

Monthly Climate Bulletin

March 2024



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Photo Credit: Molly Powers (SPC) Samoa Tide Gauge





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Issued 16 April 2024

- El Niño continues and is near its end. Climate models indicate sea surface temperatures in the central tropical Pacific are expected to return to ENSO-neutral later in autumn 2024.
- The Madden Julian Oscillation (MJO) has moved into the Maritime Continent. A majority of climate models indicate this pulse will continue eastwards over the Maritime Continent in the coming week.
- A strong South Pacific Convergence Zone (SPCZ) was shifted southwest over PNG Islands, Solomon Islands, Vanuatu, Fiji, Tonga, and Niue.
- Sea surface temperatures (SSTs) for March 2024 were warmer than average across the tropical Pacific Ocean.
- The Coral bleaching Outlook to 28 April shows 'Alert Level 2' over parts of southeastern Australia, eastern PNG, eastern Solomon Islands, northern Fiji, southern Tuvalu, Kiribati (southern Phoenix and Line Islands), northern Tonga, northern Niue, Tokelau, Wallis and Futuna, Samoa, American Samoa, and northern and central Cook Islands.
- For April to June 2024, the models agree on below normal rainfall being likely or very likely for Palau's main Islands, Guam, CNMI, northern FSM, northern RMI, New Caledonia, southern Vanuatu, Niue, southern Cook Islands, and northeast French Polynesia. In addition, there's model agreement on above normal rainfall being likely or very likely in near-equatorial regions from PNG eastward across the northern Solomon Islands, Kiribati (mainly southern Phoenix), Tuvalu, Tokelau, Wallis and Futuna, Samoa, American Samoa, northern Cook Islands, central French Polynesia and Pitcairn Islands.
- The ACCESS-S weekly tropical cyclone outlook shows significantly increased risk over northern Australia and southern PNG for the week from 17 to 23 April, and a slightly increased risk for the Philippines and Palau region for the week from 24 to 30 April.

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EL NIÑO–SOUTHERN OSCILLATION

El Niño near its end

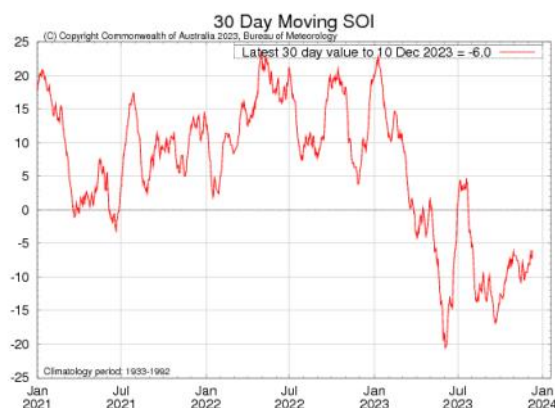
Click link to access [Climate Driver Update issued on 2 April 2024](#)

El Niño continues and is near its end. Climate models indicate sea surface temperatures in the central tropical Pacific are expected to return to ENSO-neutral later in autumn 2024. Oceanic indicators such as tropical Pacific sea surface temperatures have been steadily cooling since December but are still meeting El Niño thresholds. Atmospheric indicators are consistent with a decaying El Niño. Cloudiness near the equatorial Date Line is below average, opposite to that expected during an active El Niño. The 90-day Southern Oscillation Index (SOI) is currently -3.0, indicative of ENSO-neutral conditions. While four out of seven international models are predicting a La Niña by late winter, El Niño and La Niña predictions made in early autumn tend to have lower accuracy than predictions made at other times of the year. This means that current forecasts of the ENSO state beyond May should be used with caution. ENSO forecasts have historically had their lowest skill for forecasts issued in April, with skill increasing from May.

The oceans have been the warmest on record globally since April 2023. Sea surface temperatures continue to increase, with temperatures in February 2024 setting a record for that month, and March 2024 on track to be the warmest March on record (final data for March is not yet available). The global pattern of warmth is affecting the typical historical global pattern of sea surface temperatures associated with ENSO variability. As the current global ocean conditions have not been observed before, inferences of how ENSO may develop in 2024 that are based on past events may not be reliable. International climate models suggest the central tropical Pacific Ocean will continue to cool in the coming months, with four out of seven climate models indicating the central Pacific is likely to return to neutral El Niño-Southern Oscillation (ENSO) levels by the end of April (i.e., neither El Niño nor La Niña), and all models indicating neutral in May. Although the most recent value of the Indian Ocean Dipole (IOD) index (+0.95 °C) is above the positive IOD threshold, the IOD is neutral. Sustained values of the IOD index above the threshold are required for an IOD event to form. The eastern Indian Ocean has cooled in recent weeks, due to increased monsoonal activity in the area, including tropical low 08U, which developed into Severe Tropical Cyclone Nathan.

The Southern Annular Mode (SAM) is currently positive, as of 2 April. Forecasts indicate SAM will remain positive for almost a week before it returns to neutral.

The 30-, 60- and 90-day Southern Oscillation Index (SOI) values for the period ending 31 March 2024 were 0, -7 and -3, respectively. Compared to last fortnight, the 30- day SOI has become more negative while the 60- and 90-day values have both remained similar.



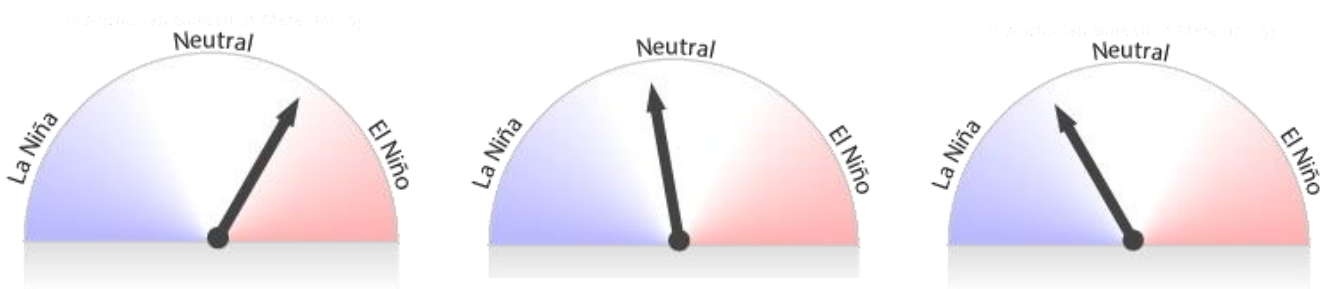


EL NIÑO–SOUTHERN OSCILLATION

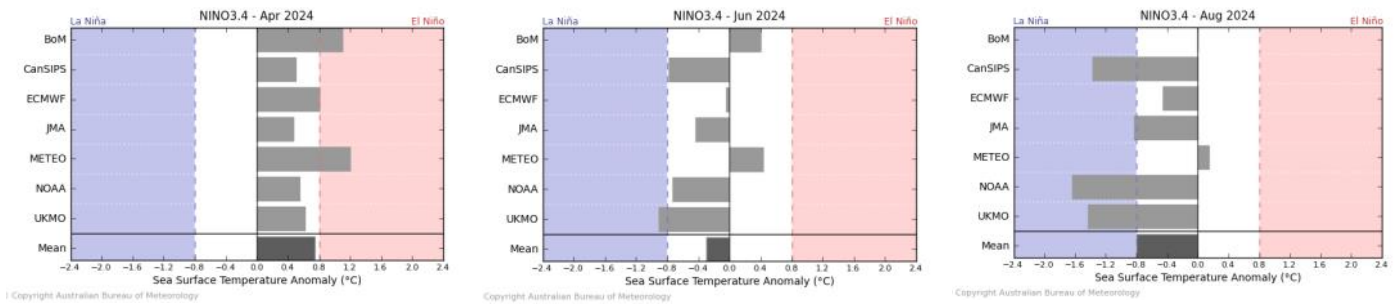
El Niño near its end

Click link to access [Climate Driver Update issued on 2 April 2024](#)

Bureau of Meteorology NINO3.4 ENSO Model Outlooks for April, June and August



Bureau of Meteorology NINO3.4 International Model Outlooks



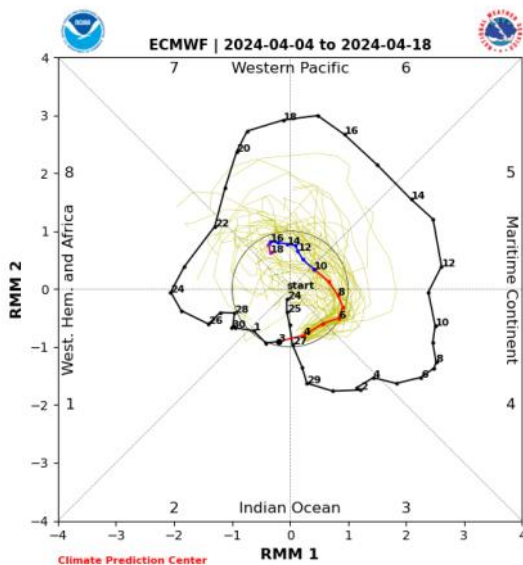
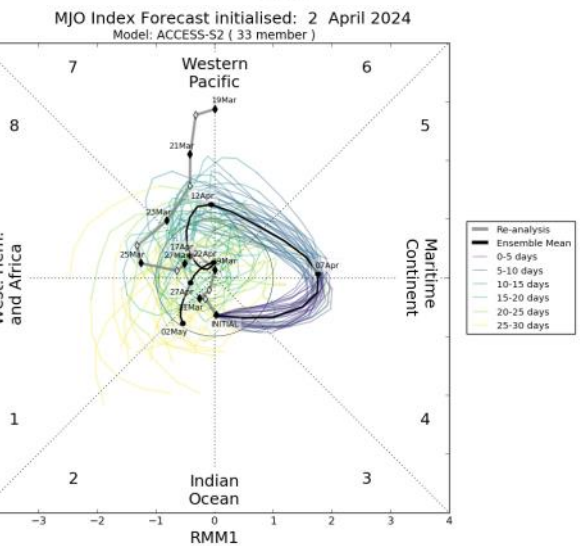
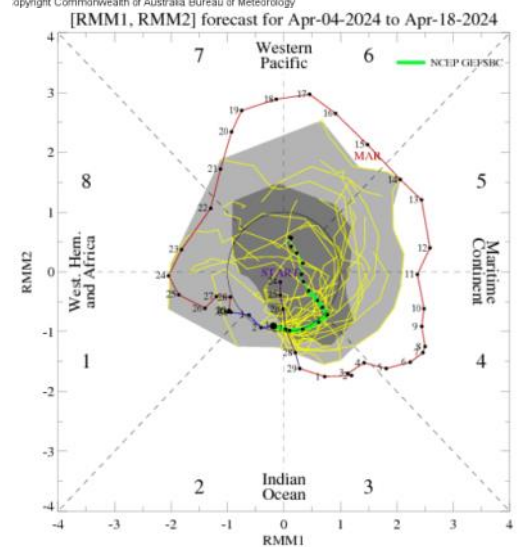
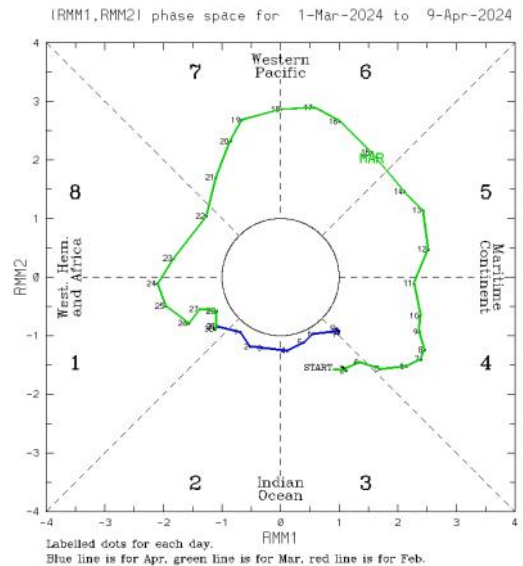
Bureau of Meteorology summary of international model outlooks for NINO3.4: <http://www.bom.gov.au/climate/model-summary/#tabs=Pacific-Ocean>

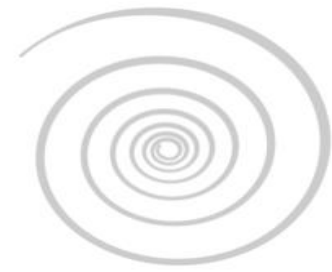
MADDEN–JULIAN OSCILLATION

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

A weakening pulse of the Madden Julian Oscillation (MJO) has moved into the Maritime Continent. A majority of climate models indicate this pulse will move further in the Maritime Continent in the coming week. While most models indicate a weak MJO pulse in the Maritime Continent, some indicate a moderately strong MJO in that region, which could enhance tropical weather over Australian longitudes.

This is an abbreviated version of the Tropical Climate Update. Click on the [Weekly Tropical Update](#) for more information .



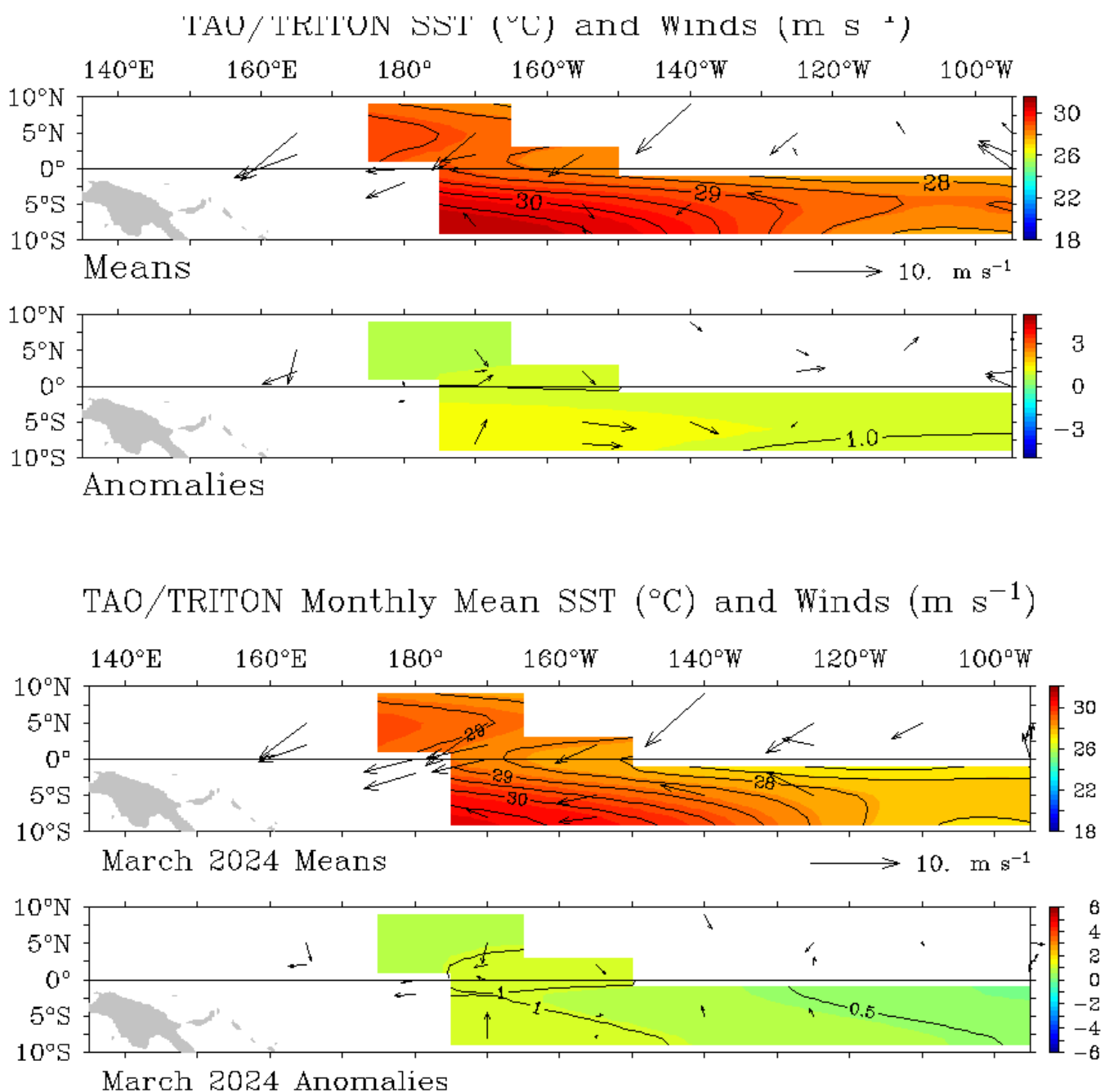


WIND

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

During March, the trade winds were generally close to normal over the equatorial Pacific, although they were somewhat stronger than normal near and just west of the Date Line in the southern hemisphere. For the five days ending 3 April 2024, the trade winds were much weaker than normal east of the Date Line, but a little stronger than normal west 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

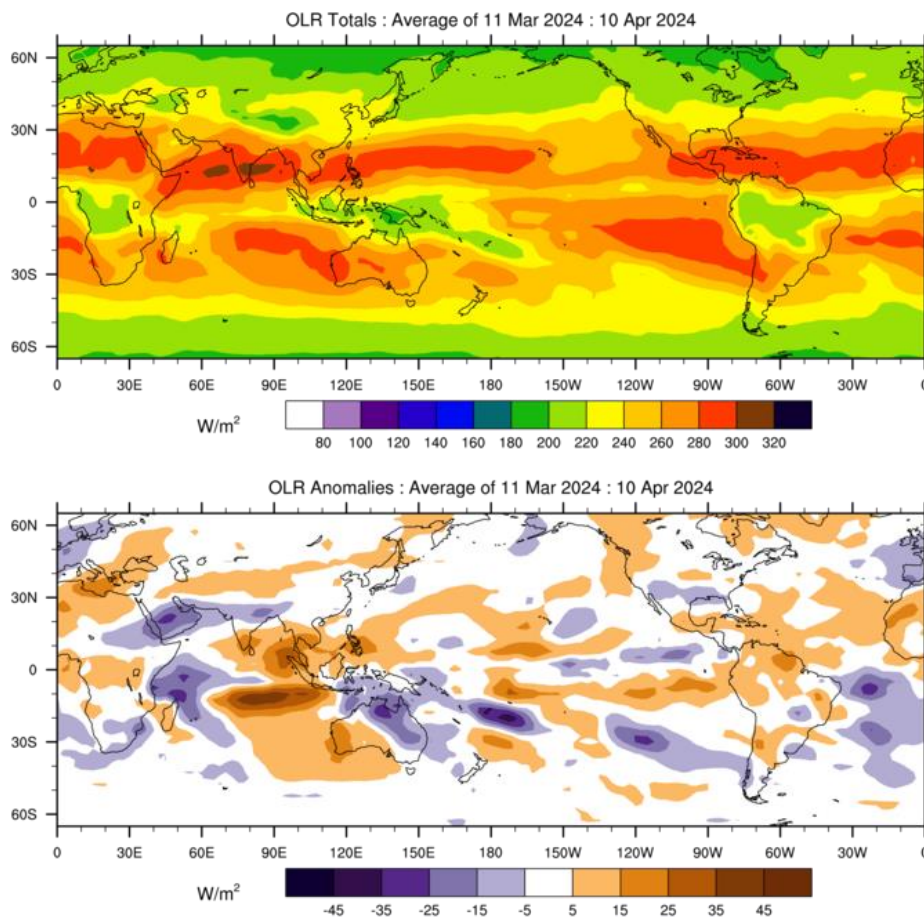
Click link to access [OLR](#)



The March 30-day OLR anomaly map shows a large region of low OLR (increased convection) that stretched south-eastwards from PNG's Islands in the west, to Niue in the east. This line of convection and rain essentially formed the South Pacific Convergence Zone (SPCZ), which was shifted southwest over PNG Islands, Solomon Islands, Vanuatu, Fiji, Tonga, and Niue. Areas of high OLR (decreased convection) were evident over Palau, Guam, CNMI, and Kiribati in the northern hemisphere. In the southern hemisphere, anomalously high OLR stretched south-eastwards from Tuvalu across, American Samoa, Tokelau, the Cook Islands and French Polynesia.

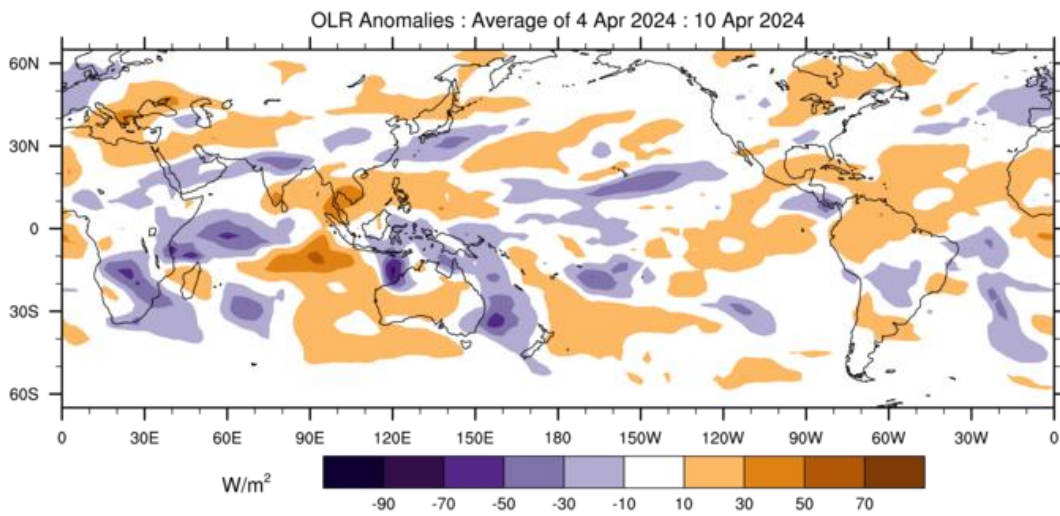
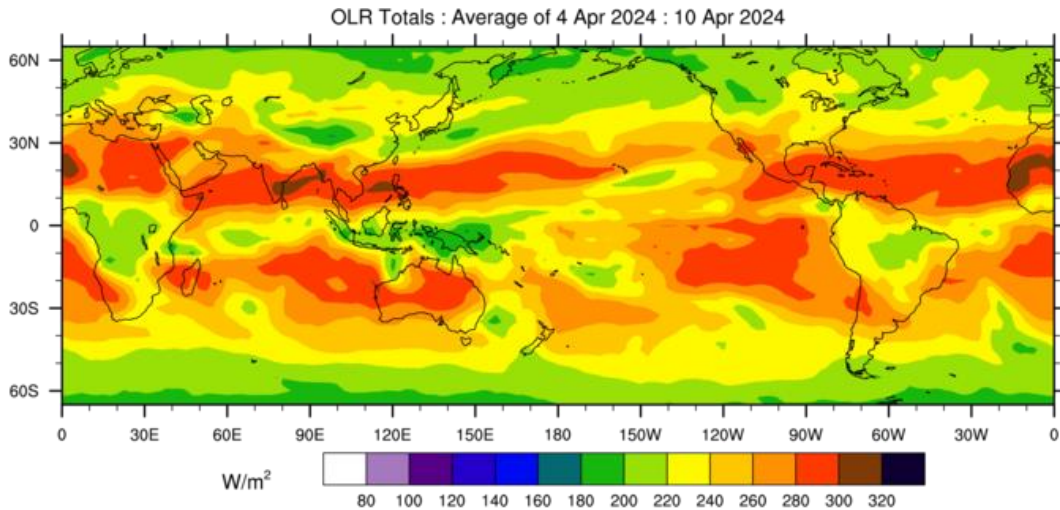
Note: Global maps of OLR below highlight regions experiencing increased or decreased cloudiness. The top panel is the total OLR in Watts per square metre (W/m^2) and the bottom panel is the anomaly (current minus the 1979-1998 climate average), in W/m^2 . In the bottom panel, negative values (blue shading)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

OLR Total and Anomalies, 30 Day OLR

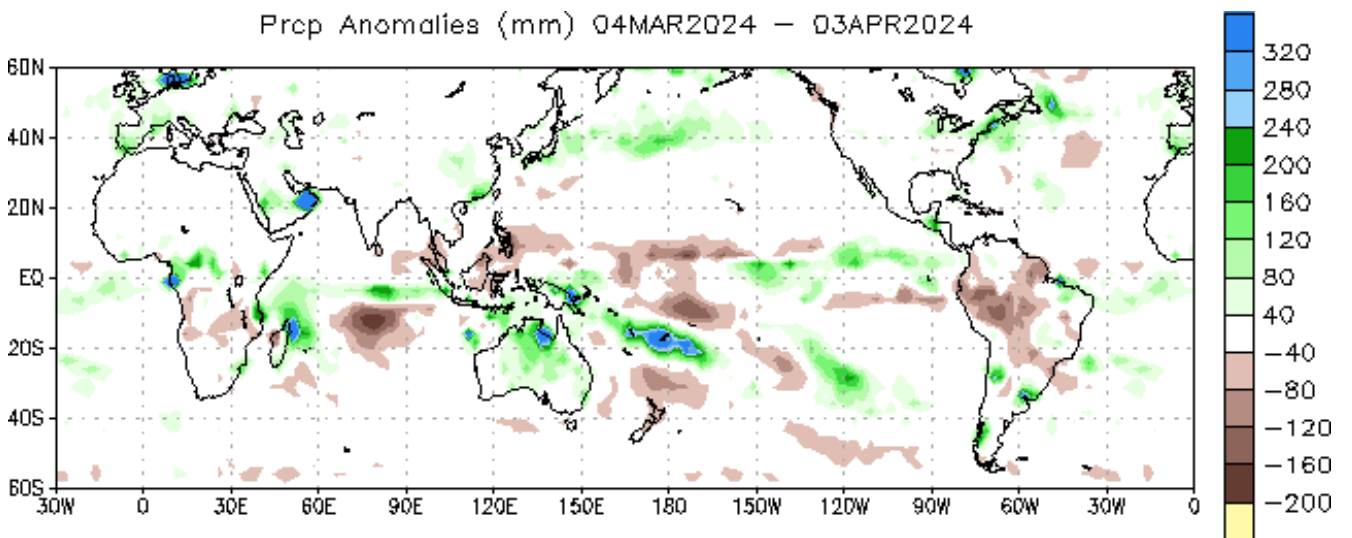


(C) Copyright Commonwealth of Australia 2024. Bureau of Meteorology

OLR Total and Anomalies, 7 Day OLR

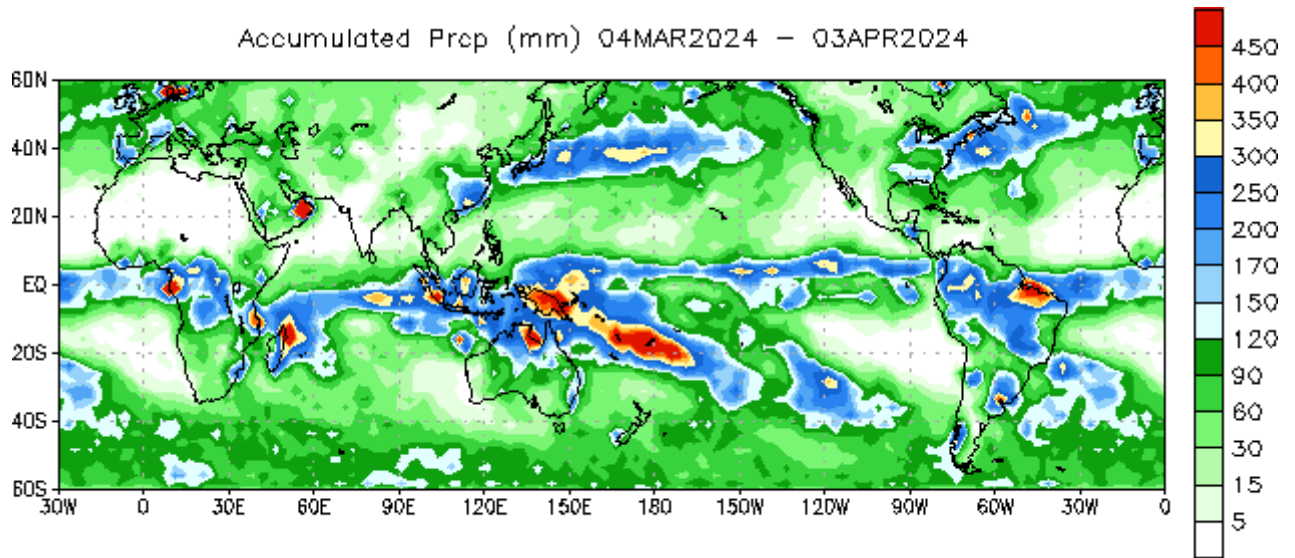


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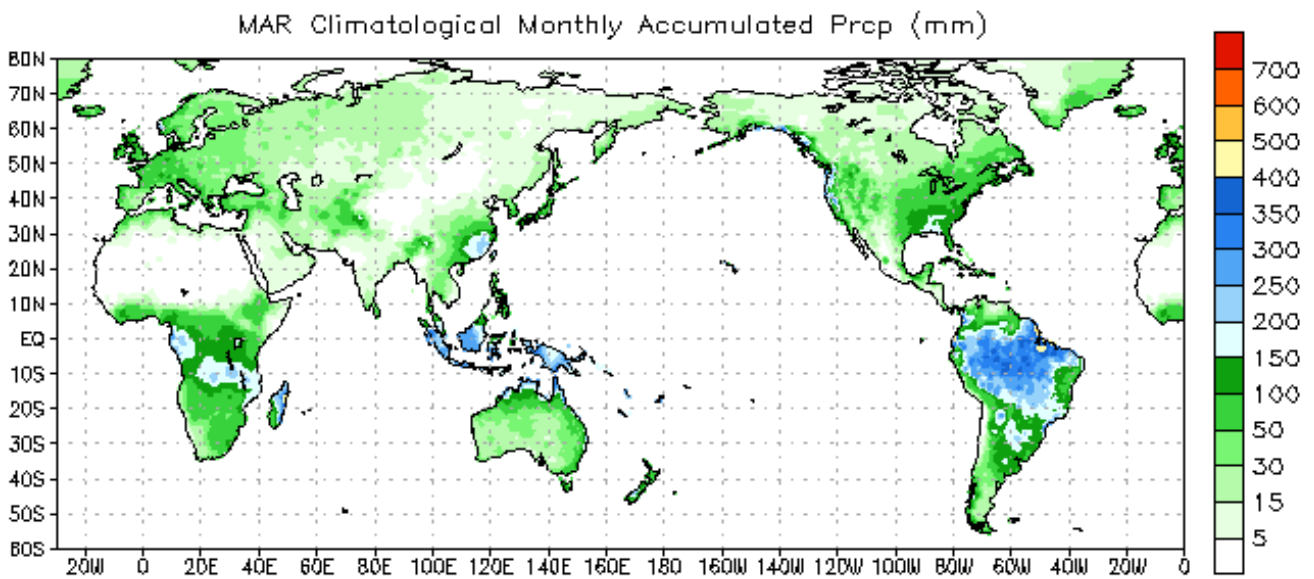


Data Source: NCEP CMAP Precipitation
Climatology (1991-2020)

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

OCEAN CONDITIONS

SEA SURFACE TEMPERATURE

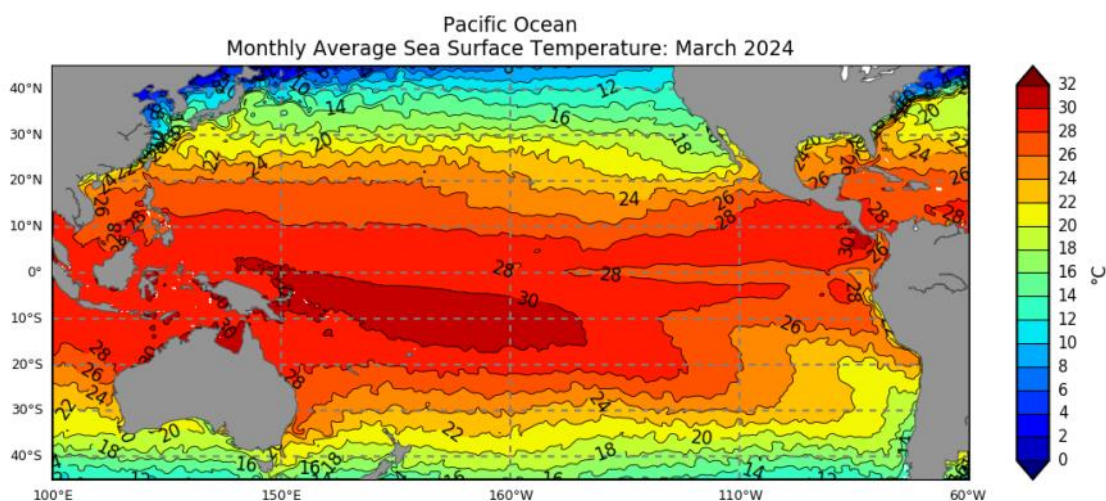


Click link to access [Pacific Community COSPPac Ocean Portal](#)

Sea surface temperatures (SSTs) for March 2024 were warmer than average across the tropical Pacific Ocean. Between 20 °S and 5 °N, SST anomalies were more than 1.5 °C warmer than the long-term (1961-1990) average in the central and eastern Pacific Ocean.

Highest-on-record March SSTs occurred in northeast PNG's EEZ, southern Nauru, parts of Kiribati (southern Gilbert, southern Phoenix, and southern Line Islands), northern Fiji, Tuvalu, Tokelau, Wallis and Futuna, Samoa, American Samoa, central and northern Cook Islands and central French Polynesia. The SST in decile 10 (very much above average) stretched east-south-eastwards from northern PNG to northern half of Fiji, and to northern French Polynesia. Another band stretched from central Line Islands eastwards towards the south American coast. Above average (8-9) decile are observed for majority of the Pacific Island Countries, spanning south-eastward from FSM, RMI, parts of PNG, western New Caledonia, northern Vanuatu to eastern French Polynesia. Average SSTs (4-7) for February were observed in Palau, parts of FSM, central Nauru, Kiribati (northwest Gilbert Islands), eastern New Caledonia, southern Fiji, southern Tonga, southern Cook Islands and southern French Polynesia. Patches of decile 2-3 (below average) were observed in part of southern French Polynesia.

Mean Sea Surface Temperature

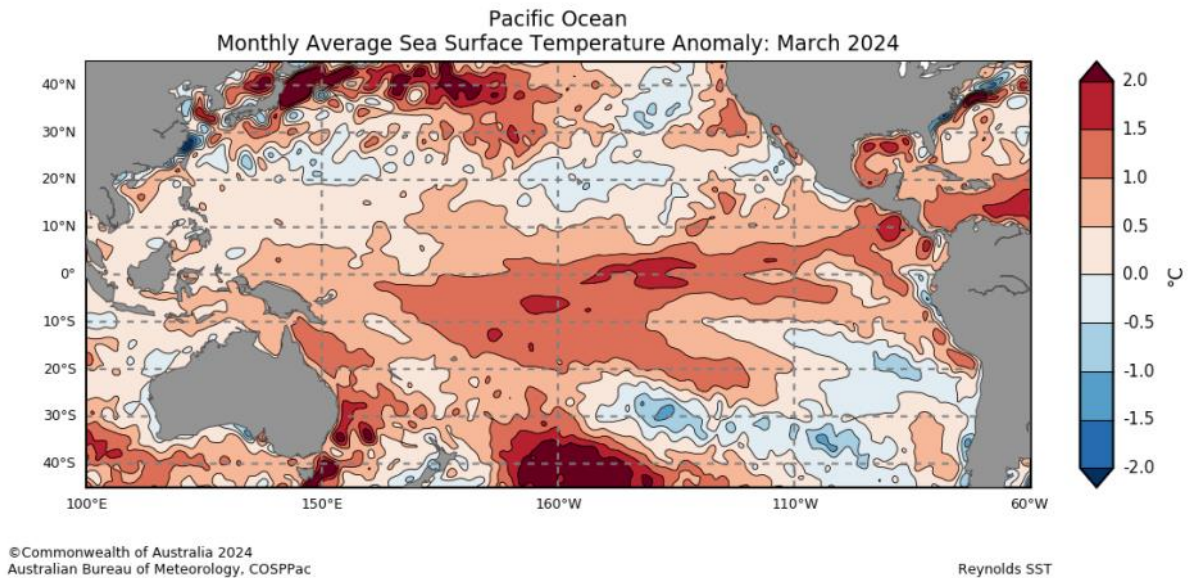


OCEAN CONDITIONS

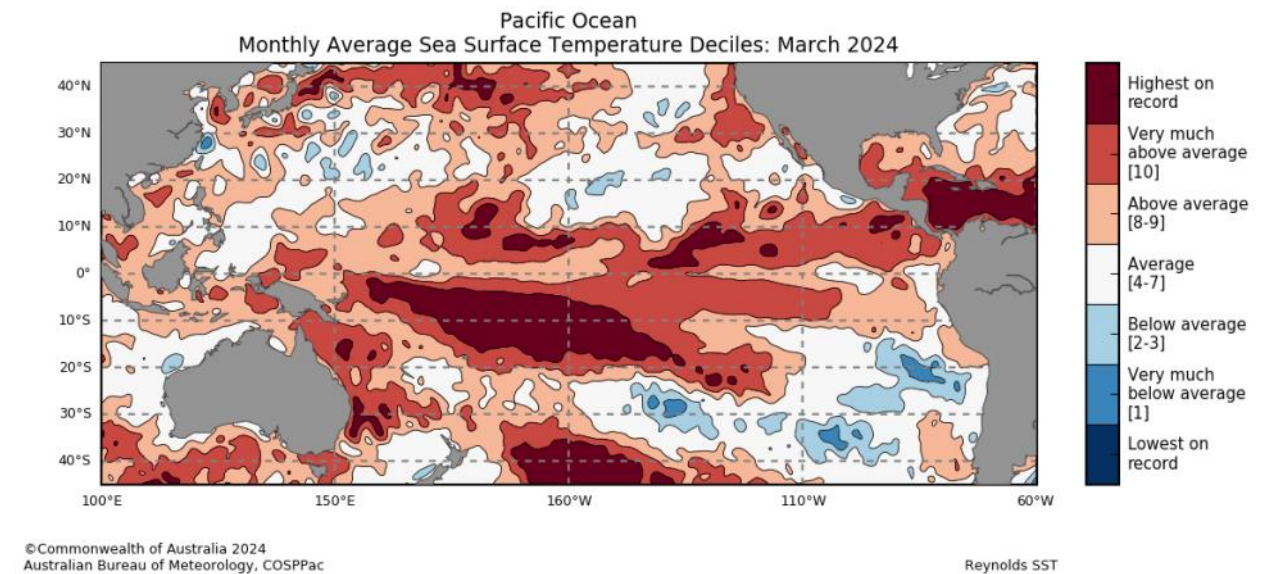
Click link to access [SEA SURFACE TEMPERATURE](#)



Anomalous Sea Surface Temperature



Sea Surface Temperatures Deciles



OCEAN CONDITIONS

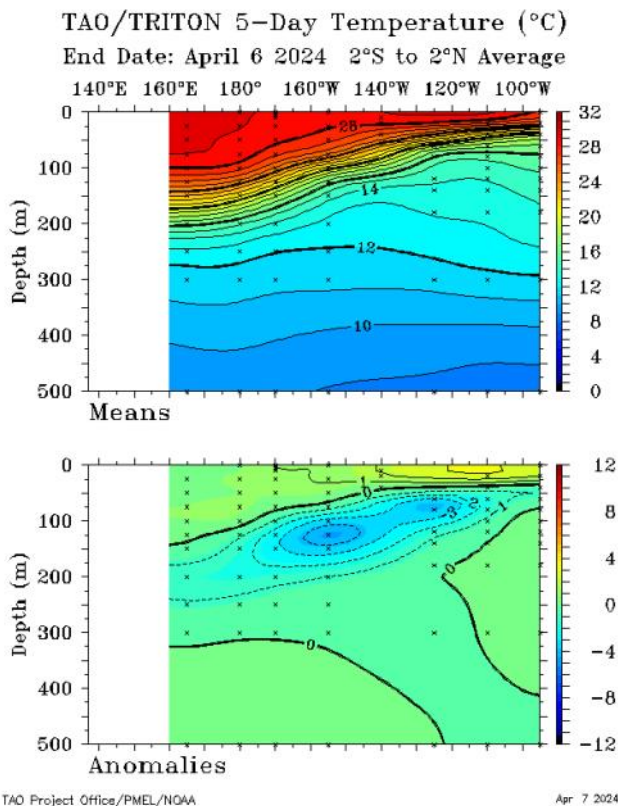
SUB SURFACE



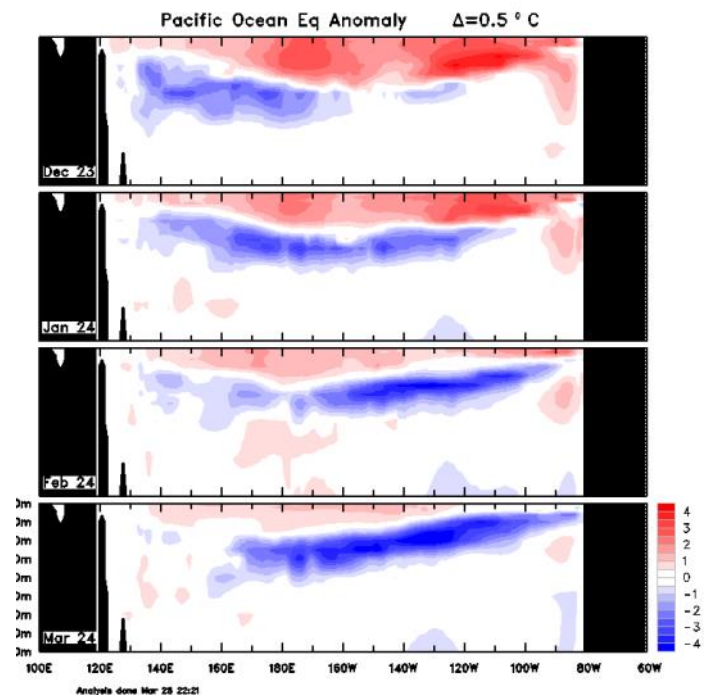
The four-month sequence of equatorial Pacific sub-surface temperature anomalies (to 31 March 2024) shows weak warm anomalies of up to 1.5 °C warmer than average across the top 25 m of the central and western equatorial Pacific during March. Cool anomalies are present below this shallow layer and exceed more than 3 °C cooler than average eastwards of 160 °W and close to the surface of the eastern Pacific.

The depth and magnitude of warm anomalies has significantly decreased over the December to March period, with weak warm anomalies of less than 1.5 °C warmer than average limited to the surface in the central and western Pacific in February. The magnitude and extent of cool anomalies has also increased and has spread eastwards over the past few months. This sub-surface pattern of a layer of warmer than average waters above a layer of cooler than average waters is typical of the declining phase of El Niño.

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

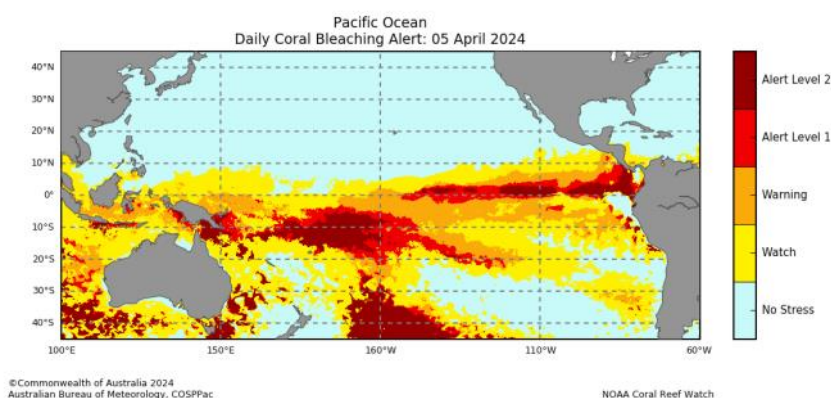
CORAL BLEACHING



The daily Coral Bleaching Alert status for 5 April 2024 shows an area of 'Alert Level 2' over parts of eastern Australia, southern PNG, eastern Solomon Islands, northern Fiji, southern Tuvalu, Tokelau, Kiribati (southern Phoenix Islands), Wallis and Futuna, American Samoa, and western Cook Islands. 'Alert Level 1' over parts of eastern PNG, eastern half of Solomon Islands, most parts of Tuvalu, Kiribati (southern half of Phoenix Is., and southern Line Is.), northern Niue, most of Cook Islands, and central French Polynesia. 'Warning' status over northern PNG, Kiribati (northern Phoenix, and central Line Is.), southern Cook Islands, and northern French Polynesia. 'Watch' or 'No stress' for the rest of the countries. The four-week Coral Bleaching Outlook to 28 April shows 'Alert Level 2' over parts of southeastern Australia, eastern PNG, eastern Solomon Islands, northern Fiji, southern Tuvalu, Kiribati (southern Phoenix and Line Islands), northern Tonga, northern Niue, Tokelau, Wallis and Futuna, Samoa, American Samoa, and northern and central Cook Islands. 'Alert Level 1' rating stretches eastwards from PNG to central French Polynesia. 'Warning' similar to 'Alert Level 1' but extend further north to Nauru, Kiribati (Gilbert and northern Islands) and central French Polynesia. 'Watch' or 'No Stress' over the rest of the countries.

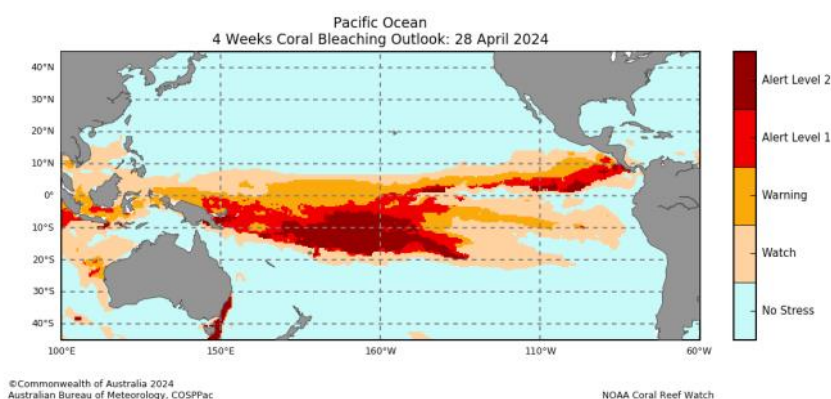
Daily Coral Bleaching Alert

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



4 Weeks Coral Bleaching Outlook

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



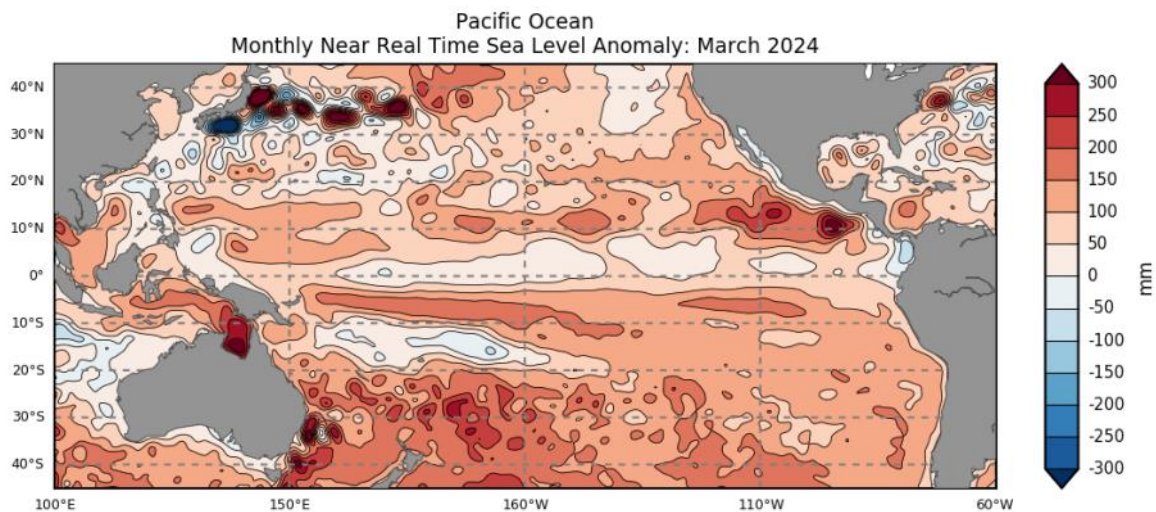
OCEAN CONDITIONS

OCEAN SURFACE CURRENTS AND SEA LEVEL

Sea levels observed in March were above normal over most COSPPac countries. Patches of anomalies from +200 to +250 mm were observed along the eastern Australia coast, New Caledonia, southern Fiji, southern Tonga, southern Niue, southern Cook Islands, and southern French Polynesia. Anomalies from +100 to +200 mm were observed in eastern PNG, Tuvalu, Tokelau, Kiribati (southern Phoenix, and southern Line Islands), northern Cook Islands, and central French Polynesia. Patches of +50 to +100 mm were observed for other COSPPac countries apart from patches of below normal sea level anomalies were observed in Palau, Kiribati (Gilbert Is.), southern Solomon Islands, Vanuatu, northern Fiji, northern Tonga, Wallis and Futuna, Samoa, American Samoa and central Cook Islands.

Monthly Sea Level Anomalies

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



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Australian Bureau of Meteorology, COSPPac

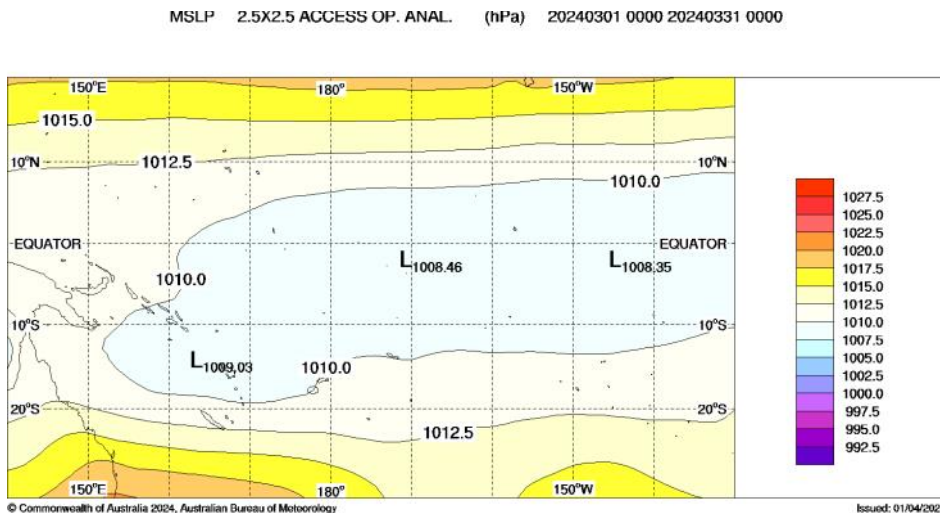
AVISO Ssalto/Duacs SLA

MEAN SEA LEVEL PRESSURE

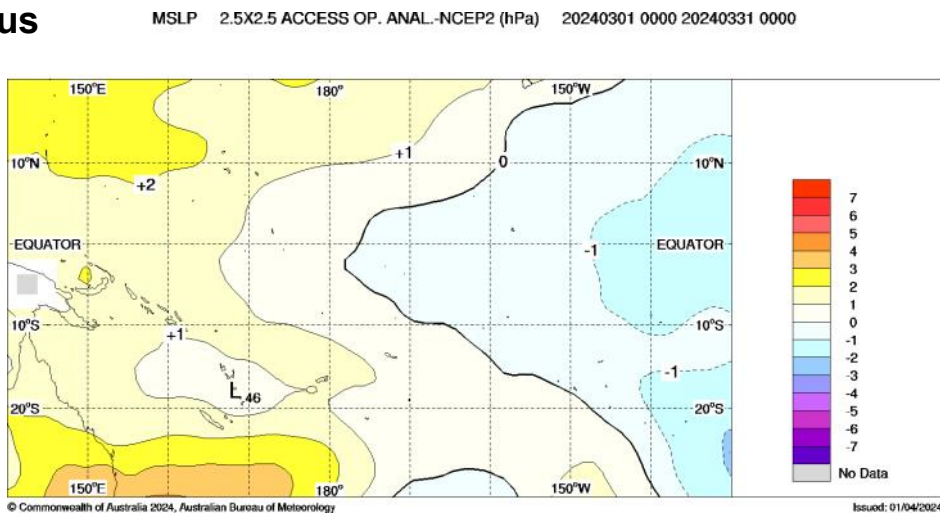
The March mean sea level pressure (MSLP) anomaly map shows negative anomalies of 1 hPa or greater over the tropical Pacific east of 155 °W. Positive anomalies of 1 hPa or greater were evident in the western tropical Pacific, south of New Caledonia and over Guam and CNMI.

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

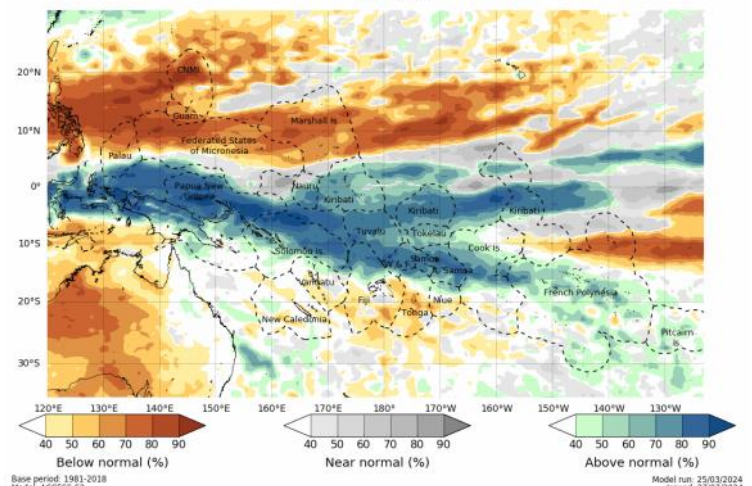
April — June 2024



The ACCESS-S model forecast for April 2024, shows below normal rainfall is likely or very likely for northern Palau, northern FSM, Guam, CNMI, most of RMI, in patches of New Caledonia's EEZ, Vanuatu, southern Fiji, central and southern Tonga, southern Niue, southern Cook Islands, plus northeast French Polynesia and the southern Line Islands. Above normal rainfall is likely or very likely for southern Palau, PNG, Solomon Islands, far northern Vanuatu, Nauru, Kiribati (Gilbert, Phoenix, and central Line Islands), northern Fiji, northern Tonga, Tuvalu, Tokelau, Wallis and Futuna, Samoa, American Samoa, northern Niue, northern and central Cook Islands, central and south French Polynesia, and Pitcairn Islands.

The ACCESS-S three-month rainfall outlook (April to June 2024) is very similar to the March outlook, but with the below normal rainfall region in the southern hemisphere being stronger and extending further west, while the above normal region is narrower east of PNG. Above normal rainfall is likely or very likely stretching east to south-easwards from southern Palau across PNG, Solomon Islands, Tuvalu, northern Fiji, Kiribati (southern Phoenix and central Line Is.), Wallis and Futuna, Samoa, American Samoa, central to northern Cook Islands, central French Polynesia, and Pitcairn Islands.

Monthly [ACCESS-S](#) Maps



The Copernicus multi-model outlook for April to June 2024 is very similar to the ACCESS outlook, but with a weaker dry signal from Vanuatu to the southern Cook Islands.

The APEC Climate Centre multi-model outlook (April to June 2024) is similar to ACCESS-S and Copernicus, except over Australia and the Pitcairn Islands.

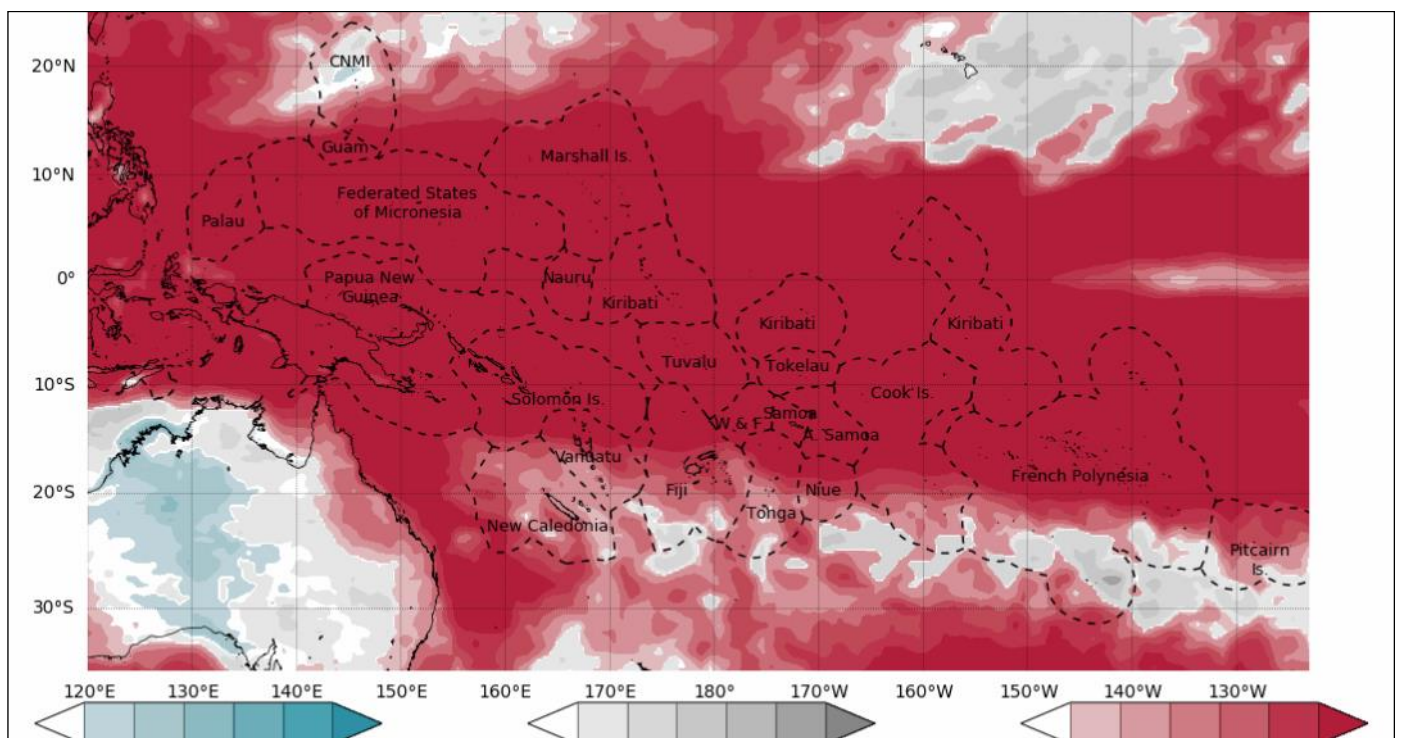
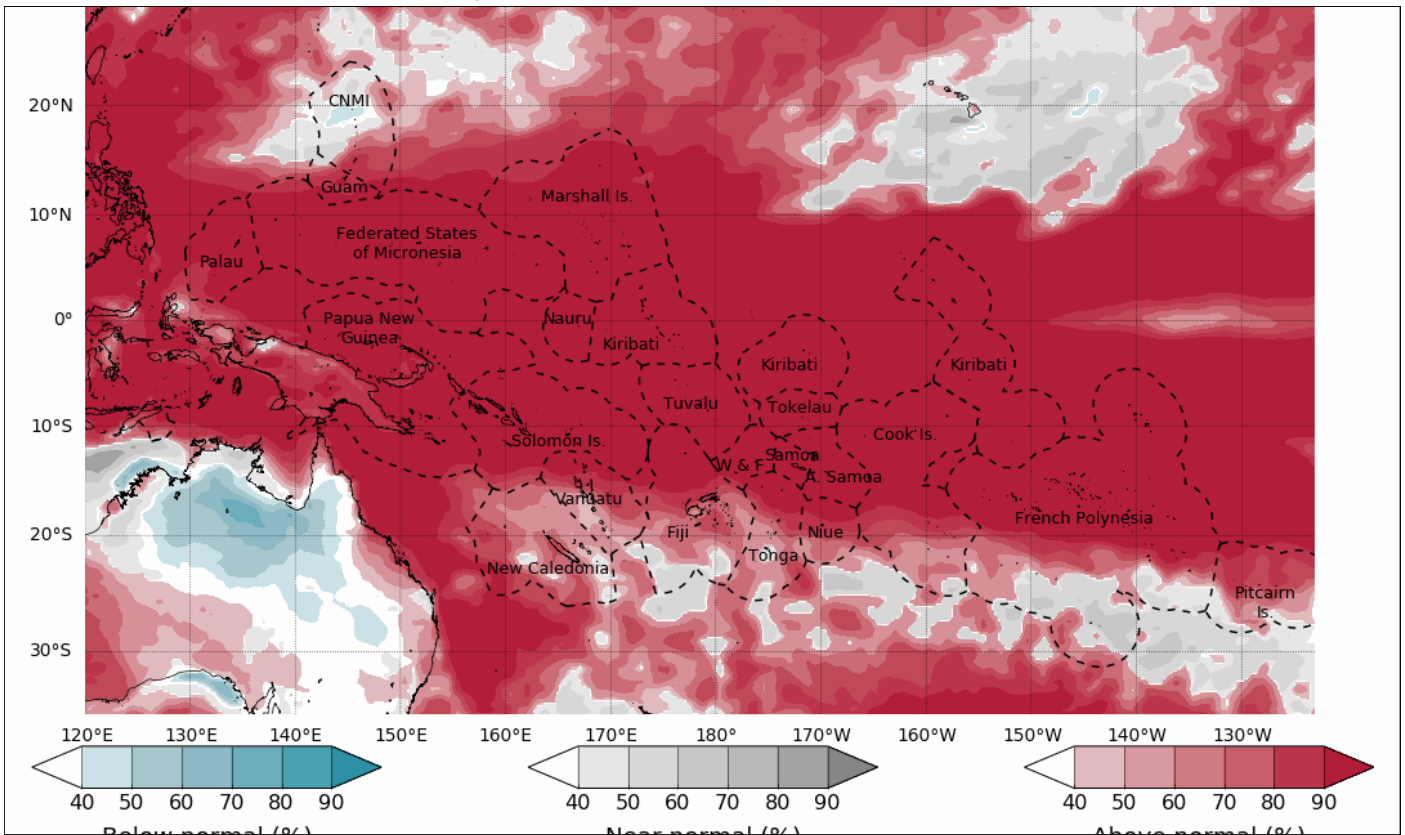
For April to June 2024, the models agree on below normal rainfall being likely or very likely for Palau's main islands, Guam, CNMI, northern FSM, northern RMI, New Caledonia, southern Vanuatu, Niue, southern Cook Islands, and north-east French Polynesia. In addition, there's model agreement on above normal rainfall being likely or very likely in near-equatorial regions from PNG eastward across the northern Solomon Islands, Kiribati (mainly southern Phoenix), Tuvalu, Tokelau, Samoa, American Samoa, northern Cook Islands, central French Polynesia and Pitcairn Islands.

SEASONAL TEMPERATURE OUTLOOK

April—June 2024



Monthly Tmax and Tmin ACCESS-S Maps



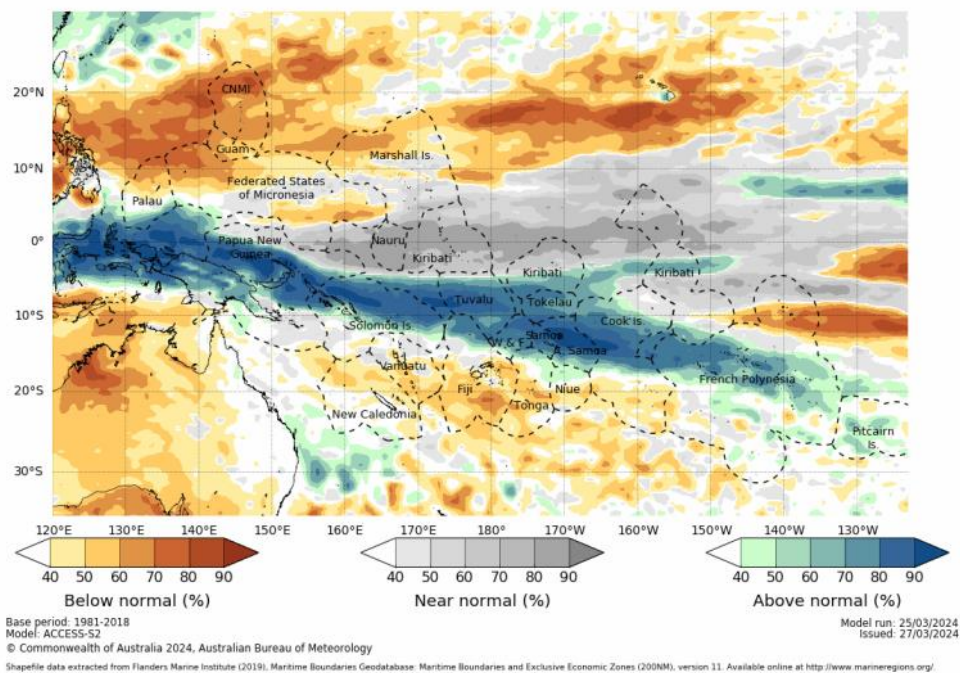
SEASONAL RAINFALL OUTLOOK

April—June 2024

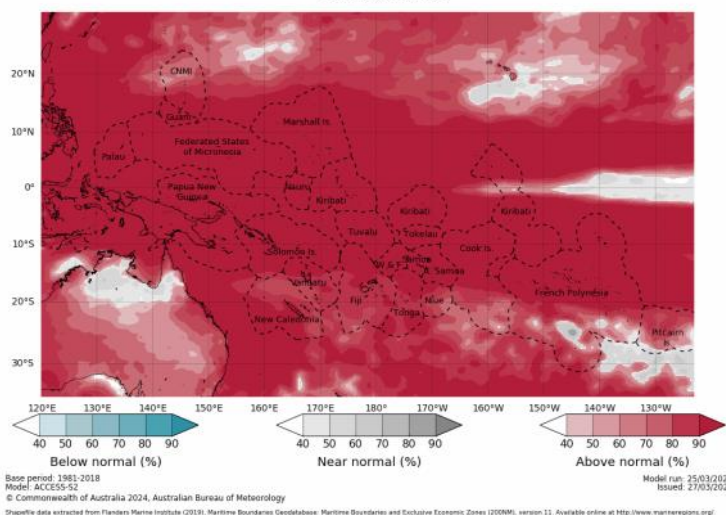


Seasonal ACCESS-S maps

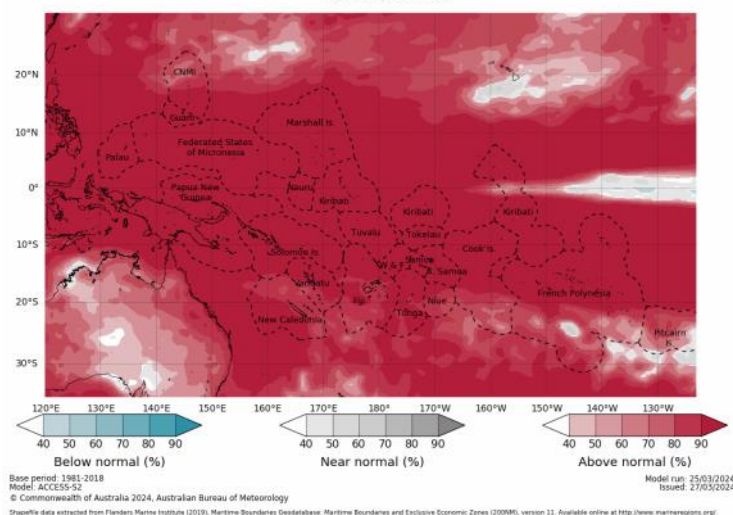
Tercile rainfall probabilities for April to June 2024



Tercile maximum temperature probabilities for April to June 2024



Tercile minimum temperature probabilities for April to June 2024



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

SEASONAL RAINFALL OUTLOOK

April—June 2024



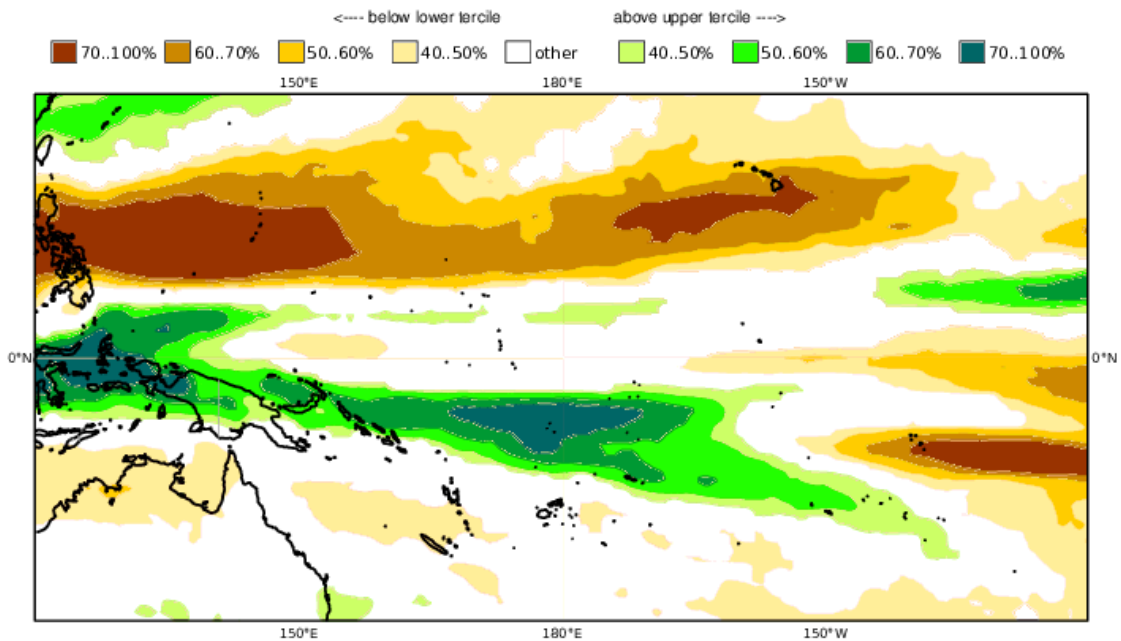
Copernicus (C3S multi-system)-Rainfall

Prob(most likely category of precipitation)

AMJ 2024

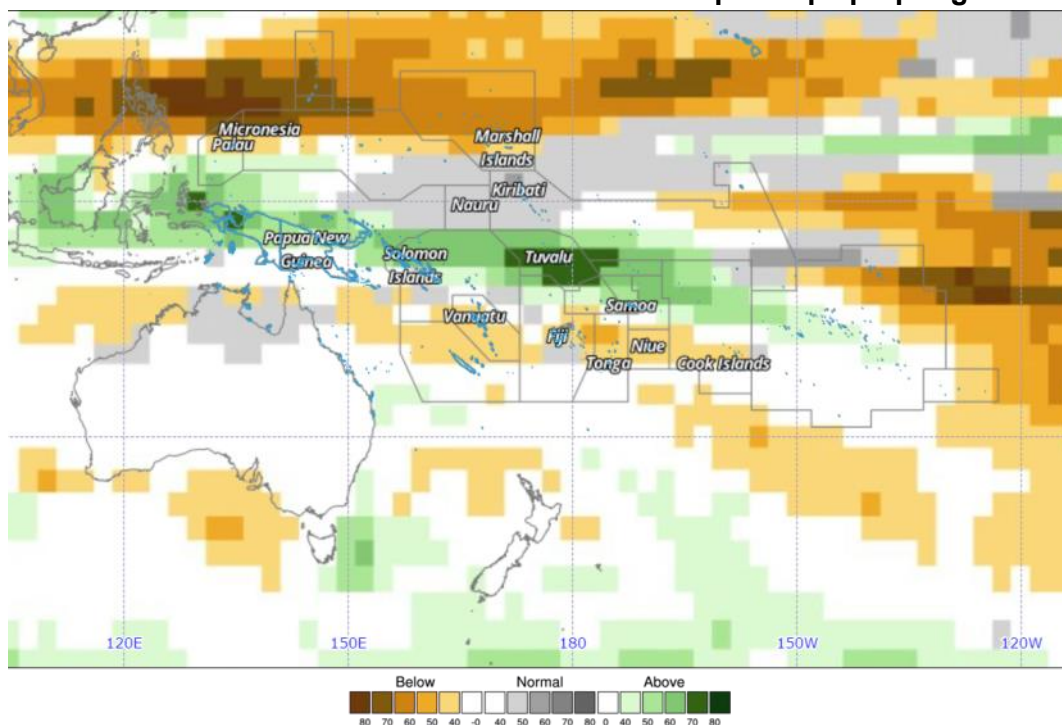
Nominal forecast start: 01/03/24

Unweighted mean



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

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



24, Season: AMJ, Lead Month: 3, Method: GAUS
 ICC, BOM, CMCC, CWB, MSC, NCEP, PNU
 ted using CLIKIP® (2024-4-8)

© APEC Climate

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 occurred as of 20 October 2023. In the southwest Pacific, the 2023-24 tropical cyclone season officially 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. The forecast remains the same for the second half of the season. Several severe TCs were considered possible anywhere in the basin. Six tropical cyclones have occurred in the south Pacific so far this season. TC Lola just formed before the start of the season on 22 October, followed by TC Mal which affected Fiji, and TC Jasper which affected the Solomon Islands before tracking slowly southwest to north Queensland, Australia, where devastating floods occurred in December. In January, TC Kirrily affected Australia, while TCs Nat and Osai affected the Cook Islands and French Polynesia in February.

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 forecasts from the ACCESS-S model show significantly increased risk over northern Australia and southern PNG for the week from 17 to 23 April, and a slightly increased risk for the Philippines and Palau region for the week from 24 to 30 April.

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>

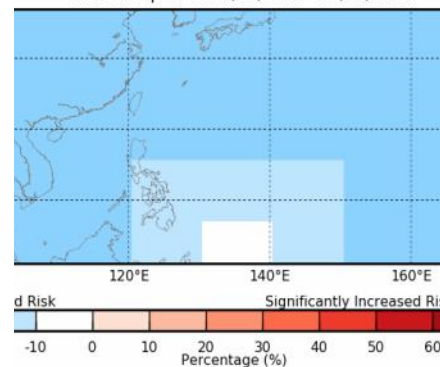
POAMA Pacific Seasonal Prediction Portal: <http://poama.bom.gov.au/experimental/pasap/index.shtml>

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

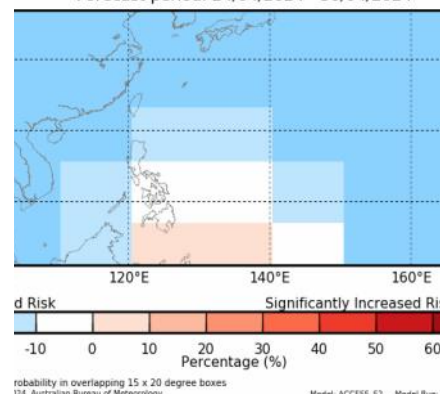
NASA GMAO GEOS-5: <http://gmao.gsfc.nasa.gov/research/ocean/>

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

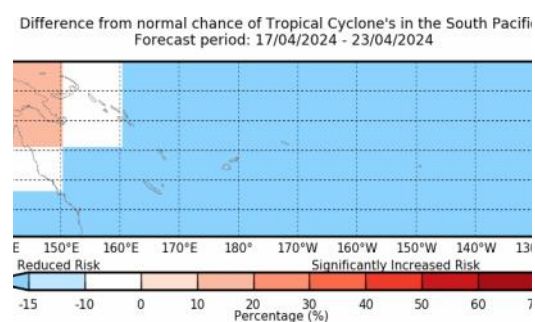
ACCESS-S Weekly Forecasts –Northwest Pacific
 Difference from normal chance of Tropical Cyclone's in the North Pacific
 Forecast period: 17/04/2024 - 23/04/2024



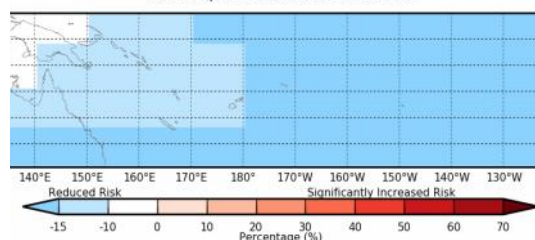
ACCESS-S Weekly Forecasts –Southwest Pacific
 Difference from normal chance of Tropical Cyclone's in the South Pacific
 Forecast period: 24/04/2024 - 30/04/2024



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Model anomaly probability in overlapping 15 x 20 degree boxes
 south of Australia 2024, Australian Bureau of Meteorology
 Model: ACCESS_S2 Model Run: 09082024 Issue:

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.

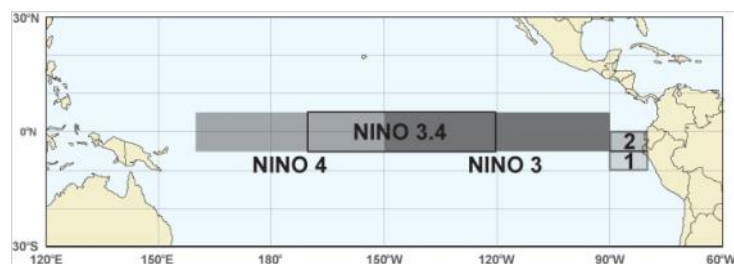
20 degrees Celsius Isotherm Depth

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