

Monthly Climate Bulletin

September 2023



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Photo Credit: Molly Powers (SPC) Samoa Tide Gauge





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Issued 13 October 2023

- An El Niño event and a positive Indian Ocean Dipole (IOD) are underway
- The Madden Julian Oscillation (MJO) pulse is currently weak and is forecast to remain weak for the next fortnight before a pulse of the MJO could emerge over the Western Pacific.
- The ITCZ was active and SPCZ enhanced near Solomon Islands in September 2023.
- Sea surface temperatures (SST) for September 2023 were warmer than average over almost all of the equatorial Pacific Ocean.
- The Coral bleaching Outlook to 29 October shows patches of area of 'Alert Level 1 and 2' over northeast FSM, western RMI, Nauru, Kiribati (central Gilbert Islands, northern Phoenix Islands and Line Islands).
- For October-December 2023, the models agree on above normal rainfall being likely or very likely from eastern FSM, southern and central RMI, northeastern PNG's EEZ, northern Solomon Islands, Nauru, Tuvalu, Kiribati (Gilbert, Phoenix and Line Islands), northern Cook Islands and northern French Polynesia. Below normal rainfall is likely or very likely for CNMI, Guam, eastern RMI, most of PNG, Australia, New Caledonia, Vanuatu, Fiji, Tonga, Niue, American Samoa, central and northern Cook Island, French Polynesia and Pitcairn Islands.
- The ACCESS-S weekly tropical cyclone outlook shows a significantly increased risk in the northwest Pacific between 15 October and 28 October around, Palau, FSM, Guam, CNMI and Philippines.

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EL NIÑO–SOUTHERN OSCILLATION

El Niño active; positive Indian Dipole strengthens

Click link to access [Climate Driver Update issued on 10 October 2023](#)

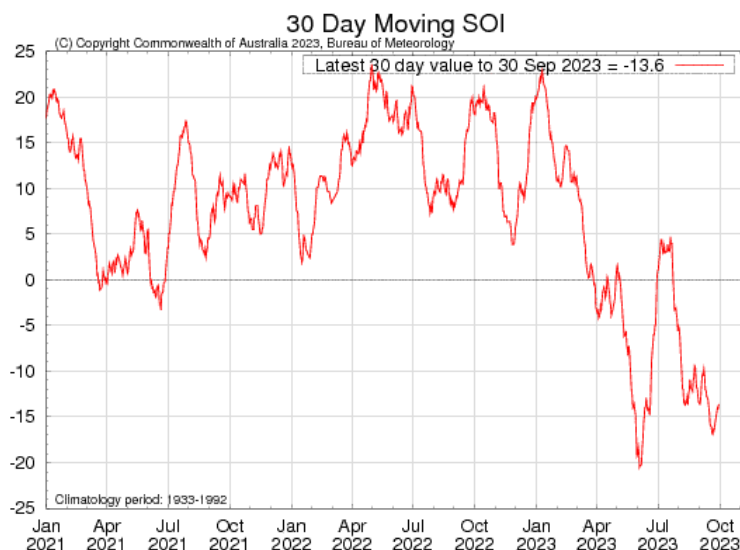
An El Niño and a positive IOD are underway.

Oceanic indicators firmly exhibit an El Niño state. Central and eastern Pacific sea surface temperatures (SSTs) continue to exceed El Niño thresholds. Models indicate further warming of the central to eastern Pacific is likely.

Broadscale pressure patterns over the tropical Pacific reflect El Niño. Trade wind strength over the past fortnight has weakened than average in the western Pacific, but is close to normal elsewhere. Overall, there are signs that the atmosphere is responding to the warm SSTs over the Pacific and coupling of ocean and atmosphere is occurring. This coupling is a characteristic of an El Niño event and is what strengthens and sustains an event for an extended period. El Niño typically leads to reduced spring rainfall for western Pacific and more rainfall in the eastern Pacific.

Climate models indicate this El Niño is likely to persist until at least the end of February. El Niño typically leads to reduced spring and early summer rainfall for western Pacific, and increase rainfall in the eastern Pacific.

The positive Indian Ocean Dipole (IOD) continues to strengthen. The IOD index is +1.85 °C for week ending 08 October. This is its sixth-highest week IOD index value since records for the Bureau SST dataset began in 2001, with all higher index values observed during the positive IOD of 2019. All models predict this positive IOD is likely to continue into at least December. A positive IOD typically leads to reduced spring rainfall for central and south-east Australia. The 30-day Southern Oscillation Index (SOI) for the period ending 8 October was -13. The 60-day SOI and the 90-day SOI were -11 and -12, respectively.



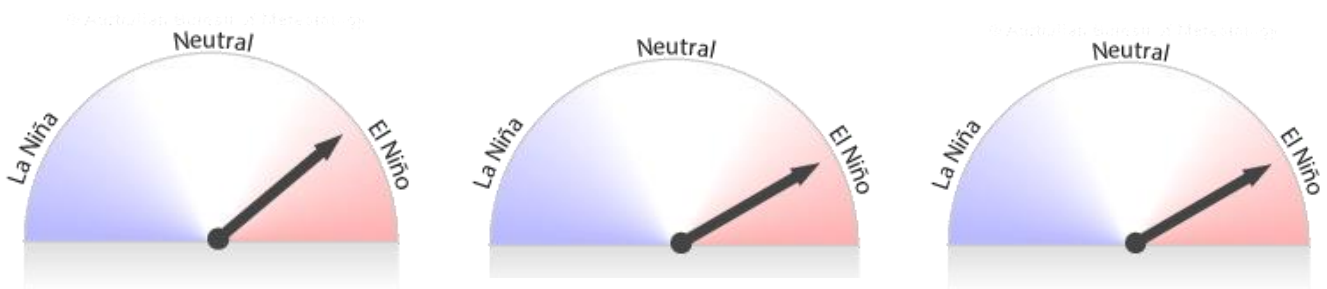


EL NIÑO–SOUTHERN OSCILLATION

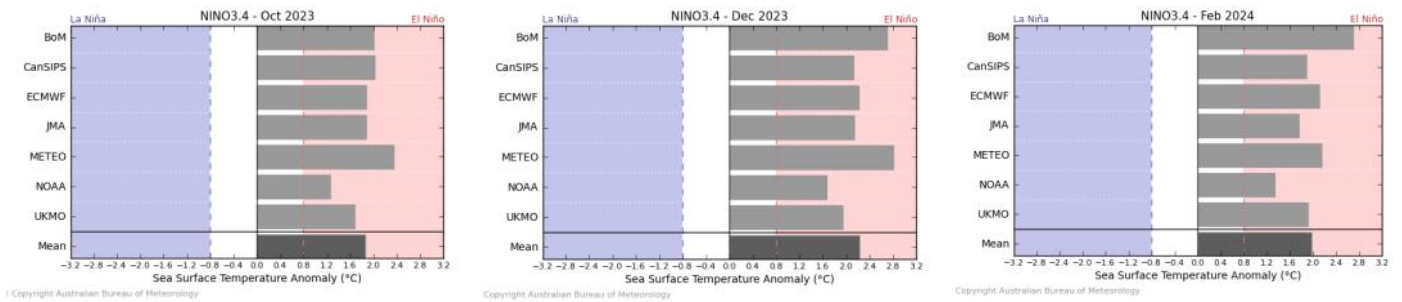
El Niño active; positive Indian Dipole strengthens

Click link to access [Climate Driver Update issued on 10 October 2023](#)

Bureau of Meteorology NINO3.4 ENSO Model Outlooks for October, December and February



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

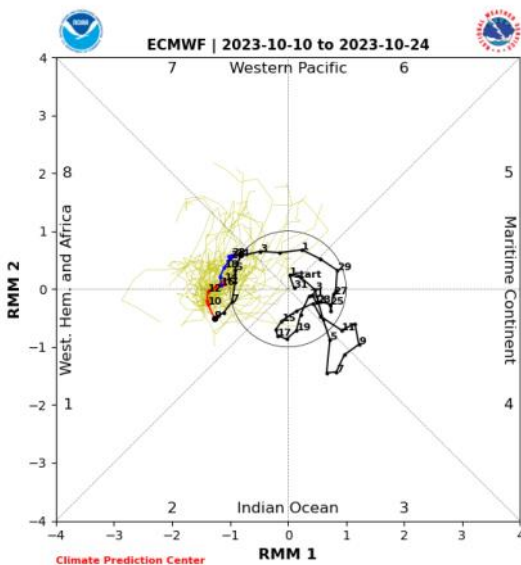
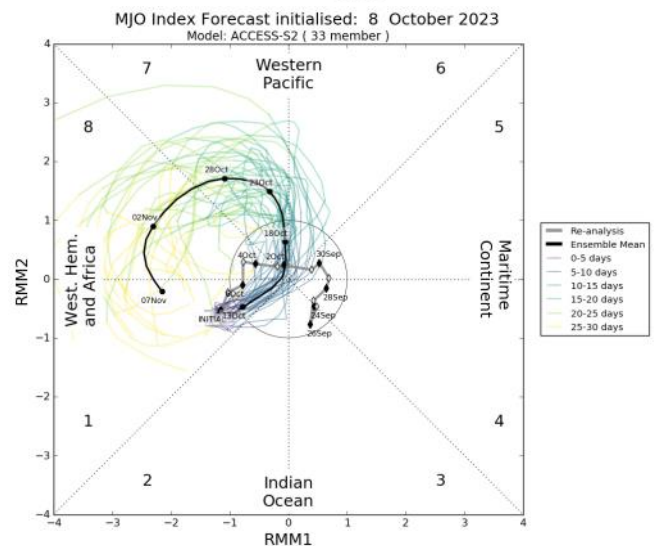
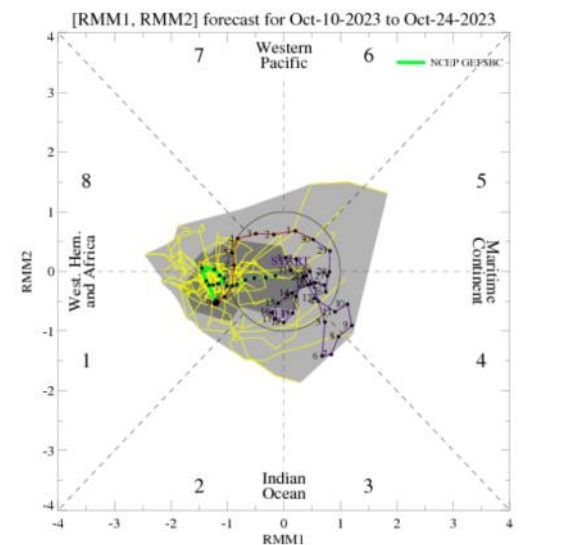
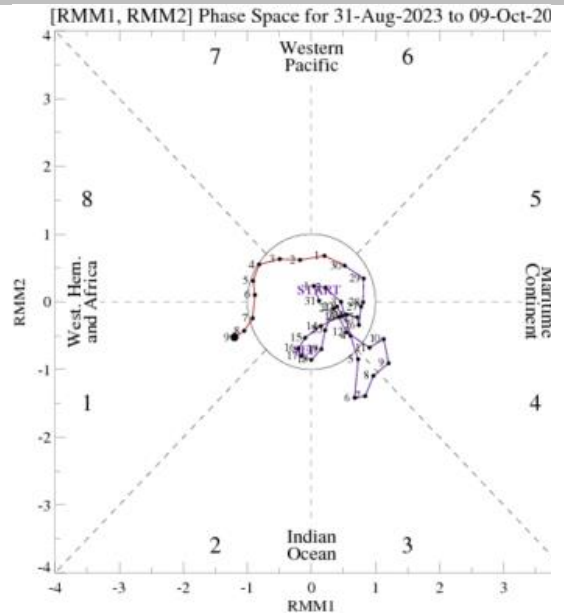
Click link to access [Tropical Climate Update](#) [Issued on Tuesday 10 October 2023]

During September, the Madden Julian Oscillation (MJO) was mostly weak with an active phase in the second week over the Indian Ocean and Maritime Continent.

The Madden Julian Oscillation (MJO) pulse is currently weak or indiscernible.

Climate models surveyed by the Bureau indicate it will remain weak for the next fortnight before a pulse of the MJO could emerge over the Western Pacific or Western Hemisphere regions towards the start of November.

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



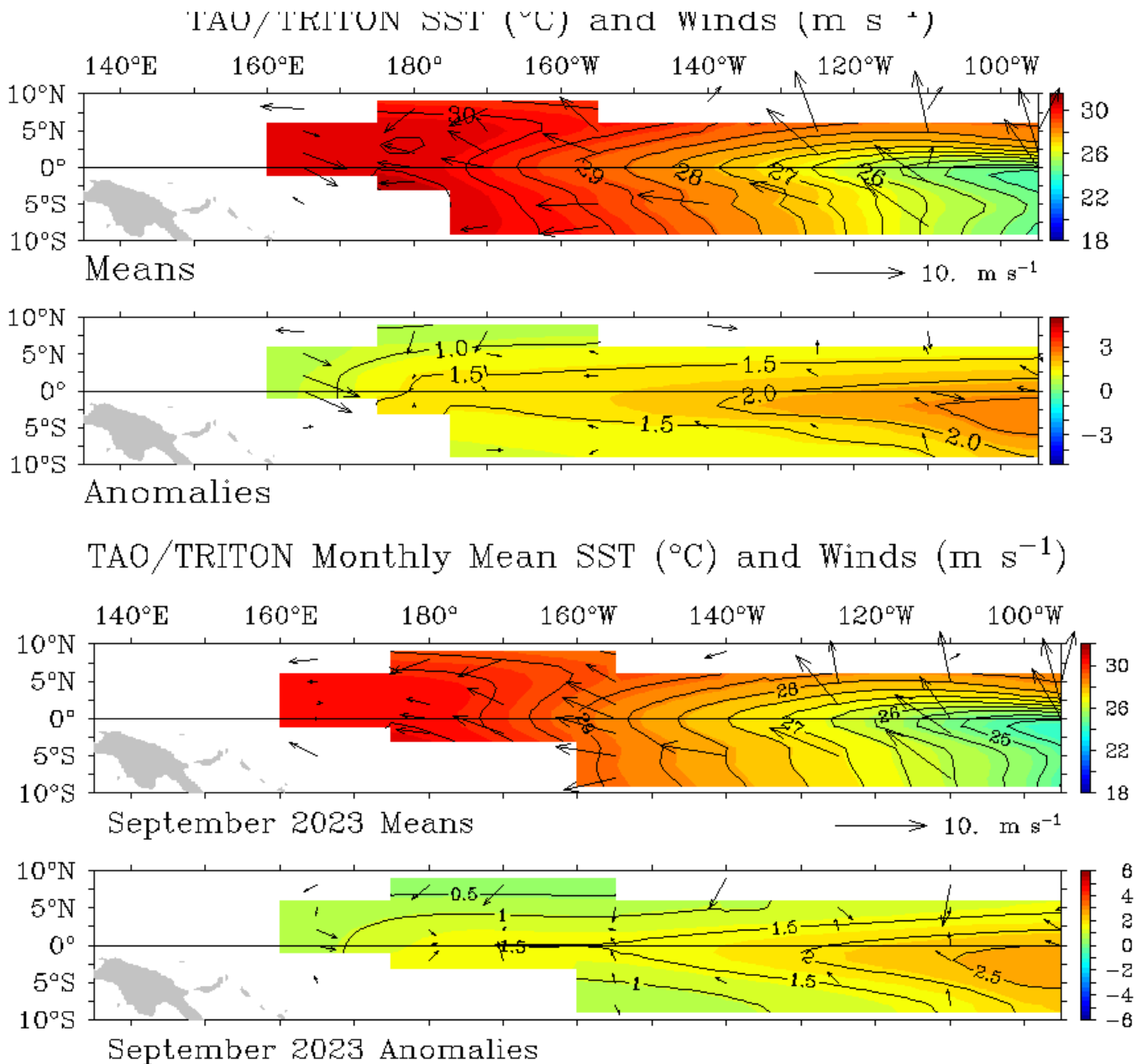


WIND

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

During September, the trade winds were generally weak across the rest of the equatorial Pacific with some westerlies occurring in the western Pacific. For the five days ending 03 October 2023, the anomalies map shows trade winds were generally normal across the rest of the equatorial Pacific with strengthened westerlies in the western equatorial Pacific.

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

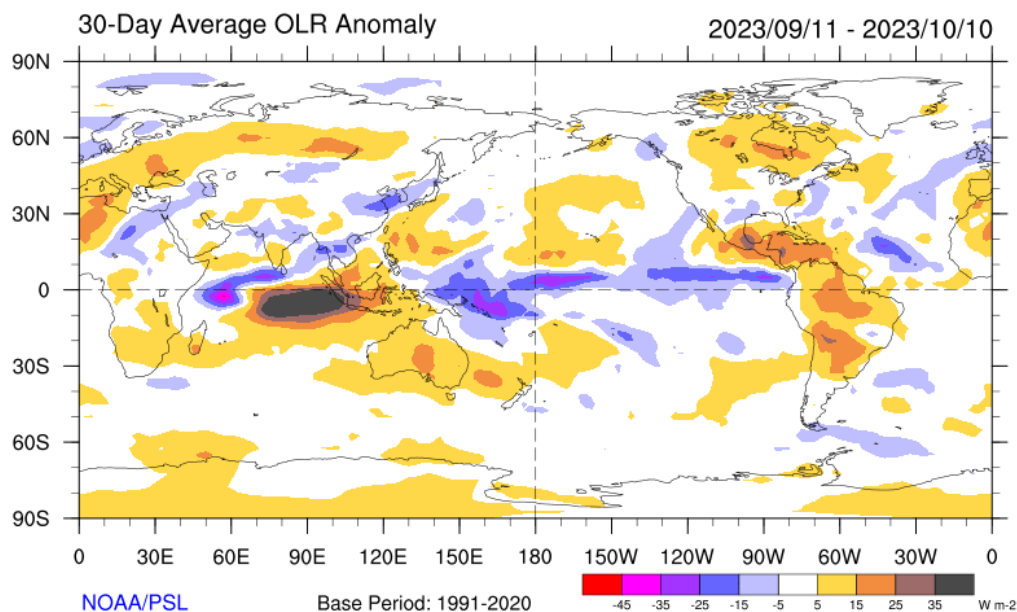
Click link to access [OLR](#)



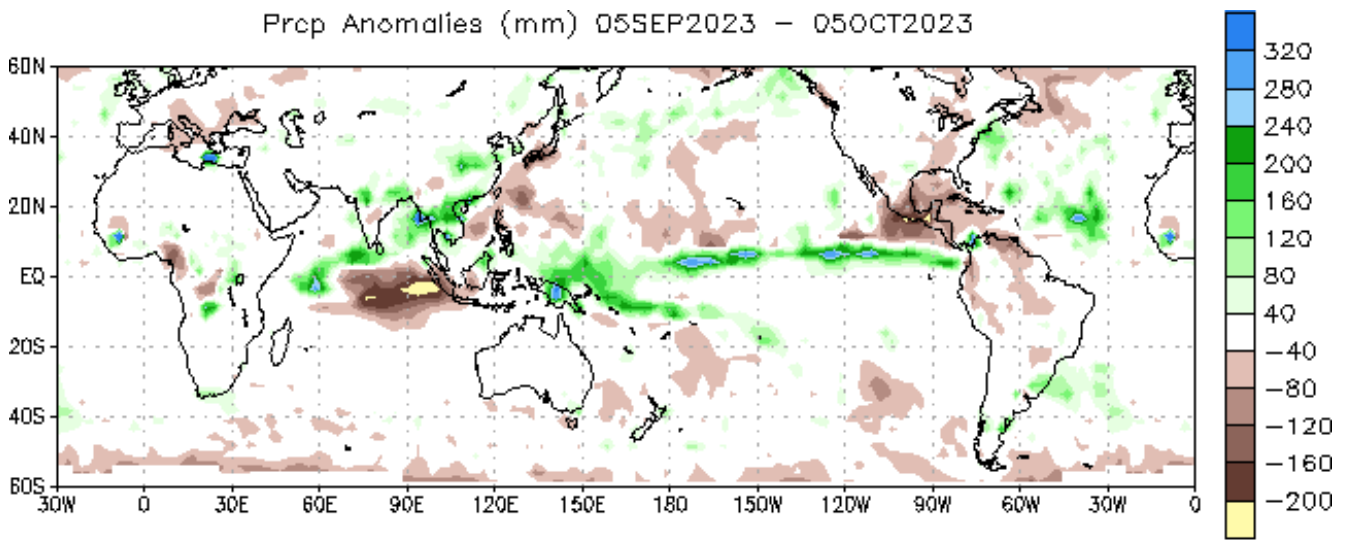
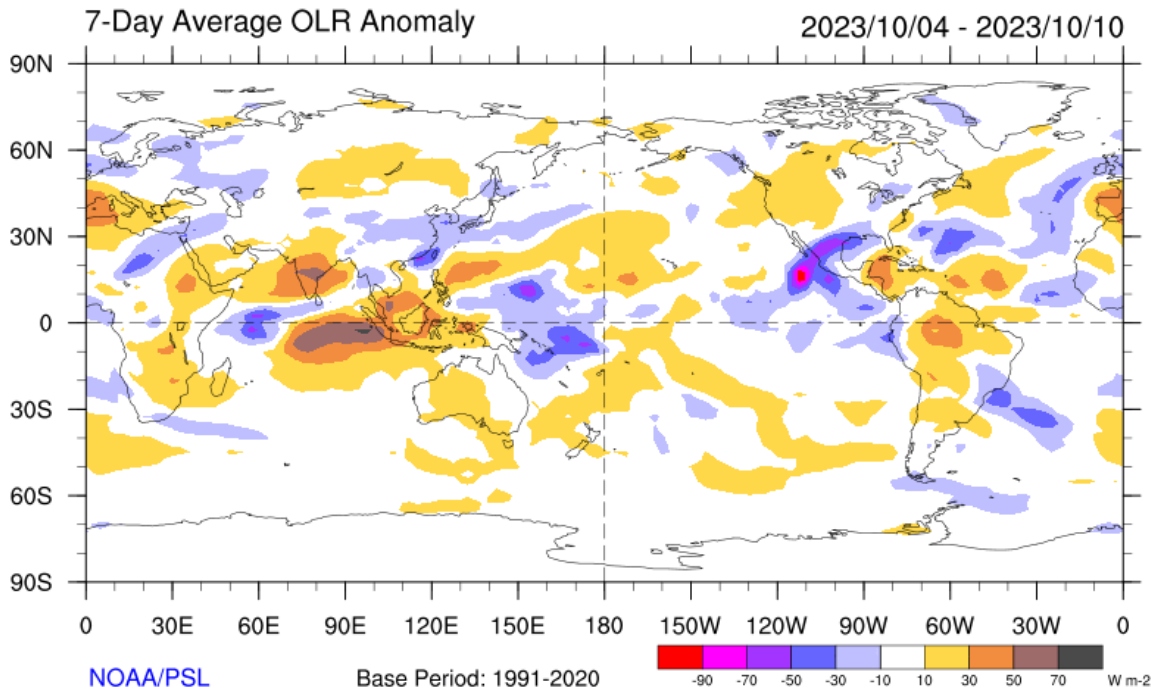
The September 30 -day OLR anomaly map shows a region of low OLR (increased convection) along the Intertropical Convergence Zone (ITCZ) and around PNG and Solomon Islands, with another region over the western French Polynesia. There was also a region of negative anomalies over the southern FSM and southern RMI. Positive anomalies (reduced convection) were observed over Philippines and northern RMI, with another band over Tonga, Samoa, Niue and southern Cook Islands.

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

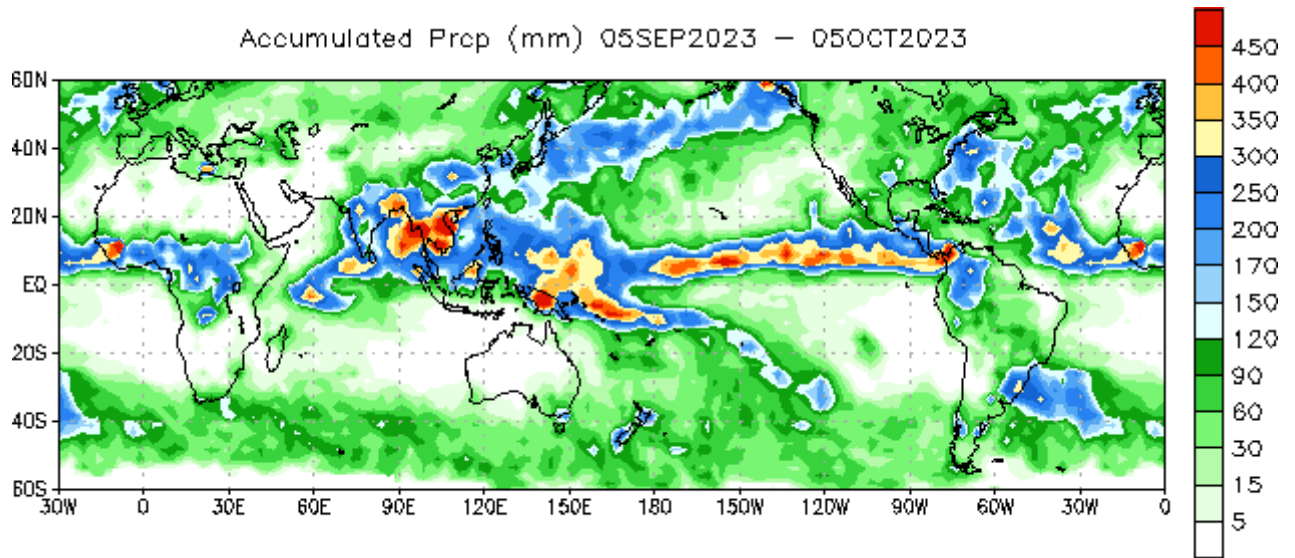


OLR Total and Anomalies, 7 Day OLR

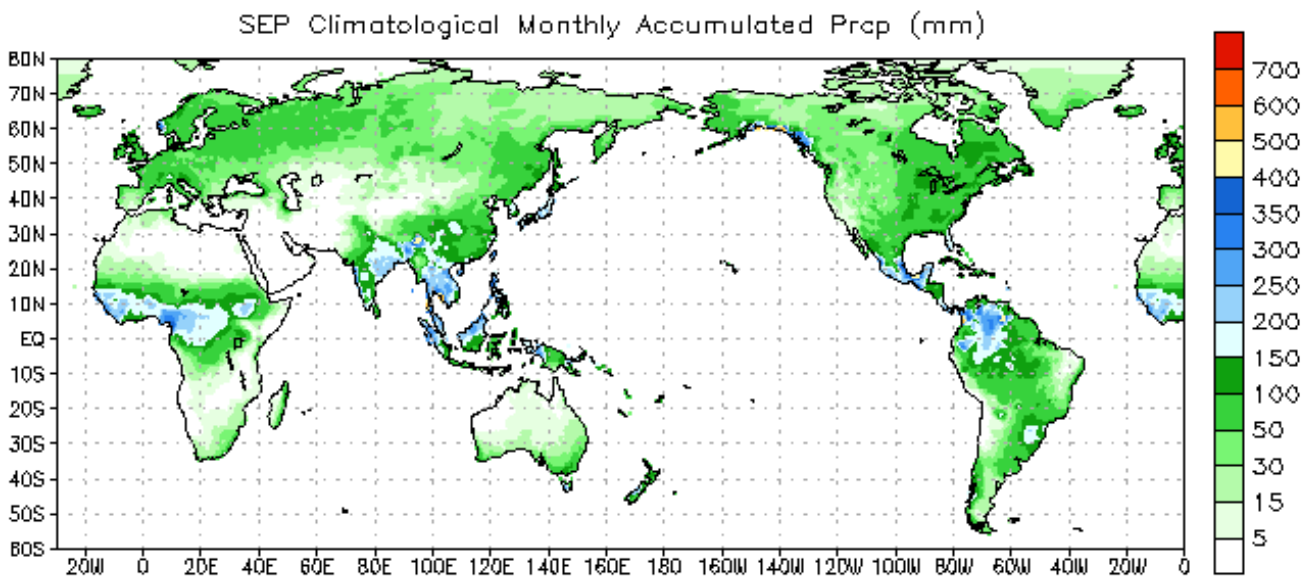


Data Source: NCEP CMAP Precipitation
Climatology (1991-2020)

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](#)

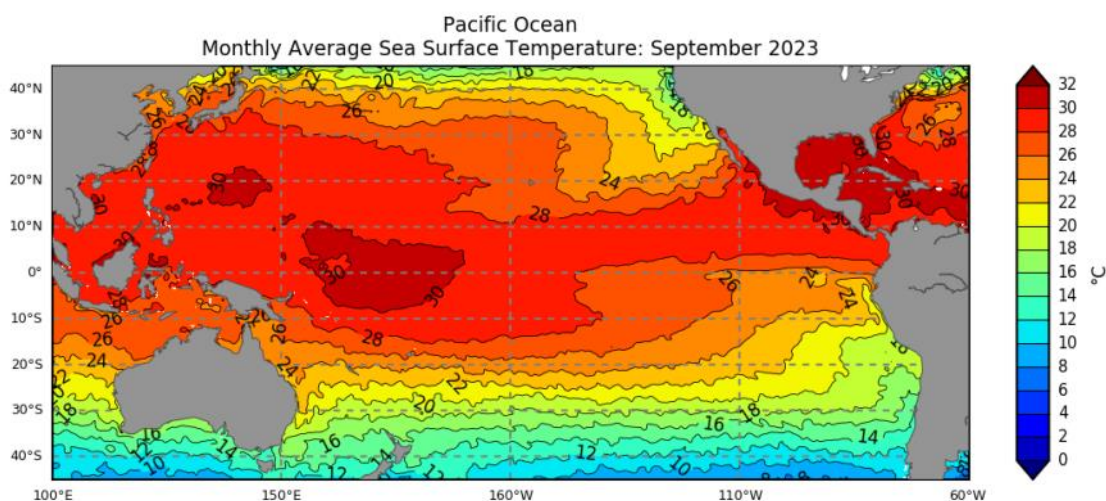
Sea surface temperatures (SST) for September 2023 were warmer than average over almost all of the equatorial Pacific Ocean. SST anomalies more than 0.8°C warmer than the long term average (1961-1990) were present over much of the Pacific between 10°S and 10°N, increasing to more than 3 °C warmer than average in the eastern tropical Pacific. Much of the central southern Pacific was also warmer than average for September.

Compared to August, warm anomalies have decreased slightly in strength in the eastern and south-west Pacific.

Warm SST anomalies also continued in the southern Tasman Sea, between south-east Australia and New Zealand, but have decreased compared to last month. Warm anomalies have also decreased in the Coral Sea, especially off the northern Queensland coast. Patches of warmer than average SSTs remain in the waters south-west and north-west of Western Australia.

Record-high September SSTs occurred in parts of northern and eastern Solomon Islands, Tuvalu, parts of Gilbert and Phoenix Islands of Kiribati, northern Fiji, Tokelau, northern American Samoa, and northern Cook Islands. The SST in decile 10 (very much above average) stretched from eastern FSM to northern Vanuatu in the south and eastwards to Kiribati (Line Islands) and northern French Polynesia. Above average (8-9) decile are observed for majority of the Pacific Island Countries, spanning southeastward from FSM to eastern French Polynesia, and along the islands located near the equatorial region of the Pacific. Average SSTs (4-7) for September were observed in parts of Palau, western FSM, northern PNG, and western Solomon Islands. Patches were also observed in New Caledonia, Vanuatu, Fiji, Tonga, Niue, southern Cook Islands, and central and south French Polynesia.

Mean Sea Surface Temperature

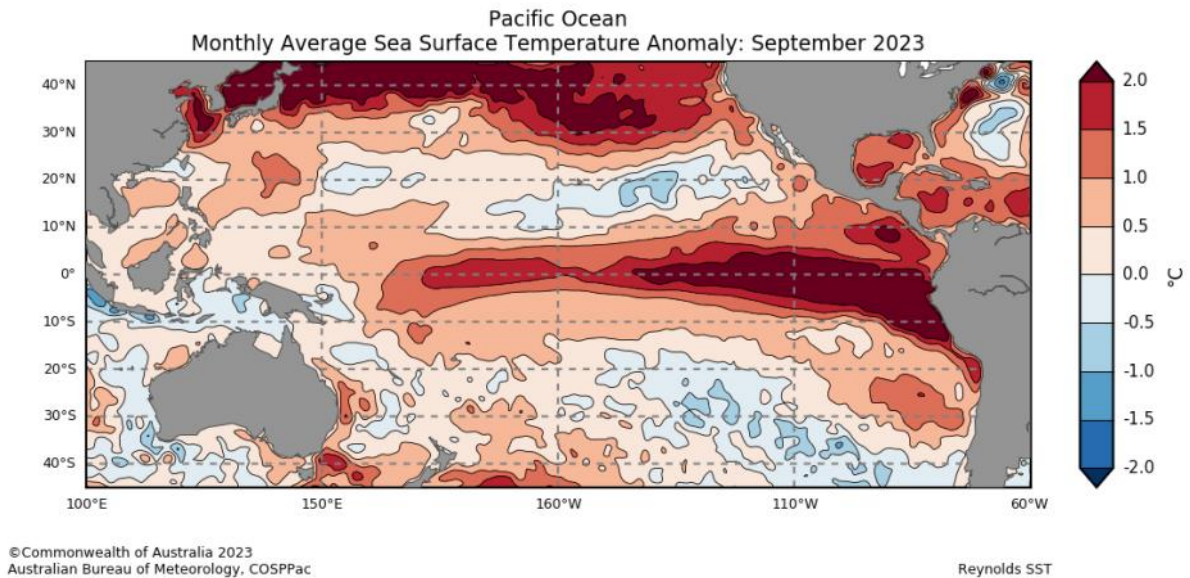


OCEAN CONDITIONS

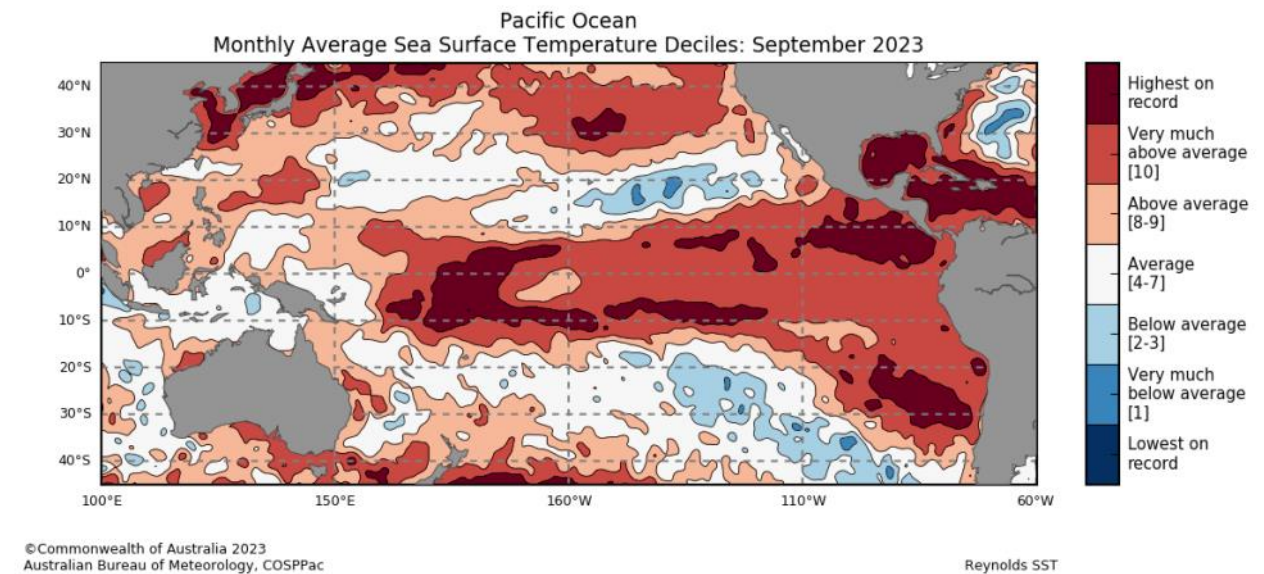
Click link to access [SEA SURFACE TEMPERATURE](#)



Anomalous Sea Surface Temperature



Sea Surface Temperatures Deciles



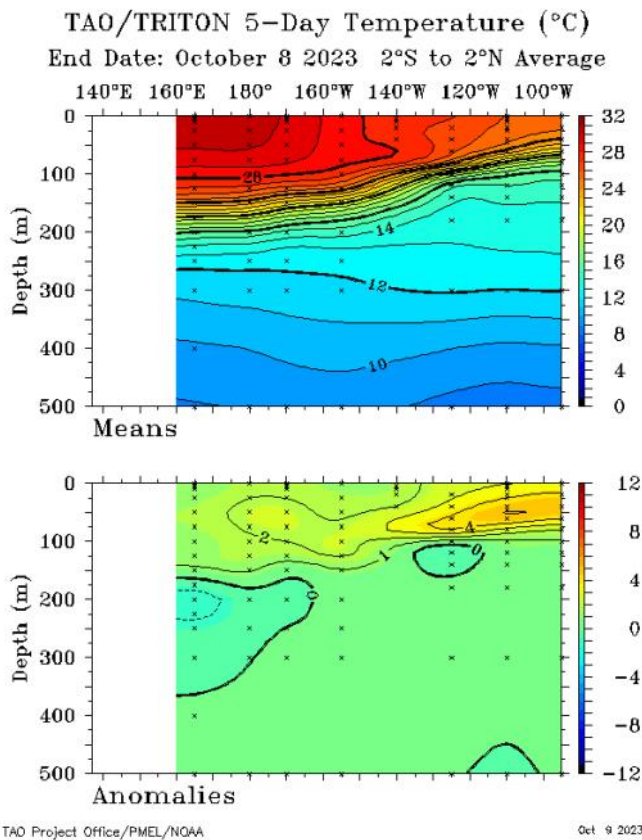
OCEAN CONDITIONS

SUB SURFACE

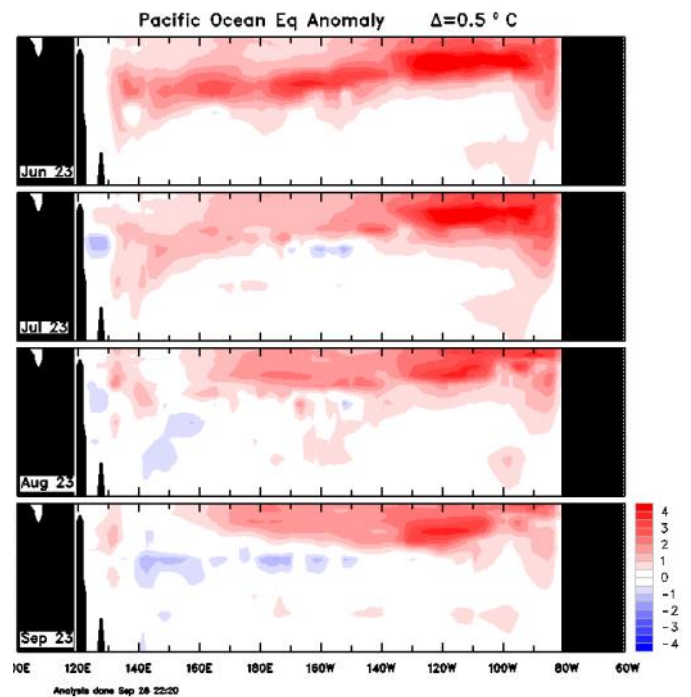


The four-month sequence of equatorial Pacific sub-surface temperature anomalies (to 30 September 2023) shows warm anomalies across most of the top 100 m of the equatorial Pacific band, except in the far west. Anomalies increase in magnitude eastwards across the equatorial Pacific band, with the far west close to average and the eastern Pacific more than 2 °C warmer than average. The last three months have seen sub-surface heat shift towards the eastern Pacific, between the surface and 150 m depth. Temperatures have decreased in the western Pacific such that most of the water column is now mostly close to average. August has seen a decrease of positive anomalies in the eastern Pacific sub-surface.

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

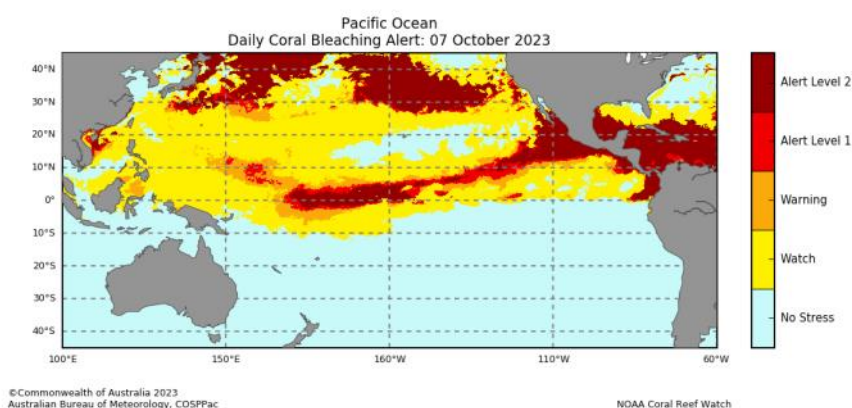
CORAL BLEACHING



The daily Coral Bleaching Alert status for 07 October 2023 shows patches of 'Alert Level 1 and 2' for northeast FSM, western RMI, Kiribati (central Gilbert Islands, northern Phoenix Islands and Line Islands). Patches of 'Warning' over northeastern FSM, western RMI, Nauru, Kiribati (Gilbert, northern Phoenix and northern Line Islands) and Tuvalu. The four-week Coral Bleaching Outlook to 29 October shows patches of area of 'Alert Level 1 and 2' over northeast FSM, western RMI, Nauru, Kiribati (central Gilbert Islands, northern Phoenix Islands and Line Islands). 'Watch to Warning' ratings from Guam, FSM, RMI, northern PNG, northern Solomon Islands, northern Fiji, Tuvalu, Tokelau, Wallis and Futuna, northern Samoa and American Samoa.

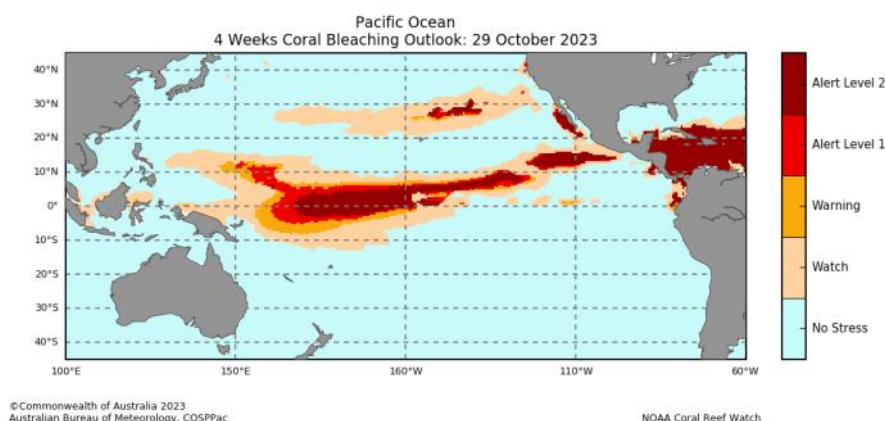
Daily Coral Bleaching Alert

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



4 Weeks Coral Bleaching Outlook

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



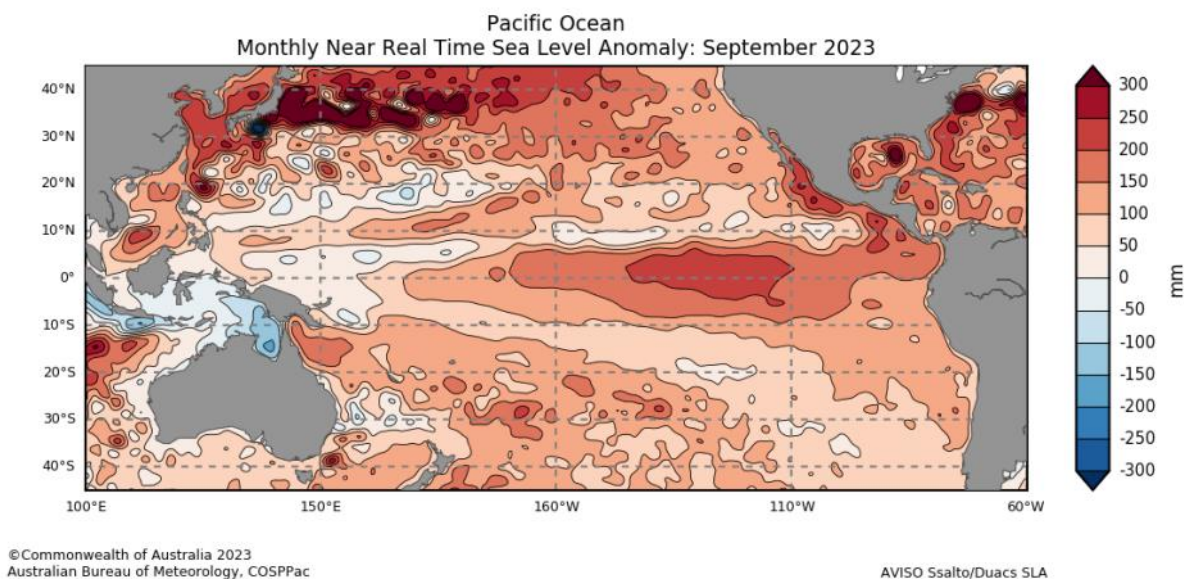
OCEAN CONDITIONS

OCEAN SURFACE CURRENTS AND SEA LEVEL

Sea level in September was above normal over COSPPac countries. Patches of anomalies above +200 mm were observed in southern PNG, Coral Sea and Kiribati (northern Line Islands). Areas of +100 to +150 were observed in northern FSM to northern RMI, Kiribati and from southeastern PNG to southern French Polynesia. Anomalies of +50 to +100 mm were observed in most of the COSPPac countries, apart from patches of below normal sea level anomalies observed in central FSM, southern RMI, eastern PNG, western Solomon Islands and, northern and eastern Australia.

Monthly Sea Level Anomalies

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

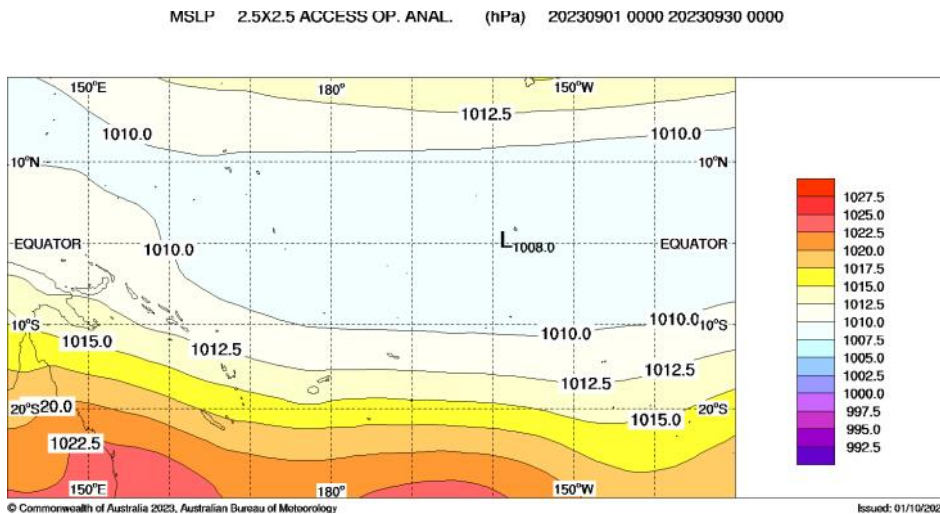


MEAN SEA LEVEL PRESSURE

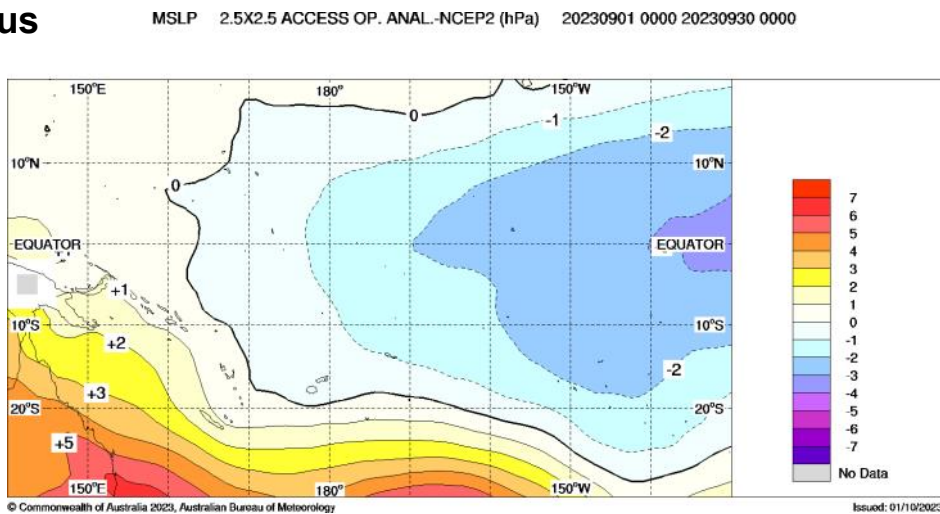
The September mean sea level pressure (MSLP) anomaly map shows mostly positive anomalies of 1 hPa or greater west of Vanuatu towards Australia and New Zealand. Negative anomalies of +1 hPa or greater were evident west of 178° W, especially over central Kiribati, Tuvalu and Samoa.

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

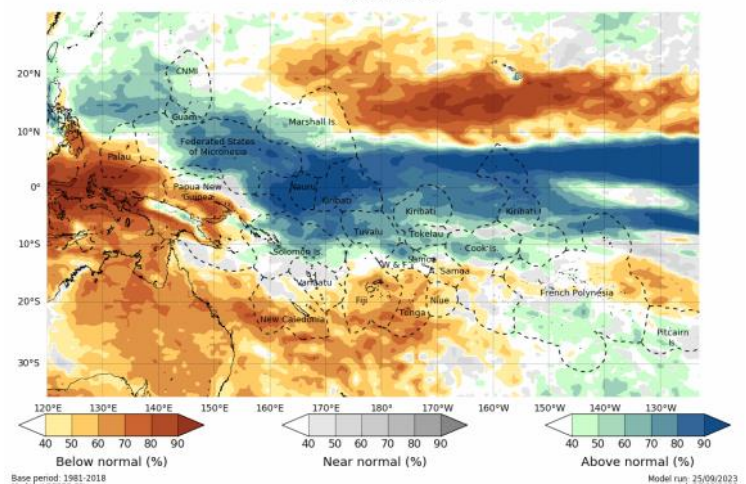
October—December 2023



The ACCESS-S model forecast for October 2023, shows below normal rainfall is likely or very likely for Palau, most of PNG's mainland and Islands regions, northeast RMI, Australia, New Caledonia, southern Vanuatu, Fiji, Tonga, Niue, American Samoa, southern Cook Islands and eastern French Polynesia. Above normal rainfall is likely or very likely for CNMI, Guam, FSM, central and southern RMI, northern PNG's mainland, Solomon Islands, Nauru, Kiribati, Wallis and Futuna, Tokelau, northern Cook Islands, south French Polynesia, and Pitcairn Islands.

The three-month rainfall outlook (October-December 2023) is very similar to the October outlook, with below normal rainfall region intensifying over Palau to western FSM, and in the southern hemisphere from New Caledonia to southern Cook Islands. Above normal rainfall region also intensifying from eastern PNG's EEZ to Kiribati and northern French Polynesia.

Monthly [ACCESS-S](#) Maps



The Copernicus multi-model outlook for October-December 2023 favours above normal rainfall for northern FSM, north-eastern PNG's EEZ, Solomon Islands, Nauru, Tuvalu, and Kiribati (Gilbert, Phoenix and Line Islands). Below normal rainfall is likely or very likely for CNMI, Guam, RMI, most of PNG, Australia, New Caledonia, Vanuatu, Fiji, Tonga, Niue, American Samoa, central and northern Cook Island, French Polynesia and Pitcairn Islands.

The APEC Climate Centre multi-model outlook is similar to the Copernicus multi-model model with above normal rainfall intensifying area concentrated over Nauru and Kiribati (Gilbert Islands).

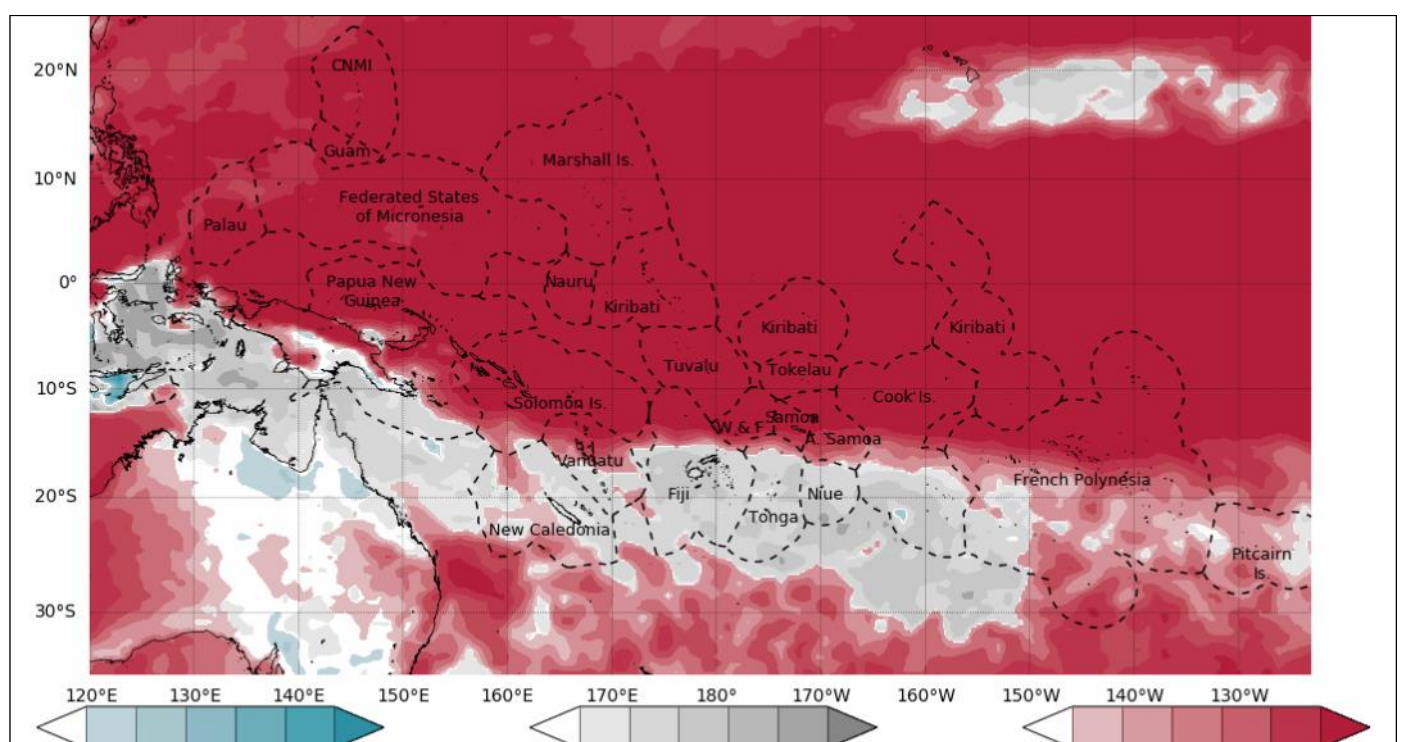
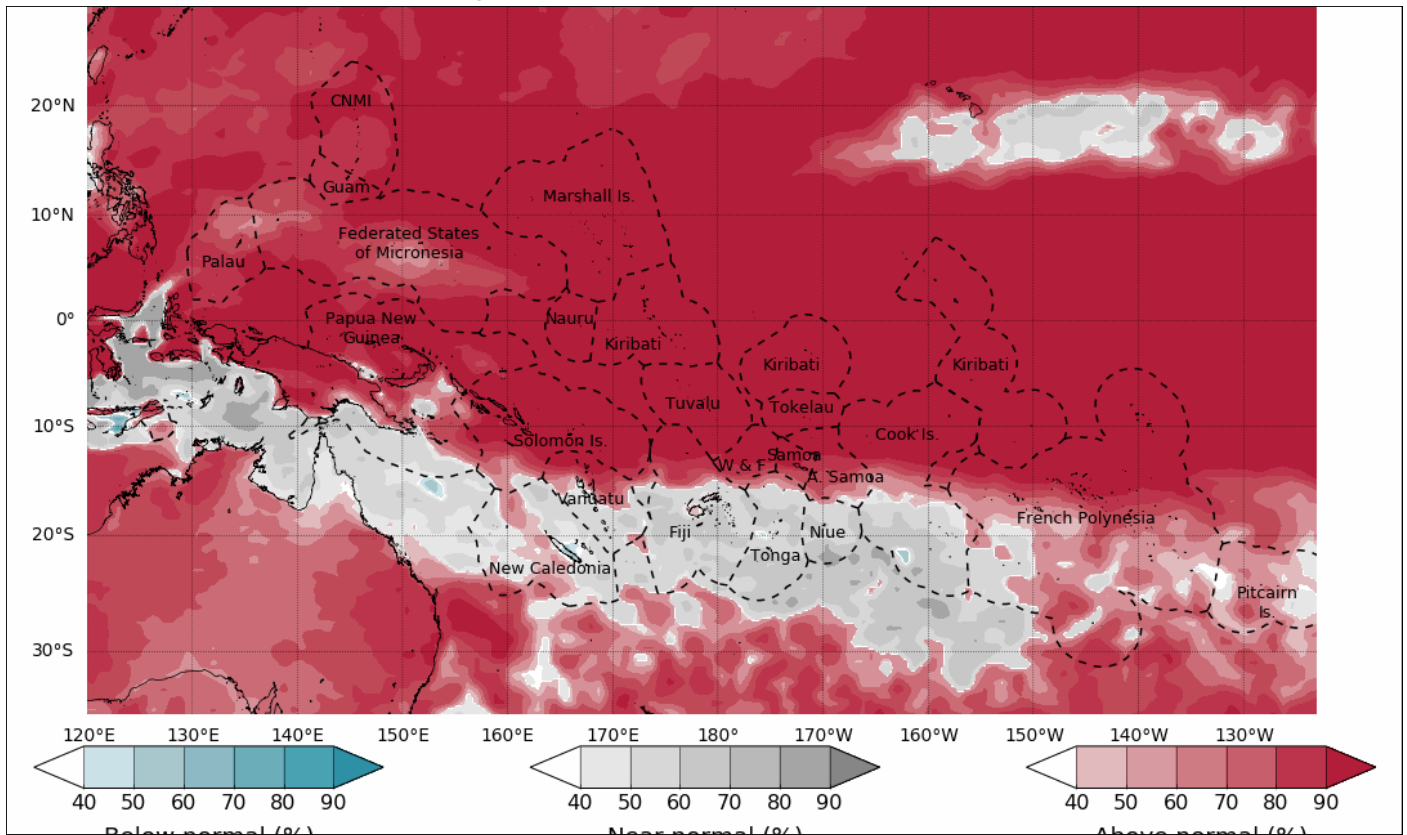
For October-December 2023, the models agree on above normal rainfall being likely or very likely from eastern FSM, southern and central RMI, northeaster PNG's EEZ, northern Solomon Islands, Nauru, Tuvalu, Kiribati (Gilbert, Phoenix and Line Islands), northern Cook Islands and northern French Polynesia. Below normal rainfall is likely or very likely for CNMI, Guam, eastern RMI, most of PNG, Australia, New Caledonia, Vanuatu, Fiji, Tonga, Niue, American Samoa, central and northern Cook Island, French Polynesia and Pitcairn Islands. .

SEASONAL TEMPERATURE OUTLOOK

October—December 2023



Monthly Tmax and Tmin **ACCESS-S** Maps



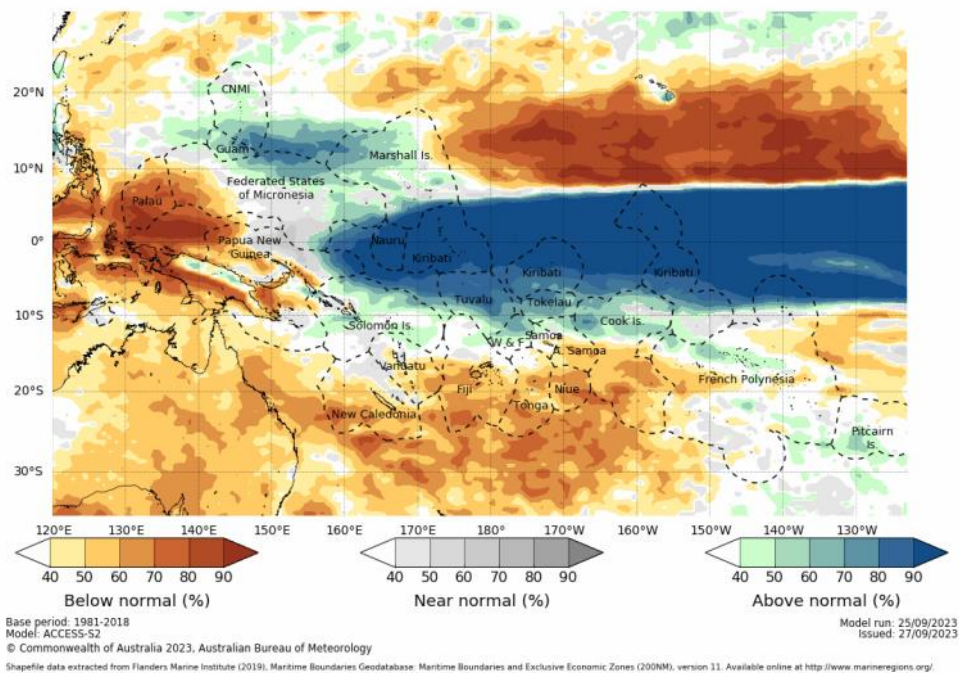
SEASONAL RAINFALL OUTLOOK

October—December 2023

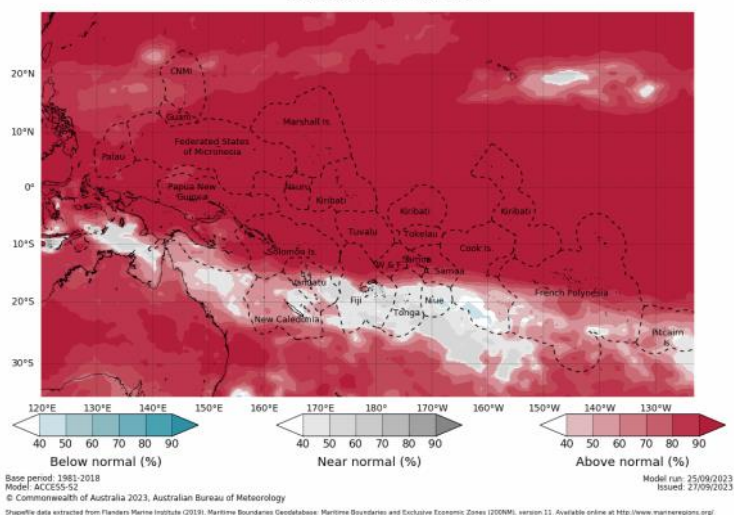


Seasonal ACCESS-S maps

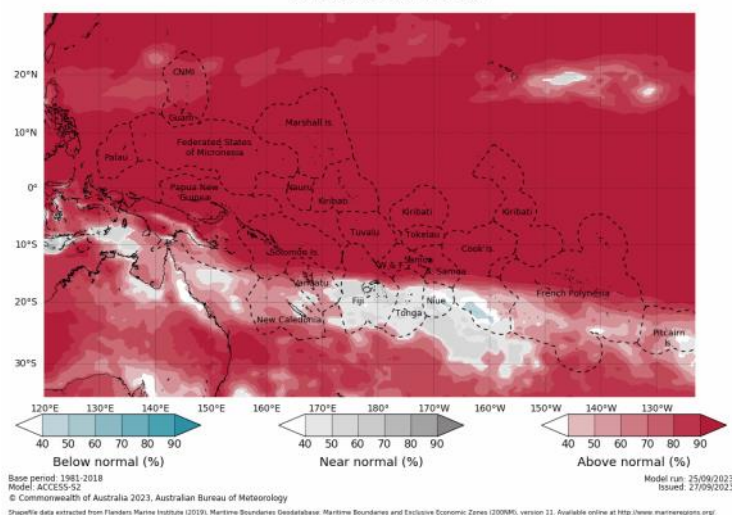
Tercile rainfall probabilities for October to December 2023



Tercile maximum temperature probabilities for October to December 2023



Tercile minimum temperature probabilities for October to December 2023



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

SEASONAL RAINFALL OUTLOOK

October—December 2023



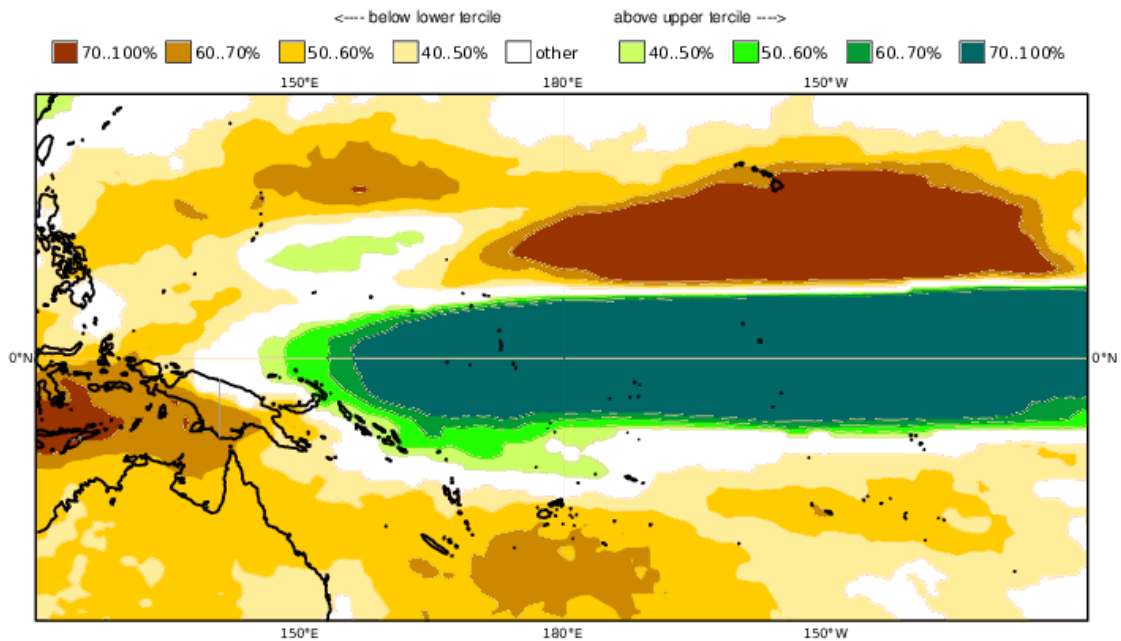
Copernicus (C3S multi-system)-Rainfall

Prob(most likely category of precipitation)

OND 2023

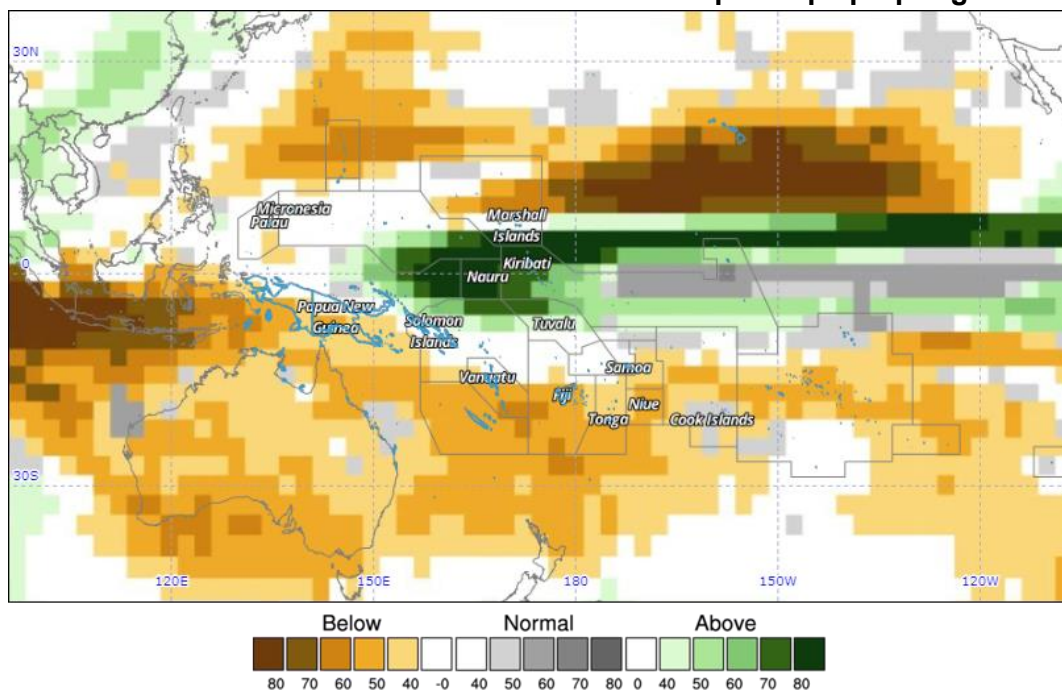
Nominal forecast start: 01/09/23

Unweighted mean



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

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



Year: 2023, Season: OND, Lead Month: 3, Method: GAUS

Model: APCC, BOM, CMCC, MSC, NASA, NCEP, PNU

Generated using CLIK® (2023-10-10)

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TROPICAL CYCLONE

2022/2023 Season



In the southwest Pacific, the 2022-23 tropical cyclone season ended on 30th April 2023. The outlook for the season favoured enhanced risk for tropical cyclone activity in the western part of the basin. In the central part of the region, cyclone risk was considered to be generally near-normal to below normal. There were five cyclones (Hale, Irene, Gabrielle, Judy, Kevin) over the southwest Pacific, with three (Gabrielle, Judy and Kevin) reaching severe status, affecting Australia, New Caledonia, Vanuatu, Fiji and New Zealand. TC activity in the western north Pacific occurs year around and with the possible development of El Niño, an increase in TC activity is supported, as stated in the PICOF 12 regional statement.

It's important to remember that history showed that TC 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 a significantly increased risk in the northwest Pacific between 15 October and 28 October around, Palau, FSM, Guam, CNMI and Philippines.

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>

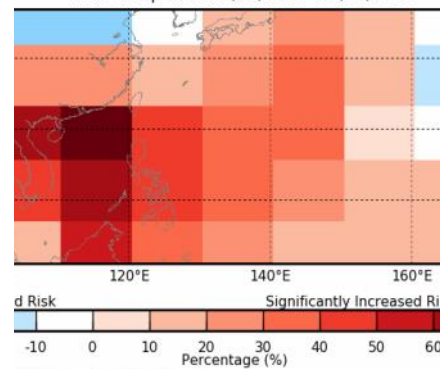
APEC Climate Center (APCC): <http://www.apcc21.org/eng/service/6mon/ps/japcc030703.jsp>

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

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

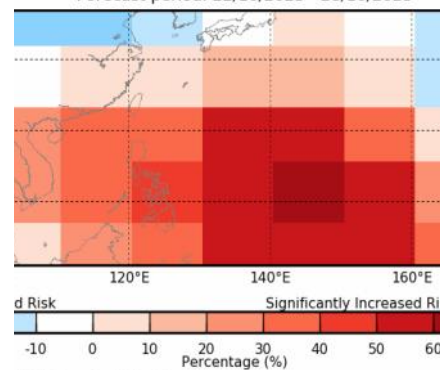
IRI for Climate and Society: <http://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate-forecasts/>

ACCESS-S Weekly Forecasts –Northwest Pacific
Difference from normal chance of Tropical Cyclone's in the Northwest Pacific
Forecast period: 15/10/2023 - 21/10/2023



Probability in overlapping 15 x 20 degree boxes
©23, Australian Bureau of Meteorology Model: ACCESS_S2 Model Run: 07/10/2023

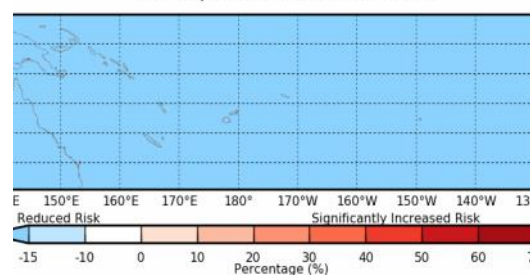
ACCESS-S Weekly Forecasts –Northwest Pacific
Difference from normal chance of Tropical Cyclone's in the Northwest Pacific
Forecast period: 22/10/2023 - 28/10/2023



Probability in overlapping 15 x 20 degree boxes
©23, Australian Bureau of Meteorology Model: ACCESS_S2 Model Run: 07/10/2023

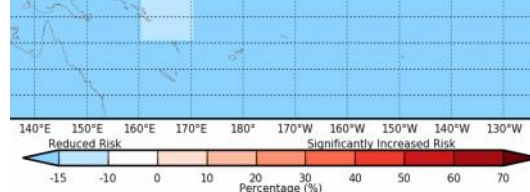
ACCESS-S Weekly Forecasts –Southwest Pacific

Difference from normal chance of Tropical Cyclone's in the Southwest Pacific
Forecast period: 15/10/2023 - 21/10/2023



Probability in overlapping 15 x 20 degree boxes
©23, Australian Bureau of Meteorology Model: ACCESS_S2 Model Run: 07/10/2023

Difference from normal chance of Tropical Cyclone's in the Southwest Pacific
Forecast period: 22/10/2023 - 28/10/2023



Probability in overlapping 15 x 20 degree boxes
©23, Australian Bureau of Meteorology Model: ACCESS_S2 Model Run: 07/10/2023

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.

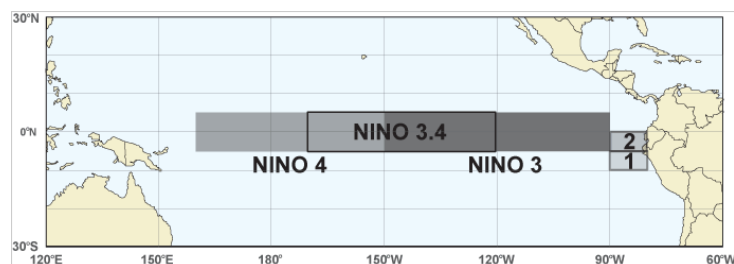
20 degrees Celsius Isotherm Depth

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