

Monthly Climate Bulletin

June 2023



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Photo Credit: Molly Powers (SPC) Samoa Tide Gauge





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Issued 10 July 2023

- The Bureau's ENSO Outlook remains at El Niño ALERT.
- The Madden Julian Oscillation (MJO) remains weak, with most surveyed climate models indicating it will remain weak or indiscernible during July.
- The ITCZ and SPCZ were both active in June 2023.
- Sea surface temperatures (SST) for June 2023 were warmer than average over the entirety of the tropical Pacific Ocean.
- The Coral bleaching Outlook to 30 July shows patches of area of 'Alert Level 1' over northern Palau, Nauru, and Kiribati (central Gilbert and northern Line Islands).
- For July-September 2023, the models agree on above normal rainfall being likely or very likely for northern Palau, Guam, FSM, central and southern RMI, PNG's Momase Region and south-east PNG, northern Solomon Islands, Nauru, northern Tuvalu, and Kiribati. The models also agree on below normal rainfall being likely or very likely for much of CNMI, Wallis and Futuna, Samoa, American Samoa, central and southern Cook Islands, and northern French Polynesia.
- The ACCESS-S weekly tropical cyclone outlook shows a significantly increased risk in the northwest Pacific between 08 and 21 July around Philippines, Japan, Guam, Palau, FSM and the Marshall Islands.

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EL NIÑO–SOUTHERN OSCILLATION

El Niño ALERT; positive Indian Ocean Dipole possible

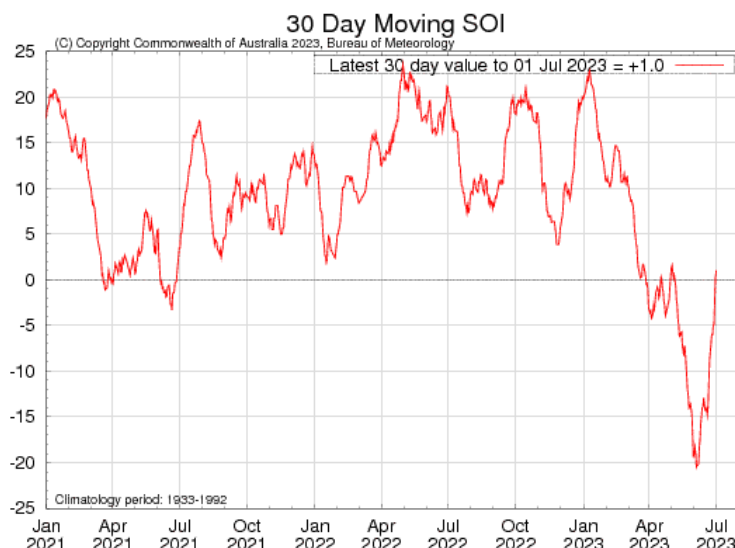
Click link to access [Climate Driver Update issued on 4 July 2023](#)

The Bureau's ENSO Outlook remains at El Niño ALERT. When an El Niño ALERT criteria have been met in the past, an El Niño event has developed around 70% of time.

Central and eastern Pacific sea surface temperatures (SSTs) are exceeding El Niño thresholds. Models indicate a high likelihood of further warming, with SSTs exceeding El Niño thresholds until at least the beginning of the southern hemisphere summer. In terms of atmospheric indicators, recent values of the Southern Oscillation Index (SOI) have risen back to neutral levels, with the 30-day SOI at +1.1 for the 30 days ending 2 July. The 90-day SOI remains close to, but just shy of, El Niño levels. Sustained changes in wind, cloud and broad-scale pressure patterns towards El Niño like patterns have not yet been observed. This means the Pacific Ocean and atmosphere have yet to become fully coupled, as occurs during El Niño events. El Niño typically suppresses winter-spring rainfall in western Pacific Island countries.

The Indian Ocean Dipole (IOD) is currently in neutral. All models suggest a positive IOD is likely to develop in the coming months. A positive IOD, and if it coincides with El Niño, it can exacerbate El Niño's drying effect.

The 30-day Southern Oscillation Index (SOI) for the period ending 2 July was +1, returning to the neutral range over the past fortnight. Values for the 60-day SOI and the 90-day SOI value were -9 and -6 respectively. Both the 30-day and 90-day SOI have shown a steady decrease in magnitude



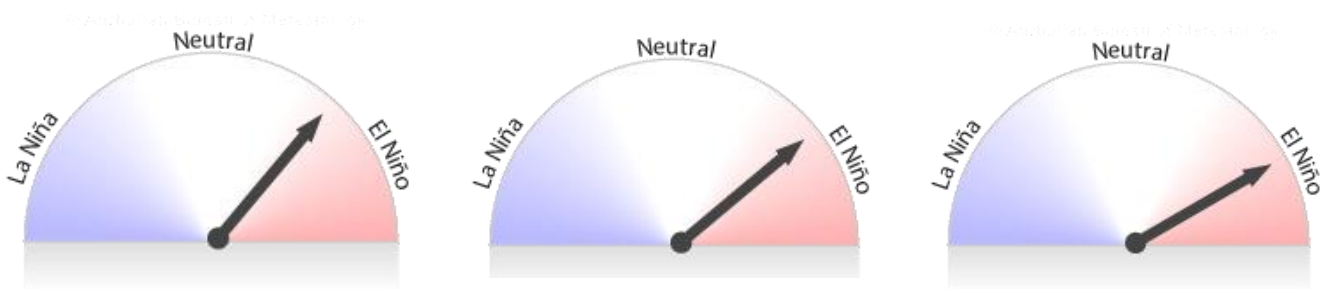


EL NIÑO–SOUTHERN OSCILLATION

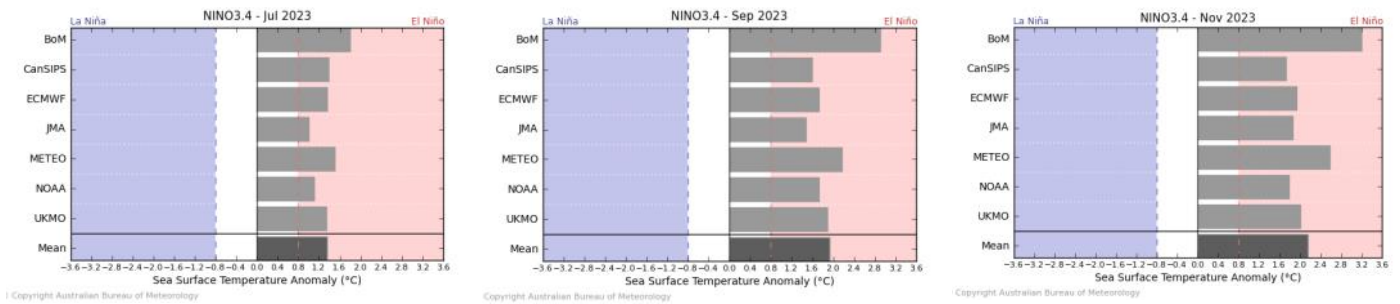
El Niño ALERT; positive Indian Ocean Dipole possible

Click link to access [Climate Driver Update issued on 4 July 2023](#)

Bureau of Meteorology NINO3.4 ENSO Model Outlooks for July, September and November



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>

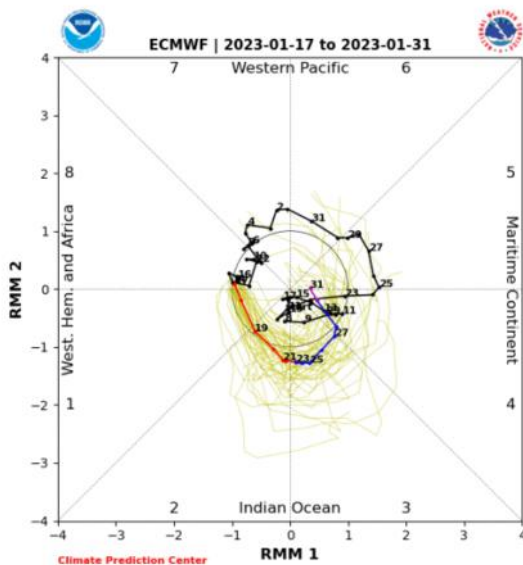
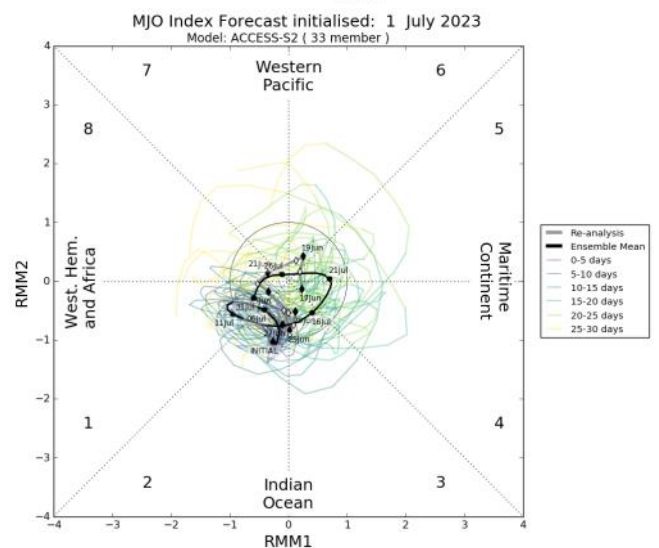
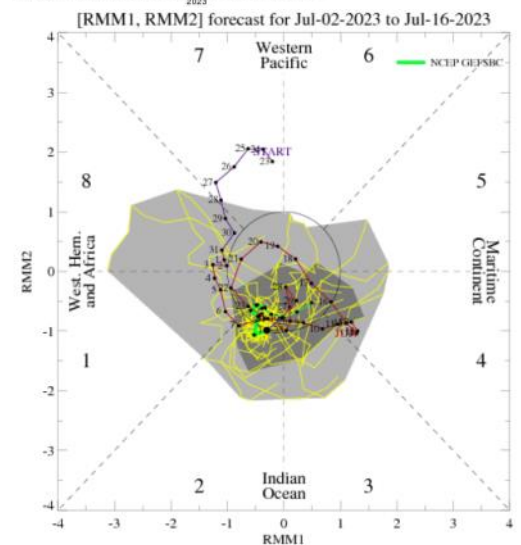
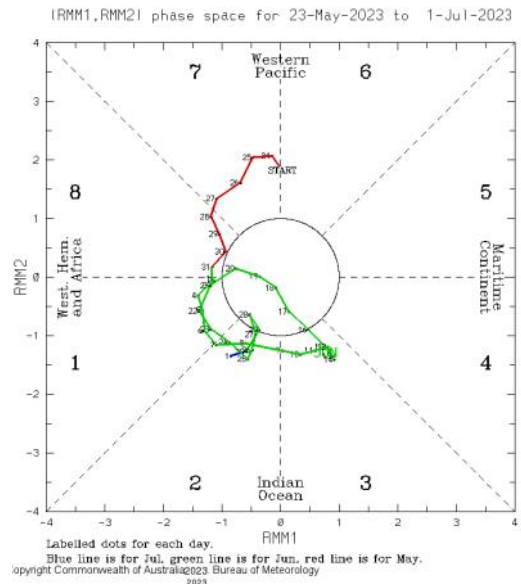
MADDEN–JULIAN OSCILLATION

Click link to access [Tropical Climate Update](#) [Issued on Tuesday 27 June 2023]

During June, the Madden Julian Oscillation (MJO) was active in Africa and Indian Ocean during the first two weeks and last week of June while weak during the third week.

The Madden Julian Oscillation (MJO) remains weak, with most surveyed climate models indicating it will remain weak or indiscernible during that time.

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



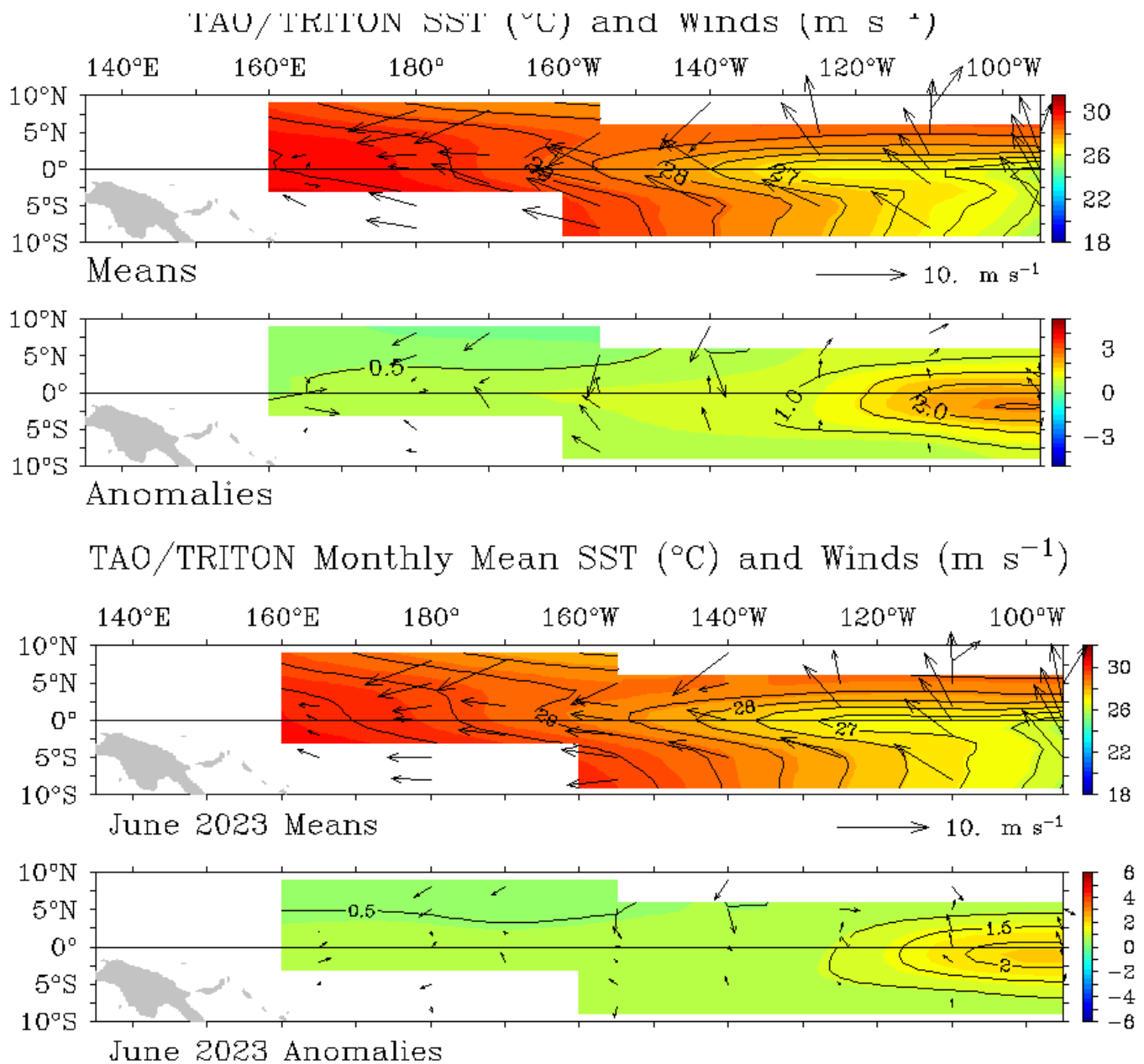


WIND

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

During June, the trade winds were close to normal across the equatorial Pacific. For the five days ending 01 July 2023, the trade winds were weaker than normal over the central-equatorial Pacific with westerlies anomalies observed west of 180°.

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



CLOUD AND RAINFALL

Click link to access [OLR](#)

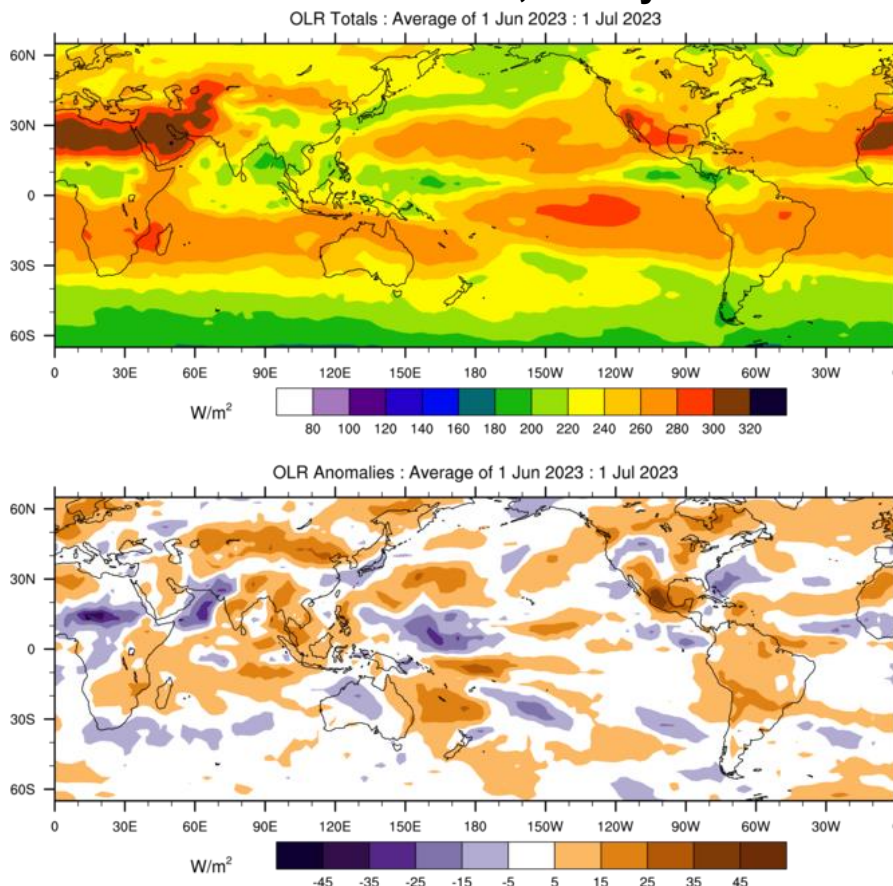


The June 30-day OLR anomaly map shows a region of low OLR (increased convection) to the west of 180° over FSM and RMI. Another region of increased convection was over eastern Fiji and areas to the southeast. In between these two areas was a region of positive anomaly (reduced convection) from the Coral Sea to Vanuatu and further south towards New Zealand. Positive anomalies also stretched from the Solomon Islands to French Polynesia.

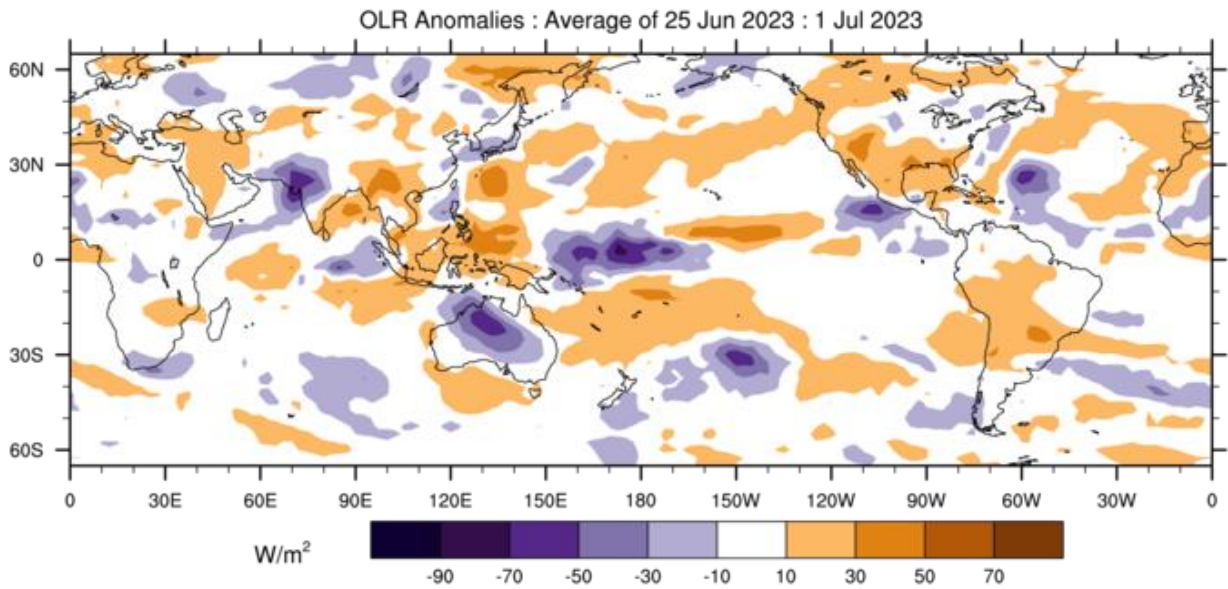
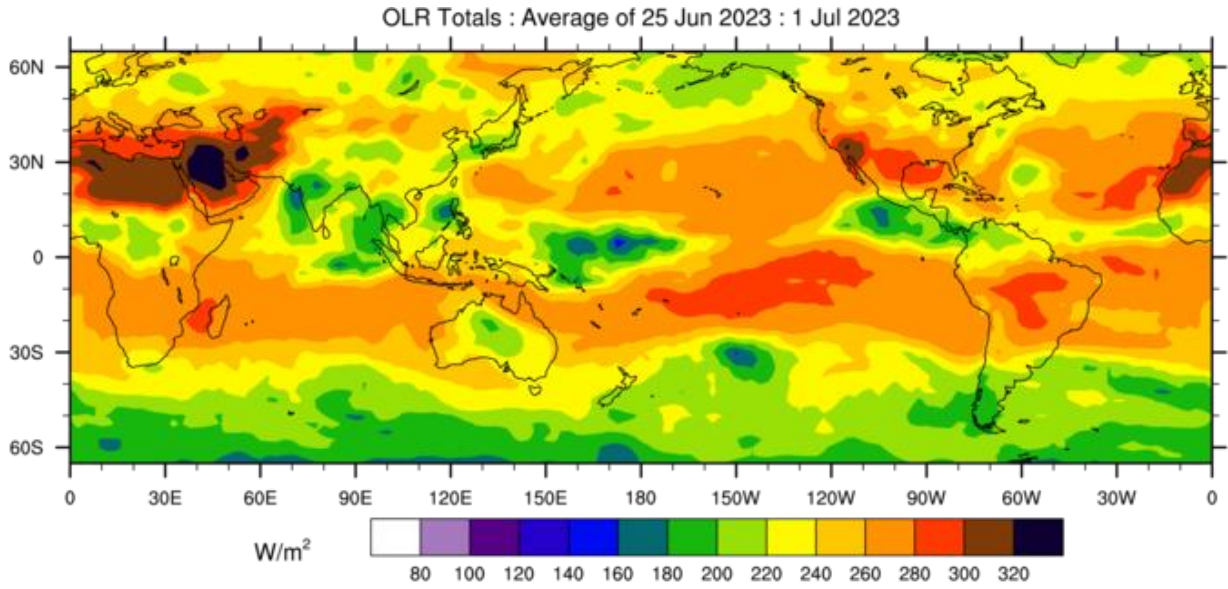
In what might be one of the first signs of the atmospheric component of El Niño, the weekly OLR to 1 July showed strong convection near the equatorial Date Line from 150°E to 160°W, while an area of reduced convection was situated from Coral Sea eastwards to Pitcairn Island.

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.

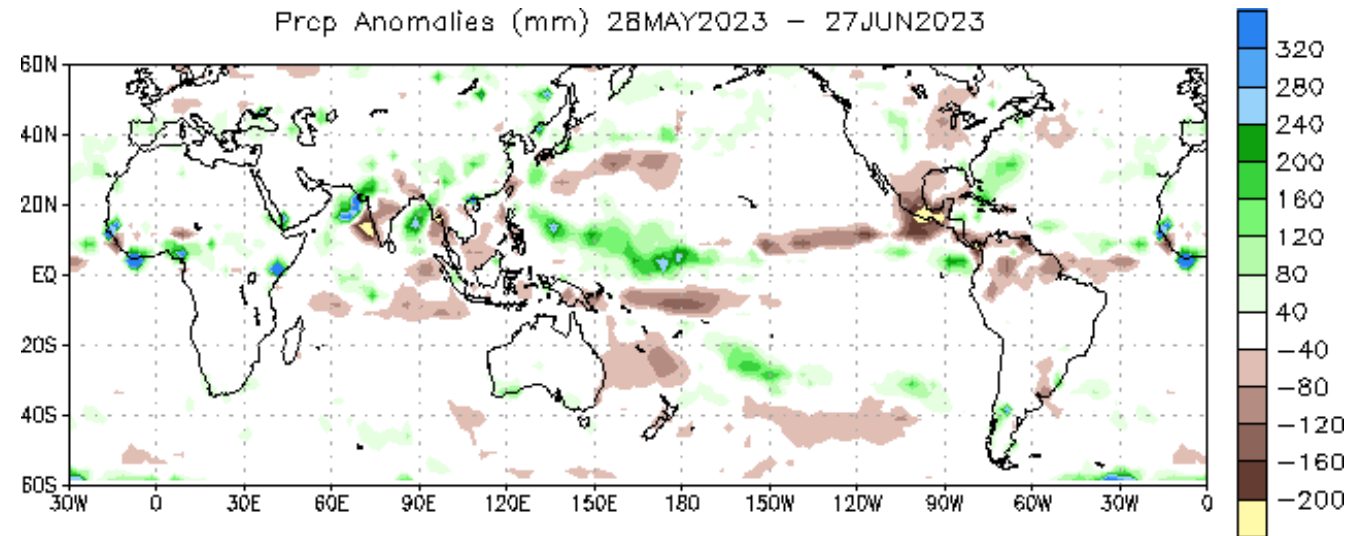
OLR Total and Anomalies, 30 Day OLR



OLR Total and Anomalies, 7 Day OLR

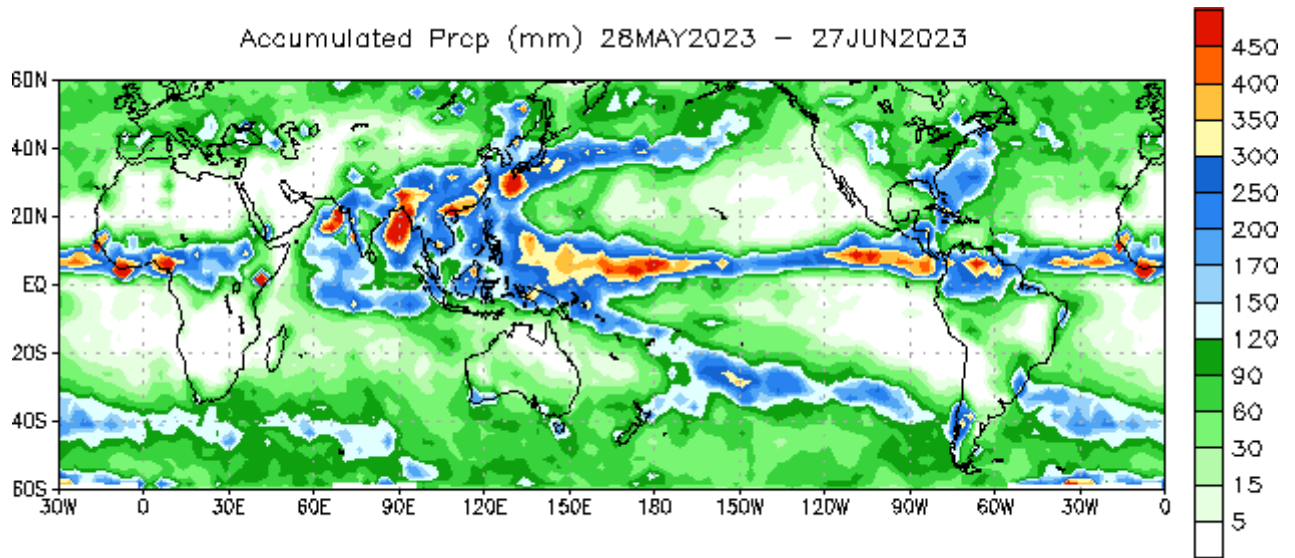


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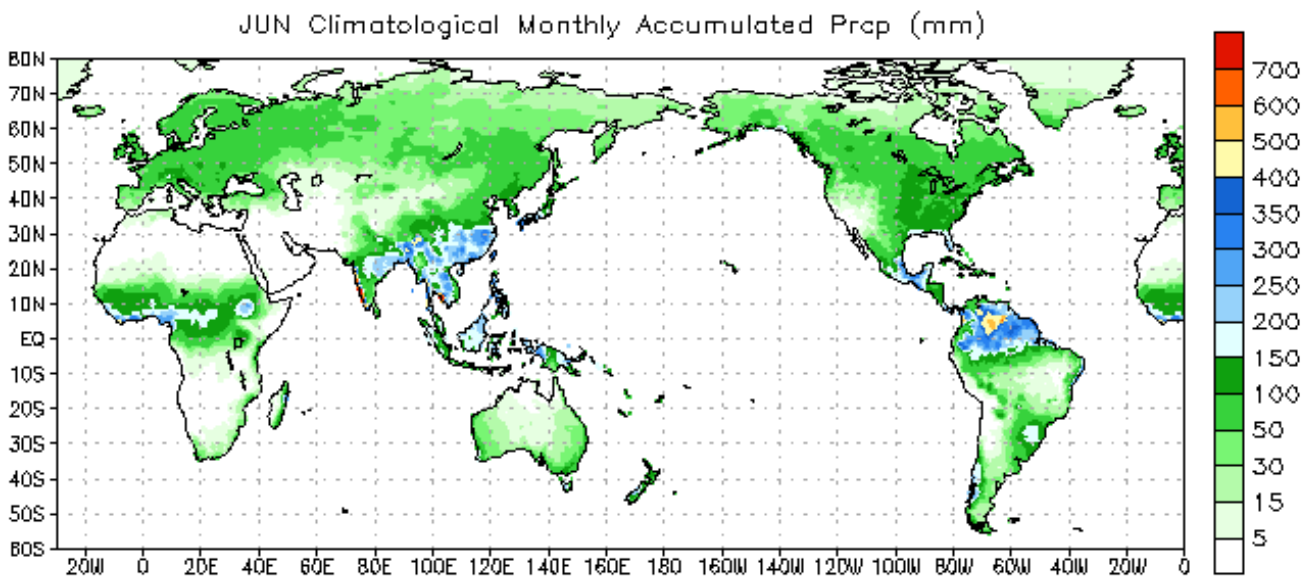


Data Source: NCEP CMAP Precipitation
Climatology (1991–2020)

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](#)

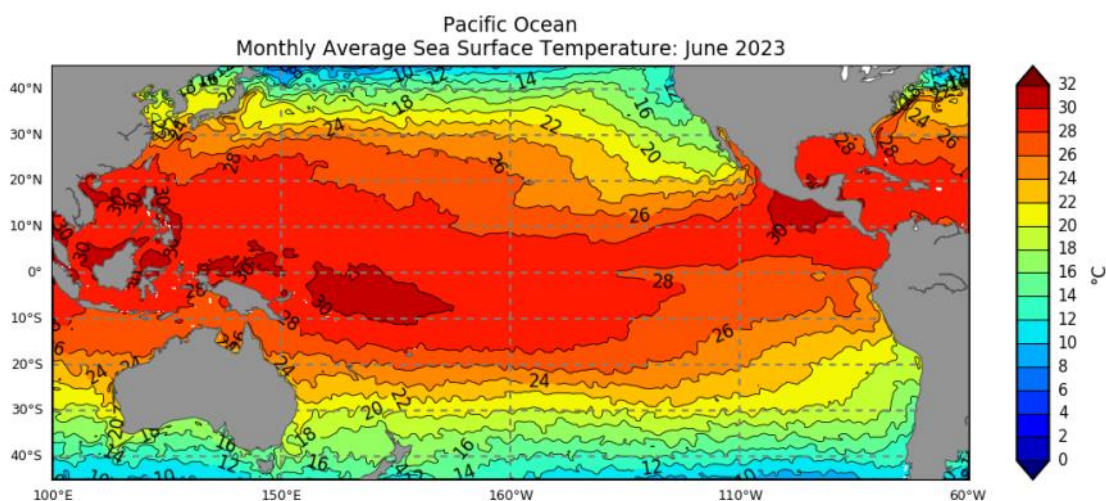
Sea surface temperatures (SST) for June 2023 were warmer than average over the entirety of the tropical Pacific Ocean and much of areas south of 10° S. Warm anomalies more than 1.2°C warmer than average were present over parts of these regions, increasing to more than 3°C warmer than average off small, isolated parts of the South American coast.

Compared to May, warm anomalies in the east equatorial tropical Pacific Ocean have extended westwards. Parts of the basin have cooled marginally in the southern central and eastern parts of the South Pacific Ocean. A band of warm anomalies extend south-eastward from Papua New Guinea to around New Caledonia, Vanuatu, Fiji and the east of New Zealand.

Warm SST anomalies also continued in the southern Tasman Sea, between south-east Australia and New Zealand, with patches of warm SST anomalies south-west of western Australia. Cool anomalies off the east coast of New South Wales decreased in strength and spatial coverage during May with a new small cool anomaly developing of the south of Western Australia.

Record-high June SSTs occurred in parts of Solomon Islands, Tuvalu, northern Fiji, Wallis and Futuna, Tokelau and northern Cook Islands. The SST in decile 10 (very much above average) and above average (8-9) span a region from Palau to Pitcairn Islands. Average SSTs (4-7) for June were observed in parts of northern PNG, northern FSM and RMI, Niue, northern Kiribati (Line Islands), southern Cook Islands, and south French Polynesia.

Mean Sea Surface Temperature



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Australian Bureau of Meteorology, COSPPac

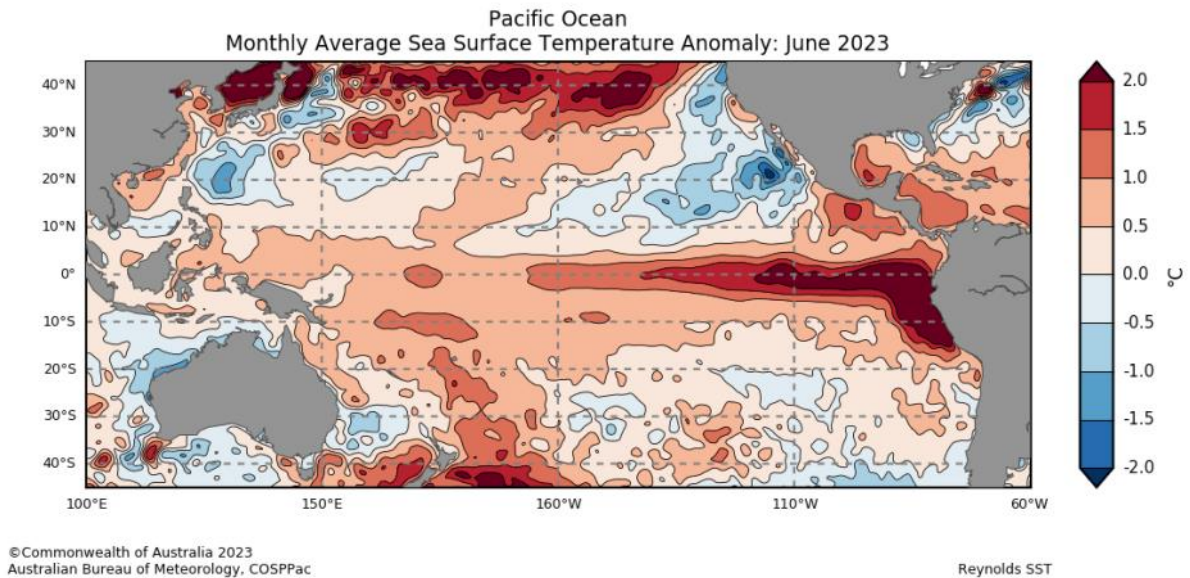
Reynolds SST

OCEAN CONDITIONS

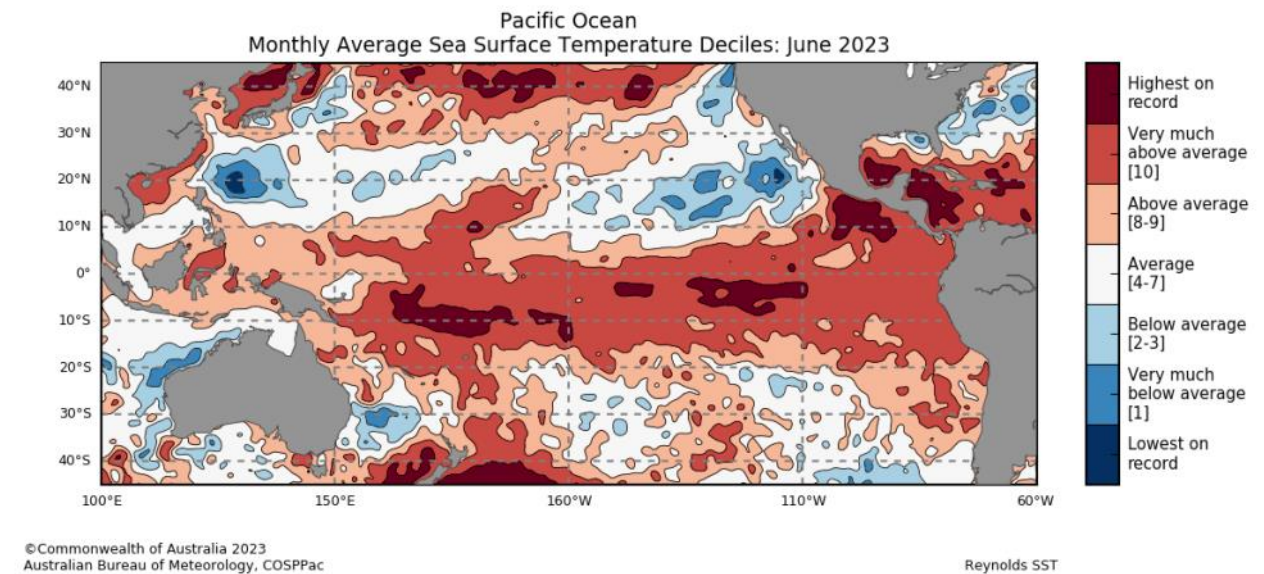
Click link to access [SEA SURFACE TEMPERATURE](#)



Anomalous Sea Surface Temperature



Sea Surface Temperatures Deciles



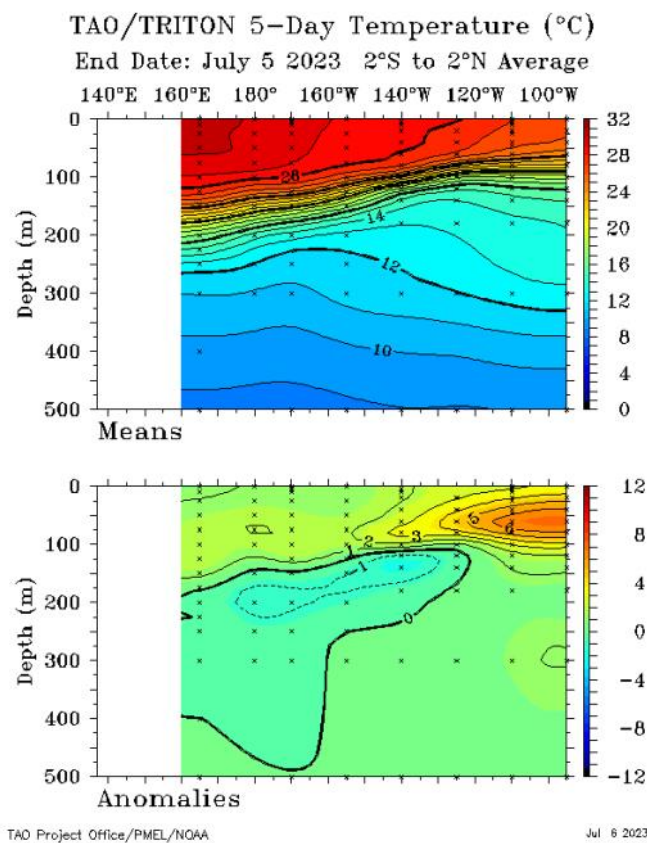
OCEAN CONDITIONS

SUB SURFACE

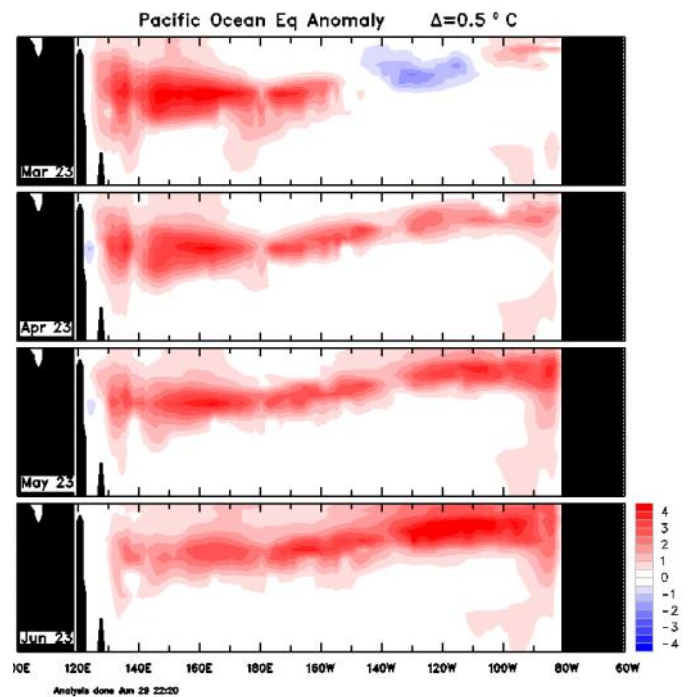


The four-month sequence of equatorial Pacific sub-surface temperature anomalies ((to 30 June 2023) shows warm anomalies were present for most of the top 175 m of the equatorial Pacific band. Anomalies reached more than 3°C warmer than average across much of this region. June has seen warm anomalies continue to be present across the equatorial sub-surface and have strengthened in the eastern 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

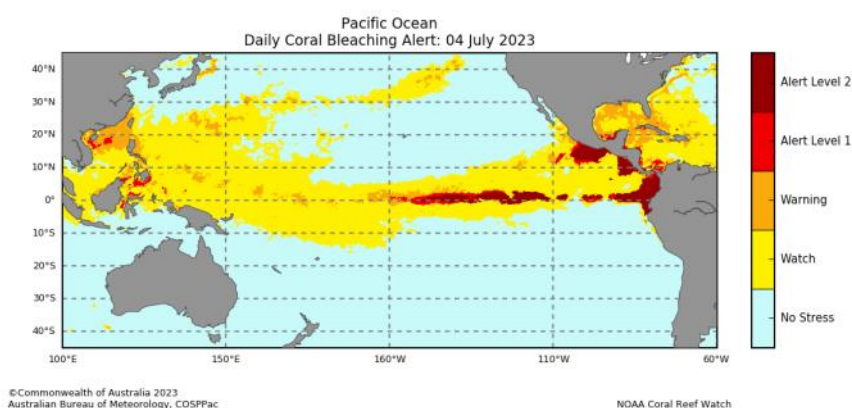
CORAL BLEACHING



The daily Coral Bleaching Alert status for 04 July 2023 shows patches of 'Alert Level 1' for south Palau and north Kiribati (Line Islands). Patches of 'Warning' over FSM, Nauru, and Kiribati (Gilbert and Line Islands). The four-week Coral Bleaching Outlook to 30 July shows patches of area of 'Alert Level 1' over northern Palau, Nauru and Kiribati (central Gilbert and northern Line Islands). 'Watch to Warning' ratings extend east from Palau, FSM, parts of RMI, northern PNG, northern Solomon Islands, Nauru, Kiribati, and northern Tuvalu.

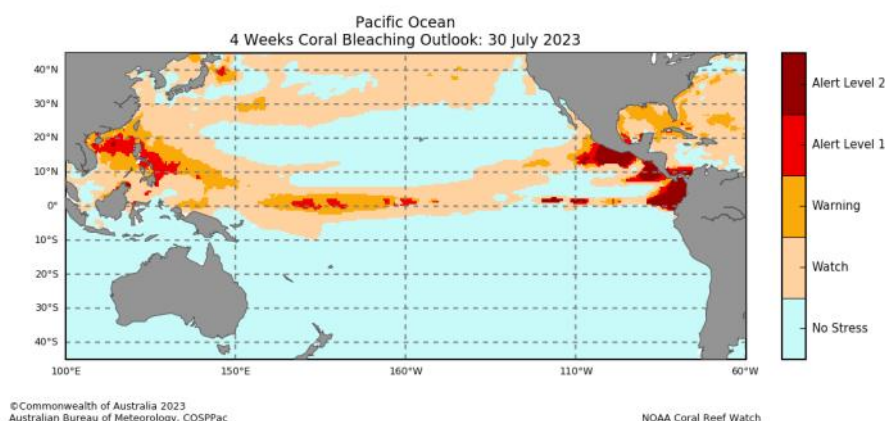
Daily Coral Bleaching Alert

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



4 Weeks Coral Bleaching Outlook

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



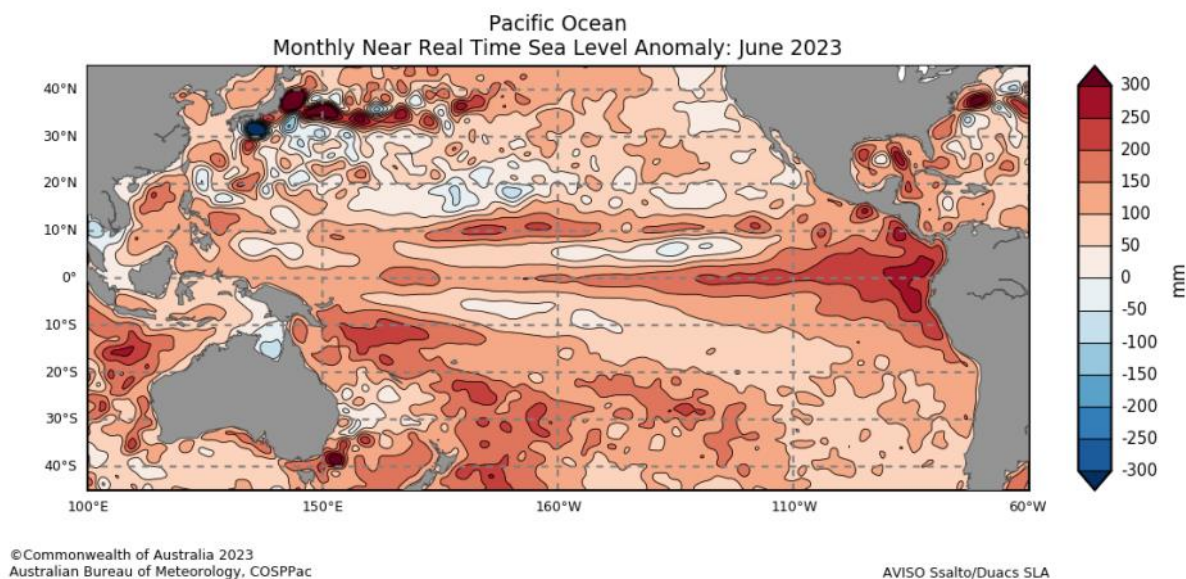
OCEAN CONDITIONS

OCEAN SURFACE CURRENTS AND SEA LEVEL

Sea level in June was above normal over COSPPac countries. Anomalies above +200 mm were observed in eastern PNG, Solomon Islands, northern Vanuatu and patches over south-east Fiji and southern Tonga. Anomalies of +50 to +150 mm were observed in most of the COSPPac countries, apart from patches of below normal sea level anomalies observed in Palau, FSM, southwest New Caledonia and eastern Australia.

Monthly Sea Level Anomalies

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

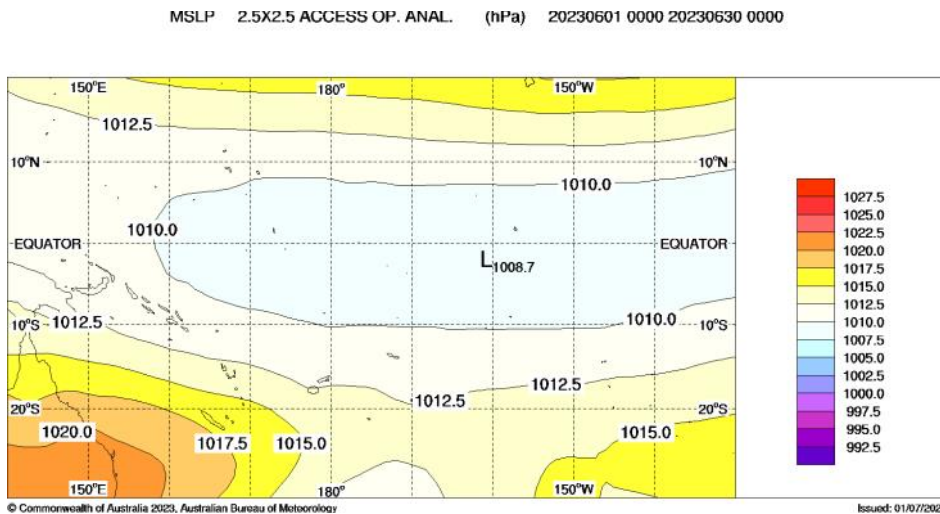


MEAN SEA LEVEL PRESSURE

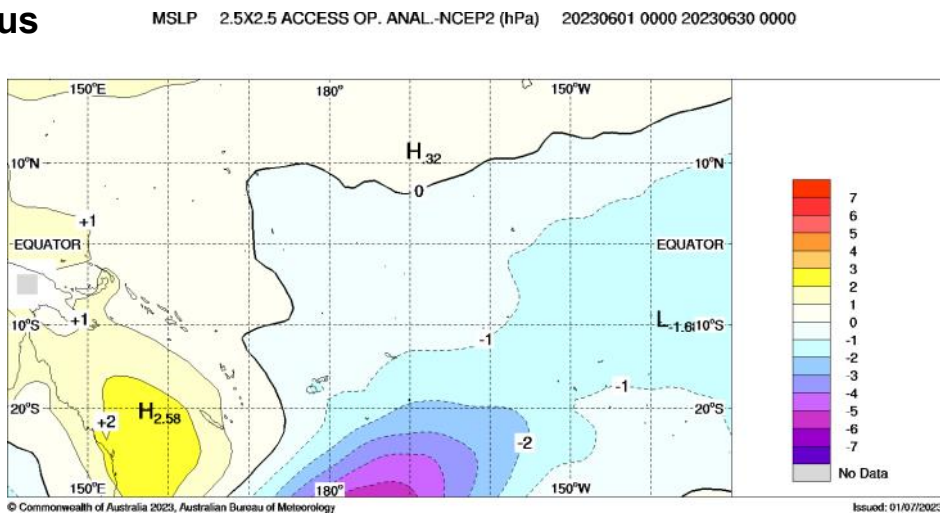
The June mean sea level pressure (MSLP) anomaly map shows mostly negative anomalies of -1 hPa or greater east of the Dateline stretching in a northeast and southwest direction. The positive anomalies of +1 hPa or greater west of New Caledonia towards PNG in the northwest and Australia.

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

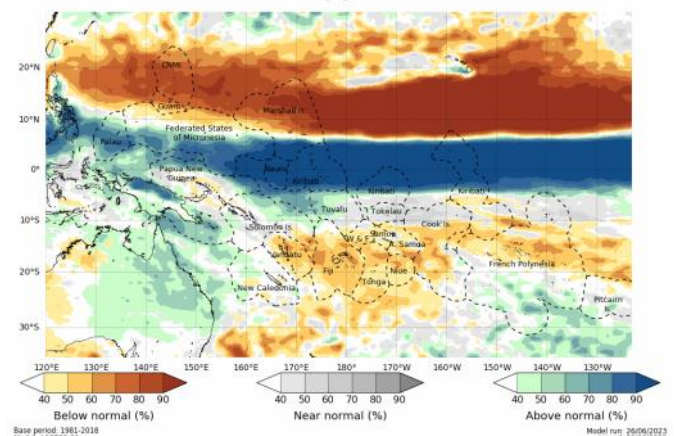
July—September 2023



The ACCESS-S model forecast for July 2023, shows below normal rainfall is likely or very likely for parts of PNG's Islands region, CNMI, Guam, northern FSM, northern and central RMI, some small patches in western Solomon Islands and New Caledonia, Vanuatu, Fiji, Tonga, Wallis and Futuna, Samoa, American Samoa, Niue, parts of Kiribati (southern Line Islands), central and southern Cook Islands and northern French Polynesia. Above normal rainfall is likely or very likely for Palau, most of FSM, southern RMI, PNG's northern mainland plus the southeast of its EEZ, northern Solomon Islands, Nauru, most of Kiribati, northern Tuvalu, and patches in French Polynesia, and Pitcairn Islands.

The three-month rainfall outlook (July-September 2023) is very similar to the July outlook as it favours below normal rainfall in PNG's Islands, CNMI, north RMI, Fiji, Tonga, Wallis and Futuna, Samoa, American Samoa, Niue, all but the far northern Cook Islands, and central and northern French Polynesia. Above normal rainfall is likely or very likely from northern Palau in the west, across Guam, FSM, southern RMI, Nauru, northern Solomon Islands, western and northern Tuvalu, to Kiribati (Gilbert Is., north of both Phoenix and Line Is.). Similarly, above normal rainfall is likely or very likely from the northern PNG mainland across the southeast of the PNG EEZ to the southwest Solomon Islands and northern New Caledonia.

Monthly [ACCESS-S](#) Maps



The Copernicus multi-model outlook for July-September 2023 favours above normal rainfall for Palau, FSM, southern RMI, PNG, Solomon Islands, Nauru, and Kiribati. Below normal rainfall is likely or very likely for Guam, CNMI, northern RMI, southern Tuvalu, northeast Fiji, northern Tonga, Wallis and Futuna, Samoa, Tokelau, American Samoa, central and southern Cook Island, French Polynesia and Pitcairn Islands.

The APEC Climate Centre multi-model for July-September 2023 is also very similar to the ACCESS-S and Copernicus models. The main differences are a decreased wet signal in APEC over Coral Sea region and Vanuatu, and decreased dry signal in APEC for Fiji, Tonga and Niue.

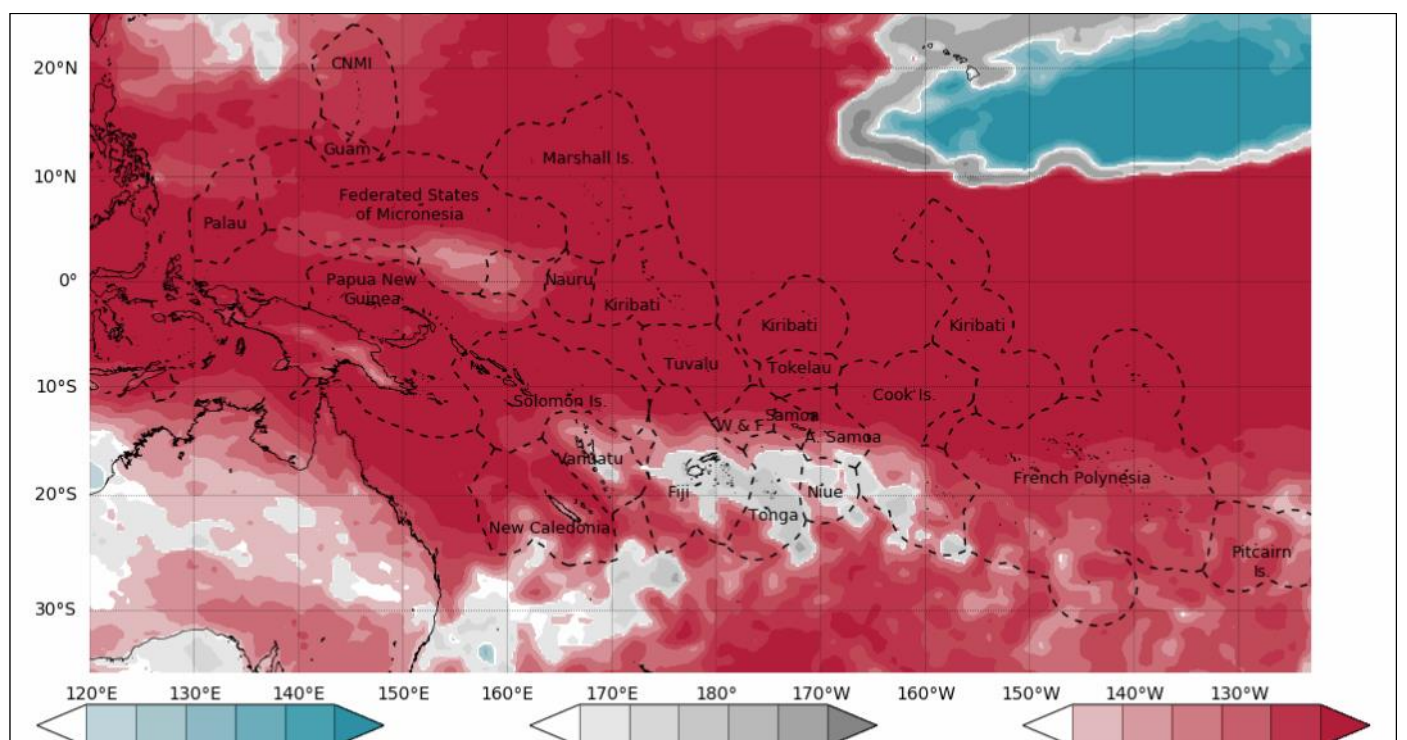
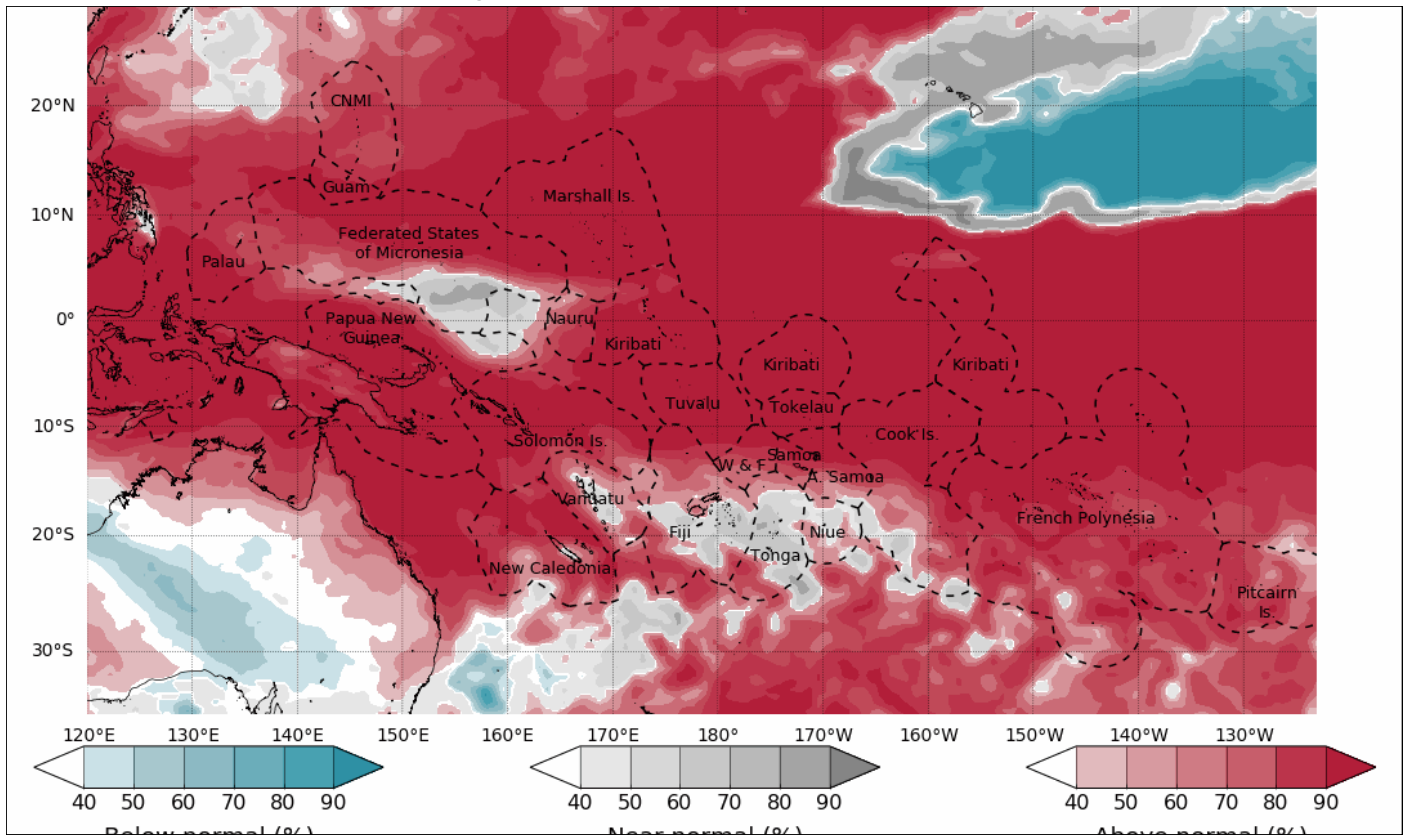
For July-September 2023, the models agree on above normal rainfall being likely or very likely for northern Palau, Guam, FSM, central and southern RMI, PNG's Momase Region and southeast PNG, northern Solomon Islands, Nauru, northern Tuvalu, and Kiribati. The models also agree on below normal rainfall being likely or very likely for much of CNMI, Wallis and Futuna, Samoa, American Samoa, central and southern Cook Islands, and northern French Polynesia.

SEASONAL TEMPERATURE OUTLOOK

July—September 2023



Monthly Tmax and Tmin ACCESS-S Maps



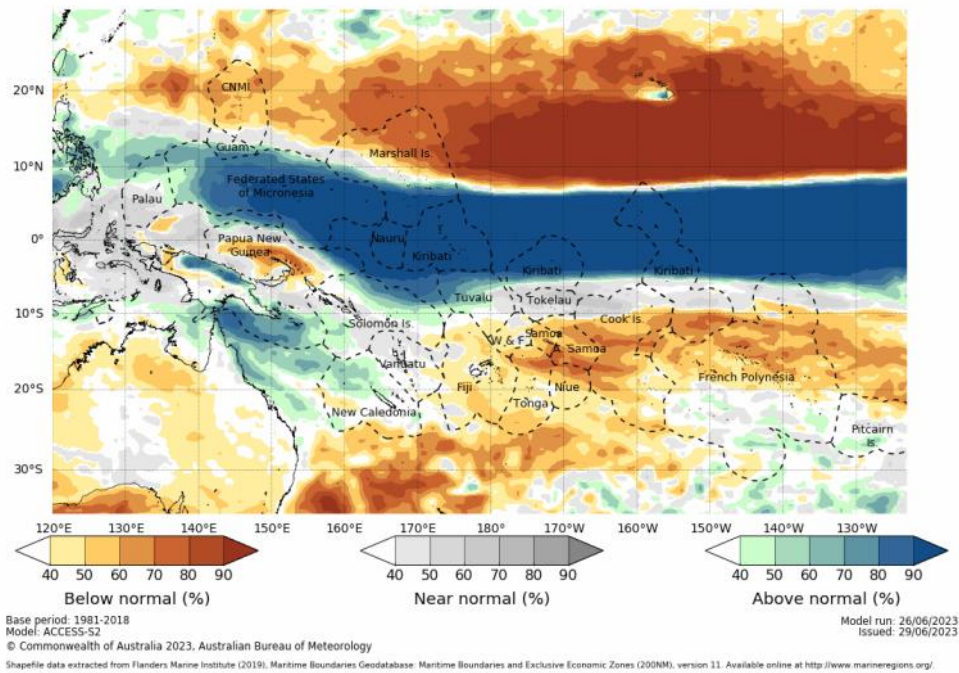
SEASONAL RAINFALL OUTLOOK

July—September 2023

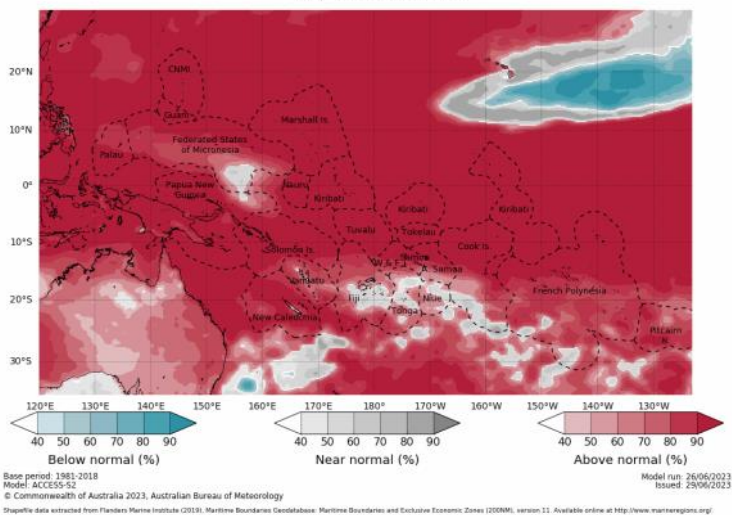


Seasonal ACCESS-S maps

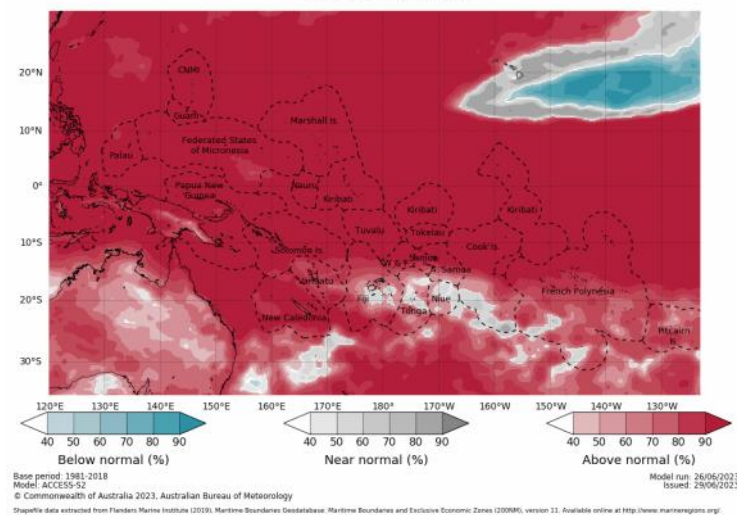
Tercile rainfall probabilities for July to September 2023



Tercile maximum temperature probabilities for July to September 2023



Tercile minimum temperature probabilities for July to September 2023



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

SEASONAL RAINFALL OUTLOOK

July—September 2023



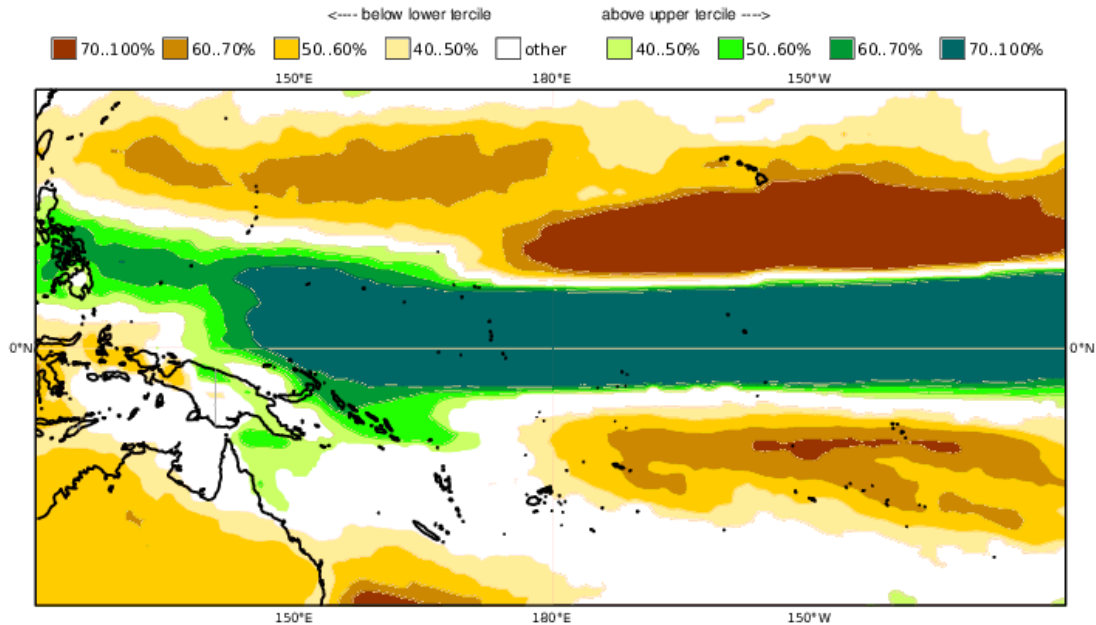
Copernicus (C3S multi-system)-Rainfall

Prob(most likely category of precipitation)

JAS 2023

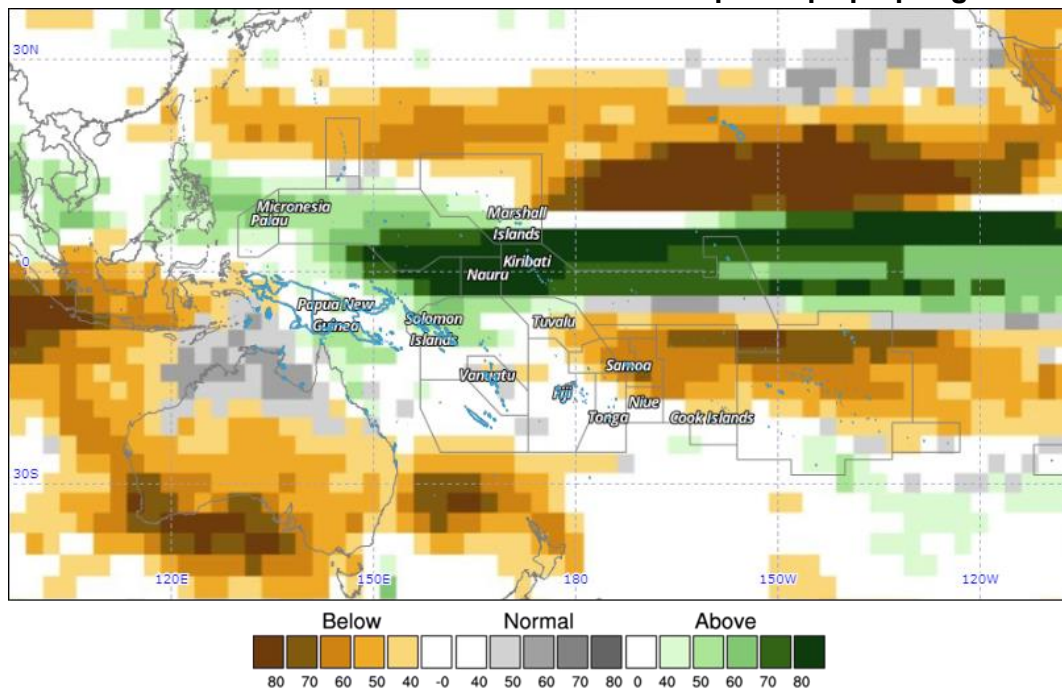
Nominal forecast start: 01/06/23

Unweighted mean



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

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



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

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

Generated using CLIK® (2023-7-5)

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TROPICAL CYCLONE

2022/2023 Season



In the southwest Pacific, the 2022-23 tropical cyclone 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 risks were 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 8 and 21 July around Philippines, Japan, Guam, Palau, FSM and the Marshall Islands.

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>

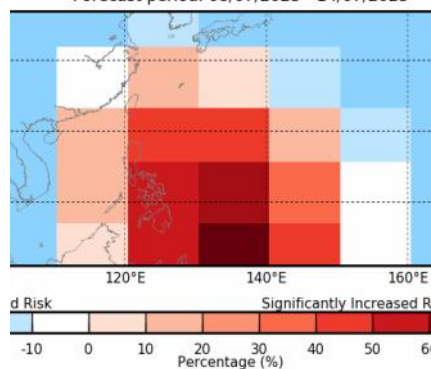
APEC Climate Center (APCC): <http://www.apcc21.org/eng/service/6mon/ps/japcc030703.jsp>

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

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

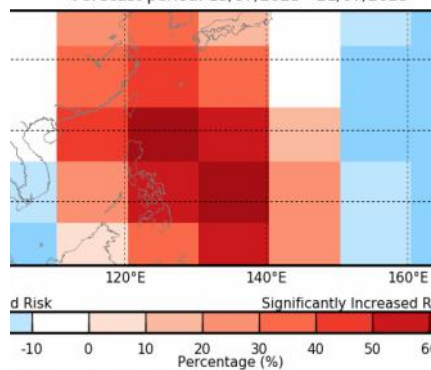
IRI for Climate and Society: <http://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate-forecasts/>

ACCESS-S Weekly Forecasts –Northwest Pacific
Difference from normal chance of Tropical Cyclone's in the Northwest Pacific
Forecast period: 08/07/2023 - 14/07/2023



Probability in overlapping 15 x 20 degree boxes
©2023, Australian Bureau of Meteorology Model: ACCESS_S2 Model Run: 1

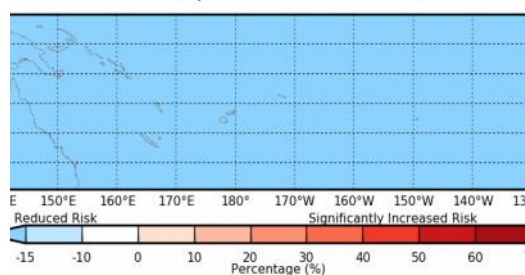
ACCESS-S Weekly Forecasts –Northwest Pacific
Difference from normal chance of Tropical Cyclone's in the Northwest Pacific
Forecast period: 15/07/2023 - 21/07/2023



Probability in overlapping 15 x 20 degree boxes
©2023, Australian Bureau of Meteorology Model: ACCESS_S2 Model Run: 1

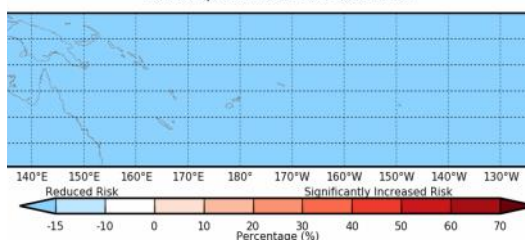
ACCESS-S Weekly Forecasts –Southwest Pacific

ACCESS-S Weekly Forecasts –Southwest Pacific
Difference from normal chance of Tropical Cyclone's in the Southwest Pacific
Forecast period: 08/07/2023 - 14/07/2023



Probability in overlapping 15 x 20 degree boxes
©2023, Australian Bureau of Meteorology Model: ACCESS_S2 Model Run: 30/06/2023

ACCESS-S Weekly Forecasts –Southwest Pacific
Difference from normal chance of Tropical Cyclone's in the Southwest Pacific
Forecast period: 15/07/2023 - 21/07/2023



Model anomaly probability in overlapping 15 x 20 degree boxes
©2023, Australian Bureau of Meteorology Model: ACCESS_S2 Model Run: 30/06/2023 Issue: 1

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.

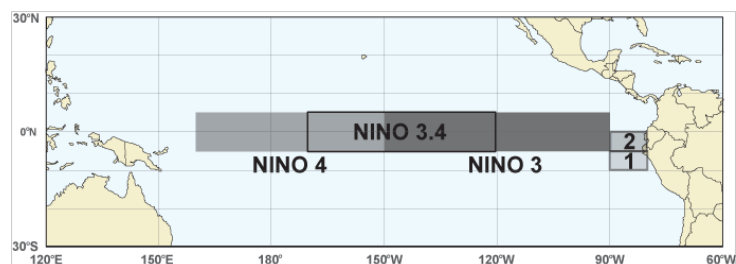
20 degrees Celsius Isotherm Depth

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