

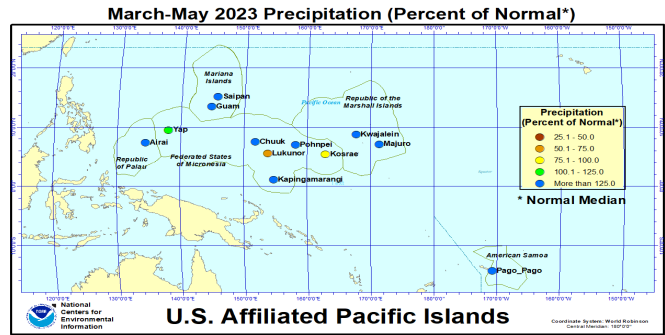
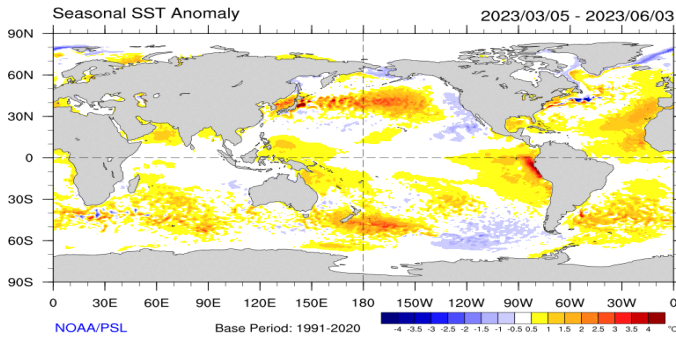
Significant Events – For March 2023–May 2023



Highlights for Hawaii and the U.S. Affiliated Pacific Islands

- During the March-May (MAM) 2023 period, negative sea surface temperature (SST) anomalies dissipated across the equatorial Pacific Ocean, and by late May all four Niño regions were observing positive SST anomalies exceeding the $+0.5^{\circ}\text{C}$ threshold for El Niño development. **On June 8, the NOAA Climate Prediction Center (CPC) issued an El Niño Advisory** with positive SST anomalies expected to gradually strengthen moving into the Northern Hemisphere winter 2023-24 and an 84% chance of exceeding moderate strength.
- For the MAM period, precipitation was above-normal across much of the Hawaiian Islands and U.S. Affiliated Pacific Islands (USAPI) including Guam which observed its wettest MAM and May on record.
- For the MAM period, most of the USAPI region was drought-free, with exception of periods of moderate-to-severe drought observed in the Republic of the Marshall Islands (RMI) in Kwajalein and Wotje as well as in the Federated States of Micronesia (FSM) in Kapingamarangi.
- In late May 2023, the first typhoon of the season, Typhoon Mawar (one of the strongest tropical cyclones in the Northern Hemisphere occurring during the month of May), made landfall in Guam as a Category 4 storm. The typhoon brought strong damaging winds in excess of 140 mph, caused widespread damage to homes and critical infrastructure, power outages, and delivered excessive rainfall with storm totals exceeding 25 inches in the central and northern portions of the island.

Climate Overview – For March 2023–May 2023



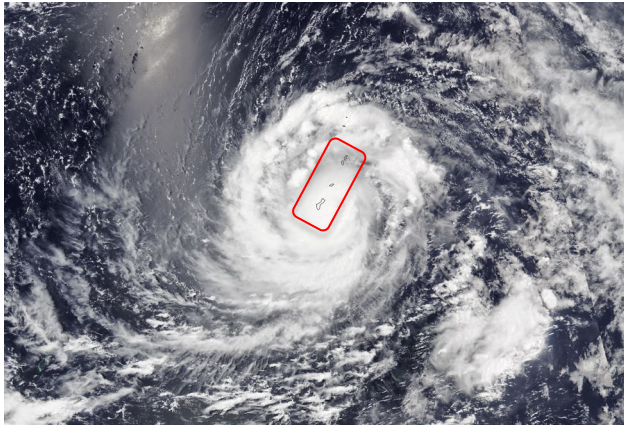
Seasonal sea surface temperature anomaly map for 3/5/23 to 6/3/23 (left) and the percent of normal precipitation across the U.S. Affiliated Pacific Islands for the March-May 2023 period (right). Sources: NOAA PSL, NOAA NCEI.

By the end of the MAM period, SSTs were above-normal across the east-central equatorial Pacific Ocean with an El Niño Advisory in effect (6/8/23). According to the latest NOAA CPC update (6/12/23), Niño region SST departures were above normal across the equatorial Pacific Ocean with Niño 3.4 at 0.9°C, Niño 3 at 1.2°C, Niño 1+2 at 2.6°C, and Niño 4 at 0.7°C.

During the MAM period, above-normal sea levels were observed across most of the western tropical Pacific with the highest sea level anomalies occurring in the southwestern tropical Pacific in the Solomon Islands (15 cm above normal). Elsewhere in the Pacific, above-normal sea levels were observed across central and eastern equatorial Pacific by March and gradually increased in magnitude and spatial extent in the region moving through April and May. Overall, the basin-wide sea level pattern was consistent with El Niño conditions by May, according to the University of Hawaii Sea Level Center.

During the MAM period, most of the USAPI were drought-free, with exception of short-term drought conditions observed in RMI in Wotje (Mar-Apr), Kwajalein (Mar-Apr), and in FSM in Kapingamarangi during March. Median precipitation for the MAM period was above normal across much of the USAPI. For MAM, Airai (Palau) recorded 38.87 in. (129% of normal). In FSM, Yap observed 22.4 in. (116% of normal), Kapingamarangi 35.43 in. (138% of normal), Pohnpei 69.82 in. (126% of normal, 6th wettest May on record), Lukunor 24.73 in. (70% of normal, 6th driest MAM on record), Kosrae 47.3 in. (87% of normal), and Chuuk 45.8 in. (133% of normal). In the Mariana Islands, Saipan observed 13.01 in. (215% of normal, 3rd wettest MAM on record) and Guam 41.61 in. (390% of normal, wettest MAM and May on record). In the RMI, Majuro observed 35.7 in. (139% of normal) for MAM, while Kwajalein logged 37.48 in. (217% of normal). In American Samoa, precipitation was above normal (41.78 in., 126% of normal) at Pago Pago. Across much of the Hawaiian Islands, above-normal rainfall was observed for the MAM period, with drought-free conditions observed across most of the island chain with exception of moderate drought observed in areas of Central/West Maui in April and in the North Kohala district on the Big Island during May, according to the U.S. Drought Monitor. For the MAM period, Lihue observed 14.81 in. (151% of normal), Honolulu 5.49 in. (139% of normal), Molokai 6.5 in. (114% of normal), Kahului 3.02 in. (65% of normal), Kailua Kona 3.42 in. (153% of normal), and Hilo 21.96 in. (74% of normal).

In the South Pacific region (east of 135°E), tropical cyclone (TC) activity has been below normal for the 2022-23 season, with 5 named storms with an Accumulated Cyclone Energy (ACE) Index of 33.3 (normal 67.3) by 4/30/23 (end of the season), including TC Judy (2/27-3/4) and TC Kevin (3/1-3/7) which both impacted the Vanuatu Islands with widespread damage to the northwest and northeastern islands, according to the UN Office for the Coordination of Humanitarian Affairs. In the Northwest Pacific region, the ACE Index has been above normal (57.6 by 6/4/23—normal for the date 28.0) with 2 named storms since late April including Typhoon Mawar (5/20-6/3) which was one of the strongest tropical cyclones in the Northern Hemisphere on record that occurred in the month of May, according to NOAA NESDIS.



Visible Infrared Imaging Radiometer Suite (VIIRS) image from NOAA-20 satellite (1:50 p.m. local time) of Typhoon Mawar moving over Guam and the Commonwealth of the Northern Mariana Islands as a Category 4 strength storm on 5/24/23. Image credit: NASA Earth Observatory.



Wind and flood damage to home in Yigo, Guam following the passing of Typhoon Mawar. Image credit: Red Cross, Guam.



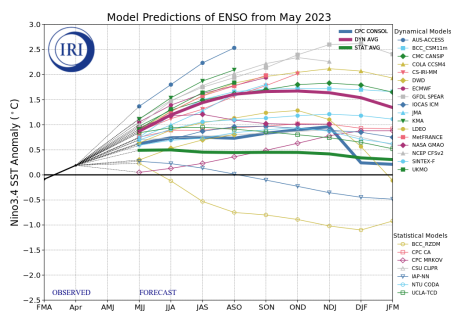
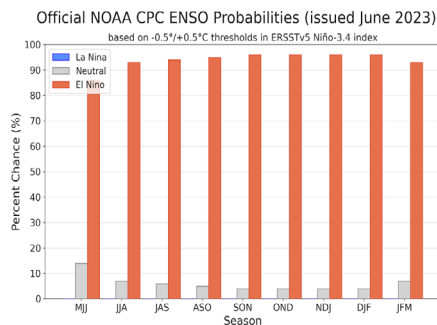
American Red Cross volunteer workers distributing relief supplies to affected communities in Guam. Image credit: American Red Cross, Guam.

Facilities and Infrastructure – On 5/23-24, Typhoon Mawar battered the island of Guam as a Category 4 storm bringing hurricane-force winds (~140 mph), torrential rains, flooding, and causing widespread extensive damage to homes, buildings, and critical infrastructure as well as extensive beach erosion across all shores of Guam, according the NWS Guam. On May 24, the Guam Power Authority reported their grid was only producing power to 1,000 of its 52,000 customers. Moreover, powerful winds caused widespread damage to local vegetation and trees with numerous roads made impassible due to downed large trees, debris, and severe flooding, according to preliminary impact reports by the NWS Guam. In terms of the emergency response to the arrival of Mawar, Guam’s Governor Guerrero signed an executive order (No. 2023-02) declaring a state of emergency (5/21/23) followed by President Biden approving an emergency declaration for both the Commonwealth of the Northern Mariana Islands (CNMI) (5/22/23) and for the Territory of Guam (5/23/23) to assist with the disaster response efforts.

North of Guam in the CNMI, the island of Rota was spared a direct hit by Typhoon Mawar. However, the island was inside the radius of the typhoon-force winds and initial reports showed impacts to primary utilities including loss of power during the peak of Mawar’s passage as well as wind damage to homes, downed trees and power poles, and some coastal inundation. Likewise, some lesser impacts (minor landslides) were observed in areas of western FSM, including Polowat Island (Chuuk State) during the initial stage of Mawar’s development.

In the Hawaiian Islands, intense rainfall in Kauai (3/29/23) caused severe flash flooding that trapped several individuals in their vehicles and lead to the closure of the Hanalei Elementary School. In April, a strong late-season cold front and associated heavy rainfall led to road closures due to flooding in the Kau District of the Big Island as well as strong damaging winds (gusts over 50 mph) on several islands that downed trees and utility poles leading to power outages.

Water Resources – In Majuro (RMI), reservoir storage reached 87% of total capacity (28,000,000 gallons) on May 31, 2023. In Maui, despite near- to above-normal rainfall across portions of the island during May, observed monthly average streamflows were below normal (ranging from the 10th-21st percentile) at numerous gaging stations, including at Wailuku River at Kepaniwai Park.



Forecast for each of the three possible ENSO categories for the next 8 overlapping 3-month seasons. Blue bars show the chances of La Niña, gray bars the chances for neutral, and red bars the chances for El Niño (left) and ENSO forecast model predictions (right).
Source: NOAA CPC, Columbia University IRI.

By the end of May, the spatial extent of positive (warmer than normal) SST anomalies had propagated westward across the equatorial eastern and central Pacific Ocean with the strongest anomalies observed in the Niño 1+2 region. According to the latest ENSO prediction model simulations (above right), there is strong agreement amongst the IRI ENSO prediction plume of gradual strengthening of positive SST anomalies during the Jun-Aug 2023 period (86% chance) in association with the on-going El Niño event and is expected to persist through the entire forecast period into the Northern Hemisphere winter 2023-24.

NOAA's Coral Reef Watch four-month coral bleaching heat stress outlook (Jun 2023-Sept 2023) calls for a high probability (90%) of high heat stress (Alert Level 1-2) developing across the equatorial Pacific Ocean from $\sim 150^{\circ}$ W eastward to the coastal waters of Colombia, Ecuador, Peru, and extending northward to Central America. Likewise, high heat stress (Alert Level 1) is expected near the Equator in an area extending from the International Date Line to $\sim 155^{\circ}$ E.

During the period of June 2023 through August 2023, above-normal precipitation is forecasted for areas of USAPI, including Palau, Guam, FSM (Chuuk, Kosrae, Pohnpei, Yap), and in the RMI (Kwajalein, Majuro). Average to above-average rainfall is forecasted for the CNMI (Saipan). Conversely, below-normal precipitation is expected in the Hawaiian Islands and American Samoa, according to the NOAA Pacific ENSO Applications Climate (PEAC) Center.

According to NOAA's Central Pacific Hurricane Center and NOAA's CPC (5/25/23), there is a 50% chance of above-normal tropical cyclone activity during the central Pacific hurricane season (Jun 1 – Nov 30) with 4 to 7 tropical cyclones predicted for the region. The primary factor influencing the forecast is the predicted development of El Niño during the summer, which historically tends to cause an increase in tropical cyclone activity across the Pacific Ocean basin, according to NOAA CPC.

NOAA Coral Reef Watch:
<https://coralreefwatch.noaa.gov/>

NOAA National Centers for Environmental Information:
<https://www.ncei.noaa.gov/>

NOAA NMFS Pacific Island Fisheries Science Center:
<https://www.fisheries.noaa.gov/region/pacific-islands#science>

NOAA NWS Weather Forecast Office Honolulu & Guam:
<https://www.weather.gov/hfo/>
<https://www.weather.gov/gum/>

NOAA OceanWatch - Central Pacific:
<https://oceanwatch.pifsc.noaa.gov/>

NPS Pacific Island Inventory & Monitoring Network:
<https://www.nps.gov/im/pacn/index.htm>

University of Guam - Water and Environmental Research Institute:
<https://weri.uog.edu/>

University of Hawaii Asia Pacific Data Research Center (APDRC):
<http://apdrc.soest.hawaii.edu/index.php>

University of Hawaii - Joint Institute of Marine and Atmospheric Research:
<https://www.soest.hawaii.edu/jimar/>

University of Hawaii Sea Level Center:
<https://uhslc.soest.hawaii.edu/>

USGS Science Center – Pacific Coastal and Marine Science Center:
<https://www.usgs.gov/centers/pcmssc>

USGS Pacific Islands Water Science Center:
<https://www.usgs.gov/centers/piwsc>

Western Regional Climate Center:
<https://wrcc.dri.edu/>