Western Kiribati to Eastern Kiribati, including Tuvalu, the Northern Cook Islands, the Marquesas, and the Tuamotu Islands. Near or below average rainfall is likely for the Solomon and Society Islands.

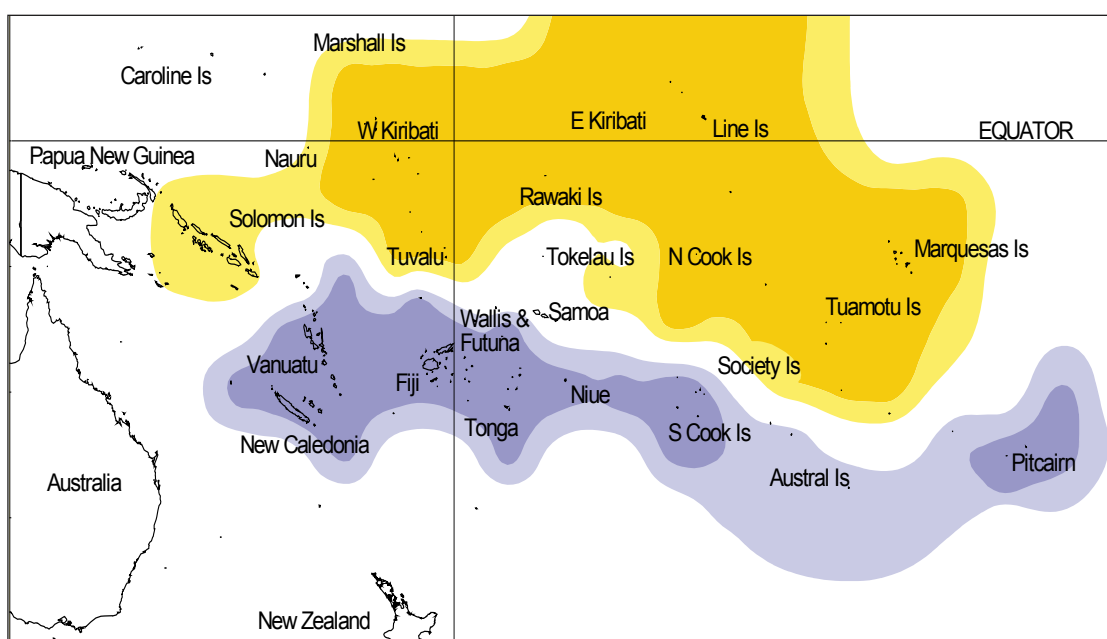
Average rainfall is likely for Papua New Guinea, Samoa and the Tokelau Islands.

Enhanced convection with above average rainfall is likely from Vanuatu through to Pitcairn Island, including New Caledonia, Fiji, Wallis and Futuna, Tonga, Niue, and the Southern Cook Islands. Near or above average rainfall is likely in the Austral Islands.

The confidence in the forecast model skill for this seasonal outlook is moderate to high for most Pacific Island countries. In the past, the average region-wide hit rate for forecasts issued in December has been 66%, 5% higher than the long term average for all months combined.

Island Group	Rainfall Outlook	Outlook confidence
Tonga	20:25:55 (Above)	High
Southern Cook Islands	15:30:55 (Above)	High
Niue	20:30:50 (Above)	High
Pitcairn Island	20:30:50 (Above)	High
Vanuatu	20:35:45 (Above)	High
New Caledonia	20:35:45 (Above)	High
Fiji	20:35:45 (Above)	High
Wallis & Futuna	20:35:45 (Above)	Moderate
Austral Islands	20:40:40 (Near or Above)	Moderate - high
Papua New Guinea	30:40:30 (Near Average)	Low
Samoa	25:45:30 (Near Average)	Moderate - high
Tokelau	30:40:30 (Near Average)	Low
Solomon Islands	40:40:20 (Near or Below)	Moderate
Society Islands	40:40:20 (Near or Below)	Moderate
Tuamotu Islands	50:30:20 (Below)	High
Tuvalu	55:30:15 (Below)	High
Northern Cook Islands	55:30:15 (Below)	High
Marquesas Islands	55:30:15 (Below)	High
Eastern Kiribati	60:25:15 (Below)	High
Western Kiribati	65:25:10 (Below)	High

NOTE: Rainfall estimates for Pacific Islands for the next three months are given in the table. The tercile probabilities (e.g., 20:30:50) are derived from the outputs of several global climate models. They correspond to the odds of the observed rainfall being in the lowest (driest) one third of the rainfall distribution, the middle one third, or the highest (wettest) one third of the distribution. On the long term average, rainfall is equally likely (33% chance) in any tercile.



Rainfall outlook map for January 2008 to March 2008



Tropical cyclones

Tropical cyclone Daman, the second this season, affected parts of Fiji between 5-9 December, with estimated maximum sustained wind speeds on the 7th of 195 km/h (category 3 on the Saffir-Simpson scale). Heavy rainfall, exceeding 100 mm, occurred over northern Fiji with the passage of the cyclone. Damage was severe north of Vanua

Levu, Fiji.

The moderate La Niña conditions presently affecting the Pacific will continue to influence tropical cyclones in several parts of the South Pacific this season. The period January through March is normally the most active part of the Southwest Pacific tropical cyclone season.

Insights provided by a historical database of tropical cyclones and their impacts in the Cook Islands

Dr. Fes de Scally, University of British Columbia-Okanagan, Canada

Historical tropical cyclone activity

Since 1820 at least 143 tropical cyclones have occurred inside the Cook Islands' 200 nautical mile Exclusive Economic Zone (EEZ). Since 1970 when satellite imagery has allowed comprehensive monitoring of tropical cyclones, a total of 65 cyclones have affected the Cook Islands. This is an average of 1.8 cyclones every season. Twenty of these became hurricanes (sustained winds of at least 119 km/hr), an average of one hurricane about every two years. The Southern Group has experienced more than twice as many cyclones as the Northern Group, with the island of Palmerston most affected on account of its proximity to the typical cyclone track through the Cooks' EEZ.

February alone accounts for 29% of all datable cyclone occurrences since 1820. While only 4% of cyclones have occurred outside the 1 November to 30 April cyclone season, the devastation of Cyclone Martin in 1997 demonstrates the importance of preparedness during this time. Cyclones achieving hurricane status have all occurred during the December-April period, with 38% occurring in February.

Only nine seasons since 1970 have experienced no cyclone activity in the Cook Islands, while another nine have experienced between three and six cyclones. The sudden increase in the number of seasons with three or more cyclones in the mid-1970s very likely reflects the beginning of improved monitoring with satellites. All six cyclones since 1970 which reached major hurricane intensity inside the Cooks' EEZ have occurred in the last four seasons, possibly reflecting a recent increase in the number of very intense cyclones in the Southwest Pacific¹. Between 1870 and 1969, 48% of cyclones in the Cook Islands occurred during El Niño events; this proportion has increased to 56% since 1970.

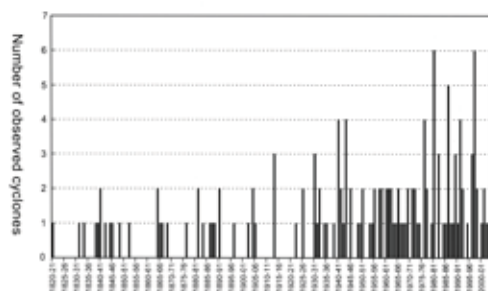
Historical tropical cyclone impacts

Since 1820 at least 91 tropical cyclones have impacted the inhabitants of the Cook Islands in some way. Beginning with relatively complete reporting in 1891, cyclones producing minor damage or disruptions have occurred on average about

every 1½ years. Those resulting in major damage or fatalities have occurred on average about once every nine years. These represent minimum estimates, since some cyclones' impacts may not have been recorded. Ninety-one percent of cyclones producing significant damage and disruption have struck the Southern Group, while only 42% have struck the Northern Group. Noteworthy is the large monetary cost of some recent cyclones, especially in relation to the small size of the national economy. For example, losses in Cyclone Sally in 1986-87 reached as high as NZ\$55 million, while the over NZ\$35 million in losses incurred in Cyclones Meena, Nancy, Olaf, and Percy in 2005 represent 14% of the country's GDP at the time. The costs of disaster mitigation need to be weighed against such potentially high costs.

Cyclone fatalities numbered in the hundreds or even thousands for some 19th century and earlier cyclones. In contrast, only six cyclone deaths were recorded between 1891 and 1997. In 1997 Cyclone Martin resulted in 19 fatalities at Manihiki when a storm surge inundated that atoll. This disaster underscores the critical importance of providing properly constructed cyclone shelters and timely warnings for inhabitants of the Northern Group atolls (and Palmerston atoll in the Southern Group).

Below: Number of observed cyclones per season 1820–2006, Cook Islands



Lead author, *A History of Tropical Cyclones and Their Impacts in the Cook Islands*, Cook Islands Meteorological Service, 2006, 377 p.

¹ Webster, P.J., Holland, G.J., Curry, J.A. and Chang, H-R., 2005: Changes in tropical cyclone number, duration, and intensity in a warming environment. *Science* 309: 1844-1846.



The Island Climate Update

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Sources of South Pacific rainfall data

This bulletin is a multi-national project, with important collaboration from the following Meteorological Services: **American Samoa, Australia, Cook Islands, Fiji, French Polynesia, Kiribati, New Caledonia, New Zealand, Niue, Papua New Guinea, Pitcairn Island, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna**

Acknowledgements

This bulletin is produced by NIWA and made possible with financial support from the New Zealand Agency for International Development (NZAID), with additional support from the Pacific Islands Applied Geosciences Commission (SOPAC) and the Secretariat for the Pacific Regional Environmental Programme (SPREP).

This summary is prepared as soon as possible following the end of the month, once the data and information are received from the Pacific Island National Meteorological Services (NMHS). Delays in data collection and communication occasionally arise. While every effort is made to verify observational data, NIWA does not guarantee the accuracy and reliability of the analysis and forecast information presented, and accepts no liability for any losses incurred through the use of this bulletin and its content.

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