Maps of the Past Climate of Vanuatu

Monthly, seasonal and annual rainfall and air temperature

Prepared for Vanuatu Meteorology and Geohazards Department

June 2023.

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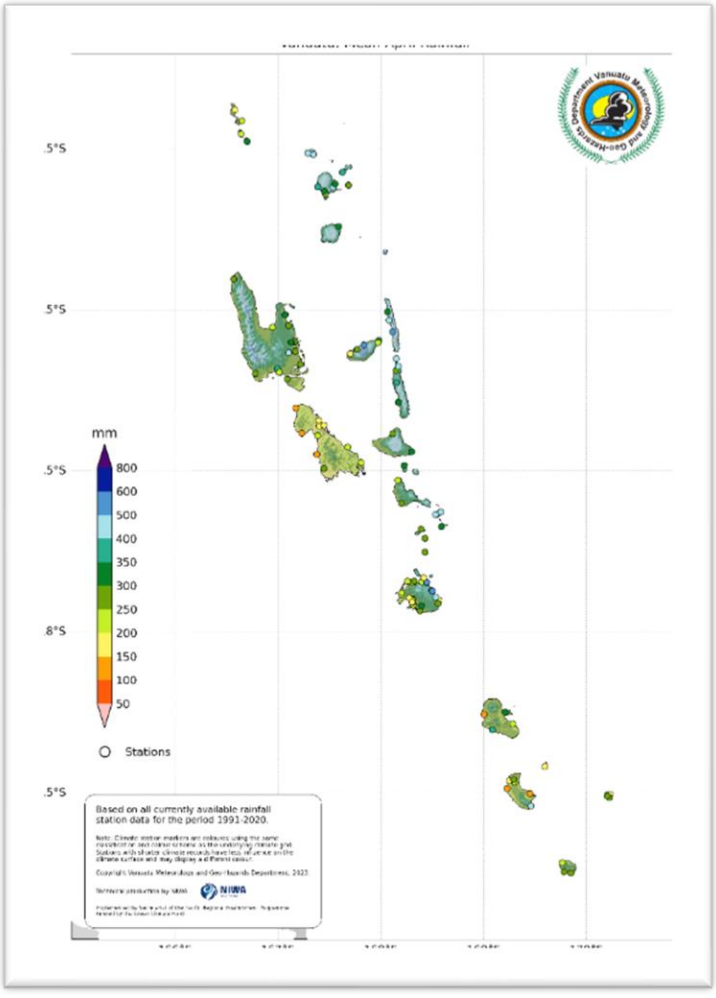

Climate, Freshwater & Ocean Science

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Executive summary

In partnership with the Vanuatu Meteorology and Geo-Hazards Department (VMGD), the Secretariate of the Pacific Regional Environment Programme (SPREP), as the Executing Entity for the Green Climate Fund (GCF) project Climate Information Services for Resilient Development in Vanuatu project (Van KIRAP), contracted NIWA (the New Zealand National Institute of Water and Atmospheric Research) to develop and compile a series of historical mean temperature and mean rainfall maps for Vanuatu.

Daily climate data required for map production were obtained from VMGD's climate data archive, supplemented by homogenized data from the Australian Bureau of Meteorology's (BOM) Pacific Climate Change Data Portal. Monthly mean temperature and mean total rainfall statistics were derived from this data.

Mapping the monthly climate statistics was undertaken by NIWA using a combination of in-house procedures, ArcGIS Pro Geoprocessing (Esri, 2023) Python scripting, ANUSPLIN (The Australian National University, 2023), and other mapping tools. Pragmatic sub-selection techniques were applied to the climate data to reduce or eliminate suspect or spurious data values from the mapping.

The work produced 120 national and 720 province historical climate maps, totalling 840 maps. These map products, along with the associated geotiff raster datasets, were made available to VMGD through VMGD’s CliDEsc user interface platform.

The completion of this project has provided VMGD with valuable mapped historical and recent climate information that contributes to Vanuatu's capacity to address climate challenges and bolster its sector-focused climate services and resilience-building efforts.

It should be noted that the accuracy of the maps produced during this work are dependent on the quality and completeness of the data that are available. Refinement of the maps may be possible as more data or additional data sources (such as additional homogenised historical data) become available.

1 Introduction

The Vanuatu Meteorology and Geo-Hazards Department (VMGD) is working to develop new procedures and capability to enhance operational climate monitoring, reporting and services to build weather and climate resilience in Vanuatu.

The Secretariate of the Pacific Regional Environment Programme (SPREP), as the Executing Entity for the Green Climate Fund (GCF) project *Climate Information Services for Resilient Development in Vanuatu project (Van KIRAP)*, has engaged the services of the NIWA (the New Zealand National Institute of Water and Atmospheric Research) to develop and compile a series of maps of historical climate data for Vanuatu. In addition, NIWA was tasked with setting up operational generation of maps of recent, climate-scale anomalies of rainfall and air temperature.

1.1 Van KIRAP Project

Van KIRAP, of which the present Contract is a part, is a large project aimed at building climate resilience in Vanuatu, as described in the project extract below.

> *'Vanuatu is among the most vulnerable countries on earth to the increasing impacts of climate change, including climate-related natural disasters and the effects of slow-onset events such as sea-level rise and ocean acidification.*
>
> *'As the effects of global warming manifest and the hazards of climate change arise at accelerating rates, there is a need to shift the paradigm towards the standardised and mainstreamed use of science-based climate information, at multiple timescales, to support resilient development pathways. The 'Climate Information Services for Resilient Development in Vanuatu' (known locally as **Van-KIRAP – Vanuatu Klaemet Infomesen blong Redy, Adapt mo Protekt**) project is supporting this paradigm shift through the strengthening and application of Climate Information Services (CIS) in five targeted development sectors: tourism; agriculture; infrastructure; water and fisheries.*
>
> *'More specifically, the project is building the technical capacity in Vanuatu to harness and manage climate data; develop and deliver practical CIS tools and resources; support enhanced coordination and dissemination of tailored information; enhance CIS information and technology infrastructure; and support the application of relevant CIS through real-time development processes, for more resilient outcomes.*
>
> *'The project is addressing information gaps and priority needs of target beneficiaries at national, provincial and local community levels across the five priority sectors through four core components:*
>
> 1. *Strengthening the VMGD platform to provide quality climate data and information for CIS.*
>
>   - *Demonstrating the value of CIS at the sectoral and community levels.*
>   - *Developing CIS tools and engaging with stakeholders through outreach and communications.*
>   - *Strengthening the institutional capacity for long-term implementation of CIS in decision-making.'*

1.2 Van KIRAP sector focus

Van KIRAP aims to support sector agencies and community climate centres in Vanuatu to be better informed in near real time on how current climate is tracking compared to average expectations, and whether changes in operational activities can be adjusted to improve responsiveness and resilience to variations in the climate.

Use cases will include but are not limited to the following:

1 Agriculture - 'investigate the climate sensitivity, potential impacts and vulnerability of food crops and cash crops in Vanuatu for future food security'.

2 Fisheries – 'to contribute towards improvements in food security and the livelihoods of communities in Vanuatu by using climate information to prepare for and respond to marine heatwaves on coastal fisheries',

3 Infrastructure – 'upgrade the standard design in the Public Works Department (PWD) for all infrastructure',

4 Tourism – 'work with stakeholders to obtain reliable and up to date climate data and convert into meaningful and useful information and tools that can be communicated to tourism operators. This will help identify solutions to the ongoing impacts of climate variability and change on tourism businesses',

5 Water – 'to support tailored climate information to provide localised floods preparedness management plans and early warning'.

1.3 Van KIRAP climate maps component

Within the overall scope of Van KIRAP, NIWA has been contracted to work with VMGD to develop maps of historical climate data in Vanuatu, and operational climate anomaly maps from recently observed rainfall and air temperature data. The maps are to be generated from VMGD's CliDE[1] data archive and delivered through the CliDEsc[2] user interface.

The climate mapping work has four components:

1. A compendium or atlas of Maps of the Past Climate of Vanuatu (reported in this document, and provided in electronic form): Monthly and seasonal maps showing historical long term average rainfall and air temperature for Vanuatu, including for ENSO phases.

2. A suite of operational climate maps for Vanuatu: operational daily updates of maps showing Vanuatu rainfall and air temperature for the past 30, 60, 90, 180 and 365 days.

3. Climate maps User Guide: User Guide and Training Manual for VMGD Climate Division staff and sector engagement

4. End of contract report

[1] Climate Data for the Environment, a database system developed by the Australian Bureau of Meteorology, which is Vanuatu's primary climate data archive. About Climate Data for the Environment (CliDE) (bom.gov.au)
[2] Climate Data for the Environment Services Client, a web-based content management system and product generator library developed by NIWA Climate Data for the Environment Services Client (CliDEsc) | NIWA

The work aims to strengthen the capability of the VMGD climate staff to interpret and generate maps based on rainfall and air temperature observations in Vanuatu. It will provide additional scope to engage with sector workers and agencies in Vanuatu, to understand their information needs, and to provide climate analysis and advice to support management of climate and weather risks and opportunities.

This report covers the first component of the climate mapping work, **maps of historical climate data**.

2 Historical climate maps

2.1 Map selection

A range of monthly, annual and seasonal maps were developed to illustrate historical average rainfall and air temperature for Vanuatu. Additional maps were produced for the six Vanuatu provinces Malampa, Penama, Sanma, Shefa, Tafea and Torba. The map products included:

1. Monthly average air temperature and rainfall (24 national and 144 provincial maps)
2. Annual average air temperature and rainfall (2 national and 12 provincial maps)
3. Average wet season and dry season air temperature and rainfall (4 national and 24 provincial maps)
4. Composite maps of seasonal, monthly and annual temperature and rainfall patterns and anomalies for each ENSO phase (90 national and 540 provincial maps)

Table 2-1: Table of map images to be produced in the Historical Maps project component. In addition to the national scale maps listed here, maps at regional scale were also produced, bring the total number of images to 840.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Wet season	Dry season	Annual	TOTAL
Historical average air temperature	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Historical average rainfall	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Monthly rainfall La Niña	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Monthly rainfall El Niño	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Monthly rainfall Neutral	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Monthly temperature La Niña	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Monthly temperature El Niño	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Monthly temperature Neutral	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
TOTAL																120

2.2 Sources of historical data

Daily climate observations including rainfall, maximum air temperature and minimum air temperature were provided by Vanuatu Meteorology and Geohazards Department (VMGD) from their CliDE data archive. In addition, historical monthly data that had been quality assured by VMGD and the Australian Bureau of Meteorology were available from the Pacific Climate Change Data Portal (http://www.bom.gov.au/climate/pccsp/). Data accessed from the Portal for this project included:

1. Homogenised monthly total rainfall data for stations at Port Vila (ref 91558/VAN07002), Sola on Vanua Lava Island (ref 91551/VAN31001) and Aneityum (ref 91568/VAN03001).

2. Non-homogenised monthly total rainfall data for stations at Bauerfield on Efate Island (ref 91557/VAN07001), Pekoa Airport on Santo Island (ref 91554/VAN25001), Lamap on Malekula Island (ref 91555/VAN16001) and White Grass Airport (ref 91565/VAN26003).

3. Homogenised monthly minimum, maximum and mean temperature data for Aneityum (ref 91568/VAN03001).

4. Non-homogenised monthly minimum, maximum and mean temperature data for Port Vila (ref 91558/VAN07002), Sola on Vanua Lava Island (ref 91551/VAN31001), Pekoa Airport on Santo Island (ref 91554/VAN25001), Bauerfield on Efate Island (ref 91557/VAN07001), Lamap on Malekula Island (ref 91555/VAN16001) and White Grass Airport (ref 91565/VAN26003).

2.3 Quality assurance of daily data

A Python programming language[3] application was written and utilised to automate the extraction of historical station data from Vanuatu's (CliDE) climate data management system (http://www.bom.gov.au/climate/pacific/about-clide.shtml), quality check these data, estimate mean daily temperature, and determine mean monthly total rainfall and mean temperature statistics.

The application used reasonable minimum quality criteria as well as extreme daily rainfall and temperature percentile statistics to check for data outliers, thus ensuring the quality of the daily station data prior to further analysis. The incoming data were grouped by station identifier, month and year, and the 1 and 99 percentile values were determined for each group. Daily rainfall or temperature values falling outside of these extremes were flagged for manual review. VMGD provided expertise with respect to identifying spurious climate station data, including identifying data range thresholds that were reasonable and acceptable value ranges for Vanuatu. The selected thresholds are shown below in Table 3-2; data outside these thresholds were subsequently excluded from the working data. Note that no upper limit was set for daily rainfall amounts as we considered that each of the rainfalls that exceeded the 99th percentile were likely to be accurate (apart from values coded '999'). There were seven daily rainfall totals that exceeded 1000mm. These were assessed manually, and on examination it was considered that there was not enough evidence to determine them to be errors.

Table 2-2: Maximum and minimum thresholds applied to daily rainfall and air temperatures to remove suspect of spurious data.

	Daily rainfall (mm)	Daily maximum air temperature (°C)	Daily minimum air temperature (°C)
Maximum threshold	None	38	32
Minimum threshold	0	15	10

[3] https://www.python.org/

Following quality control, daily mean temperatures were estimated for all days where both maximum and minimum temperatures were available.

2.4 Estimates of long-term monthly values

The quality assured daily data described above were then used to calculate long term monthly averages. The World Meteorological Organization (WMO) data completeness guidelines (WMO 2017, WMO 2020) were applied to minimize the impact of missing daily data on estimates of monthly air temperature and rainfall statistics. For mean temperature, these guidelines specify that no more than 11 days of observations may be missing in a given month, with a limit of 5 consecutive days of missing data. For rainfall, it was considered important to capture the variability of day-to-day rainfall amounts, and therefore months with missing rainfall observations were excluded from the final rainfall statistics used for mapping.

Finally, following the convention of using the most recent climate 'Normals', (and as the reference period agreed with VMGD) monthly means for the 30 years 1991 to 2020 were calculated. To make use of data from recently constructed climate stations with shorter data records, a rule that required a minimum of three cases of monthly mean temperature or rainfall values for any given month to determine mean climate statistics was implemented. This criterion was applied to determine the mean climate statistics that were to be included in the mapping routine. Before executing the mapping procedure, the mean climate statistics underwent a manual review to identify and remove outlier values that could potentially distort or excessively influence the climate maps.

2.5 Wet and dry season climates

In Vanuatu, the wet season is conventionally defined as the six-month period from November to April, and the dry seasons the remaining six months from May to October.

To enable wet and dry season data for map production gridded data of the monthly rainfall and temperature means to calculate the wet and dry season climate averages was used – the average mean monthly air temperature, and the average total rainfall respectively.

2.6 ENSO impact on wet and dry season climates

The monthly climate statistics were further categorised by their respective occurrence in a prevailing El Niño, La Niña, or neutral phase of the El Niño Southern Oscillation (ENSO). An extended period comprising 1 January 1951 to 31 December 2022 was used to capture a greater number of El Niño and La Niña phases.

The monthly time series of the Southern Oscillation Index (SOI) computed with respect to the 1991-2020 normal period were averaged using a five-month rolling mean centred on each month. A threshold of ±0.5 was then applied to designate whether each month respectively was in an El Niño, La Niña, or ENSO Neutral phase[4]. Months with average SOI index values of greater than or equal to 0.5 were categorised as La Niña; El Niño months were taken to be those with mean SOI values less than or equal to –0.5. Remaining months were categorised as ENSO Neutral. The ENSO phase designation for each month since 1950 is shown in a table appended to this report (Appendix A).

[4] NIWA has routinely used a higher threshold of ±0.7 to identify La Niña and El Niño events (Reference: El Niño and La Niña | NIWA). However, our procedure allows for the testing of alternative threshold values, which can identify lower intensity La Niña and El Niño events. This flexibility enables us to include additional climate observations during months with milder La Niña and El Niño conditions in the mapping routine and thus ensure there are sufficient months to get representative ENSO season samples.

In order to analyse the impact of the El Niño-Southern Oscillation (ENSO) on monthly mean temperature and rainfall, monthly means were calculated for the respective ENSO phases. To ensure that sufficient climate stations were available for the ANUSPLIN interpolation algorithm to produce realistic results, the three cases limit of monthly mean temperature or rainfall values for any given month was lowered. This allowed for inclusion of stations with only two monthly values, thereby increasing the sample size.

Once again, before executing the mapping procedure, the ENSO mean climate statistics underwent a manual review to identify and remove outlier values that could potentially distort or excessively influence the climate maps where the reason for the outlier values could not be ascertained.

Table 2-3: Count of months defined as occurring during ENSO phases, noting that, in some seasons, only two months were available that satisfied the SOI index threshold of ±0.5.

	El Niño	La Niña	Neutral	Total
January	15	17	41	73
February	11	20	43	73
March	12	22	39	73
April	14	21	38	73
May	14	27	32	73
June	12	27	34	73
July	15	28	30	73
August	16	29	28	73
September	20	25	28	73
October	21	24	28	73
November	20	21	32	73
December	20	20	33	73
	190	281	406	877

2.7 Generation of map layers

This Section outlines the use of two key components of the mapping procedure—(i) the application of the land surface elevation data to estimate the effect of height above sea level on climate and improve the resolution of the mapped layers, and (ii) the use of the spatial ANUSPLIN software to spatially interpret the climate data.

2.7.1 Digital Elevation Model (DEM)

A digital elevation model provides a three-dimensional representation of the terrain surface. DEMs typically constitute a regularly gridded dataset that provides a convenient set of topographic reference points for the interpolation of observed climate values.

For this work the Australian National University's Shuttle Radar Topography Mission (ASTER) Global Elevation Model (GDEM) Version 3 (ASTGM) elevation dataset was selected because it provided a

consistent coverage across Vanuatu at an acceptable spatial resolution of 1 arc second (approximately 30-metre) and was freely available via the Vanuatu Environment Data Portal[5].

Using Esri ArcGIS Pro Geographic Information System (GIS) software (Esri, 2023), a raster resample tool was employed to change the cell size of the ASTGM elevation data grid from a 1 arc second (approximately 30-meter) resolution to a 0.001 decimal degree (approximately 111-meter) regularly spaced Digital Elevation Model (DEM), as shown in Figure 2-1. These DEM modifications were done to improve the performance of the ANUSPLIN algorithm and to produce historical climate grids that are easily managed, represent the climatic features of Vanuatu, and retain topographical detail.

Figure 2-1: ASTER Global Digital Elevation Model (GDEM) Version 3 (ASTGTM) for Vanuatu.

[5] https://vanuatu-data.sprep.org/dataset/aster-global-digital-elevation-model-gdem-version-3-astgtm-vanuatu

2.7.2 ANUSPLIN Interpolation of rainfall and temperature

ANUSPLIN is a software tool (ANU 2023) that is used to interpolate multi-variate climate data values from irregularly-spaced observing sites and provide interpolated values at regularly spaced grid point locations. The method can be described as estimating unknown values by bending a surface through the known climate station values, as is demonstrated in Figure 2-2 below.

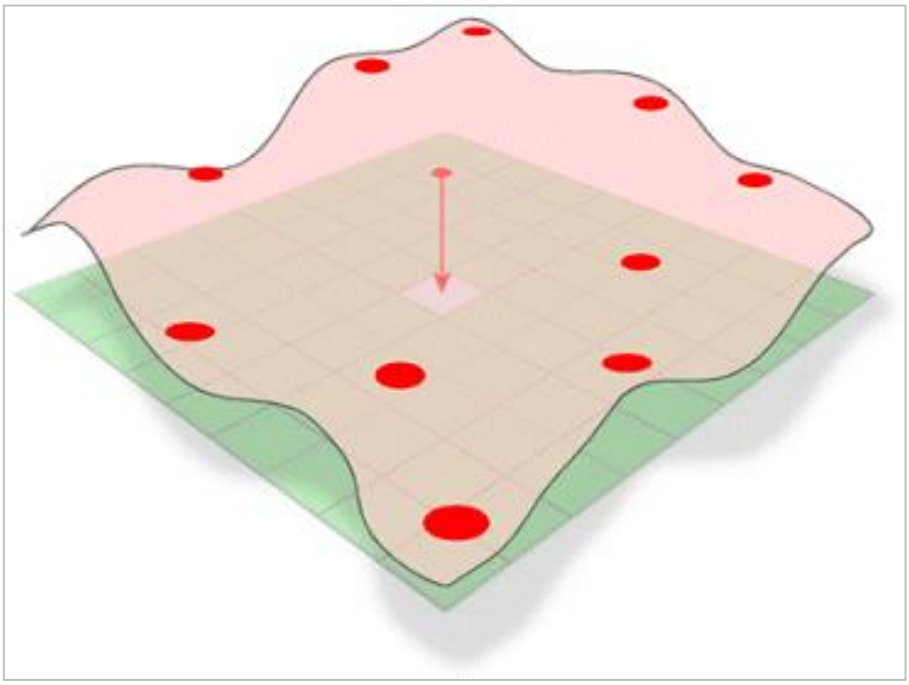

Figure 2-2: An illustration showing how a spline interpolation might bend a surface (pink area) through known values (red dots). (http://www.gisresources.com/types-interpolation-methods_3/).

The ANUSPLIN algorithm works by considering various factors such as the location of climate stations, the distance between these stations and the correlation between climate variables and covariate data such as station height above sea level. Through the analysis of these factors ANUSPLIN generates accurate interpolated values for climate data at regularly spaced grid point locations.

These gridded data created by ANUSPLIN can then be conveniently used to generate more informative contour maps that provide a more detailed representation of historical climate conditions than can be obtained from the original sparse data set.

The Python programming application created for this project was used to overlay the climate station coordinate pairs on the ASTER Global Digital Elevation Model and extract elevation values for each station. The climate station location, extracted elevation values, and climate mean monthly statistics were then combined, and ANUSPLIN input data files were generated.

Using the ANUSPLIN trivariate (three independent variables: easting, northing and elevation) thin-plate smoothing spline interpolation methodology, described by Wratt et al. [2006], the climate mean monthly statistics were interpolated onto a regular grid with a spatial resolution of approximately 111m. The ANUSPLIN interpolation parameters were set so that stations with longer climate records were given a greater statistical weighting, and therefore had more influence on the interpolated climate surface than stations with shorter climate records.

3 Map products

In discussion with VMGD it was decided to produce climate maps showing both national and regional coverage. The boundaries adopted for the six province level maps are shown in Figure 3-1 below.

The additional province-level maps increased the number of images from the 120 listed in Table 2-1, to a total of 840. These maps are presently stored in VMGD's installation of CliDEsc where they are accessible to VMGD staff under the Map Library menu, as shown below (Figure 3-2).

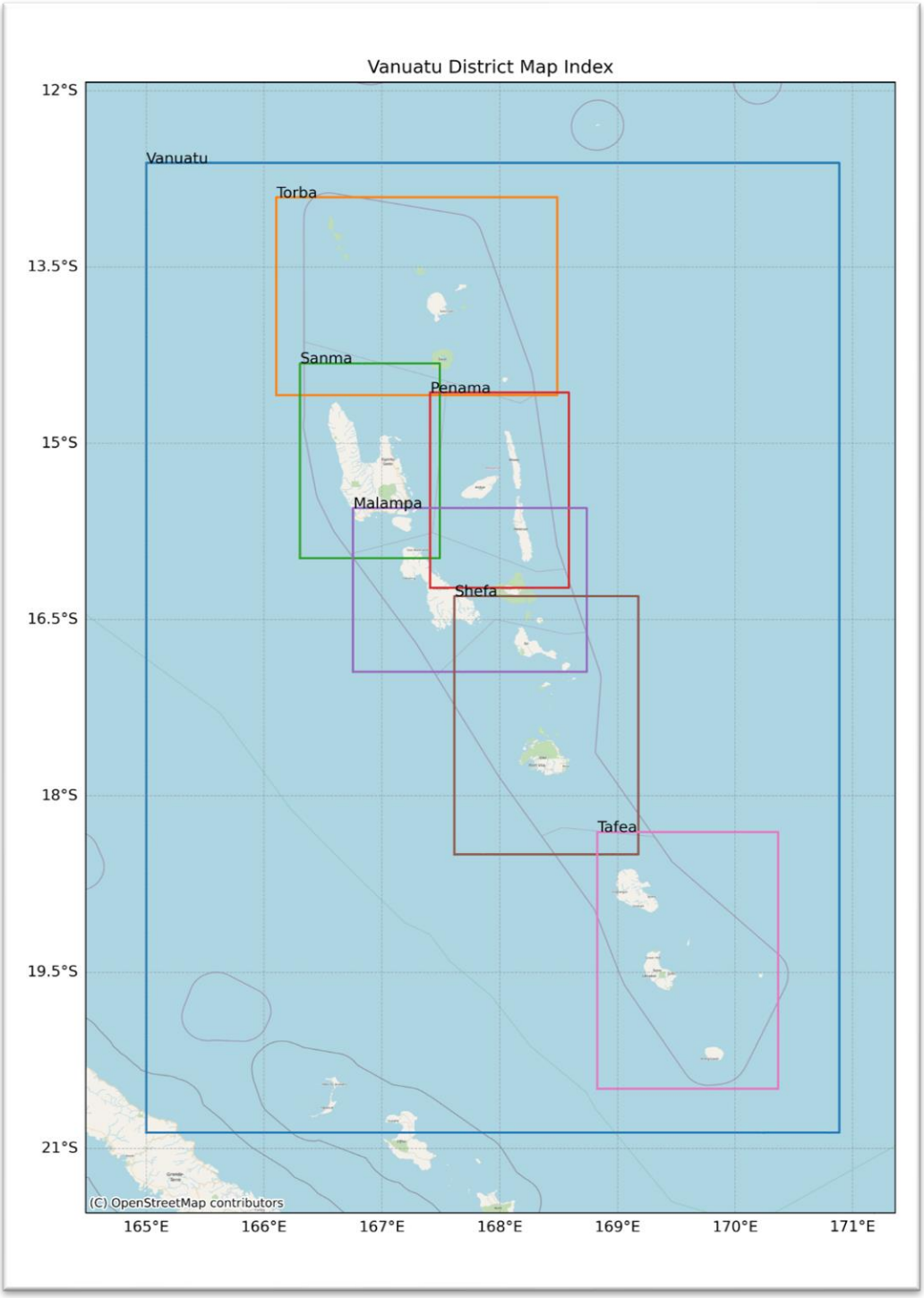

Figure 3-1: Map showing boundaries adopted for province level maps.

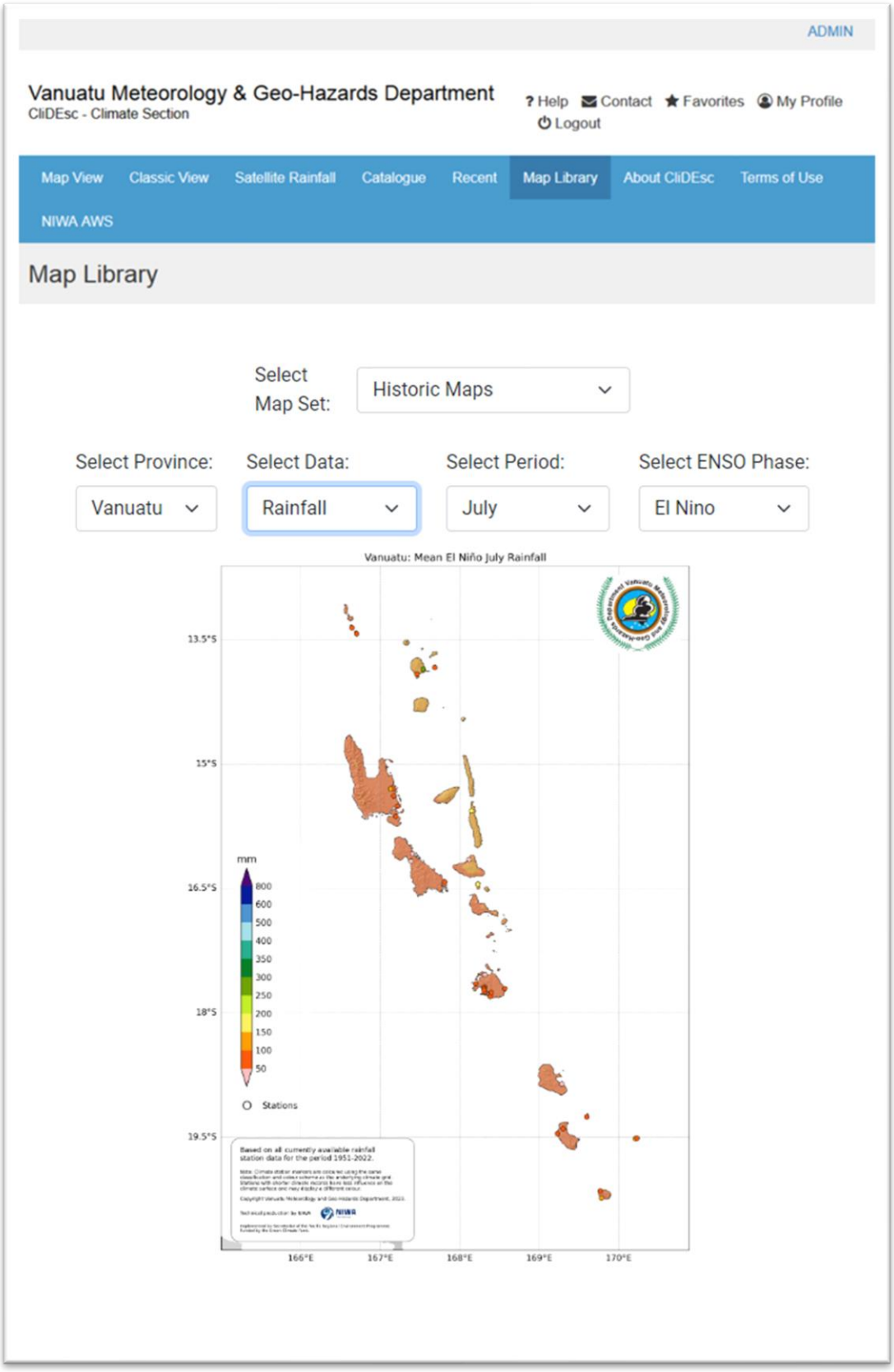

Figure 3-2: CliDEsc Map Library page.

Some example map images are shown in the following sections.

3.1 Monthly means

Monthly rainfall means were calculated from all available months within the climate *Normals* period. As an example, the December and August average rainfalls are shown in Figure 3-4 and Figure 3-5 below.

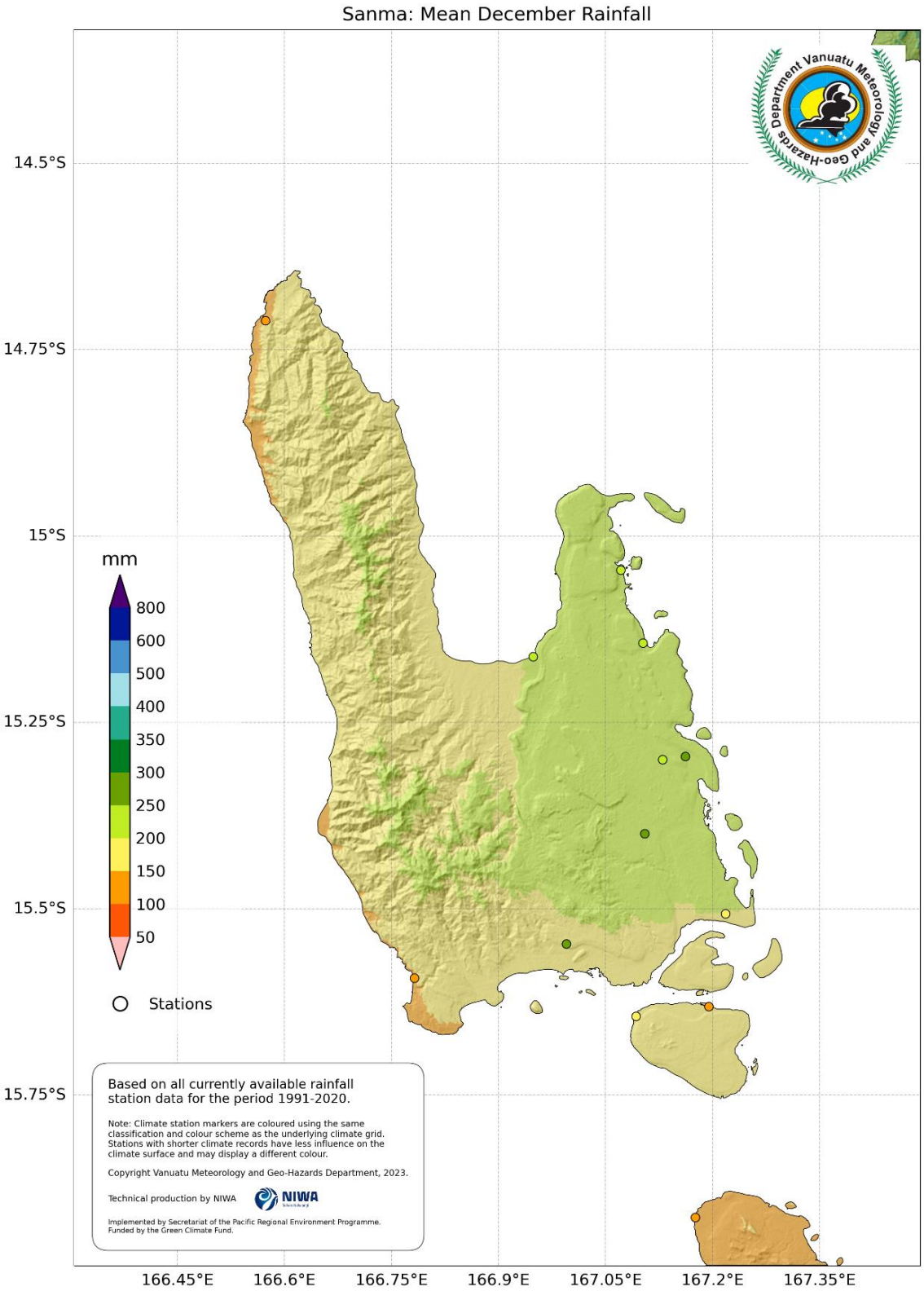

Figure 3-3: Variation in December average rainfall, compared with August (Figure 3-4), in Sanma province.

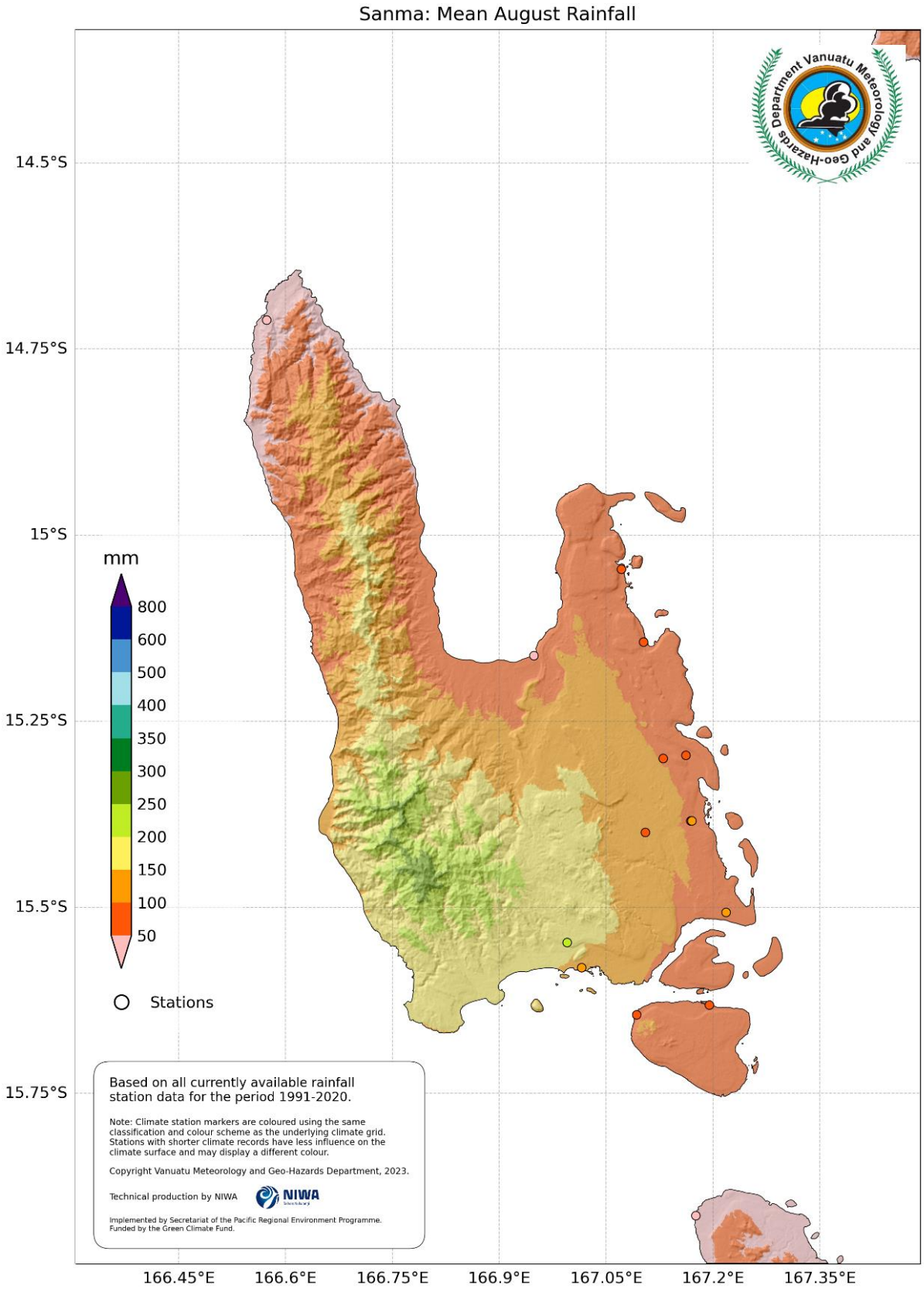

Figure 3-4: Variation in August average rainfall, compared with December (Figure 3-3), in Sanma province.

3.2 Wet and dry seasons

Gridded data of the monthly rainfall and temperature means were used to calculate the wet (November to April) and dry (May to October) season climate averages. The wet and dry season average rainfalls are shown in Figure 3-5 and Figure 3-6 below.

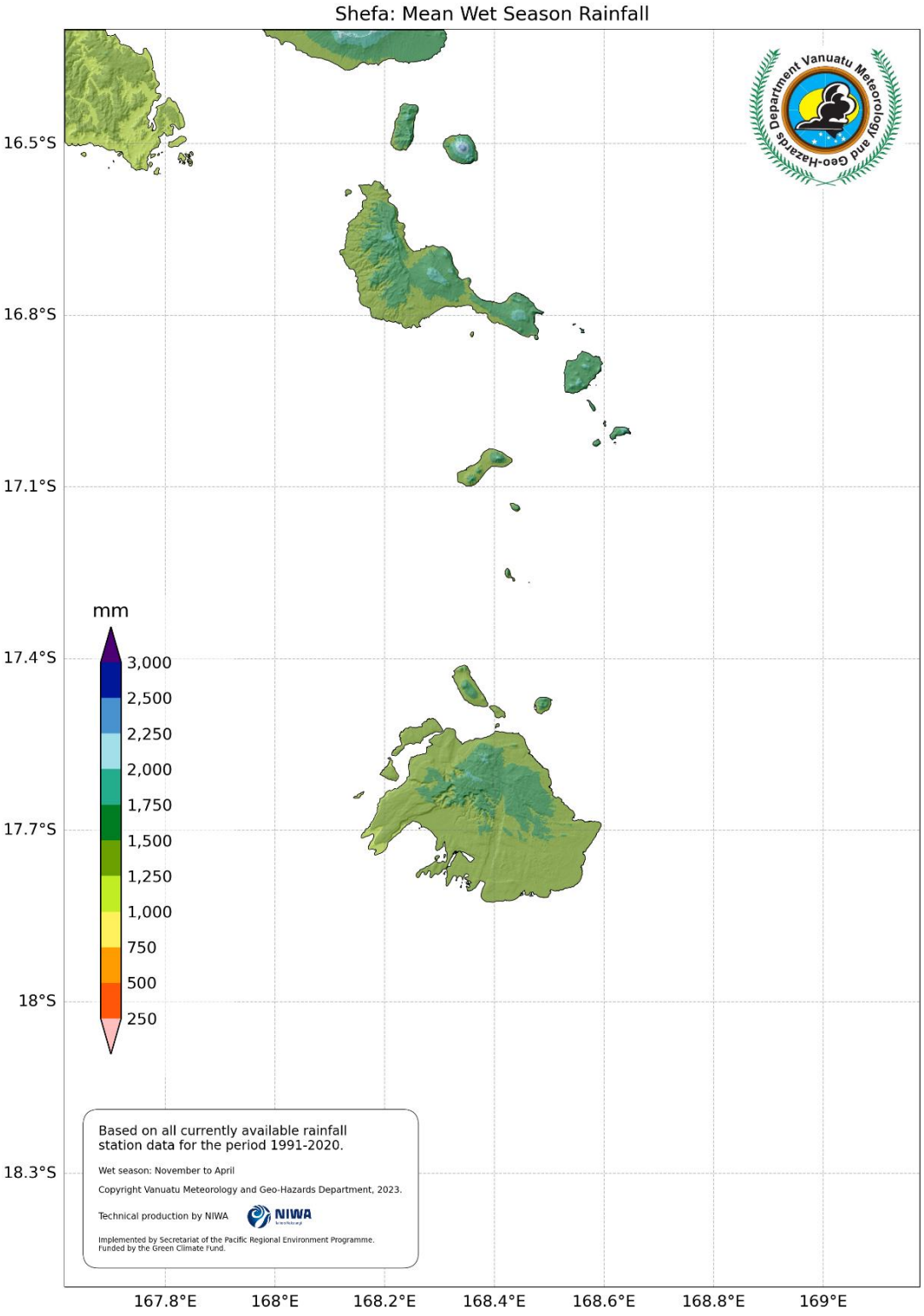

Figure 3-5: Variation in wet season average rainfall, compared with the dry season (Figure 3-6), in Shefa province.

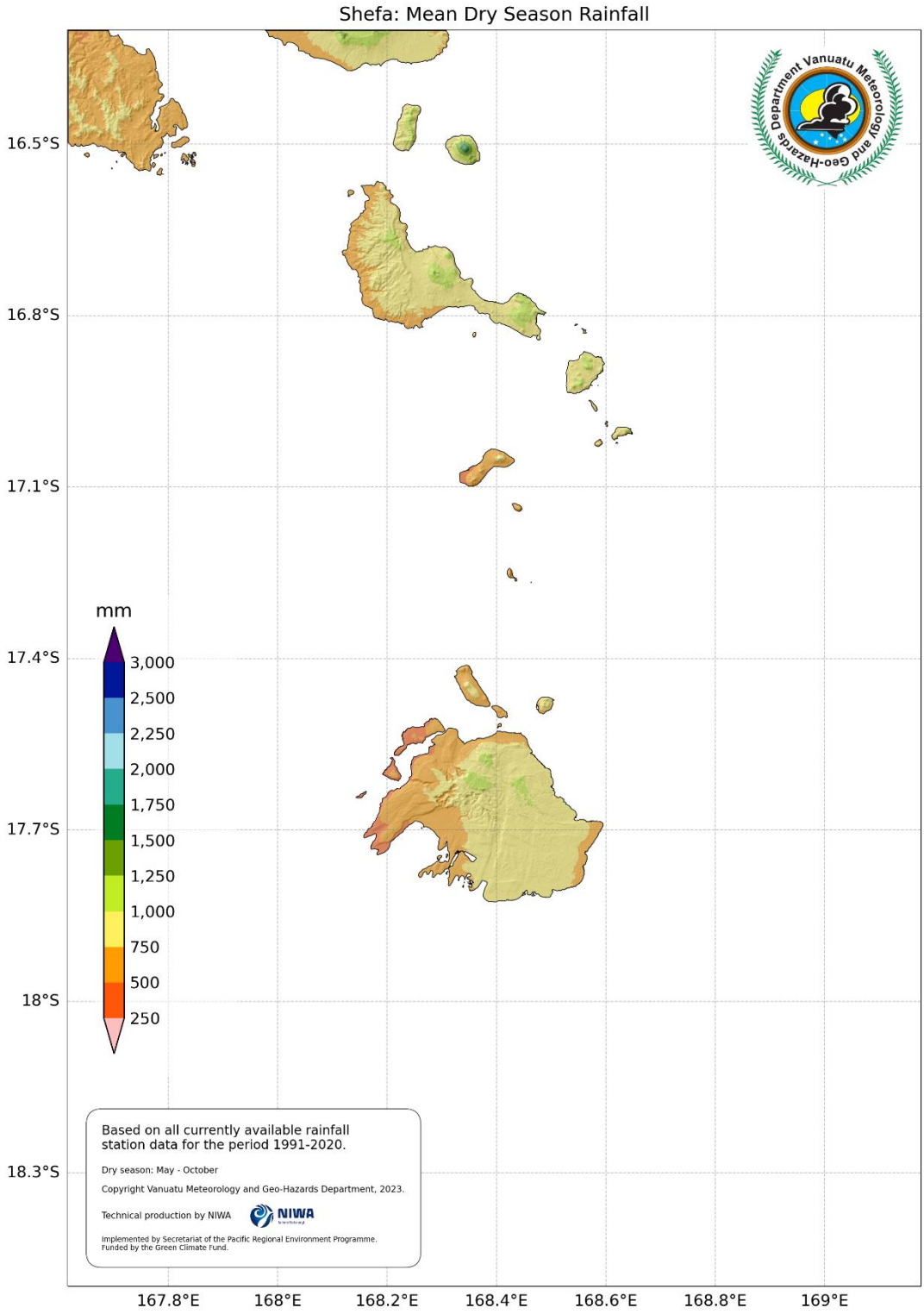

Figure 3-6: Variation in dry season average rainfall, compared with the wet season (Figure 3-5), in Shefa province.

3.3 ENSO impacts on wet and dry seasons rainfall

Figures 3-7, 3-8 and 3-9 illustrate changes in wet season rainfall across El Niño and La Niña ENSO phases compared to the average of all wet seasons. Differences are subtle and are highly dependent on the availability of observational data. However, the maps provide evidence of reduced rainfall during El Niño wet seasons and increased rainfall during La Niña wet seasons, in comparison to average.

Likewise, figures 3-10, 3-11 and 3-12 depict changes in dry season rainfall for the El Niño and La Niña ENSO phases. Once again differences between these maps are subtle, but reveal a pattern of decreased rainfall during El Niño dry seasons and increased rainfall during La Niña dry seasons, relative to the average.

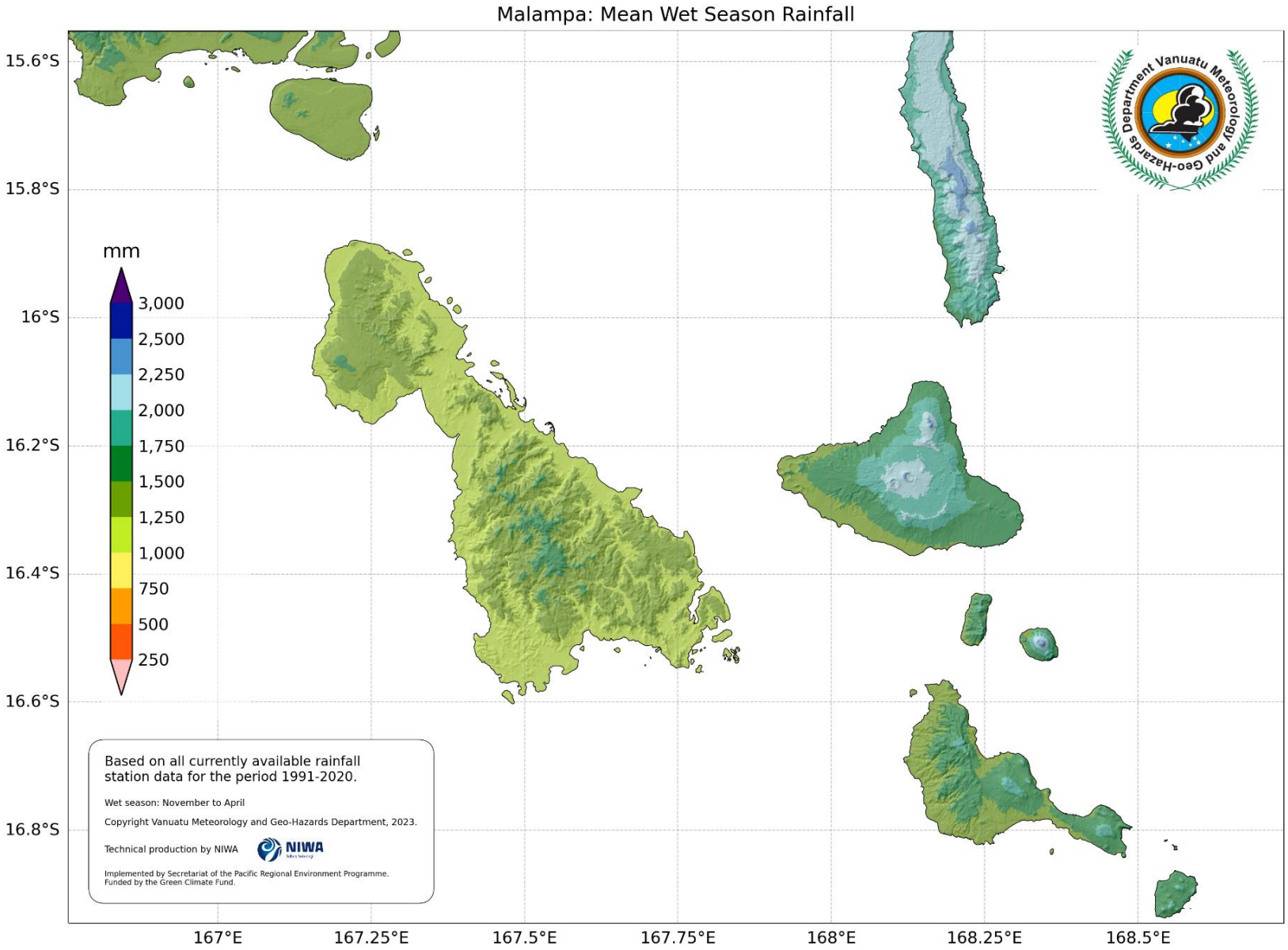

Figure 3-7: Average wet season rainfall, compared with La Niña (Figure 3-8) and El Niño (Figure 3-9) wet season rainfall, in Malampa Province.

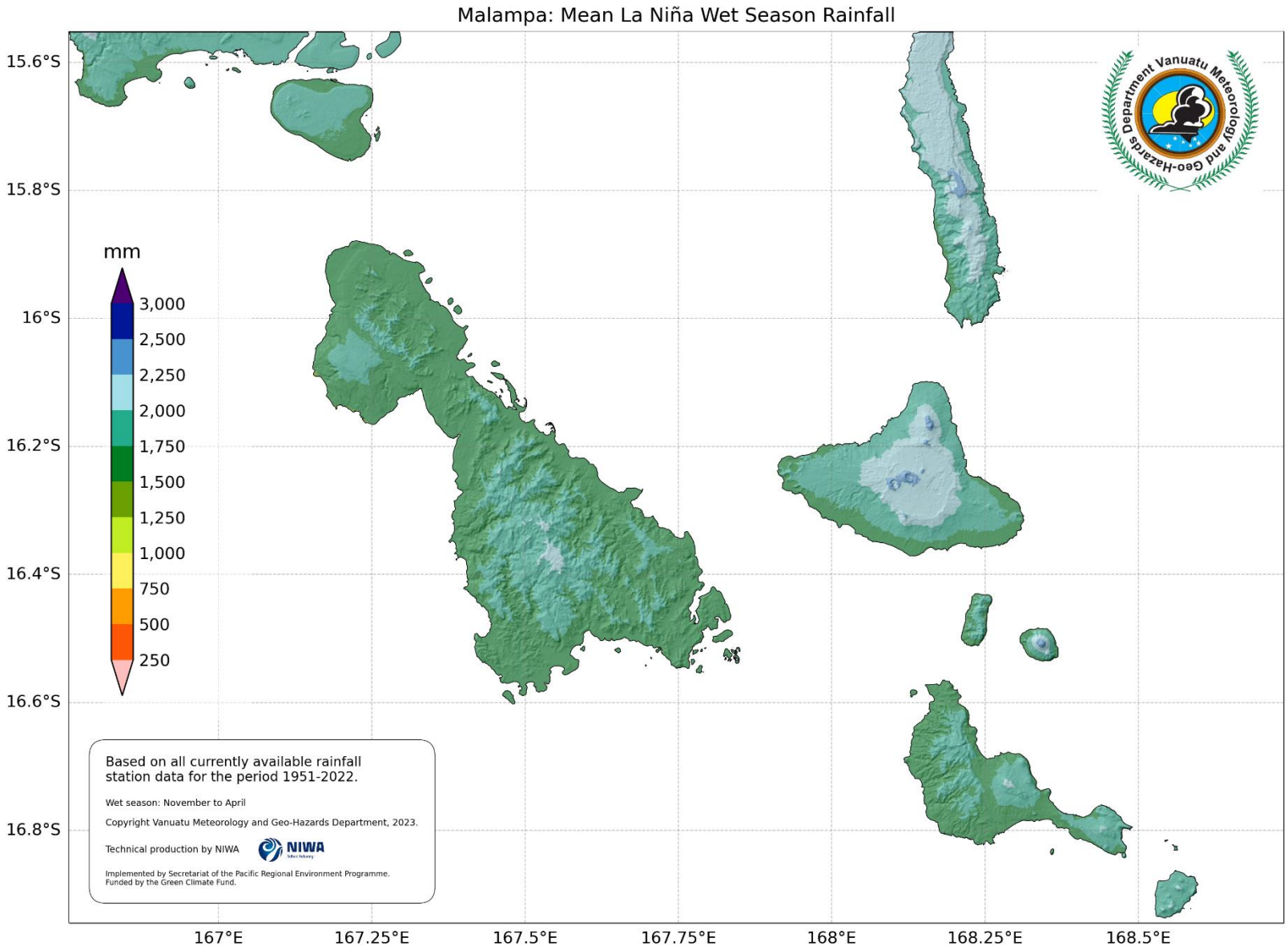

Figure 3-8: Average La Niña wet season rainfall in Malampa Province.

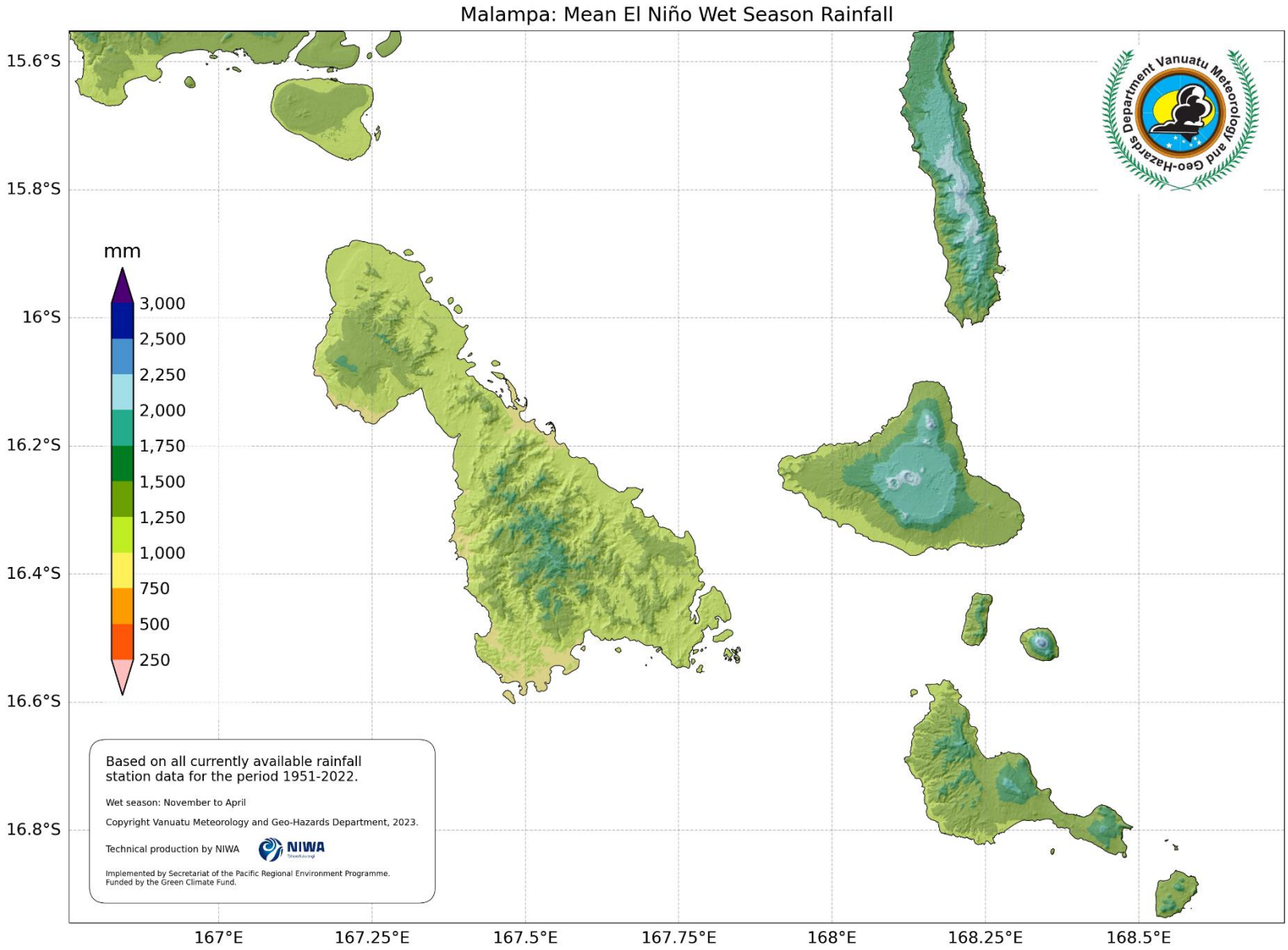

Figure 3-9: Average El Niño wet season rainfall in Malampa Province.

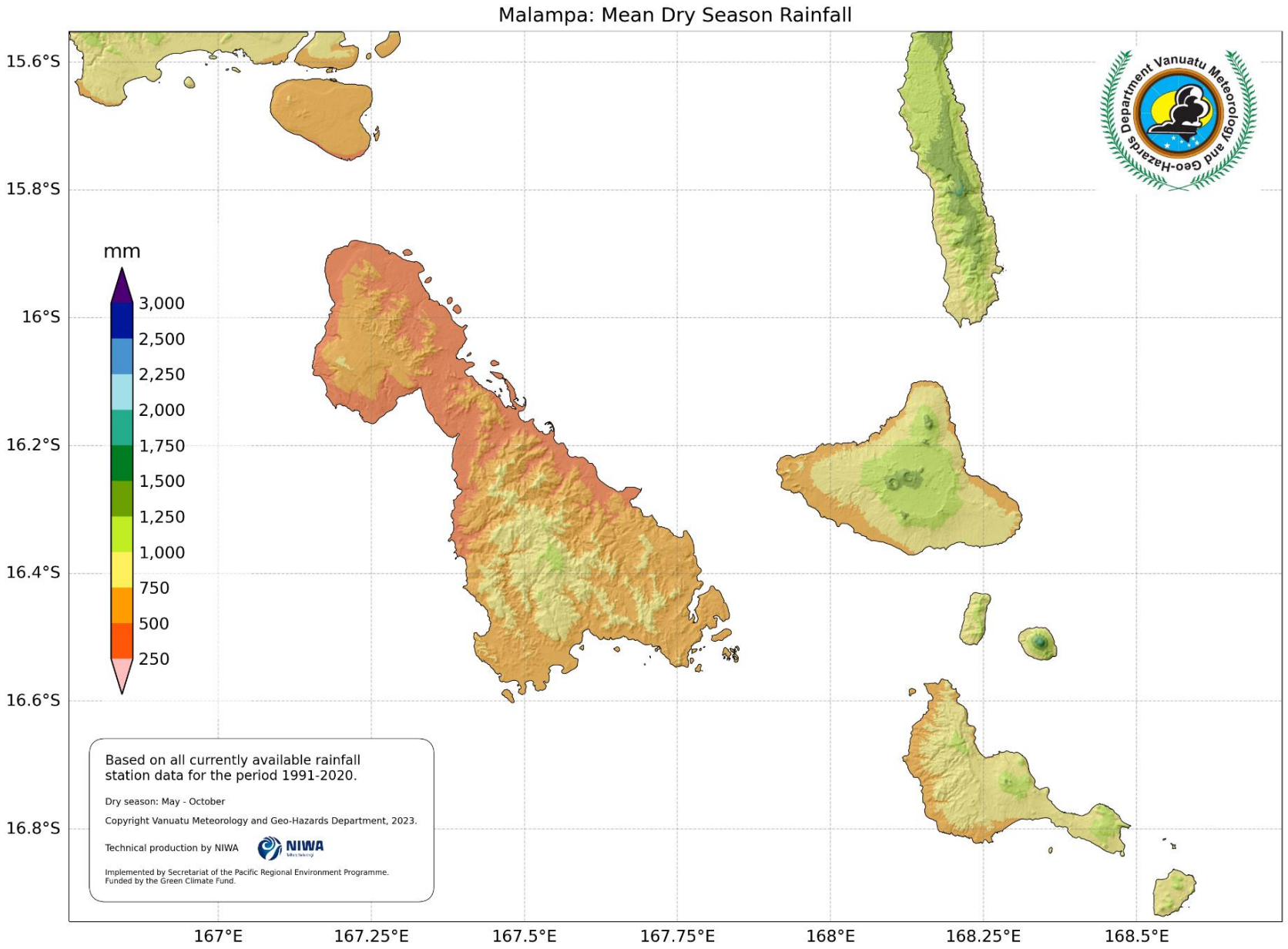

Figure 3-10: Average dry season rainfall, compared with La Niña (Figure 3-11) and El Niño (Figure 3-12) dry season rainfall, in Malampa Province.

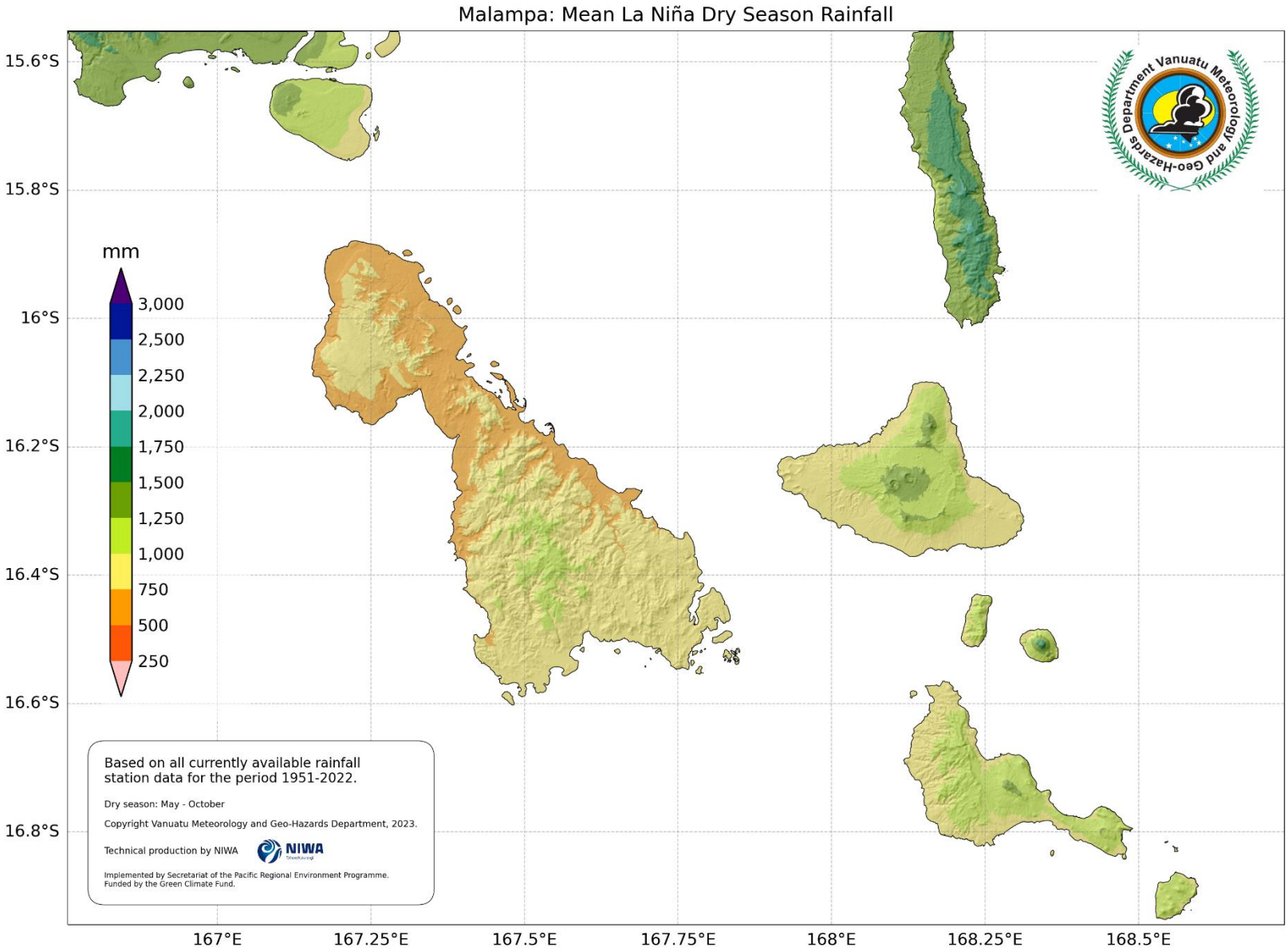

Figure 3-11: Average La Niña Dry Season rainfall in Malampa Province.

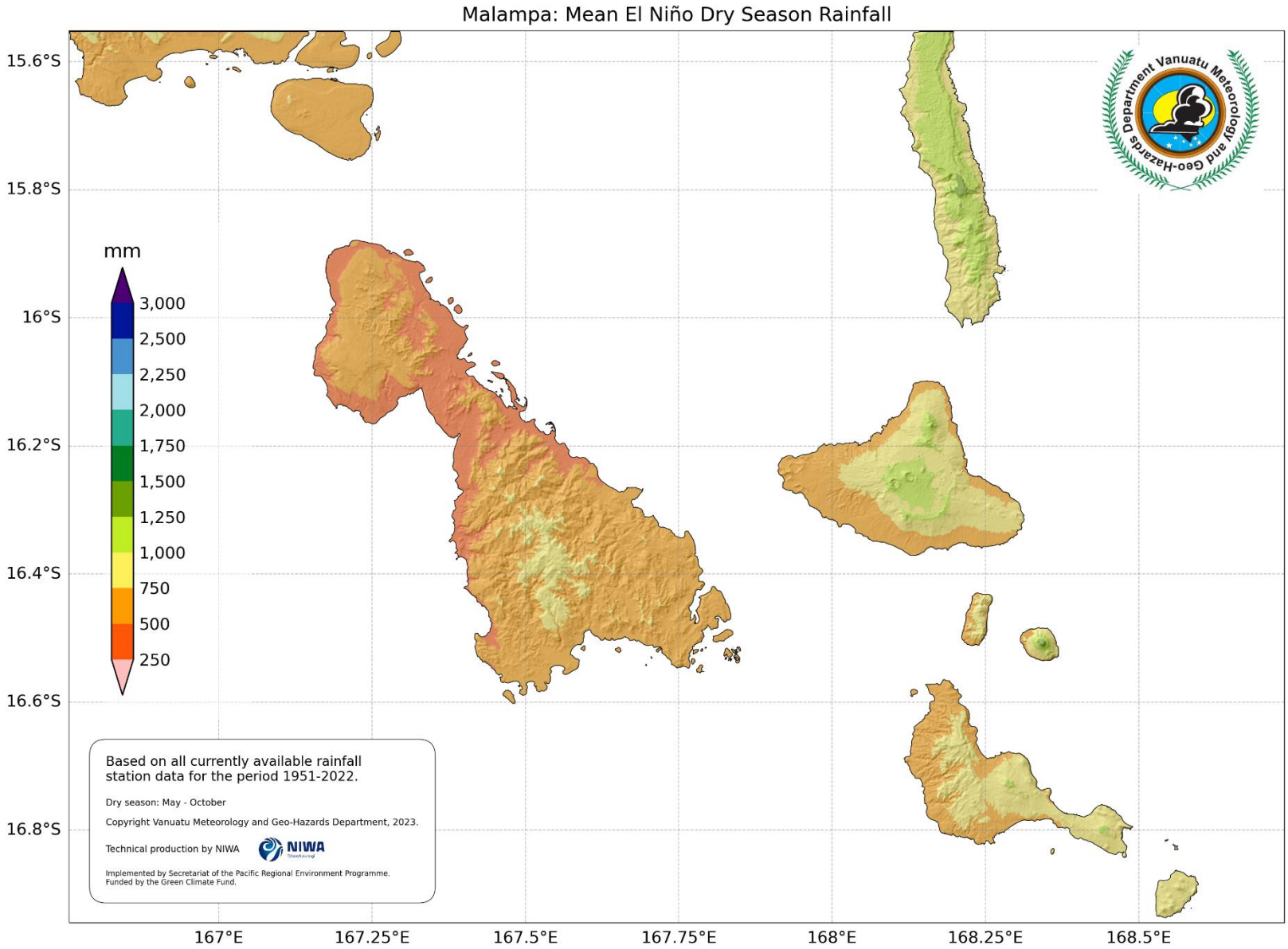

Figure 3-12: Average El Niño dry season rainfall in Malampa Province.

3.4 La Niña impact on average air temperature

A series of maps showing the impact of phases of ENSO on mean monthly rainfall and temperature were compiled. In most cases *averaged* changes due to ENSO at the monthly scale are typically minor. This is illustrated in figures 3-13, 3-14, 3-15 and 3-16 below, where there the typically expected cooling effect of La Niña on mean air temperatures in two example months, January and August, appears to be minimal.

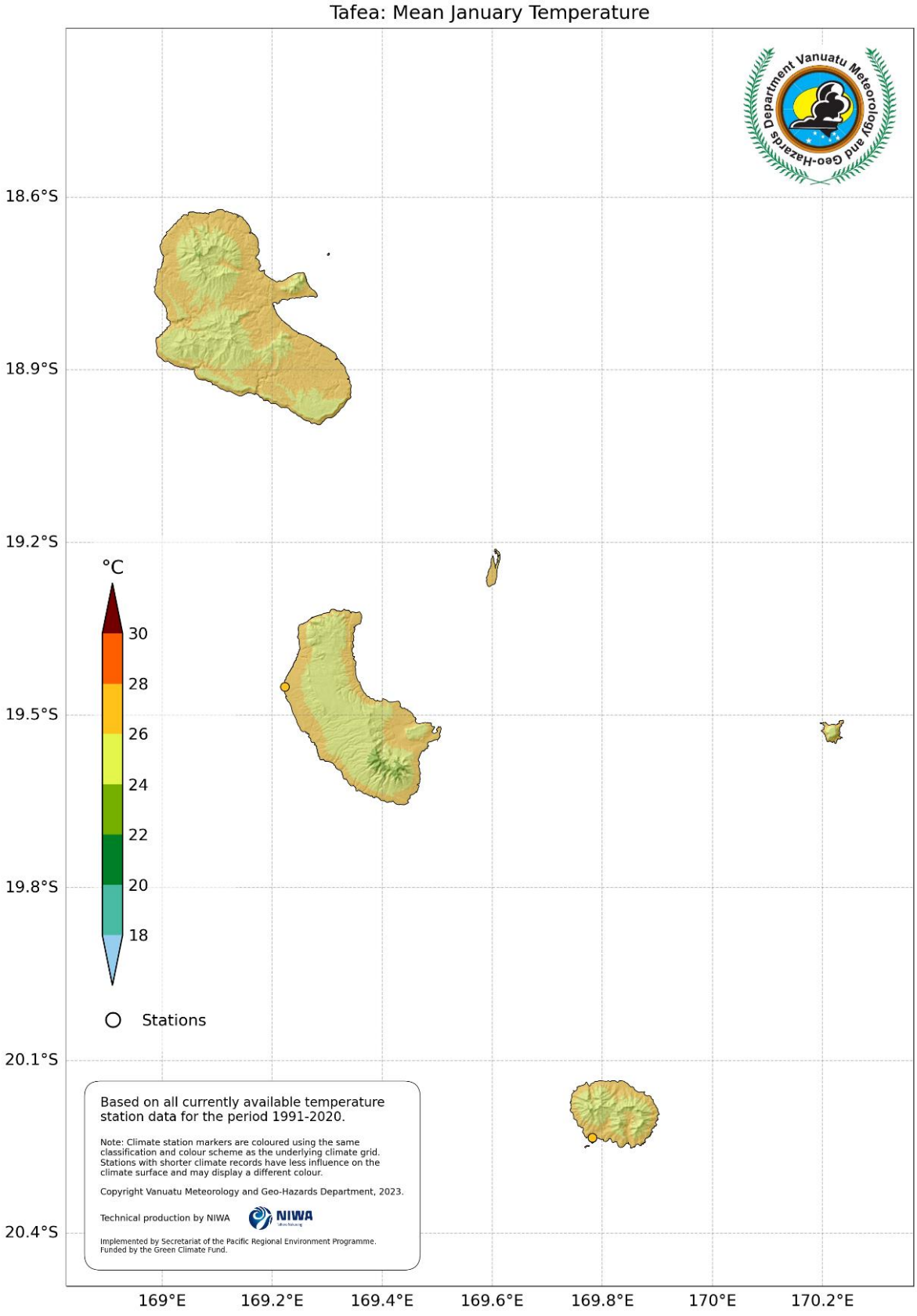

Figure 3-13: Average January air temperature, compared with average La Niña air temperature for January (Figure 3-14), in Tafea Province.

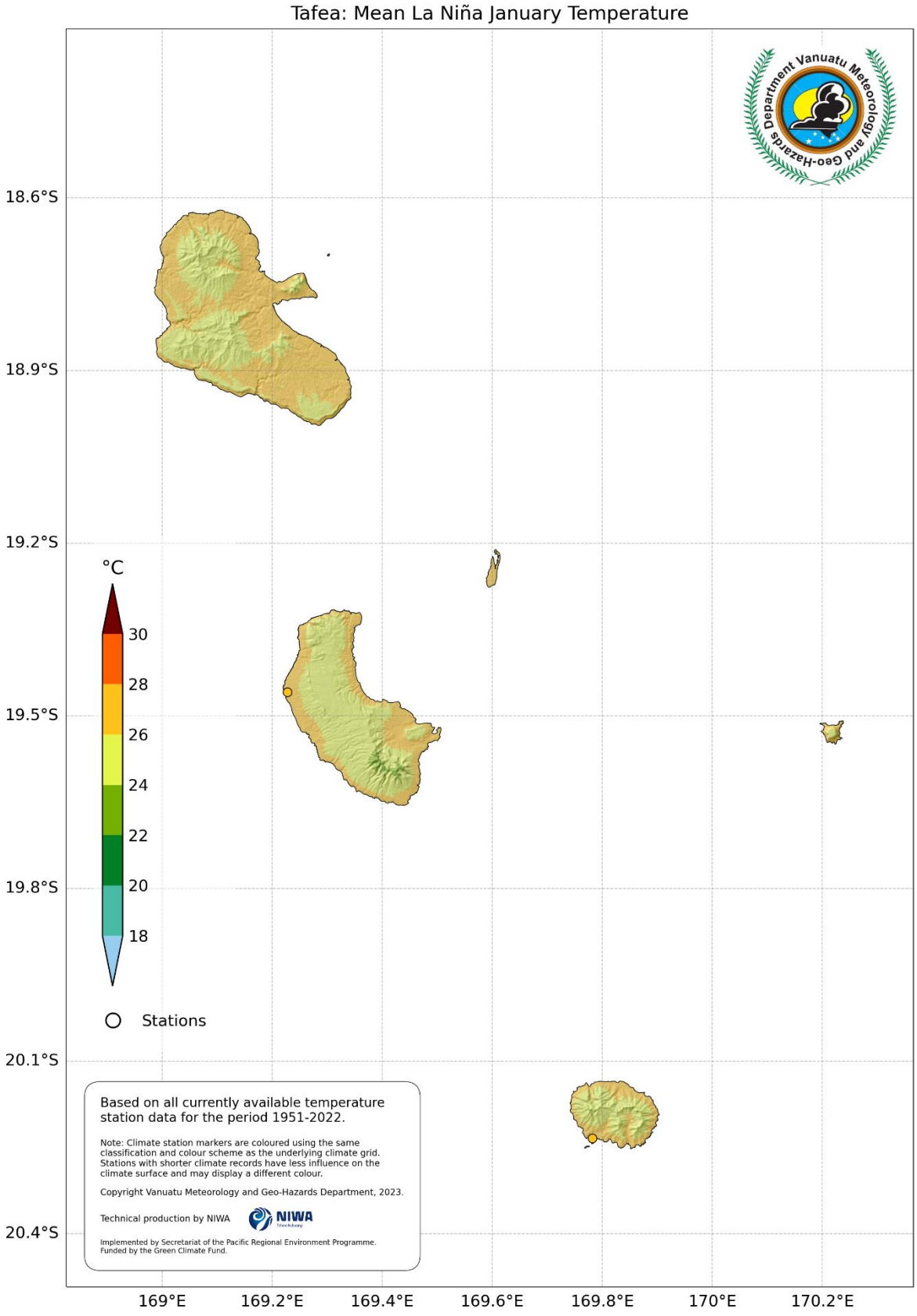

Figure 3-14: Average La Niña January air temperature in Tafea Province.

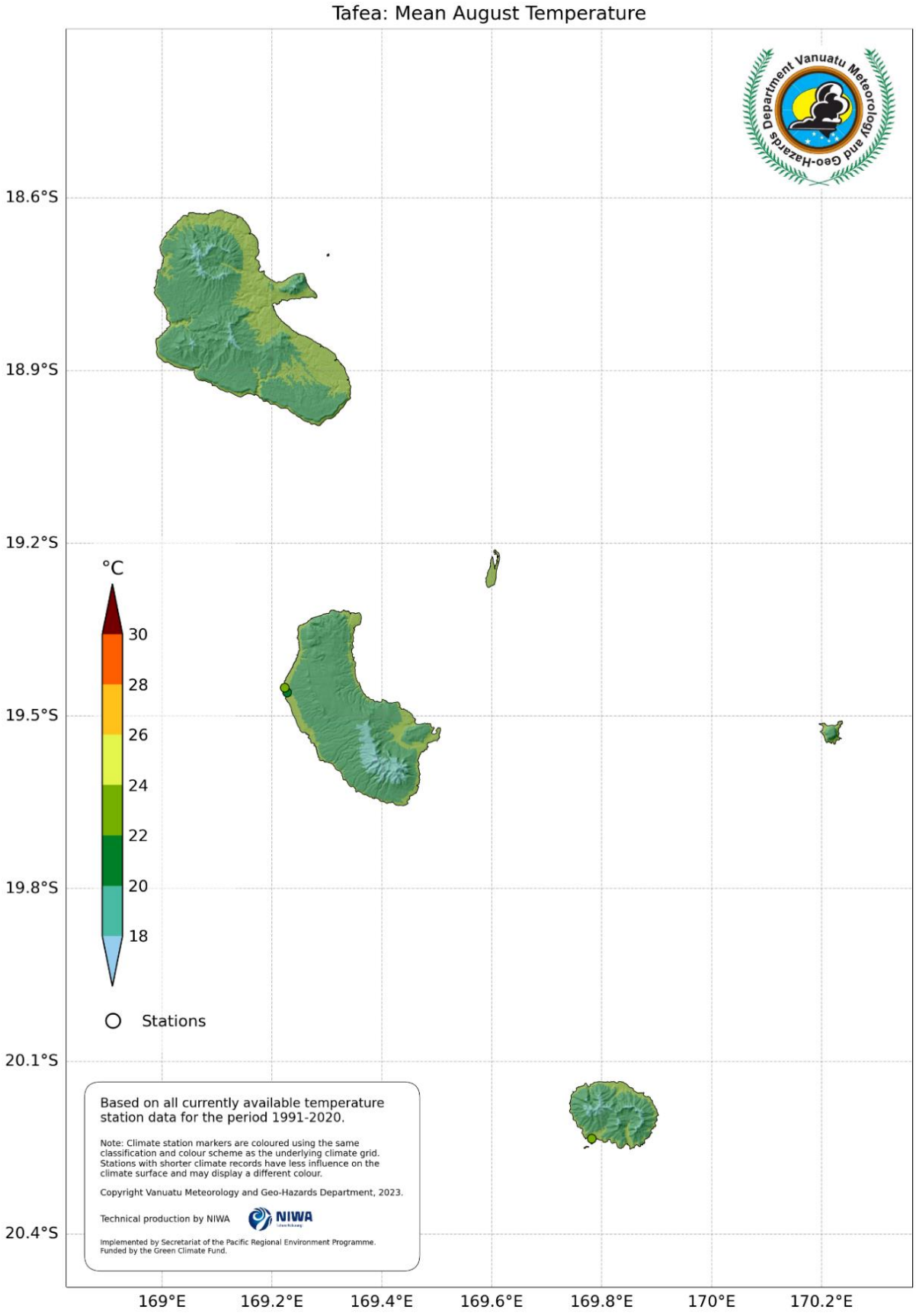

Figure 3-15: Average August air temperature, compared with average La Niña air temperature for August (Figure 3-16), in Tafea Province.

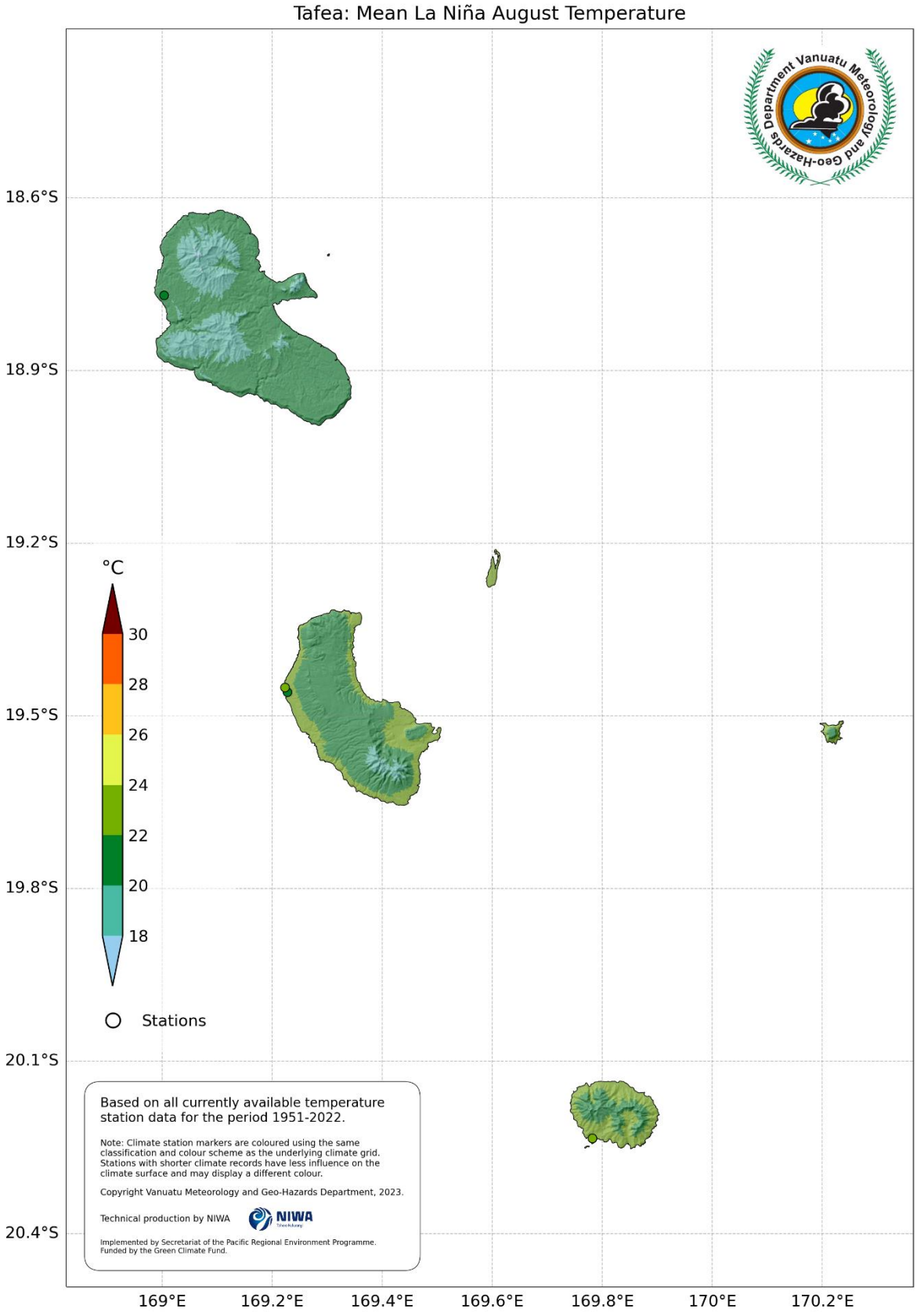

Figure 3-16: Average La Niña August air temperature in Tafea Province.

3.5 Digital map formats

The historical climate grids for Vanuatu have been converted and stored using the OGC standard GeoTIFF raster data format allowing for them to be shared easily with other organisations and used in a variety of GIS software applications.

The coordinate reference system used for these grids is the World Geodetic System 1984 (WGS84 ESPG code 4326). This common geographic coordinate system was chosen as it allows for the data to be combined with other geospatial datasets from the Pacific region.

4 Acknowledgements

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Appendix A Monthly ENSO phase categorisation

Table A-1: Monthly ENSO phase with average SOI centred on the month shown, January 1951 to December 2020. Values above 0.7 (below -0.7) were taken to be La Niña (El Niño) phases respectively.

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1951	January	1.42	1.06	La Niña
1951	February	0.84	0.87	La Niña
1951	March	0.01	0.41	Neutral
1951	April	0.12	0.33	Neutral
1951	May	-0.34	-0.03	Neutral
1951	June	1.01	0.03	Neutral
1951	July	-0.93	-0.13	Neutral
1951	August	0.27	-0.18	Neutral
1951	September	-0.69	-0.5	Neutral
1951	October	-0.59	-0.39	Neutral
1951	November	-0.55	-0.62	El Niño
1951	December	-0.41	-0.61	El Niño
1952	January	-0.87	-0.46	Neutral
1952	February	-0.62	-0.43	Neutral
1952	March	0.16	-0.13	Neutral
1952	April	-0.43	0.3	Neutral
1952	May	1.14	0.52	La Niña
1952	June	1.28	0.48	Neutral
1952	July	0.46	0.49	Neutral
1952	August	-0.06	0.33	Neutral
1952	September	-0.34	0.02	Neutral
1952	October	0.34	-0.33	Neutral
1952	November	-0.28	-0.28	Neutral
1952	December	-1.28	-0.31	Neutral
1953	January	0.15	-0.45	Neutral
1953	February	-0.46	-0.36	Neutral
1953	March	-0.38	-0.76	El Niño
1953	April	0.18	-0.75	El Niño
1953	May	-3.28	-0.67	El Niño
1953	June	0.19	-0.89	El Niño
1953	July	-0.08	-1.18	El Niño
1953	August	-1.46	-0.49	Neutral
1953	September	-1.26	-0.61	El Niño
1953	October	0.16	-0.69	El Niño

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1953	November	-0.41	-0.31	Neutral
1953	December	-0.5	-0.11	Neutral
1954	January	0.49	-0.13	Neutral
1954	February	-0.26	0.1	Neutral
1954	March	0.06	0.39	Neutral
1954	April	0.73	0.35	Neutral
1954	May	0.95	0.51	La Niña
1954	June	0.28	0.78	La Niña
1954	July	0.53	0.71	La Niña
1954	August	1.4	0.59	La Niña
1954	September	0.4	0.58	La Niña
1954	October	0.34	0.67	La Niña
1954	November	0.21	0.29	Neutral
1954	December	1.02	0.47	Neutral
1955	January	-0.53	0.48	Neutral
1955	February	1.32	0.44	Neutral
1955	March	0.4	0.63	La Niña
1955	April	0	1.19	La Niña
1955	May	1.96	1.39	La Niña
1955	June	2.28	1.68	La Niña
1955	July	2.3	1.94	La Niña
1955	August	1.86	1.87	La Niña
1955	September	1.32	1.69	La Niña
1955	October	1.6	1.37	La Niña
1955	November	1.38	1.19	La Niña
1955	December	0.7	1.14	La Niña
1956	January	0.95	1.02	La Niña
1956	February	1.08	0.95	La Niña
1956	March	0.98	1.31	La Niña
1956	April	1.03	1.49	La Niña
1956	May	2.52	1.58	La Niña
1956	June	1.82	1.67	La Niña
1956	July	1.53	1.47	La Niña
1956	August	1.46	1.34	La Niña
1956	September	0	0.98	La Niña
1956	October	1.89	0.83	La Niña
1956	November	0.00E+00	0.62	La Niña
1956	December	0.79	0.6	La Niña

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1957	January	0.44	0.23	Neutral
1957	February	-0.15	0.29	Neutral
1957	March	0.06	-0.07	Neutral
1957	April	0.3	-0.12	Neutral
1957	May	-0.98	-0.06	Neutral
1957	June	0.19	-0.2	Neutral
1957	July	0.15	-0.47	Neutral
1957	August	-0.66	-0.26	Neutral
1957	September	-1.03	-0.59	El Niño
1957	October	0.05	-0.71	El Niño
1957	November	-1.45	-0.89	El Niño
1957	December	-0.45	-0.79	El Niño
1958	January	-1.55	-0.8	El Niño
1958	February	-0.54	-0.45	Neutral
1958	March	0.01	-0.46	Neutral
1958	April	0.3	-0.06	Neutral
1958	May	-0.52	0.11	Neutral
1958	June	0.46	0.34	Neutral
1958	July	0.3	0.21	Neutral
1958	August	1.13	0.31	Neutral
1958	September	-0.34	0.08	Neutral
1958	October	-0.01	-0.13	Neutral
1958	November	-0.69	-0.52	El Niño
1958	December	-0.73	-0.68	El Niño
1959	January	-0.83	-0.5	Neutral
1959	February	-1.13	-0.27	Neutral
1959	March	0.88	0.03	Neutral
1959	April	0.48	0.15	Neutral
1959	May	0.77	0.27	Neutral
1959	June	-0.26	0.05	Neutral
1959	July	-0.54	-0.05	Neutral
1959	August	-0.2	-0.09	Neutral
1959	September	0	0.16	Neutral
1959	October	0.57	0.39	Neutral
1959	November	0.97	0.42	Neutral
1959	December	0.6	0.39	Neutral
1960	January	-0.02	0.41	Neutral
1960	February	-0.15	0.37	Neutral

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1960	March	0.64	0.46	Neutral
1960	April	0.79	0.5	La Niña
1960	May	1.04	0.65	La Niña
1960	June	0.19	0.73	La Niña
1960	July	0.61	0.7	La Niña
1960	August	1	0.51	La Niña
1960	September	0.63	0.58	La Niña
1960	October	0.11	0.55	La Niña
1960	November	0.55	0.3	Neutral
1960	December	0.47	0.28	Neutral
1961	January	-0.28	-0.09	Neutral
1961	February	0.57	-0.01	Neutral
1961	March	-1.74	0.01	Neutral
1961	April	0.91	0.09	Neutral
1961	May	0.58	0.03	Neutral
1961	June	0.1	0.45	Neutral
1961	July	0.3	0.28	Neutral
1961	August	0.33	0.1	Neutral
1961	September	0.06	0.19	Neutral
1961	October	-0.3	0.35	Neutral
1961	November	0.55	0.58	La Niña
1961	December	1.11	0.66	La Niña
1962	January	1.46	0.72	La Niña
1962	February	0.49	0.67	La Niña
1962	March	0.01	0.83	La Niña
1962	April	0.3	0.74	La Niña
1962	May	1.87	0.64	La Niña
1962	June	1.01	0.8	La Niña
1962	July	-0.01	0.83	La Niña
1962	August	0.8	0.68	La Niña
1962	September	0.46	0.55	La Niña
1962	October	1.14	0.53	La Niña
1962	November	0.35	0.53	La Niña
1962	December	-0.09	0.49	Neutral
1963	January	0.78	0.42	Neutral
1963	February	0.29	0.49	Neutral
1963	March	0.79	0.66	La Niña
1963	April	0.67	0.38	Neutral

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1963	May	0.77	0.3	Neutral
1963	June	-0.62	0.16	Neutral
1963	July	-0.08	-0.08	Neutral
1963	August	0.07	-0.44	Neutral
1963	September	-0.51	-0.55	El Niño
1963	October	-1.05	-0.77	El Niño
1963	November	-1.17	-0.87	El Niño
1963	December	-1.19	-0.76	El Niño
1964	January	-0.4	-0.37	Neutral
1964	February	0.01	0.1	Neutral
1964	March	0.88	0.49	Neutral
1964	April	1.22	0.83	La Niña
1964	May	0.77	1	La Niña
1964	June	1.28	1.18	La Niña
1964	July	0.84	1.2	La Niña
1964	August	1.8	1.32	La Niña
1964	September	1.32	1.08	La Niña
1964	October	1.37	0.83	La Niña
1964	November	0.07	0.39	Neutral
1964	December	-0.41	0.16	Neutral
1965	January	-0.4	-0.03	Neutral
1965	February	0.17	-0.2	Neutral
1965	March	0.4	-0.03	Neutral
1965	April	-0.74	-0.15	Neutral
1965	May	0.4	-0.71	El Niño
1965	June	-0.98	-0.96	El Niño
1965	July	-2.61	-1.09	El Niño
1965	August	-0.86	-1.34	El Niño
1965	September	-1.38	-1.56	El Niño
1965	October	-0.87	-1.04	El Niño
1965	November	-2.07	-1.09	El Niño
1965	December	0.01	-0.87	El Niño
1966	January	-1.12	-0.92	El Niño
1966	February	-0.3	-0.57	El Niño
1966	March	-1.11	-0.69	El Niño
1966	April	-0.31	-0.36	Neutral
1966	May	-0.61	-0.31	Neutral
1966	June	0.56	0.06	Neutral

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1966	July	-0.08	0.07	Neutral
1966	August	0.73	0.18	Neutral
1966	September	-0.23	0.03	Neutral
1966	October	-0.07	-0.05	Neutral
1966	November	-0.21	0.05	Neutral
1966	December	-0.5	0.32	Neutral
1967	January	1.25	0.5	Neutral
1967	February	1.12	0.54	La Niña
1967	March	0.83	0.65	La Niña
1967	April	0	0.63	La Niña
1967	May	0.03	0.45	Neutral
1967	June	1.19	0.47	Neutral
1967	July	0.23	0.57	La Niña
1967	August	0.93	0.59	La Niña
1967	September	0.46	0.23	Neutral
1967	October	0.16	0.06	Neutral
1967	November	-0.62	-0.06	Neutral
1967	December	-0.64	0.01	Neutral
1968	January	0.32	-0.05	Neutral
1968	February	0.84	0.08	Neutral
1968	March	-0.14	0.63	La Niña
1968	April	0	0.94	La Niña
1968	May	2.15	0.95	La Niña
1968	June	1.82	1.04	La Niña
1968	July	0.92	0.99	La Niña
1968	August	0.33	0.56	La Niña
1968	September	-0.29	0.08	Neutral
1968	October	-0.01	-0.09	Neutral
1968	November	-0.55	-0.41	Neutral
1968	December	0.05	-0.46	Neutral
1969	January	-1.25	-0.4	Neutral
1969	February	-0.54	-0.37	Neutral
1969	March	0.3	-0.45	Neutral
1969	April	-0.43	-0.13	Neutral
1969	May	-0.34	-0.17	Neutral
1969	June	0.37	-0.26	Neutral
1969	July	-0.77	-0.38	Neutral
1969	August	-0.13	-0.5	Neutral

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1969	September	-1.03	-0.61	El Niño
1969	October	-0.93	-0.42	Neutral
1969	November	-0.21	-0.59	El Niño
1969	December	0.19	-0.55	El Niño
1970	January	-0.95	-0.31	Neutral
1970	February	-0.86	-0.29	Neutral
1970	March	0.3	-0.19	Neutral
1970	April	-0.13	0.31	Neutral
1970	May	0.68	0.36	Neutral
1970	June	1.55	0.44	Neutral
1970	July	-0.62	0.71	La Niña
1970	August	0.73	0.8	La Niña
1970	September	1.21	0.87	La Niña
1970	October	1.14	1.28	La Niña
1970	November	1.87	1.17	La Niña
1970	December	1.43	1.2	La Niña
1971	January	0.19	1.34	La Niña
1971	February	1.36	1.34	La Niña
1971	March	1.85	1.36	La Niña
1971	April	1.89	1.47	La Niña
1971	May	1.5	1.24	La Niña
1971	June	0.74	1.24	La Niña
1971	July	0.23	1.16	La Niña
1971	August	1.86	1.23	La Niña
1971	September	1.49	1.19	La Niña
1971	October	1.83	1.16	La Niña
1971	November	0.55	0.84	La Niña
1971	December	0.05	0.69	La Niña
1972	January	0.27	0.39	Neutral
1972	February	0.73	0.24	Neutral
1972	March	0.35	-0.06	Neutral
1972	April	-0.19	-0.29	Neutral
1972	May	-1.44	-0.87	El Niño
1972	June	-0.89	-1.05	El Niño
1972	July	-2.15	-1.3	El Niño
1972	August	-0.6	-1.19	El Niño
1972	September	-1.43	-1.12	El Niño
1972	October	-0.87	-0.94	El Niño

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1972	November	-0.55	-0.88	El Niño
1972	December	-1.23	-0.82	El Niño
1973	January	-0.32	-0.6	El Niño
1973	February	-1.1	-0.48	Neutral
1973	March	0.2	-0.08	Neutral
1973	April	0.06	0.35	Neutral
1973	May	0.77	0.72	La Niña
1973	June	1.82	1	La Niña
1973	July	0.76	1.24	La Niña
1973	August	1.6	1.31	La Niña
1973	September	1.26	1.56	La Niña
1973	October	1.09	1.69	La Niña
1973	November	3.11	1.73	La Niña
1973	December	1.38	1.76	La Niña
1974	January	1.8	1.93	La Niña
1974	February	1.4	1.51	La Niña
1974	March	1.95	1.57	La Niña
1974	April	1.03	1.36	La Niña
1974	May	1.69	1.37	La Niña
1974	June	0.74	1.18	La Niña
1974	July	1.45	1.21	La Niña
1974	August	1	1.06	La Niña
1974	September	1.15	0.85	La Niña
1974	October	0.97	0.51	La Niña
1974	November	-0.35	0.21	Neutral
1974	December	-0.22	0.08	Neutral
1975	January	-0.49	0.12	Neutral
1975	February	0.49	0.45	Neutral
1975	March	1.17	0.72	La Niña
1975	April	1.28	1.25	La Niña
1975	May	1.14	1.66	La Niña
1975	June	2.19	1.92	La Niña
1975	July	2.53	2.09	La Niña
1975	August	2.46	2.23	La Niña
1975	September	2.13	2.04	La Niña
1975	October	1.83	1.86	La Niña
1975	November	1.24	1.56	La Niña
1975	December	1.61	1.36	La Niña

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1976	January	0.99	1.26	La Niña
1976	February	1.12	1.07	La Niña
1976	March	1.32	0.88	La Niña
1976	April	0.3	0.78	La Niña
1976	May	0.68	0.26	Neutral
1976	June	0.46	-0.19	Neutral
1976	July	-1.46	-0.5	El Niño
1976	August	-0.93	-0.55	El Niño
1976	September	-1.26	-0.47	Neutral
1976	October	0.45	-0.26	Neutral
1976	November	0.83	-0.16	Neutral
1976	December	-0.41	0.23	Neutral
1977	January	-0.4	0	Neutral
1977	February	0.69	-0.27	Neutral
1977	March	-0.72	-0.36	Neutral
1977	April	-0.49	-0.59	El Niño
1977	May	-0.89	-1.06	El Niño
1977	June	-1.53	-1.11	El Niño
1977	July	-1.69	-1.19	El Niño
1977	August	-0.93	-1.22	El Niño
1977	September	-0.92	-1.26	El Niño
1977	October	-1.05	-1.14	El Niño
1977	November	-1.73	-1.02	El Niño
1977	December	-1.1	-1.24	El Niño
1978	January	-0.32	-1.11	El Niño
1978	February	-2.01	-0.83	El Niño
1978	March	-0.38	-0.15	Neutral
1978	April	-0.37	0.14	Neutral
1978	May	2.33	0.69	La Niña
1978	June	1.1	0.86	La Niña
1978	July	0.76	0.94	La Niña
1978	August	0.47	0.39	Neutral
1978	September	0.06	0.09	Neutral
1978	October	-0.41	-0.1	Neutral
1978	November	-0.41	-0.28	Neutral
1978	December	-0.22	-0.17	Neutral
1979	January	-0.4	-0.11	Neutral
1979	February	0.61	-0.07	Neutral

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1979	March	-0.14	0.15	Neutral
1979	April	-0.19	0.45	Neutral
1979	May	0.86	0.14	Neutral
1979	June	1.1	0.13	Neutral
1979	July	-0.93	0.19	Neutral
1979	August	-0.2	0.01	Neutral
1979	September	0.12	-0.35	Neutral
1979	October	-0.07	-0.33	Neutral
1979	November	-0.69	-0.25	Neutral
1979	December	-0.82	-0.24	Neutral
1980	January	0.23	-0.35	Neutral
1980	February	0.13	-0.36	Neutral
1980	March	-0.62	-0.19	Neutral
1980	April	-0.74	-0.25	Neutral
1980	May	0.03	-0.31	Neutral
1980	June	-0.08	-0.09	Neutral
1980	July	-0.16	-0.05	Neutral
1980	August	0.47	-0.06	Neutral
1980	September	-0.51	-0.15	Neutral
1980	October	-0.01	-0.17	Neutral
1980	November	-0.55	-0.22	Neutral
1980	December	-0.22	-0.16	Neutral
1981	January	0.19	-0.43	Neutral
1981	February	-0.22	-0.36	Neutral
1981	March	-1.35	-0.05	Neutral
1981	April	-0.19	0.26	Neutral
1981	May	1.32	0.53	La Niña
1981	June	1.73	0.99	La Niña
1981	July	1.15	1.16	La Niña
1981	August	0.93	0.84	La Niña
1981	September	0.69	0.51	La Niña
1981	October	-0.3	0.34	Neutral
1981	November	0.07	0.31	Neutral
1981	December	0.28	0.19	Neutral
1982	January	0.78	0.31	Neutral
1982	February	0.09	0.29	Neutral
1982	March	0.35	0.13	Neutral
1982	April	-0.07	-0.39	Neutral

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1982	May	-0.52	-0.85	El Niño
1982	June	-1.8	-1.35	El Niño
1982	July	-2.23	-1.75	El Niño
1982	August	-2.12	-1.99	El Niño
1982	September	-2.06	-2.32	El Niño
1982	October	-1.74	-2.29	El Niño
1982	November	-3.45	-2.42	El Niño
1982	December	-2.06	-2.56	El Niño
1983	January	-2.77	-2.68	El Niño
1983	February	-2.76	-2.2	El Niño
1983	March	-2.37	-1.56	El Niño
1983	April	-1.04	-0.99	El Niño
1983	May	1.14	-0.6	El Niño
1983	June	0.1	-0.06	Neutral
1983	July	-0.85	0.33	Neutral
1983	August	0.33	0.21	Neutral
1983	September	0.92	0.14	Neutral
1983	October	0.57	0.28	Neutral
1983	November	-0.28	0.23	Neutral
1983	December	-0.13	0.15	Neutral
1984	January	0.06	-0.04	Neutral
1984	February	0.53	0.09	Neutral
1984	March	-0.38	0.19	Neutral
1984	April	0.36	0.08	Neutral
1984	May	0.4	0.03	Neutral
1984	June	-0.53	0.23	Neutral
1984	July	0.3	0.19	Neutral
1984	August	0.6	0.05	Neutral
1984	September	0.17	0.2	Neutral
1984	October	-0.3	0.08	Neutral
1984	November	0.21	-0.11	Neutral
1984	December	-0.27	-0.02	Neutral
1985	January	-0.36	0.03	Neutral
1985	February	0.61	0.24	Neutral
1985	March	-0.04	0.45	Neutral
1985	April	1.28	0.4	Neutral
1985	May	0.77	0.23	Neutral
1985	June	-0.62	0.48	Neutral

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1985	July	-0.24	0.22	Neutral
1985	August	1.2	0	Neutral
1985	September	0	0.05	Neutral
1985	October	-0.36	0.11	Neutral
1985	November	-0.35	0	Neutral
1985	December	0.05	-0.17	Neutral
1986	January	0.65	-0.06	Neutral
1986	February	-0.86	0.07	Neutral
1986	March	0.2	-0.01	Neutral
1986	April	0.3	0.19	Neutral
1986	May	-0.34	0.42	Neutral
1986	June	1.64	0.29	Neutral
1986	July	0.3	0.13	Neutral
1986	August	-0.46	0.34	Neutral
1986	September	-0.51	-0.32	Neutral
1986	October	0.74	-0.65	El Niño
1986	November	-1.66	-0.68	El Niño
1986	December	-1.37	-0.78	El Niño
1987	January	-0.62	-1.2	El Niño
1987	February	-1.02	-1.19	El Niño
1987	March	-1.35	-1.33	El Niño
1987	April	-1.59	-1.57	El Niño
1987	May	-2.09	-1.8	El Niño
1987	June	-1.8	-1.75	El Niño
1987	July	-2.15	-1.65	El Niño
1987	August	-1.13	-1.31	El Niño
1987	September	-1.09	-1.01	El Niño
1987	October	-0.36	-0.69	El Niño
1987	November	-0.35	-0.5	Neutral
1987	December	-0.55	-0.36	Neutral
1988	January	-0.15	-0.21	Neutral
1988	February	-0.38	-0.12	Neutral
1988	March	0.35	0.31	Neutral
1988	April	0.12	0.34	Neutral
1988	May	1.6	0.69	La Niña
1988	June	0.01	0.99	La Niña
1988	July	1.38	1.35	La Niña
1988	August	1.86	1.34	La Niña

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1988	September	1.9	1.74	La Niña
1988	October	1.55	1.63	La Niña
1988	November	2	1.48	La Niña
1988	December	0.83	1.26	La Niña
1989	January	1.12	1.1	La Niña
1989	February	0.8	1.05	La Niña
1989	March	0.74	1.32	La Niña
1989	April	1.76	1.35	La Niña
1989	May	2.15	1.42	La Niña
1989	June	1.28	1.2	La Niña
1989	July	1.15	0.95	La Niña
1989	August	-0.33	0.69	La Niña
1989	September	0.52	0.36	Neutral
1989	October	0.85	0.01	Neutral
1989	November	-0.41	0.04	Neutral
1989	December	-0.59	-0.34	Neutral
1990	January	-0.15	-0.64	El Niño
1990	February	-1.41	-0.52	El Niño
1990	March	-0.62	-0.01	Neutral
1990	April	0.18	0.13	Neutral
1990	May	1.96	0.55	La Niña
1990	June	0.56	0.64	La Niña
1990	July	0.69	0.45	Neutral
1990	August	-0.2	0.13	Neutral
1990	September	-0.74	-0.14	Neutral
1990	October	0.34	-0.35	Neutral
1990	November	-0.76	-0.23	Neutral
1990	December	-0.36	-0.06	Neutral
1991	January	0.4	-0.29	Neutral
1991	February	0.09	-0.28	Neutral
1991	March	-0.81	-0.57	El Niño
1991	April	-0.74	-0.69	El Niño
1991	May	-1.81	-0.74	El Niño
1991	June	-0.17	-0.67	El Niño
1991	July	-0.16	-0.84	El Niño
1991	August	-0.46	-0.69	El Niño
1991	September	-1.61	-0.85	El Niño
1991	October	-1.05	-1.15	El Niño

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1991	November	-0.97	-1.52	El Niño
1991	December	-1.65	-1.34	El Niño
1992	January	-2.31	-1.54	El Niño
1992	February	-0.74	-1.58	El Niño
1992	March	-2.03	-1.15	El Niño
1992	April	-1.16	-0.88	El Niño
1992	May	0.49	-0.89	El Niño
1992	June	-0.98	-0.39	Neutral
1992	July	-0.77	-0.15	Neutral
1992	August	0.47	-0.54	El Niño
1992	September	0.06	-0.53	El Niño
1992	October	-1.45	-0.51	El Niño
1992	November	-0.97	-0.76	El Niño
1992	December	-0.64	-0.89	El Niño
1993	January	-0.78	-0.73	El Niño
1993	February	-0.62	-0.8	El Niño
1993	March	-0.62	-0.78	El Niño
1993	April	-1.35	-0.89	El Niño
1993	May	-0.52	-1.01	El Niño
1993	June	-1.35	-1.14	El Niño
1993	July	-1.23	-1.02	El Niño
1993	August	-1.26	-1.14	El Niño
1993	September	-0.74	-0.9	El Niño
1993	October	-1.1	-0.65	El Niño
1993	November	-0.14	-0.43	Neutral
1993	December	0.01	-0.27	Neutral
1994	January	-0.19	-0.21	Neutral
1994	February	0.09	-0.47	Neutral
1994	March	-0.81	-0.69	El Niño
1994	April	-1.47	-0.8	El Niño
1994	May	-1.07	-1.23	El Niño
1994	June	-0.71	-1.36	El Niño
1994	July	-2.08	-1.4	El Niño
1994	August	-1.46	-1.41	El Niño
1994	September	-1.66	-1.47	El Niño
1994	October	-1.16	-1.29	El Niño
1994	November	-0.97	-1.08	El Niño
1994	December	-1.19	-0.79	El Niño

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1995	January	-0.4	-0.48	Neutral
1995	February	-0.22	-0.46	Neutral
1995	March	0.4	-0.34	Neutral
1995	April	-0.86	-0.2	Neutral
1995	May	-0.61	-0.05	Neutral
1995	June	0.28	-0.05	Neutral
1995	July	0.53	0.17	Neutral
1995	August	0.4	0.3	Neutral
1995	September	0.23	0.23	Neutral
1995	October	0.05	0	Neutral
1995	November	-0.07	0.06	Neutral
1995	December	-0.59	0.04	Neutral
1996	January	0.7	0.16	Neutral
1996	February	0.09	0.33	Neutral
1996	March	0.69	0.57	La Niña
1996	April	0.79	0.81	La Niña
1996	May	0.58	0.96	La Niña
1996	June	1.91	0.98	La Niña
1996	July	0.84	0.95	La Niña
1996	August	0.8	0.95	La Niña
1996	September	0.63	0.53	La Niña
1996	October	0.57	0.49	Neutral
1996	November	-0.21	0.4	Neutral
1996	December	0.65	0.51	La Niña
1997	January	0.36	0.28	Neutral
1997	February	1.16	0.11	Neutral
1997	March	-0.57	-0.44	Neutral
1997	April	-1.04	-0.96	El Niño
1997	May	-2.09	-1.42	El Niño
1997	June	-2.25	-1.65	El Niño
1997	July	-1.16	-1.73	El Niño
1997	August	-1.73	-1.6	El Niño
1997	September	-1.43	-1.48	El Niño
1997	October	-1.45	-1.45	El Niño
1997	November	-1.66	-1.54	El Niño
1997	December	-0.96	-1.56	El Niño
1998	January	-2.18	-1.77	El Niño
1998	February	-1.57	-1.76	El Niño

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
1998	March	-2.46	-1.47	El Niño
1998	April	-1.65	-0.73	El Niño
1998	May	0.49	-0.06	Neutral
1998	June	1.55	0.7	La Niña
1998	July	1.76	1.23	La Niña
1998	August	1.33	1.38	La Niña
1998	September	1.04	1.29	La Niña
1998	October	1.2	1.15	La Niña
1998	November	1.11	1.15	La Niña
1998	December	1.06	1.09	La Niña
1999	January	1.33	1.03	La Niña
1999	February	0.73	1.11	La Niña
1999	March	0.93	1	La Niña
1999	April	1.52	0.83	La Niña
1999	May	0.49	0.82	La Niña
1999	June	0.46	0.74	La Niña
1999	July	0.69	0.42	Neutral
1999	August	0.53	0.53	La Niña
1999	September	-0.06	0.66	La Niña
1999	October	1.03	0.73	La Niña
1999	November	1.11	0.7	La Niña
1999	December	1.02	0.93	La Niña
2000	January	0.4	0.92	La Niña
2000	February	1.12	1	La Niña
2000	March	0.98	0.96	La Niña
2000	April	1.46	0.85	La Niña
2000	May	0.86	0.55	La Niña
2000	June	-0.17	0.53	La Niña
2000	July	-0.39	0.42	Neutral
2000	August	0.87	0.46	Neutral
2000	September	0.92	0.92	La Niña
2000	October	1.09	1.11	La Niña
2000	November	2.14	1.08	La Niña
2000	December	0.56	1.1	La Niña
2001	January	0.7	1.04	La Niña
2001	February	1.04	0.65	La Niña
2001	March	0.74	0.42	Neutral
2001	April	0.24	0.41	Neutral

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
2001	May	-0.61	0.12	Neutral
2001	June	0.65	-0.14	Neutral
2001	July	-0.39	-0.17	Neutral
2001	August	-0.6	-0.05	Neutral
2001	September	0.12	-0.06	Neutral
2001	October	-0.01	-0.18	Neutral
2001	November	0.55	-0.02	Neutral
2001	December	-0.96	0.09	Neutral
2002	January	0.19	0.03	Neutral
2002	February	0.69	-0.1	Neutral
2002	March	-0.33	-0.16	Neutral
2002	April	-0.07	-0.25	Neutral
2002	May	-1.26	-0.55	El Niño
2002	June	-0.26	-0.73	El Niño
2002	July	-0.85	-0.86	El Niño
2002	August	-1.19	-0.72	El Niño
2002	September	-0.74	-0.83	El Niño
2002	October	-0.53	-0.88	El Niño
2002	November	-0.83	-0.69	El Niño
2002	December	-1.1	-0.65	El Niño
2003	January	-0.23	-0.64	El Niño
2003	February	-0.58	-0.51	El Niño
2003	March	-0.48	-0.38	Neutral
2003	April	-0.19	-0.53	El Niño
2003	May	-0.43	-0.34	Neutral
2003	June	-0.98	-0.22	Neutral
2003	July	0.38	-0.23	Neutral
2003	August	0.14	-0.14	Neutral
2003	September	-0.23	-0.06	Neutral
2003	October	-0.01	0.01	Neutral
2003	November	-0.55	-0.24	Neutral
2003	December	0.7	-0.03	Neutral
2004	January	-1.08	0	Neutral
2004	February	0.8	-0.07	Neutral
2004	March	0.16	0.19	Neutral
2004	April	-0.92	0.15	Neutral
2004	May	1.96	-0.17	Neutral
2004	June	-1.26	-0.29	Neutral

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
2004	July	-0.77	-0.16	Neutral
2004	August	-0.46	-0.59	El Niño
2004	September	-0.29	-0.56	El Niño
2004	October	-0.18	-0.58	El Niño
2004	November	-1.11	-0.47	Neutral
2004	December	-0.87	-0.88	El Niño
2005	January	0.1	-0.82	El Niño
2005	February	-2.36	-0.72	El Niño
2005	March	0.16	-0.79	El Niño
2005	April	-0.61	-0.67	El Niño
2005	May	-1.26	-0.17	Neutral
2005	June	0.74	-0.28	Neutral
2005	July	0.15	-0.08	Neutral
2005	August	-0.4	0.41	Neutral
2005	September	0.35	0.18	Neutral
2005	October	1.2	0.12	Neutral
2005	November	-0.41	0.42	Neutral
2005	December	-0.13	0.36	Neutral
2006	January	1.08	0.39	Neutral
2006	February	0.05	0.73	La Niña
2006	March	1.37	0.61	La Niña
2006	April	1.28	0.35	Neutral
2006	May	-0.71	0.17	Neutral
2006	June	-0.26	-0.37	Neutral
2006	July	-0.85	-0.74	El Niño
2006	August	-1.33	-0.87	El Niño
2006	September	-0.57	-0.89	El Niño
2006	October	-1.33	-0.81	El Niño
2006	November	-0.35	-0.68	El Niño
2006	December	-0.45	-0.6	El Niño
2007	January	-0.7	-0.33	Neutral
2007	February	-0.18	-0.27	Neutral
2007	March	0.01	-0.15	Neutral
2007	April	0	0.19	Neutral
2007	May	0.12	0.12	Neutral
2007	June	1.01	0.24	Neutral
2007	July	-0.54	0.26	Neutral
2007	August	0.6	0.37	Neutral

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
2007	September	0.12	0.32	Neutral
2007	October	0.68	0.66	La Niña
2007	November	0.76	0.78	La Niña
2007	December	1.16	1.13	La Niña
2008	January	1.21	1.24	La Niña
2008	February	1.83	1.19	La Niña
2008	March	1.22	0.97	La Niña
2008	April	0.54	0.91	La Niña
2008	May	0.03	0.6	La Niña
2008	June	0.92	0.61	La Niña
2008	July	0.3	0.76	La Niña
2008	August	1.26	1.04	La Niña
2008	September	1.26	1.17	La Niña
2008	October	1.43	1.31	La Niña
2008	November	1.59	1.22	La Niña
2008	December	1.02	1.22	La Niña
2009	January	0.78	0.96	La Niña
2009	February	1.28	0.82	La Niña
2009	March	0.16	0.55	La Niña
2009	April	0.85	0.43	Neutral
2009	May	-0.34	0.23	Neutral
2009	June	0.19	0.18	Neutral
2009	July	0.3	0.07	Neutral
2009	August	-0.13	-0.1	Neutral
2009	September	0.35	-0.32	Neutral
2009	October	-1.22	-0.54	El Niño
2009	November	-0.9	-0.7	El Niño
2009	December	-0.78	-1	El Niño
2010	January	-0.95	-0.93	El Niño
2010	February	-1.17	-0.49	Neutral
2010	March	-0.86	-0.01	Neutral
2010	April	1.34	0.31	Neutral
2010	May	1.6	1.03	La Niña
2010	June	0.65	1.66	La Niña
2010	July	2.45	1.86	La Niña
2010	August	2.26	1.92	La Niña
2010	September	2.36	2.1	La Niña
2010	October	1.89	2.07	La Niña

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
2010	November	1.52	1.96	La Niña
2010	December	2.3	1.87	La Niña
2011	January	1.71	1.9	La Niña
2011	February	1.91	2.02	La Niña
2011	March	2.05	1.7	La Niña
2011	April	2.13	1.45	La Niña
2011	May	0.68	1.32	La Niña
2011	June	0.46	1.02	La Niña
2011	July	1.3	0.81	La Niña
2011	August	0.53	0.85	La Niña
2011	September	1.09	0.99	La Niña
2011	October	0.85	1.12	La Niña
2011	November	1.17	1.17	La Niña
2011	December	1.94	1	La Niña
2012	January	0.78	0.91	La Niña
2012	February	0.25	0.61	La Niña
2012	March	0.4	0.25	Neutral
2012	April	-0.31	-0.05	Neutral
2012	May	0.12	-0.13	Neutral
2012	June	-0.71	-0.25	Neutral
2012	July	-0.16	-0.14	Neutral
2012	August	-0.2	-0.09	Neutral
2012	September	0.23	0.11	Neutral
2012	October	0.39	0	Neutral
2012	November	0.28	0.01	Neutral
2012	December	-0.68	-0.09	Neutral
2013	January	-0.15	0.05	Neutral
2013	February	-0.26	0.04	Neutral
2013	March	1.08	0.46	Neutral
2013	April	0.24	0.89	La Niña
2013	May	1.41	1.15	La Niña
2013	June	2	0.98	La Niña
2013	July	0.99	1	La Niña
2013	August	0.27	0.72	La Niña
2013	September	0.35	0.47	Neutral
2013	October	-0.01	0.26	Neutral
2013	November	0.76	0.41	Neutral
2013	December	-0.09	0.33	Neutral

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
2014	January	1.04	0.12	Neutral
2014	February	-0.07	0.14	Neutral
2014	March	-1.06	0.34	Neutral
2014	April	0.85	0.19	Neutral
2014	May	0.95	0.14	Neutral
2014	June	0.28	0.18	Neutral
2014	July	-0.31	-0.14	Neutral
2014	August	-0.86	-0.44	Neutral
2014	September	-0.74	-0.75	El Niño
2014	October	-0.59	-0.81	El Niño
2014	November	-1.24	-0.79	El Niño
2014	December	-0.64	-0.62	El Niño
2015	January	-0.74	-0.68	El Niño
2015	February	0.09	-0.44	Neutral
2015	March	-0.86	-0.55	El Niño
2015	April	-0.07	-0.58	El Niño
2015	May	-1.17	-0.94	El Niño
2015	June	-0.89	-1.11	El Niño
2015	July	-1.69	-1.44	El Niño
2015	August	-1.73	-1.55	El Niño
2015	September	-1.72	-1.53	El Niño
2015	October	-1.74	-1.38	El Niño
2015	November	-0.76	-1.4	El Niño
2015	December	-0.96	-1.37	El Niño
2016	January	-1.8	-1.08	El Niño
2016	February	-1.61	-1.21	El Niño
2016	March	-0.28	-0.87	El Niño
2016	April	-1.41	-0.29	Neutral
2016	May	0.77	0.14	Neutral
2016	June	1.1	0.37	Neutral
2016	July	0.53	0.91	La Niña
2016	August	0.87	0.7	La Niña
2016	September	1.26	0.43	Neutral
2016	October	-0.24	0.34	Neutral
2016	November	-0.28	0.18	Neutral
2016	December	0.1	-0.1	Neutral
2017	January	0.06	0.07	Neutral
2017	February	-0.15	0.07	Neutral

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
2017	March	0.59	0.15	Neutral
2017	April	-0.25	0	Neutral
2017	May	0.49	0.22	Neutral
2017	June	-0.71	0.24	Neutral
2017	July	0.99	0.41	Neutral
2017	August	0.67	0.52	La Niña
2017	September	0.63	0.87	La Niña
2017	October	1.03	0.62	La Niña
2017	November	1.04	0.63	La Niña
2017	December	-0.27	0.41	Neutral
2018	January	0.74	0.42	Neutral
2018	February	-0.46	0.33	Neutral
2018	March	1.08	0.51	La Niña
2018	April	0.54	0.33	Neutral
2018	May	0.68	0.47	Neutral
2018	June	-0.17	0.18	Neutral
2018	July	0.23	-0.13	Neutral
2018	August	-0.4	-0.17	Neutral
2018	September	-0.97	-0.18	Neutral
2018	October	0.45	-0.09	Neutral
2018	November	-0.21	-0.03	Neutral
2018	December	0.7	-0.05	Neutral
2019	January	-0.11	-0.24	Neutral
2019	February	-1.1	-0.17	Neutral
2019	March	-0.48	-0.43	Neutral
2019	April	0.12	-0.56	El Niño
2019	May	-0.61	-0.46	Neutral
2019	June	-0.71	-0.39	Neutral
2019	July	-0.62	-0.66	El Niño
2019	August	-0.13	-0.6	El Niño
2019	September	-1.2	-0.7	El Niño
2019	October	-0.36	-0.7	El Niño
2019	November	-1.17	-0.66	El Niño
2019	December	-0.64	-0.45	Neutral
2020	January	0.06	-0.44	Neutral
2020	February	-0.15	-0.17	Neutral
2020	March	-0.33	0.11	Neutral
2020	April	0.18	-0.03	Neutral

Year	Month	SOI	SOI 5-month rolling mean, centred on month shown	ENSO Phase
2020	May	0.77	0.11	Neutral
2020	June	-0.62	0.44	Neutral
2020	July	0.53	0.6	La Niña
2020	August	1.33	0.56	La Niña
2020	September	0.98	0.83	La Niña
2020	October	0.57	1	La Niña
2020	November	0.76	1.02	La Niña
2020	December	1.38	1.03	La Niña
2021	January	1.42	0.93	La Niña
2021	February	1.00	0.85	La Niña
2021	March	0.11	0.75	La Niña
2021	April	0.36	0.61	La Niña
2021	May	0.86	0.80	La Niña
2021	June	0.74	0.93	La Niña
2021	July	1.91	1.03	La Niña
2021	August	0.80	1.02	La Niña
2021	September	0.86	1.10	La Niña
2021	October	0.80	0.93	La Niña
2021	November	1.11	0.84	La Niña
2021	December	1.11	0.81	La Niña
2022	January	0.32	0.92	La Niña
2022	February	0.73	1.08	La Niña
2022	March	1.37	1.36	La Niña
2022	April	1.89	1.86	La Niña
2022	May	2.52	1.93	La Niña
2022	June	2.82	1.91	La Niña
2022	July	1.07	1.88	La Niña
2022	August	1.26	1.74	La Niña
2022	September	1.72	1.23	La Niña
2022	October	1.83	1.35	La Niña
2022	November	0.28	1.30	La Niña
2022	December	1.66	1.14	La Niña