

# Monthly Climate Bulletin

December 2023



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Photo Credit: Molly Powers (SPC) Samoa Tide Gauge





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## Issued 16 January 2024

- The El Niño continues in the tropical Pacific.
- The Madden Julian Oscillation (MJO) is currently over the Indian Ocean. In the coming weeks, international climate models suggest it is likely to move across the Maritime Continent.
- An active ITCZ and active SPCZ merged in an anomalous convective centre near the equatorial Date Line - a sign of El Niño.
- Sea surface temperatures (SST) for December 2023 were warmer than average across the central and eastern tropical Pacific Ocean.
- The Coral bleaching Outlook to 4 February shows 'Alert 2' over eastern Solomon Islands, Tuvalu, Kiribati (eastern Gilbert Islands, and Phoenix Islands), and Tokelau.
- For January to March 2024, the models agree on below normal rainfall being likely or very likely for Palau, FSM, central RMI, southern PNG EEZ, southern Solomon Islands, New Caledonia, Vanuatu, much of Fiji, Niue, and northeastern French Polynesia. In addition, there's model agreement on above normal rainfall being likely or very likely in near-equatorial regions from PNG's central and northern mainland plus Islands eastward to Nauru, Tuvalu, Kiribati (Gilbert, Phoenix, far northern Line Islands), Tokelau, and the far northern Cook Islands.
- The ACCESS-S weekly tropical cyclone outlook shows lower than normal risk in the southwest Pacific between 20 and 26 January and in the northwest Pacific between 20 January and 2 February. The risk is near-normal in the southwest Pacific from 27 January to 2 February.

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# EL NIÑO–SOUTHERN OSCILLATION

## El Niño persists as positive Indian Ocean Dipole continues to weaken

Click link to access [Climate Driver Update issued on 9 January 2024](#)

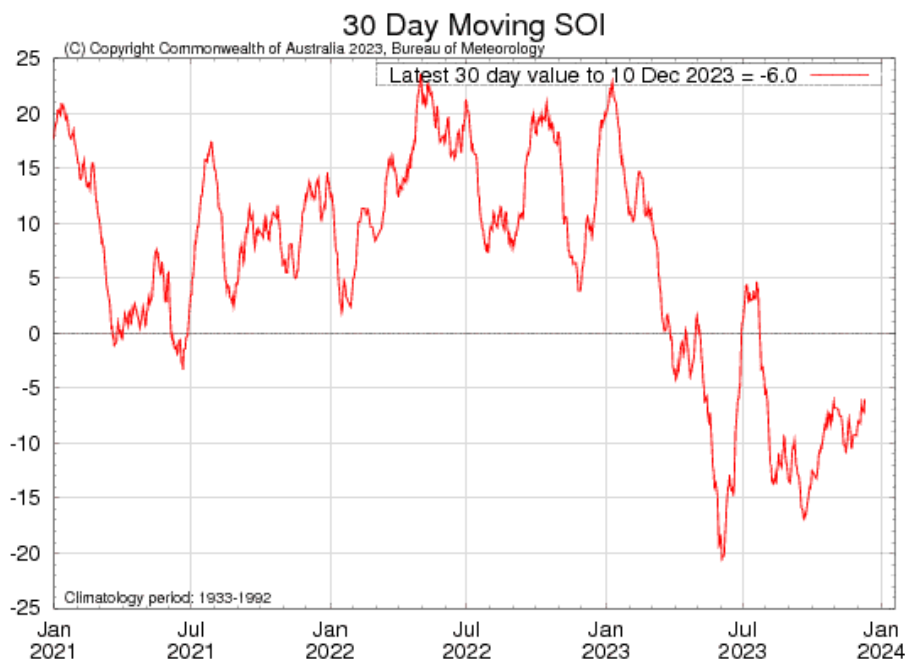
The El Niño continues in the tropical Pacific. Model forecasts indicate the warmth of sea surface temperatures (SSTs) is likely at or near its peak, with SSTs expected to remain above El Niño thresholds into the southern hemisphere autumn 2024. Some atmospheric indicators have weakened over the past three weeks, and the SOI is currently neutral.

The positive Indian Ocean Dipole (IOD) event is weakening steadily. IOD events typically break down as the monsoon trough shifts south into the southern hemisphere, typically at the end of spring, meaning the breakdown this year has been later than usual. Model forecasts suggest the positive IOD is likely to continue to ease over the coming weeks, with the majority indicating the IOD index will fall below +0.4 °C in January.

The Southern Annular Mode (SAM) is currently positive. The SAM index is expected to decrease slightly, but stay near the positive SAM threshold for the coming fortnight.

The Southern Annular Mode (SAM) index is currently neutral. Forecasts suggest it is likely to remain mostly neutral over the coming fortnight.

The 30-, 60- and 90-day Southern Oscillation Index (SOI) for the period ending 7 January 2024 were -2, -4 and -5, respectively.



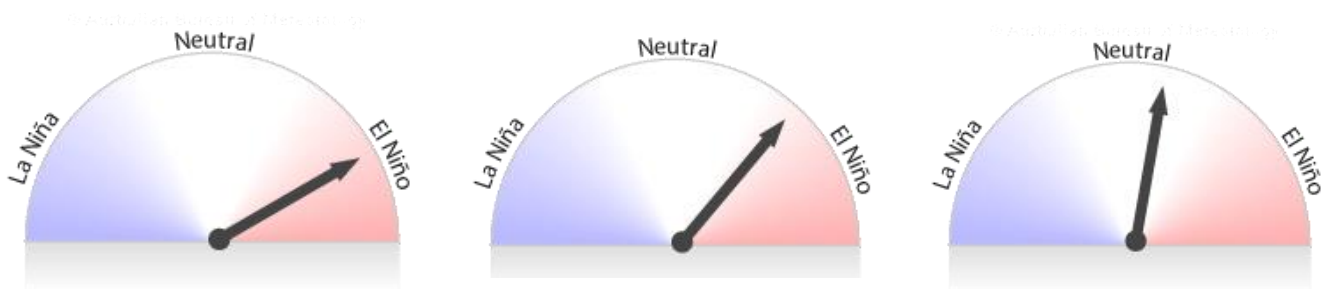


# EL NIÑO–SOUTHERN OSCILLATION

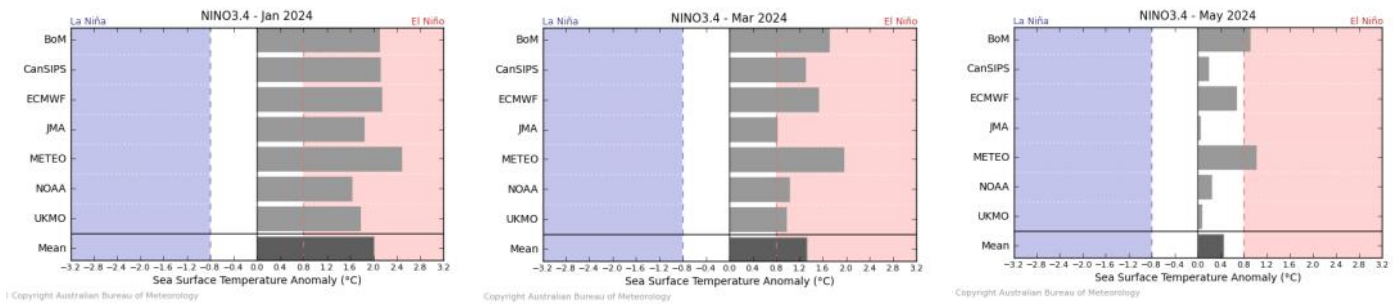
El Niño persists as positive Indian Ocean Dipole continues to weaken

Click link to access [Climate Driver Update issued on 9 January 2024](#)

## Bureau of Meteorology NINO3.4 ENSO Model Outlooks for January, March and May



## Bureau of Meteorology NINO3.4 International Model Outlooks



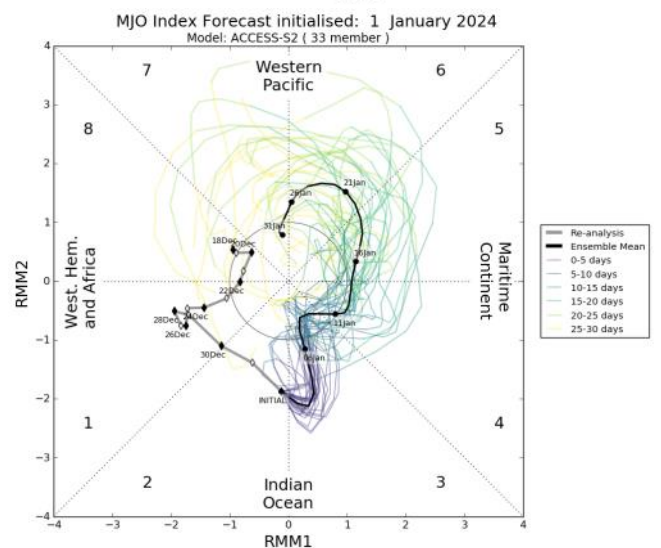
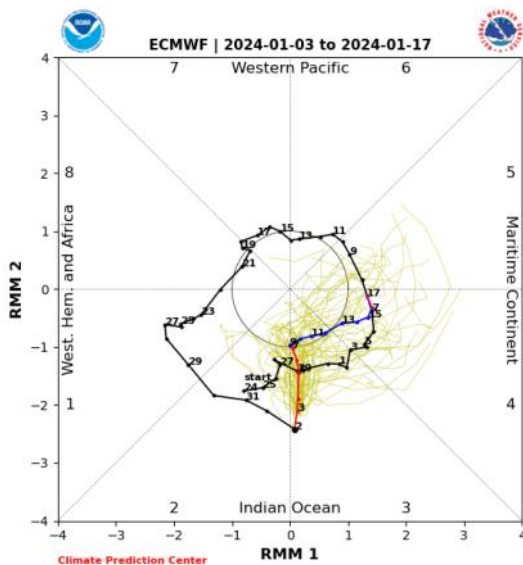
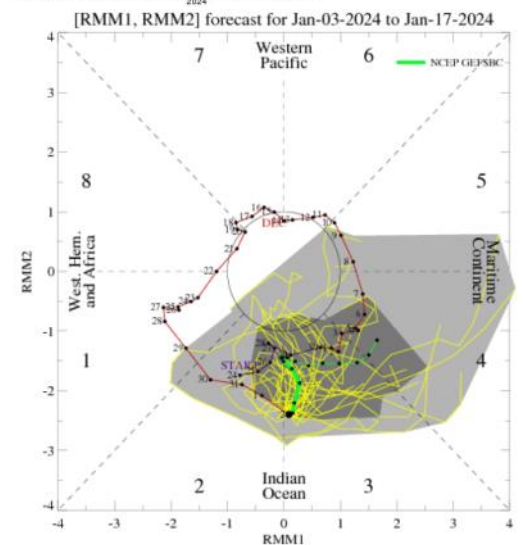
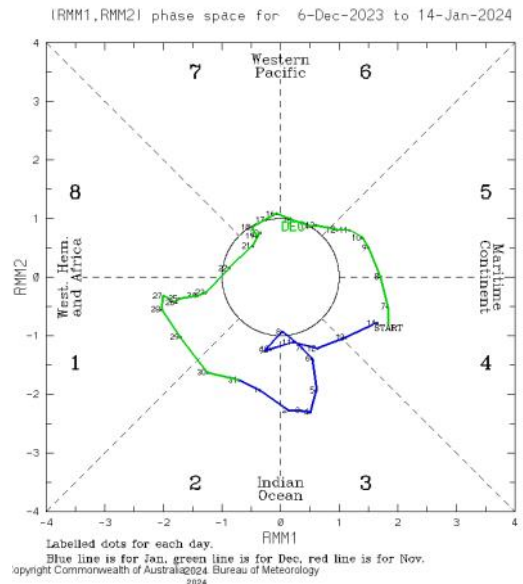
Bureau of Meteorology summary of international model outlooks for NINO3.4: <http://www.bom.gov.au/climate/model-summary/#tabs=Pacific-Ocean>

# MADDEN–JULIAN OSCILLATION

Click link to access [Tropical Climate Update](#) [Issued on Tuesday 9 January 2024]

The Madden Julian Oscillation (MJO) is currently over the Indian Ocean. In the coming weeks, international climate models suggest it is likely to move across the Maritime Continent. At this time of year, when the MJO is in the western Maritime Continent, the chance of above average rainfall typically increases across the western Pacific countries including Australia.

This is an abbreviated version of the Tropical Climate Update. Click on the *Weekly Tropical Update* for more information .



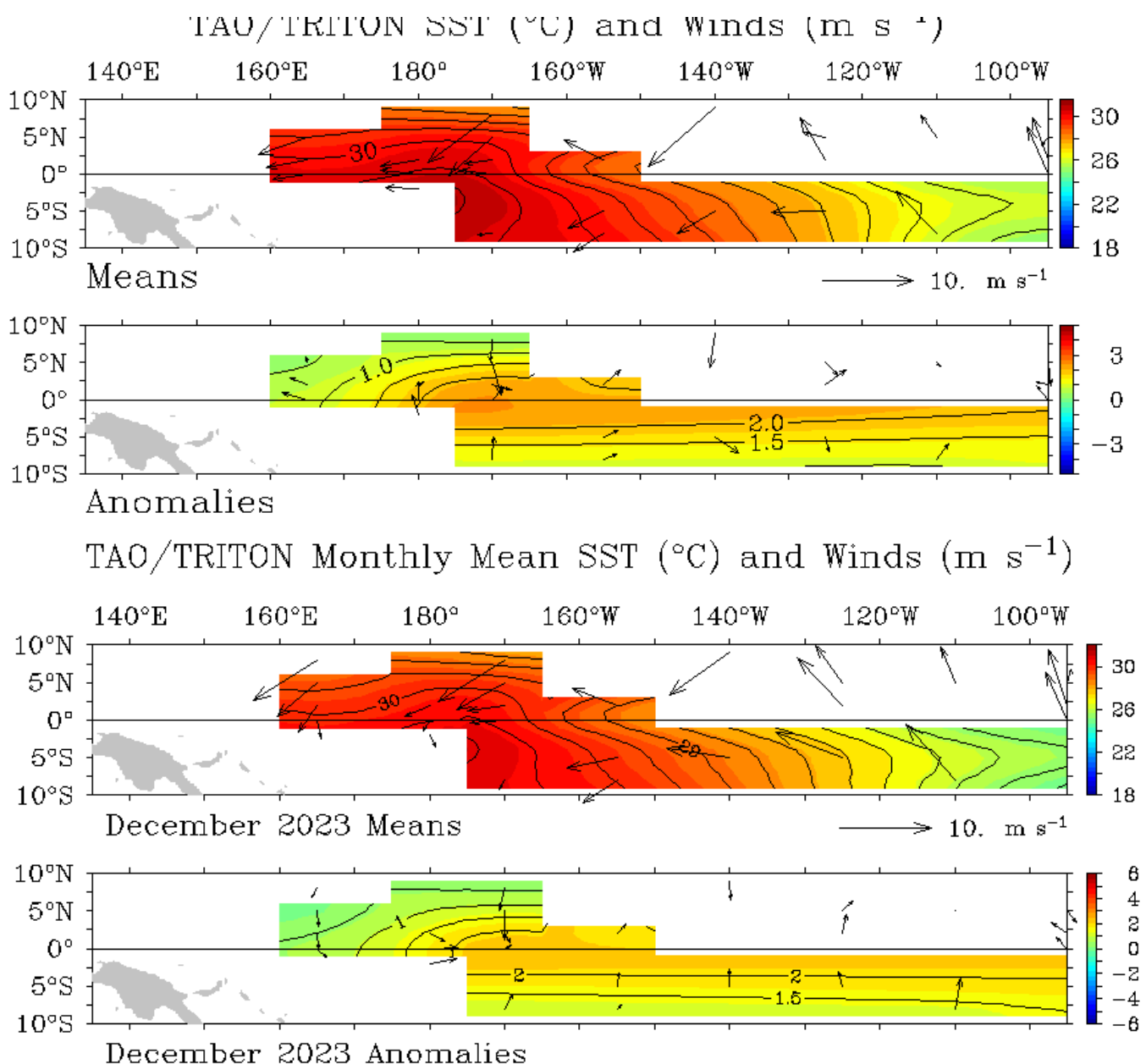


# WIND

Click link to access [Wind plots link](#)

During December, the trade winds were generally close to normal near and east of the Date Line, where mean northerly were observed at a few locations. Weak westerly anomalies (weaker trades) were analysed over the western Pacific, which is consistent with the prevailing El Niño. For the five days ending 2 January 2024, west of the Date Line, but weaker than normal over much of the near-equatorial Pacific east of the Date Line.

During El Niño events there is a sustained weakening, or even reversal, of the trade winds across much of the tropical Pacific, while during La Niña, there is a sustained strengthening of the trade winds.



# CLOUD AND RAINFALL

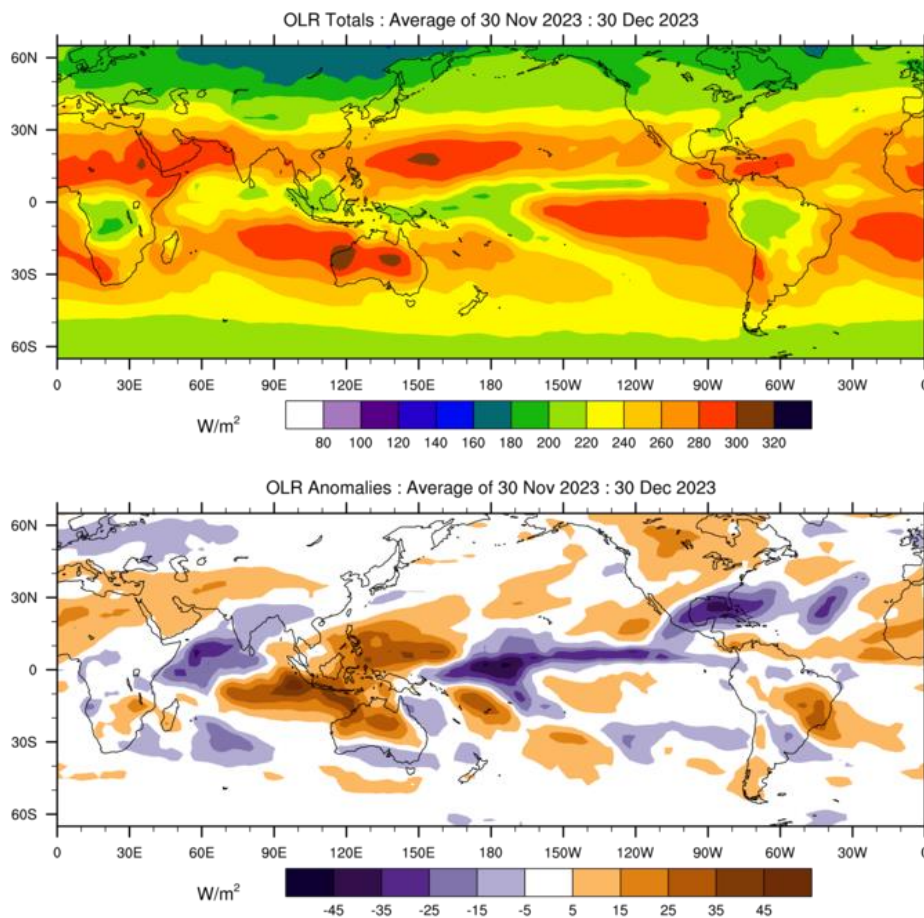
Click link to access [OLR](#)



The December 30-day OLR anomaly map shows a region of low OLR (increased convection) along the equator centred over the Date Line. The ITCZ and SPCZ seemed to merge here, with anomalous convection extending to PNG Islands in the west and Kiribati (Line islands) in the east. The Intertropical Convergence Zone (ITCZ), which extended towards the central American coast, was shifted south of its normal location. High OLR (decreased convection) was evident over Palau, FSM and northern RMI. These areas were connected to a strong positive OLR region focussed over the central Indian Ocean with another extension across northern and central Australia. Another area of increased OLR extended southeast from the Solomon Islands and Tuvalu to Fiji and Tonga.

Note: Global maps of OLR below highlight regions experiencing increased or decreased cloudiness. The top panel is the total OLR in Watts per square metre ( $W/m^2$ ) and the bottom panel is the anomaly (current minus the 1979-1998 climate average), in  $W/m^2$ . In the bottom panel, negative values (blue shading) represent above normal cloudiness while positive values (brown shading) represent below normal cloudiness.

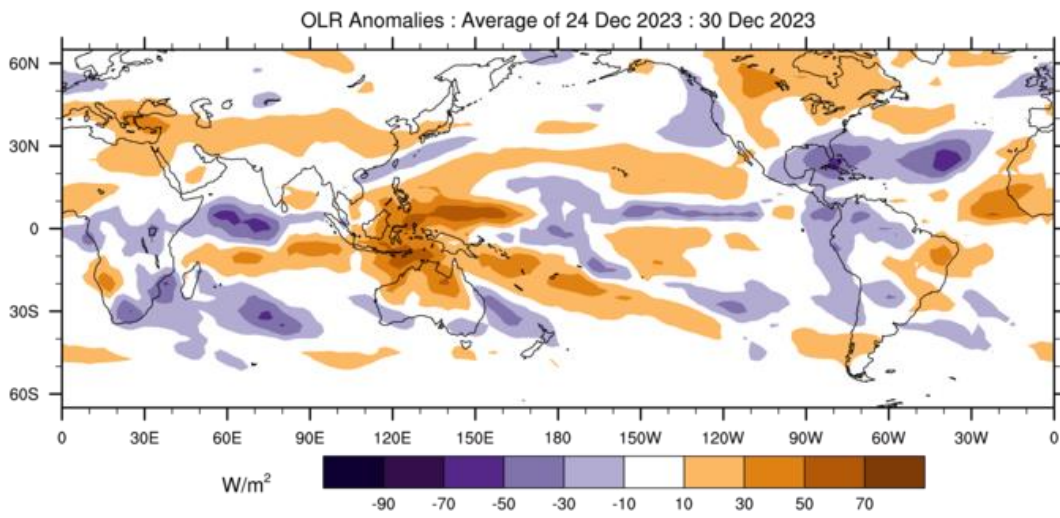
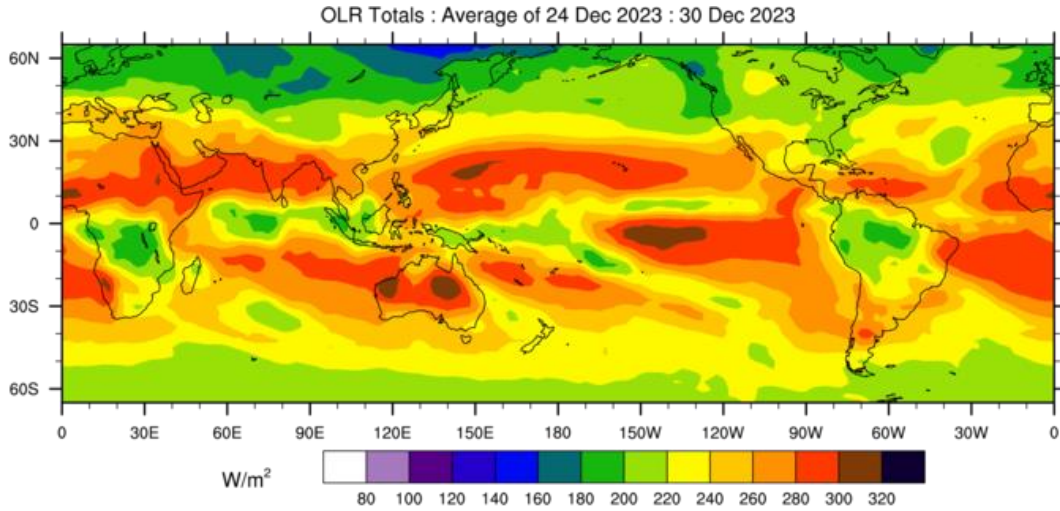
## OLR Total and Anomalies, 30 Day OLR



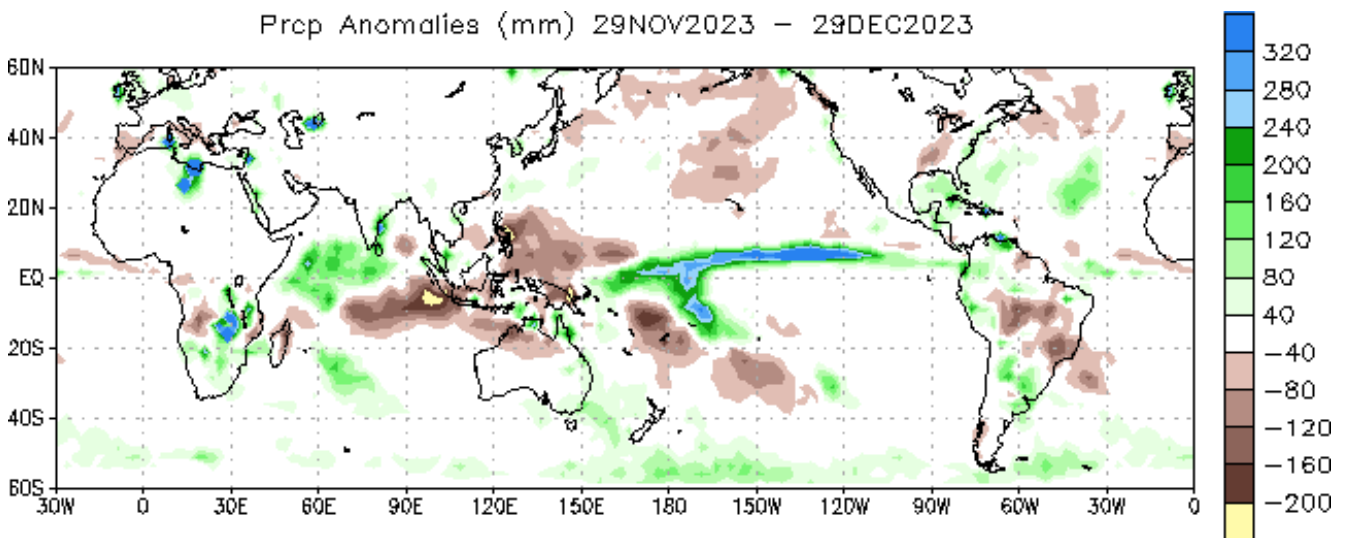
(C) Copyright Commonwealth of Australia 2023. Bureau of Meteorology



# OLR Total and Anomalies, 7 Day OLR

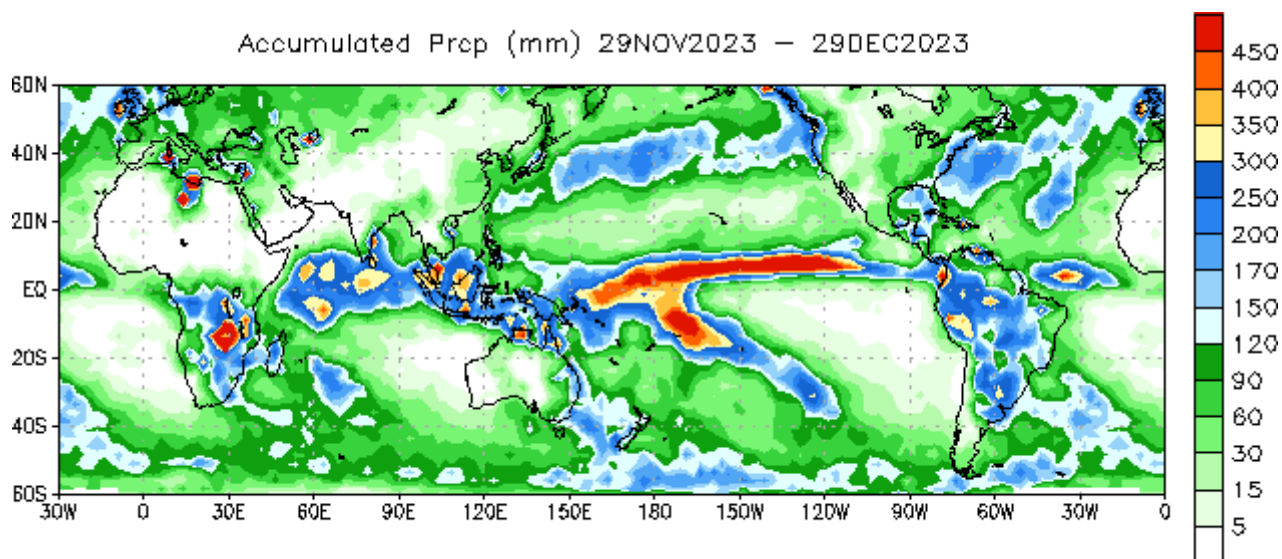


(C) Copyright Commonwealth of Australia 2023. Bureau of Meteorology

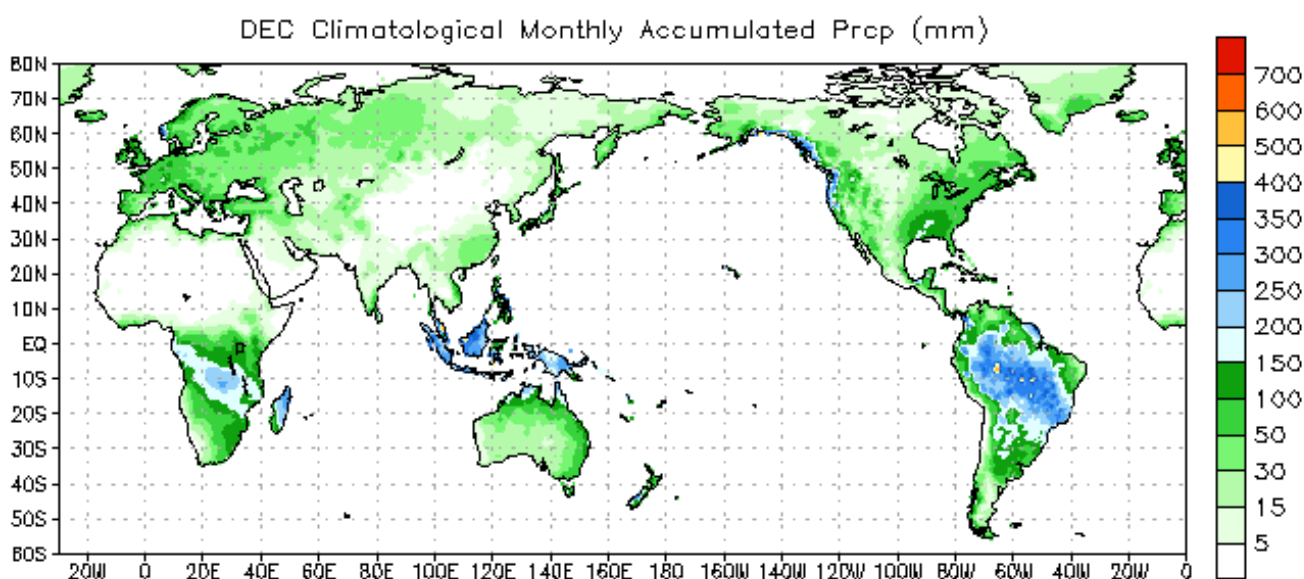


Data Source: NCEP CMAP Precipitation  
Climatology (1991-2020)

## 30-Day Rainfall Accumulated



Data Source: NCEP CMAP Precipitation



Data Source: CPC Unified (gauge-based) Precipitation  
Climatology (1979–1995)

NOAA Climate Prediction Centre - NCEP CMAP precipitation:

[https://ww.cpc.ncep.noaa.gov/products/Global\\_Monsoons/Global-Monsoon.shtml](https://ww.cpc.ncep.noaa.gov/products/Global_Monsoons/Global-Monsoon.shtml)

# OCEAN CONDITIONS

## SEA SURFACE TEMPERATURE



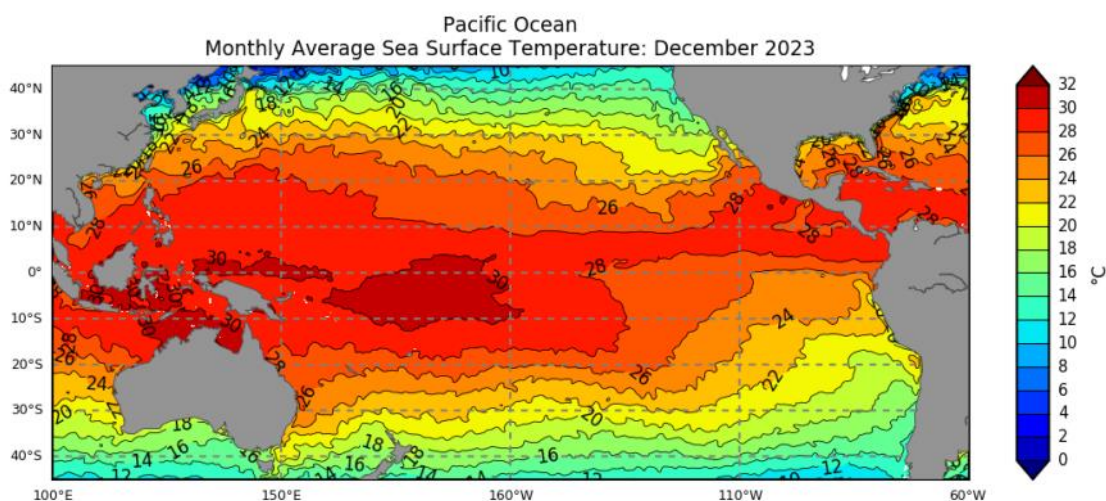
Click link to access [Pacific Community COSPPac Ocean Portal](#)

Sea surface temperatures (SSTs) for December 2023 were warmer than average across the central and eastern tropical Pacific Ocean. Between 10°S and 10°N, SST anomalies were more than 1.2°C warmer than the long-term (1961-1990) average, and more than 2°C warmer than average in some areas along the equator.

The extent and magnitude of warm anomalies across the equatorial Pacific has decreased compared to November.

Highest on record December SSTs occurred in parts of Kiribati (southeast Gilbert, Phoenix and northern Line Islands), parts of Tuvalu, and Tokelau. The SST in decile 10 (very much above average) stretched from western Kiribati to southeastern Solomon Islands and eastwards towards the south American coast. There were also areas of decile 10 over Palau, central FSM and northern RMI. Above average (8-9) decile are observed for majority of the Pacific Island Countries, spanning southeastward from Palau, central and southern RMI, Nauru to eastern French Polynesia, and along the islands located near the equatorial region of the Pacific. Average SSTs (4-7) for December were observed in parts of southeastern FSM, most of PNG, most of Solomon Islands, Vanuatu, western Fiji, parts of Tonga, Samoa, Niue, central Cook Islands and parts of central French Polynesia. Patches of decile 2-3 (below average) were observed in parts of eastern PNG, western Solomon Islands, New Caledonia, southern Cook Islands and southern French Polynesia.

### Mean Sea Surface Temperature

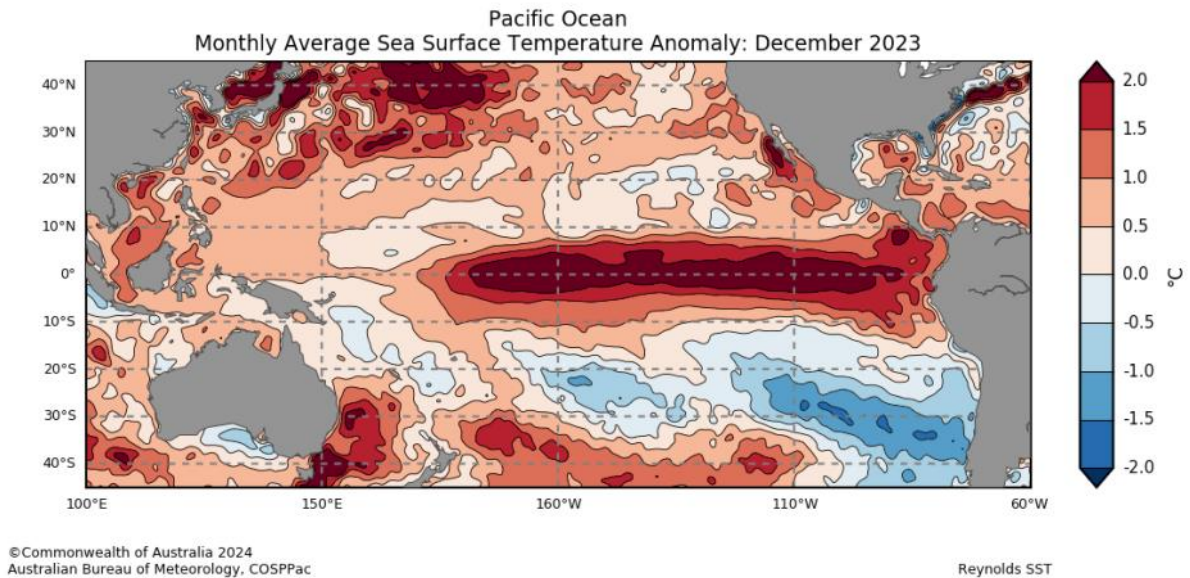


# OCEAN CONDITIONS

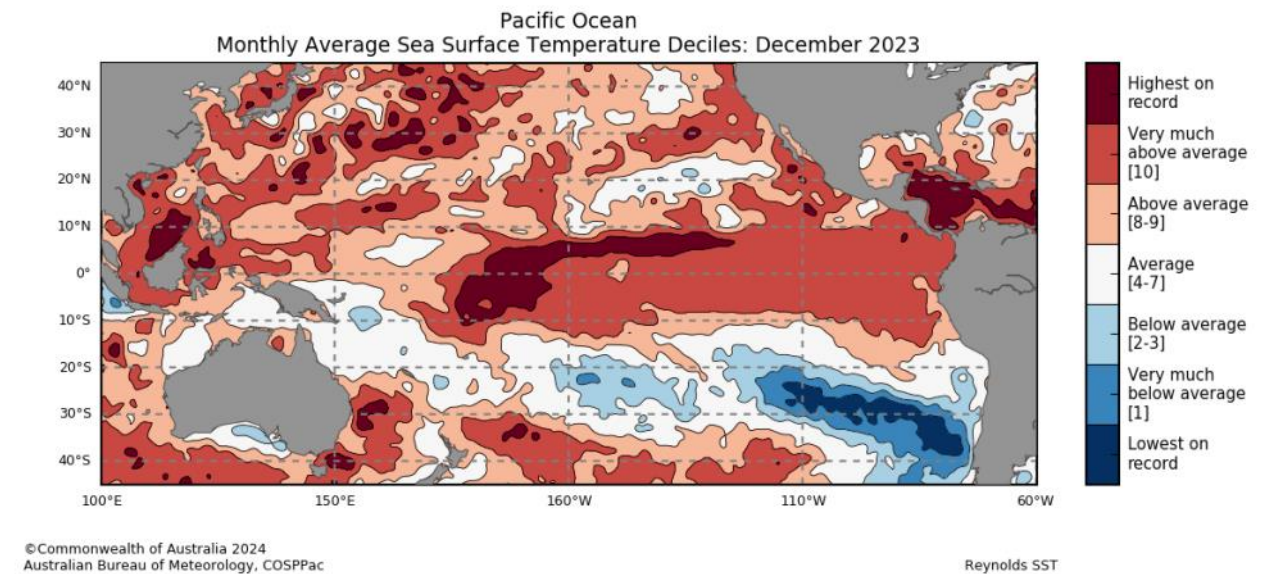
Click link to access [SEA SURFACE TEMPERATURE](#)



## Anomalous Sea Surface Temperature



## Sea Surface Temperatures Deciles



# OCEAN CONDITIONS

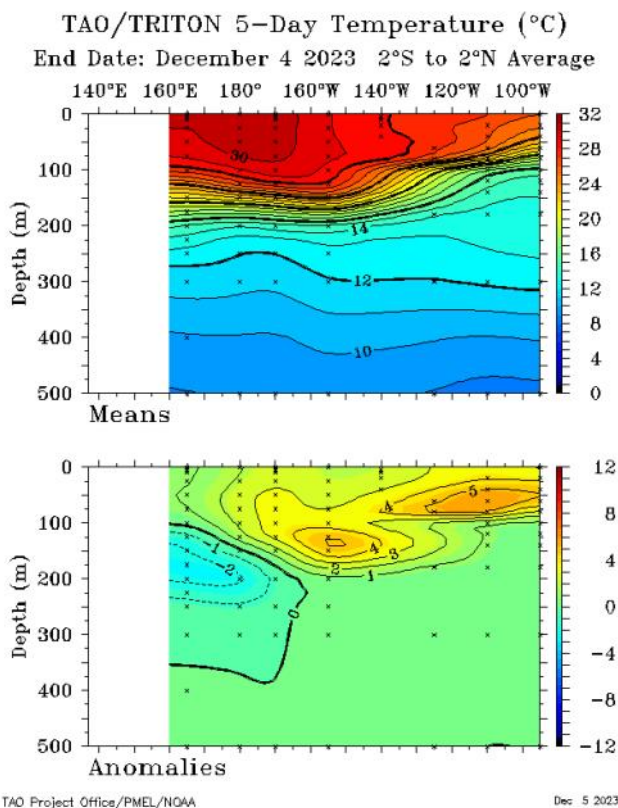
## SUB SURFACE



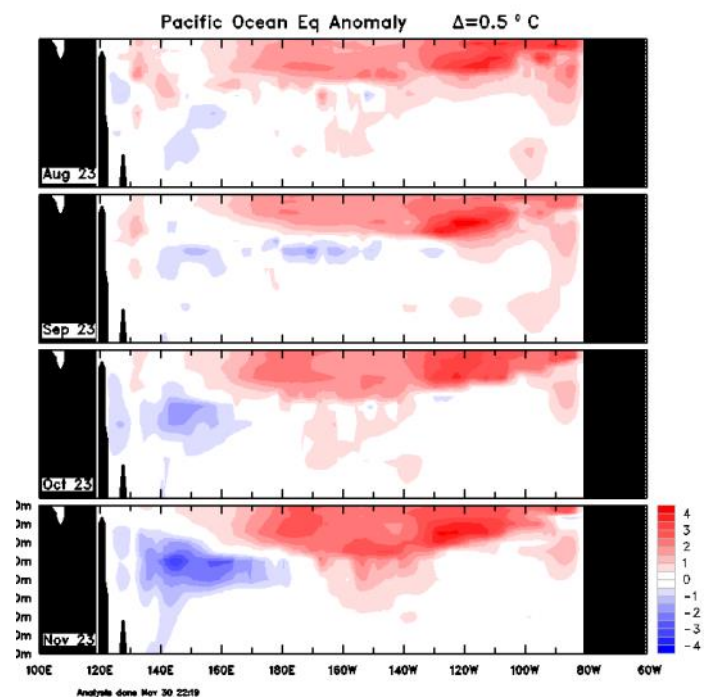
The four-month sequence of equatorial Pacific sub-surface temperature anomalies (to December 2023) shows warm anomalies across most of the top 100 m of the equatorial Pacific during December, with areas of cooler than average water below the surface of the western half of the basin. Warm anomalies generally increase in magnitude eastwards across the equatorial Pacific, although areas in both the central equatorial Pacific near the Date Line and in the east of the basin reach more than 3 °C warmer than average.

Warm anomalies have persisted in the central and eastern Pacific between the surface and 200 m depth across the past several months, with patterns remaining generally similar while the magnitude of anomalies slowly increased. Compared to November, the magnitude of cool anomalies in the western equatorial Pacific sub-surface has increased, and now extend to around 160°W, reaching more than 2 °C cooler than average between 100 and 200 m depth across much of their extent. Warm anomalies have persisted in the central and eastern Pacific between the surface and 200 m depth. Compared to September, the depth of warm anomalies above 1 °C in the central Pacific have increased to depths of 200 m. The depth of warm anomalies in the eastern Pacific has decreased over the past 4 months. West of the Date Line, cool anomalies continue to strengthen between 100 and 300 m depth, undercutting warm anomalies above them in the central Pacific.

### Weekly Temperatures Mean and Anomalies



### Monthly Temperatures Anomalies



Bureau of Meteorology Sea Temperature Analysis: <http://www.bom.gov.au/marine/sst.shtml>

TAO/TRITON Data Display: <http://www.pmel.noaa.gov/tao/jsdisplay/>

# OCEAN CONDITIONS

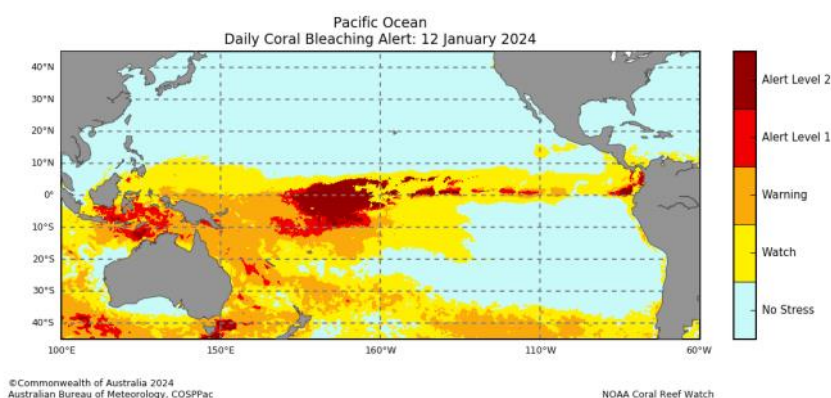
## CORAL BLEACHING



The daily Coral Bleaching Alert status for 12 January 2024 shows an area of 'Alert Level 2' over Kiribati (central and eastern Gilbert, Phoenix Islands and northern Line Islands), northern Tuvalu and Tokelau. 'Alert Level 1' over southern PNG mainland, eastern Solomon Islands, northern Fiji, most of Tuvalu, rest of Tokelau and parts of northern Cook Islands. 'Warning' status stretches eastwards from PNG to Niue and northern Cook Islands. 'Watch' or 'No stress' for the rest of the countries. The four-week Coral Bleaching Outlook to 4 February shows 'Alert 2' over eastern Solomon Islands, Tuvalu, Kiribati (eastern Gilbert Islands, and Phoenix Islands), and Tokelau. Patches of 'Alert 2' over eastern PNG, western New Caledonia, northern Fiji, northern Wallis and Futuna and northern Cook Islands. 'Alert Level 1' rating over similar areas to Alert Level 2 but extend further south over eastern Australia, most of Solomon Islands, northern Vanuatu, Nauru, and Samoa. 'Warning' over rest of Vanuatu, Fiji, Tonga, American Samoa, Niue, central Cook Islands and northwestern French Polynesia. 'Watch' or 'No Stress' over the rest of the countries.

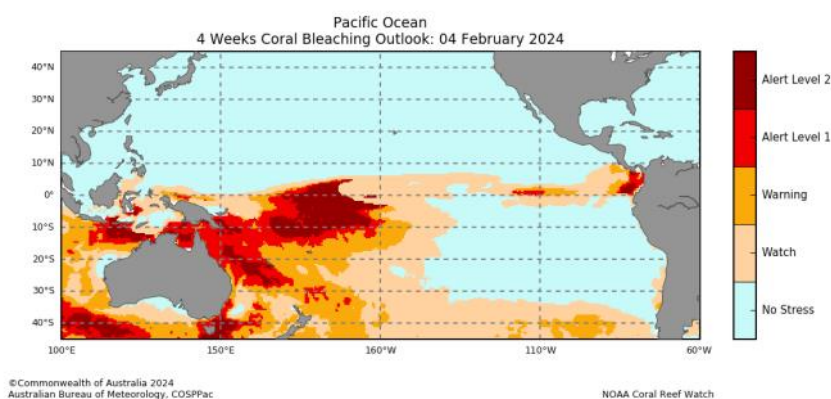
### Daily Coral Bleaching Alert

(Source: [Pacific Community COSPPac Ocean Portal Coral Bleaching](#))



### 4 Weeks Coral Bleaching Outlook

(Source: [Pacific Community COSPPac Ocean Portal](#))



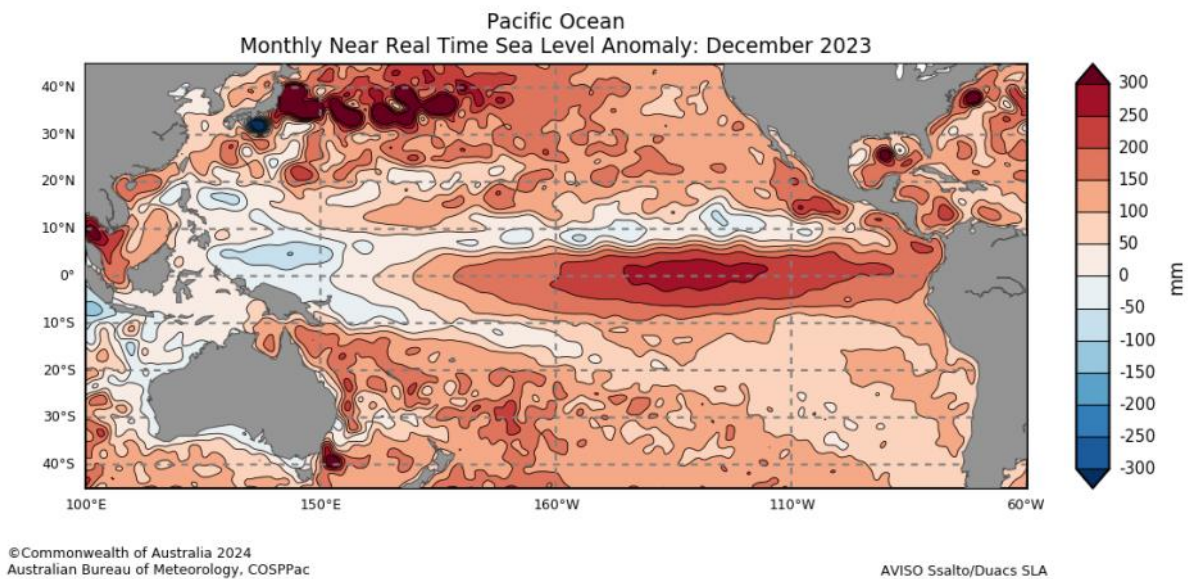
# OCEAN CONDITIONS

## OCEAN SURFACE CURRENTS AND SEA LEVEL

Sea level in December was above normal over most COSPPac countries. Anomalies from +150 to +250 mm were observed in Kiribati (Line Islands) with patches of +150 over south-east PNG, southern Solomon Islands, New Caledonia, Vanuatu, northern Tuvalu, Tokelau, Fiji, Tonga, Niue, Cook Islands and French Polynesia. Areas of +50 to +100 were observed for other COSPPac countries apart from patches of below normal sea level anomalies observed in southern Palau, central FSM, southern RMI, eastern and northern PNG, northern Solomon Islands and, patches over eastern Australia, southern Fiji, Samoa, and central Cook Islands.

### Monthly Sea Level Anomalies

Source: [Pacific Community COSPPac Ocean Portal](#)

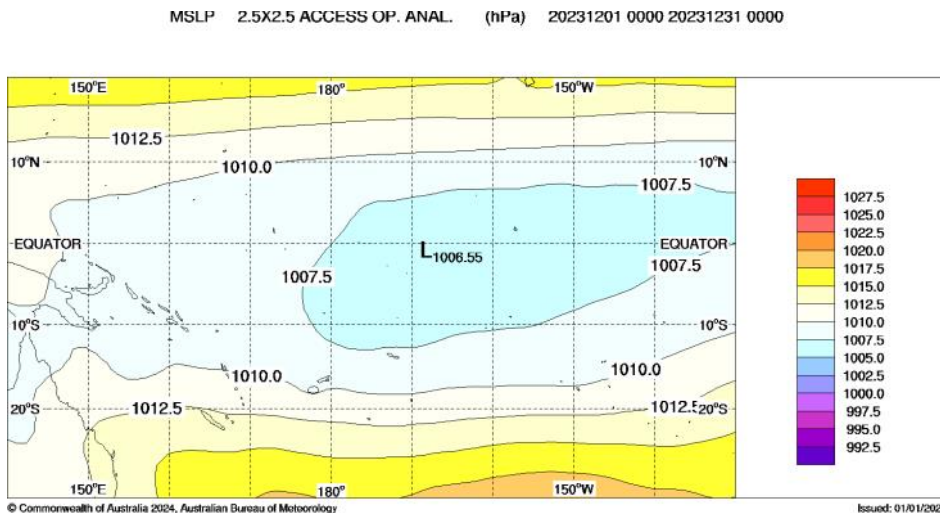


# MEAN SEA LEVEL PRESSURE

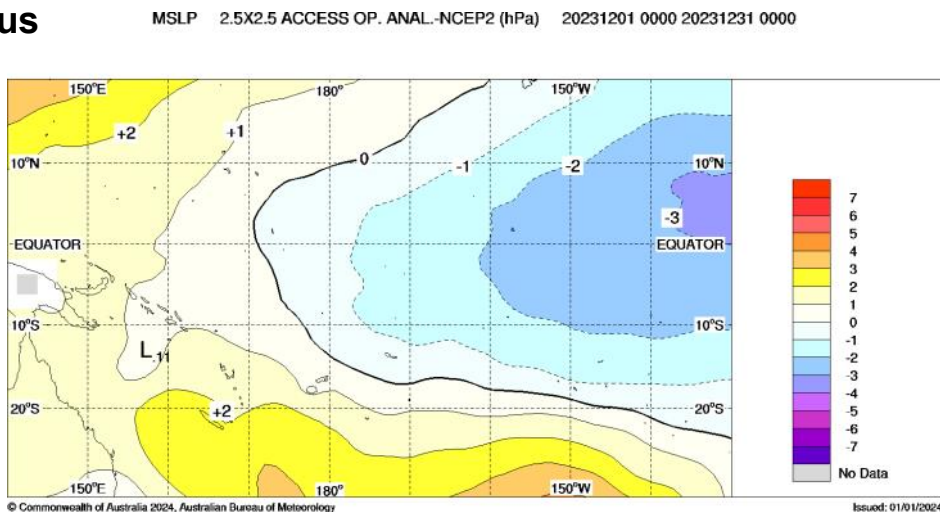
The December mean sea level pressure (MSLP) anomaly map shows positive anomalies of 1 hPa or greater south of 20°S, and over Vanuatu, PNG, plus areas northwest of a line joining the southeast tip of the PNG mainland with 20°N, 180°E. extending further south. Negative anomalies of 1 hPa or greater were evident east of the Date Line within 10° latitude of the equator.

Areas of above (below) average MSLP usually coincide with areas of suppressed (enhanced) convection and rain throughout the month.

## Mean



## Anomalous



Bureau of Meteorology South Pacific Circulation Patterns: <http://www.bom.gov.au/cgi-bin/climate/cmb.cgi?variable=mslp&area=spac&map=anomaly&time=latest>



# SEASONAL RAINFALL OUTLOOK

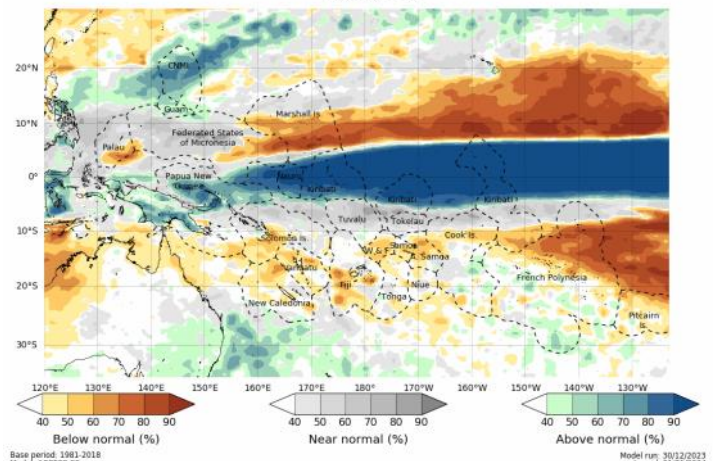
January — March 2024



The ACCESS-S model forecast for January 2024, shows below normal rainfall is likely or very likely for southern Palau, eastern FSM, central RMI, the southern PNG EEZ, southern Solomon Islands, New Caledonia, Vanuatu, Fiji, northern and southern Tonga, Wallis and Futuna, Samoa, American Samoa, parts of Niue, parts of northern and southern Cook Islands, the southern Line Islands, northeastern French Polynesia and Pitcairn Islands. Above normal rainfall is likely or very likely for CNMI, Guam, PNG's Islands and most of PNG's mainland, Nauru, Kiribati (Gilbert, most of Phoenix and northern half of Line Islands).

The three-month rainfall outlook (January to March 2024) is very similar to the December outlook, but with the below normal rainfall region being stronger and extending further west over Palau, FSM, RMI. In the southern hemisphere the below normal region was more intense and more extensive over New Caledonia, Vanuatu, but largely absent from Wallis and Futuna, Samoa, and American Samoa. The above normal rainfall region also more intense in the 3-month outlook from PNG northern mainland across the Islands eastwards to northern Cook Island. In addition, the above normal rainfall region is also broader, extending further south to Tuvalu, Tokelau, the northern to central Cook Islands and then to the southeast over central French Polynesia.

Monthly [ACCESS-S](#) Maps



The Copernicus multi-model outlook for January to March 2024 is very similar to the ACCESS outlook, the main differences being a stronger dry signal in Copernicus over Guam, CNMI, Tonga, Niue, and southern Cook Islands. In addition, Copernicus has a weaker wet signal over PNG's southern mainland

The APEC Climate Centre multi-model outlook (January to March 2024) is also very similar to the other two, especially Copernicus, the main difference from that model being a much weaker equatorial wet signal from the Line Islands eastward.

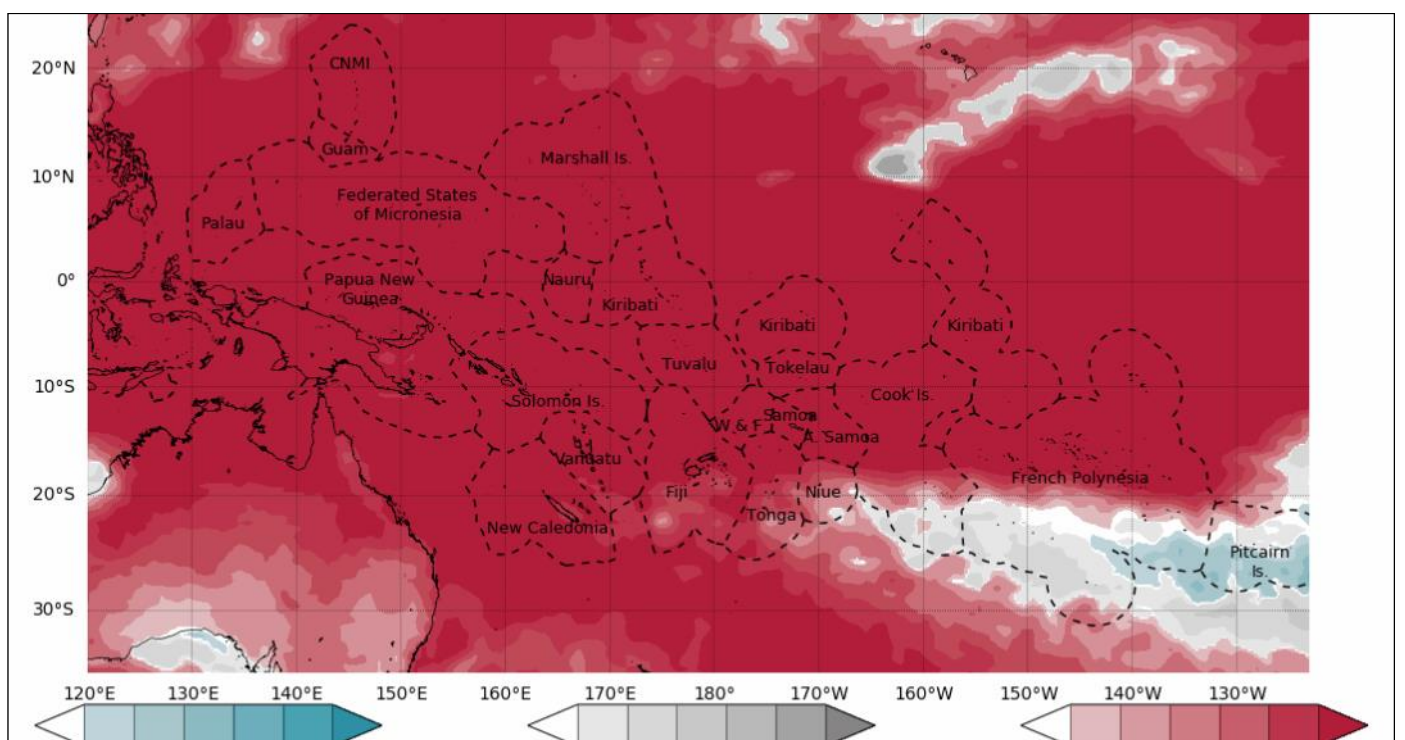
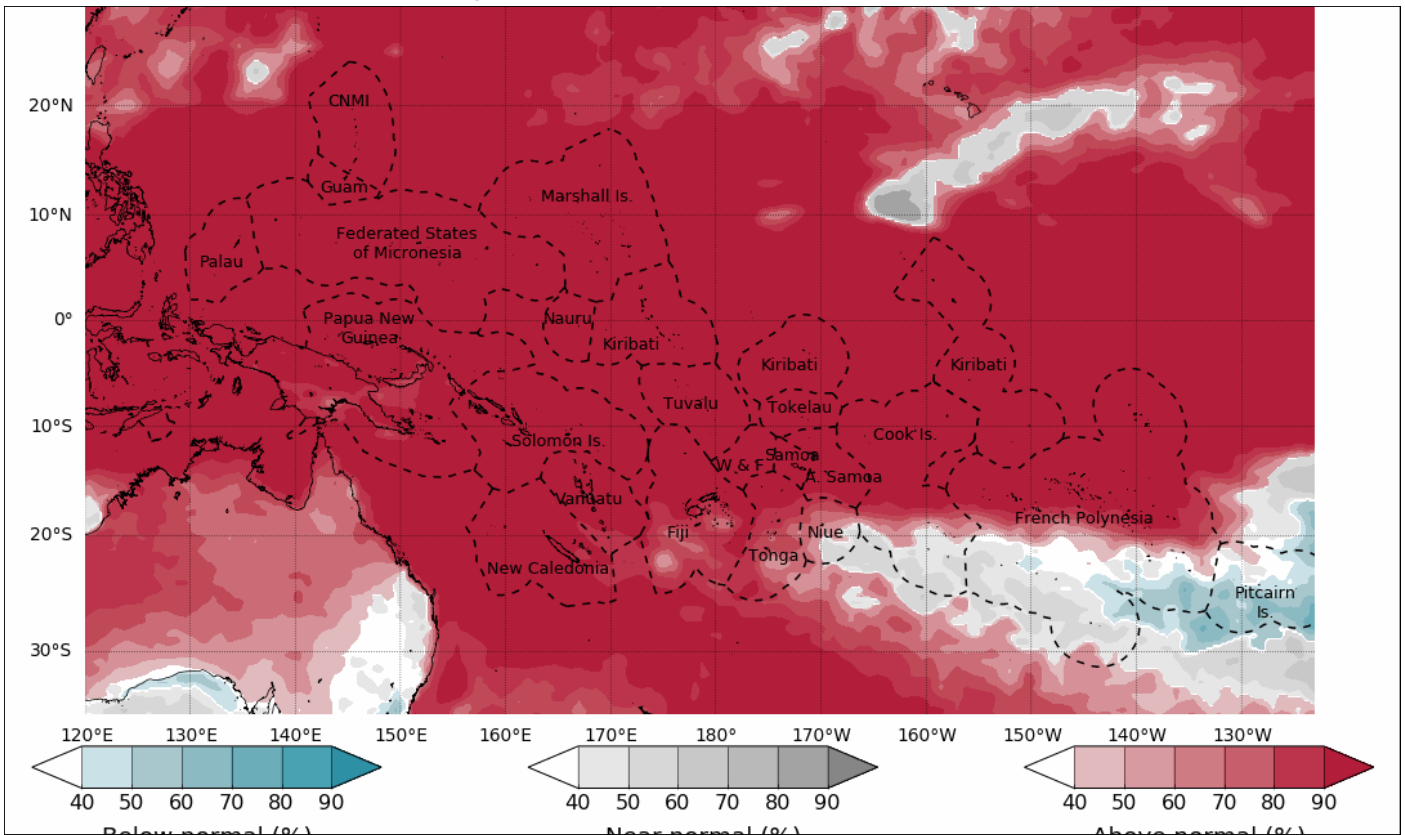
For January to March 2024, the models agree on below normal rainfall being likely or very likely for Palau, FSM, central RMI, southern PNG EEZ, southern Solomon Islands, New Caledonia, Vanuatu, much of Fiji, Niue, and northeastern French Polynesia. In addition, there's model agreement on above normal rainfall being likely or very likely in near-equatorial regions from PNG's central and northern mainland plus Islands eastward to Nauru, Tuvalu, Kiribati (Gilbert, Phoenix, far northern Islands), Tokelau, and the far northern Cook Islands.

# SEASONAL TEMPERATURE OUTLOOK

January—March 2024



## Monthly Tmax and Tmin ACCESS-S Maps



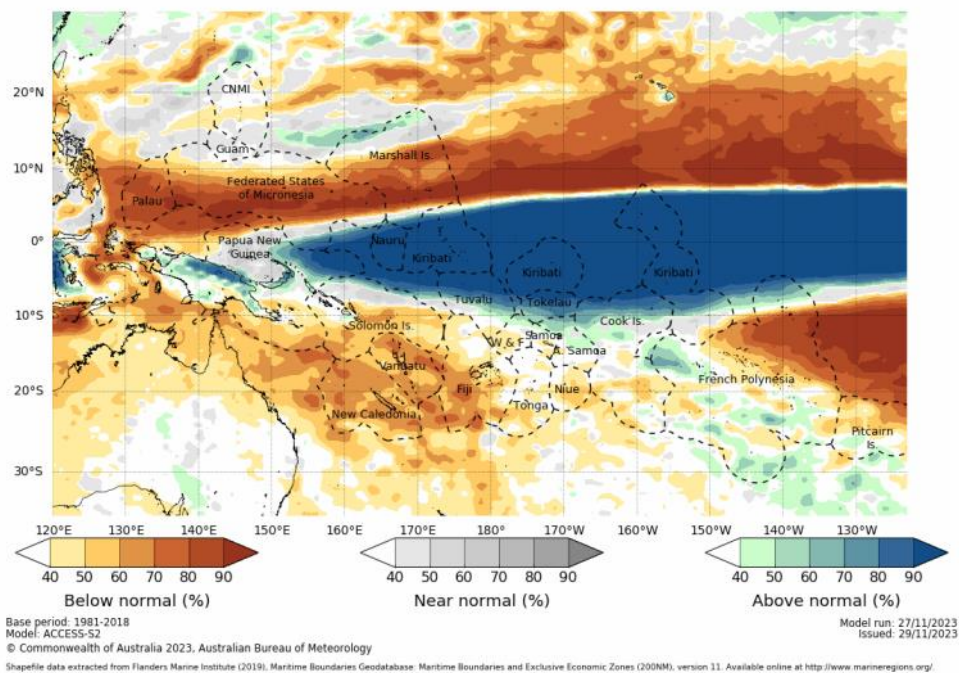
# SEASONAL RAINFALL OUTLOOK

January—March 2024

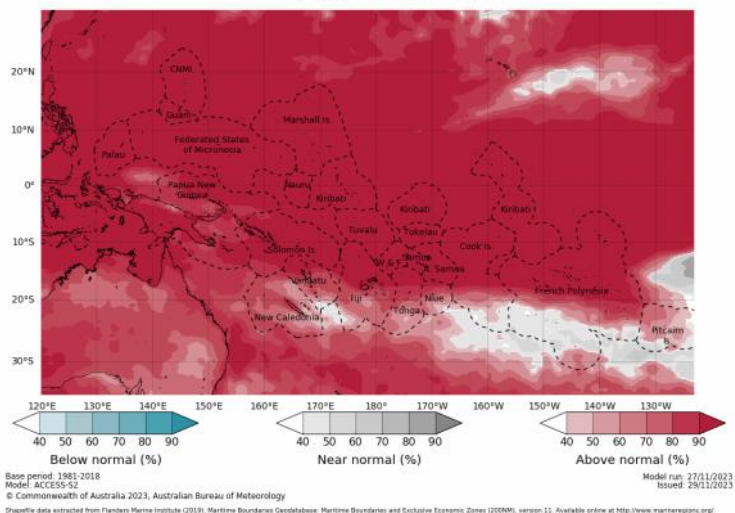


## Seasonal ACCESS-S maps

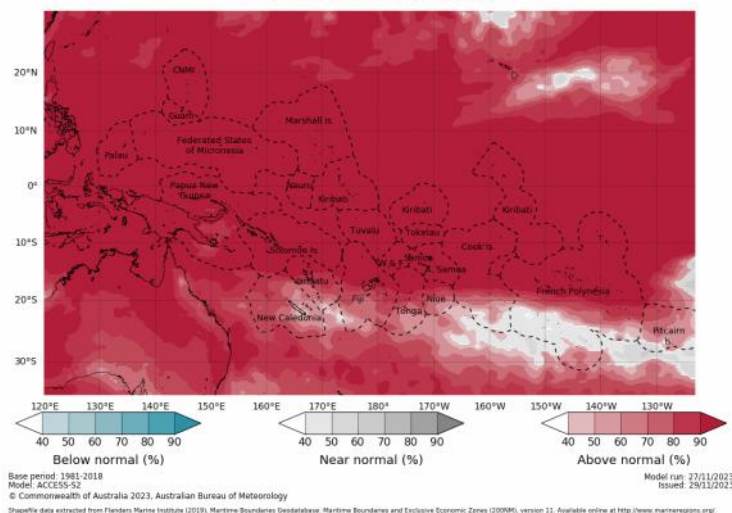
Tercile rainfall probabilities for December 2023 to February 2024



Tercile maximum temperature probabilities for December 2023 to February 2024



Tercile minimum temperature probabilities for December 2023 to February 2024



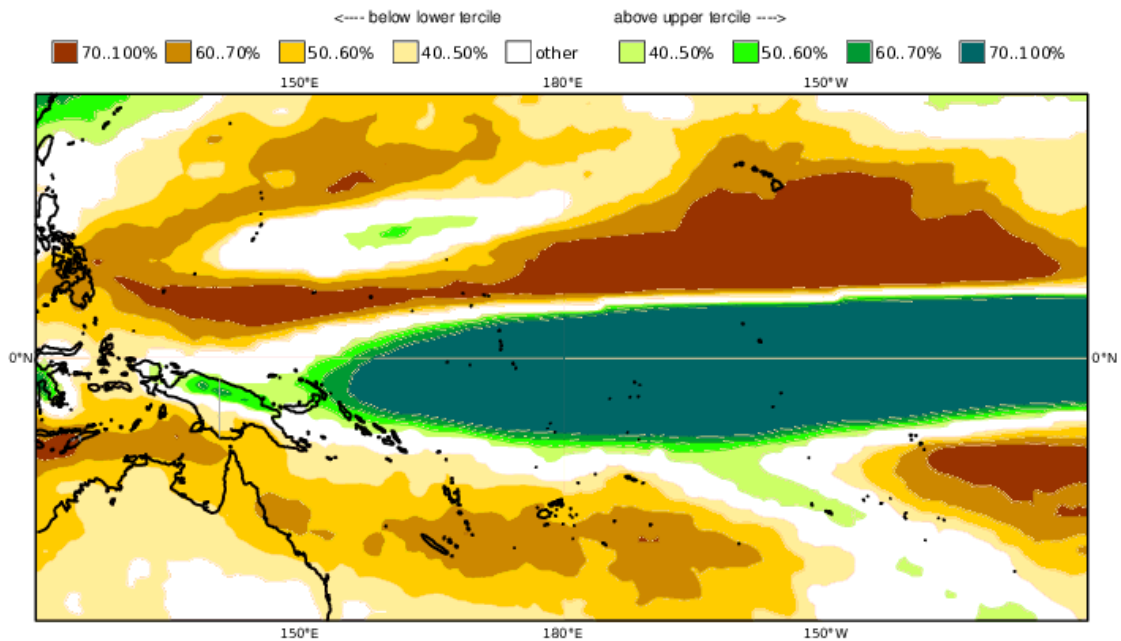
About ACCESS-S <http://access-s.clide.cloud/>

# SEASONAL RAINFALL OUTLOOK

January—March 2024

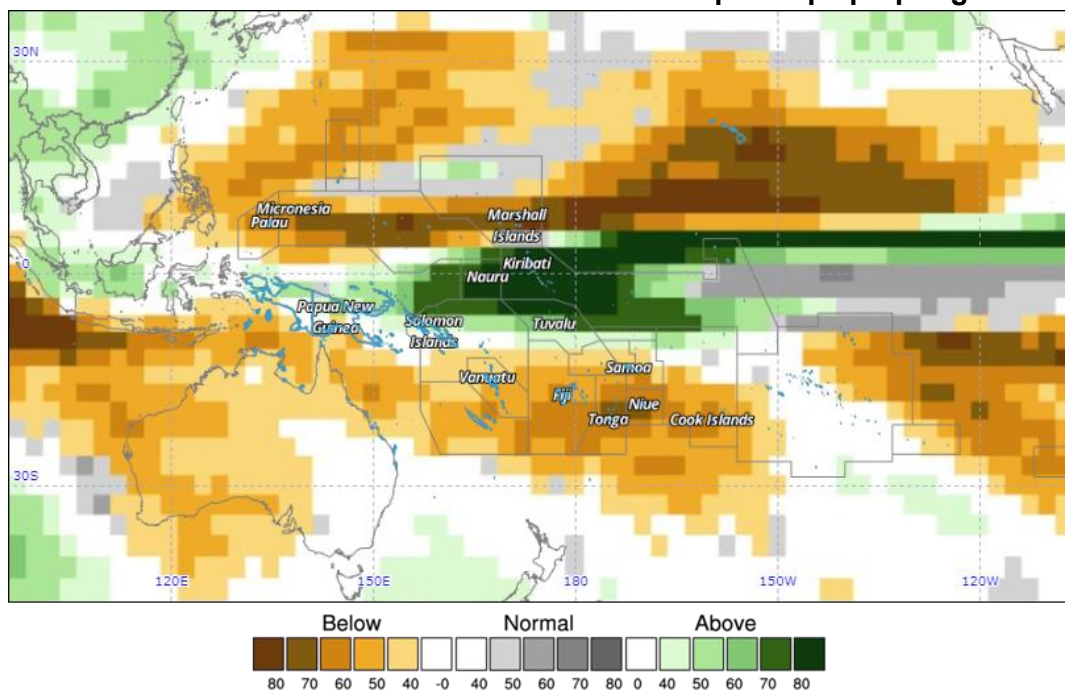


**Copernicus (C3S multi-system)-Rainfall**  
 Prob(most likely category of precipitation) DJF 2023/24  
 Nominal forecast start: 01/11/23  
 Unweighted mean



Copernicus Rainfall: <https://climate.copernicus.eu/charts/>

**APEC Climate Information Toolkit for the Pacific: <http://clikp.sprep.org/>**



Year: 2023, Season: DJF, Lead Month: 3, Method: GAUS  
 Model: APCC, BOM, CMCC, MSC, NASA, NCEP, PNU  
 Generated using CLIK® (2023-12-5)

© APEC Climate Center

# TROPICAL CYCLONE

## 2023/2024 Season



The northwest Pacific tropical cyclone season is year round, with most cyclones occurring between May and October. Sixteen named TCs have occurred as of 20 October 2023. In the southwest Pacific, the 2023-24 tropical cyclone season started on 1 November 2023. The outlook for the season favoured normal-to-enhanced risk for TC activity in the eastern part of the basin and normal-to-reduced TC activity in the western part of the basin. Several severe TCs are possible anywhere in the basin. Three tropical cyclones have occurred in the south Pacific this season. TC Lola just formed before the start of the season on 22 October, followed by TC Mal which affected Fiji, and most recently TC Jasper which affected the Solomon Islands before tracking slowly southwest to north Queensland, Australia, where devastating floods occurred in December.

It's important to remember that history shows that tropical cyclones can happen outside the normal cyclone season, and it does not take a severe cyclone to produce severe impacts. Coastal and river flooding rainfall can occur with a distant, weak, or former cyclone, especially if the system is slow-moving. Communities should remain vigilant, and follow forecast information provided by their National Meteorological and Hydrological Service (NMHS).

The weekly tropical cyclone forecast from the ACCESS-S model shows lower than normal risk in the southwest Pacific between 20 and 26 January and in the northwest Pacific between 20 January and 2 February. The risk is near-normal in the southwest Pacific from 27 January to 2 February.

### Individual Model Links

UKMO Global long-range model probability maps: <http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks/glob-seas-prob>

ECMWF Rain (Public charts) - Long range forecast: <http://www.ecmwf.int/en/forecasts/charts/seasonal/rain-public-charts-long-range-forecast>

POAMA Pacific Seasonal Prediction Portal: <http://poama.bom.gov.au/experimental/pasap/index.shtml>

APEC Climate Center (APCC): <http://www.apcc21.org/eng/service/6mon/ps/japcc030703.jsp>

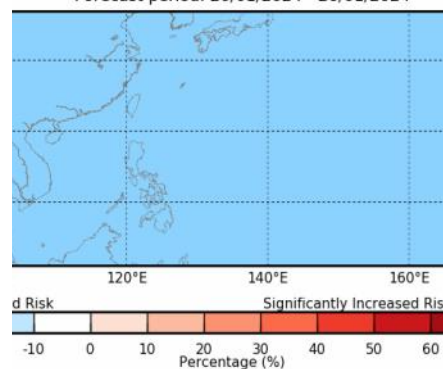
NASA GMAO GEOS-5: <http://gmao.gsfc.nasa.gov/research/ocean/>

NOAA CFSv2: <http://www.cpc.ncep.noaa.gov/products/CFSv2/CFSv2seasonal.shtml>

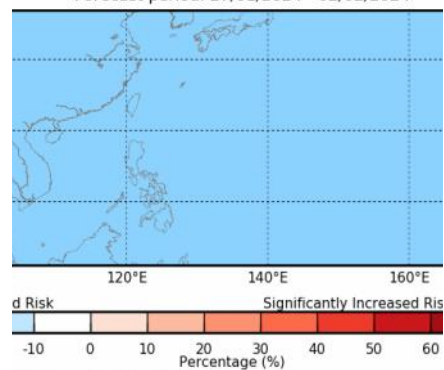
IRI for Climate and Society: <http://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate-forecasts/>

### ACCESS-S Weekly Forecasts –Northwest Pacific

Difference from normal chance of Tropical Cyclone's in the Northwest Pacific  
Forecast period: 20/01/2024 - 26/01/2024

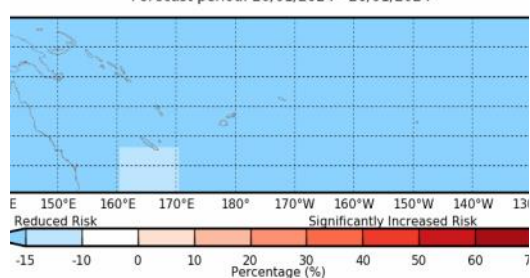


Difference from normal chance of Tropical Cyclone's in the Northwest Pacific  
Forecast period: 27/01/2024 - 02/02/2024

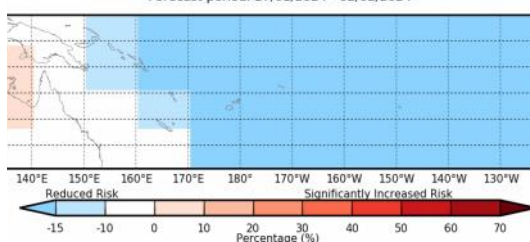


### ACCESS-S Weekly Forecasts –Southwest Pacific

Difference from normal chance of Tropical Cyclone's in the Southwest Pacific  
Forecast period: 20/01/2024 - 26/01/2024



Difference from normal chance of Tropical Cyclone's in the Southwest Pacific  
Forecast period: 27/01/2024 - 02/02/2024



# OTHER INFORMATION

## Southern Oscillation Index

The Southern Oscillation Index, or SOI, gives an indication of the development and intensity of El Niño and La Niña events across the Pacific Basin. The SOI is calculated using the difference in air pressure between Tahiti and Darwin. Sustained negative values of the SOI below  $-7$  often indicate El Niño episodes. These negative values are usually accompanied by sustained warming of the central and/or eastern tropical Pacific Ocean, and a decrease in the strength of the Pacific Trade Winds. Sustained positive values of the SOI greater than  $+7$  are typical of La Niña episodes. They are associated with stronger Pacific Trade Winds and sustained cooling of the central and eastern tropical Pacific Ocean. In contrast, ocean temperatures to the north of Australia usually become warmer than normal.

## Multivariate ENSO Index (MEI)

The Climate Diagnostics Center Multivariate ENSO Index (MEI) is derived from a number of parameters typically associated with El Niño and La Niña. Sustained negative values indicate La Niña, and sustained positive values indicate El Niño.

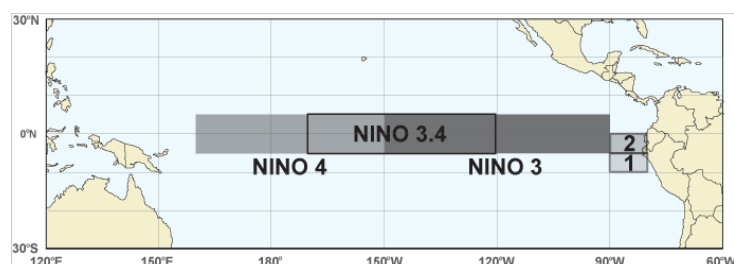
## 20 degrees Celsius Isotherm Depth

The 20°C Isotherm Depth is the depth at which the water temperature is 20°C. This measurement is important, as the 20°C isotherm usually occurs close to the thermocline, the region of most rapid change of temperature with depth, or the division between the mixed surface layer and deep ocean. A 20°C isotherm that is deeper than normal (positive anomaly) implies a greater heat content in the upper ocean, while a shallower 20°C isotherm (negative anomaly) implies a lower-than-normal heat content in the upper ocean.

## Regions

SST measurements may refer to the NINO1, 2, 1+2, 3, 3.4 or 4 regions. These descriptions simply refer to the spatially averaged SST for the region described. The NINO regions (shown in the figure below) cover the following areas:

Region	Latitude	Longitude
NINO1	5-10°S	80-90°W
NINO2	0-5°S	80-90°W
NINO3	5°N to 5°S	150-90°W
NINO3.4	5°N to 5°S	120-170°W
NINO4	5°N to 5°S	160°E to 150°W



NOTE: NINO1+2 is the combined areas 1 and 2