PACIFIC ENSO UPDATE

A Quarterly Bulletin of the Pacific El Niño-Southern Oscillation Applications Climate (PEAC) Center

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Providing Information on Climate Variability in the U.S.-Affiliated Pacific Islands for the Past 20 Years.

http://www.weather.gov/peac

CURRENT CONDITIONS

Guam and some of the islands of the CNMI were leaders-of-the-pack for rainfall totals during the 3rd Quarter of 2018, both in terms of rainfall amount and rainfall percent-of-average (see Figures 4 and 5 on page 18). The passage of several tropical cyclones over-or-near these islands contributed substantially to the high rainfall totals. Two typhoons (Typhoon Mangkhut and Super Typhoon Yutu) were particularly destructive on some of the islands of the CNMI (see the Tropical Cyclone section, and also the LVS for Guam and the CNMI for more details). While islands in the mid-section of Micronesia (e.g., Yap, Guam, Chuuk and Saipan) were wet, dry conditions have recently developed in the far west (e.g. Palau) and in the east (e.g., some of the islands of Pohnpei State, Kosrae and some of the atolls of the RMI). Recent dryness during September and October on Kosrae has already had impacts of lower stream flow and reduced rain catchment. At some of the atolls of the RMI (e.g., Kwajalein and Majuro), where rainfall earlier in the year had surged to new historical highs [1], an abrupt lowering of rainfall amounts occurred during September and October.

Temperature

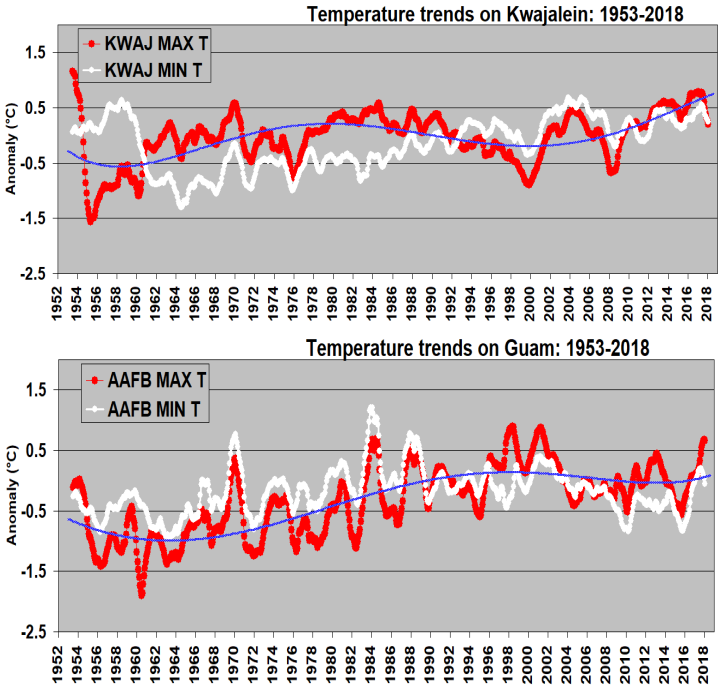


Figure CC-1. A 1953-2018 time series of maximum and minimum temperatures at Andersen Air Force Base (AAFB) on Guam (Top panel) and on Kwajalein (Bottom panel). Values plotted are a 12-month moving average of the monthly anomalies of temperature. Note a general warming trend, with some obvious non-linear inter-annual and inter-decadal variability. The inter-decadal variability is highlighted by the smooth non-linear trend lines. Very warm MAX and MIN temperatures at Kwajalein during the 1950s are probably an artifact of station location and exposure or instrumentation.

The temperatures across Micronesia through the 3rd Quarter of 2018 were mostly above average, but have dropped slightly in the past few months, especially in areas where tropical cyclones and other rain-producing systems have dominated. Very warm temperatures are typically experienced in the US-API when skies are clear and winds are light. Cooler temperatures occur when conditions are unusually cloudy, wet and windy. Note a persistent increase of temperature at Guam from a pronounced coolness during 2015 (wet and windy) to warmer conditions during 2016 and 2017 (abundant sunshine and light winds). Cooler conditions in Kwajalein in 2018 accompanied very wet weather there.

Sea Level

During the 1st Quarter of 2018, the trade winds began to weaken. The sea level across most of Micronesia was above average during the 1st Quarter of 2018, but underwent a sudden fall during April 2018, with Palau dropping all the way from a stand at +6 inches above average to 0. The sea level at Palau is now

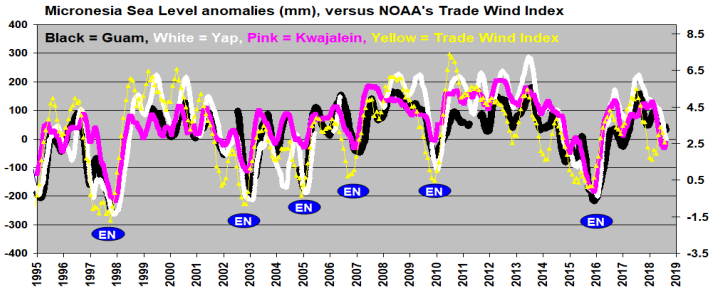


Figure CC-2. Sea level recorded at Yap (white), Guam (black) and Kwajalein (pink). Also plotted is NOAA's Trade Wind Index (5N-5S ; 135E-180) (yellow) 1985 to present. During El Niño, there is a sharp drop in sea level at most locations followed by a steep rise thereafter (blue circles inscribed with "EN" show CPC-declared El Niño events. The sea level across all of Micronesia closely tracks the trade wind forcing. Recent weakening of the trade winds corresponds with a net fall of sea level of about 4-6 inches from early 2018 to now (see the sea level discussion for more details).

CURRENT CONDITIONS

below average. At other locations across the US-API, the sea level has remained near average. Above average sea level was noted along the equator (e.g., at Kapingamarangi), in the Hawaiian Islands and at American Samoa. Note the strong coherence of sea level across the stations of Micronesia, and also the close relationship of the sea level with the trade winds (see Figure CC-2). Also note the abrupt lowering of sea level that typically accompanies El Niño ("EN" on the figure). (see the sea level section for more details).

ENSO Evolution

La Niña-like weather patterns persisted through the 4th Quarter of 2017 into the 1st Quarter of 2018, as the climate system continued to be within the SST bounds of La Niña (see Fig. CC-3). During March and April, the Oceanic Niño Index (ONI) warmed to the threshold of ENSO-neutral. By June 2018, the ONI became weakly positive, where it has remained to-date. With the anticipation of further warming, the CPC's latest ENSO diagnostic discussion (appended below) continues an El Niño Watch. Some weather features typical of El Niño or impending El Niño have occurred during 2018; these include:

(1) a very wet eastern Micronesia in the first half of the year;

(2) dryness in Palau for several months;
(3) several early season tropical disturbances in eastern Micronesia;
(4) some unusual westerly winds in eastern Micronesia; and,
(5) a lowering of the sea level at many islands of Micronesia.

Note: Until just the past few weeks, the SST in the tropical Pacific has not reached El Niño thresholds in CPC's official Niño regions along the equator (e.g. i.e., the Niño 3.4 box used for the CPC's Oceanic Niño Index). Rather, the highest positive SST anomalies have been found north of the equator between 5° and 10°N.

Some weather features of 2018 to-date are not typical of El Niño or impending El Niño; these include:

(1) the rainy season monsoon and many of the basin's typhoons were well to the north and west of average;

(2) there have not been very many episodes of strong westerly winds along the equator;
(3) the typhoon distribution has yet to penetrate deeply into the "El Niño" Box (see the TC Section); and,
(4) the sea level remains high along the equator.

CURRENT STATE OF ENSO

ENSO Alert System Status: El Niño Watch

El Niño Diagnostic Discussion[1]
CLIMATE PREDICTION CENTER/NCEP/NWS
and the International Research Institute for Climate and Society
08 November 2018

Synopsis: El Niño is expected to form and continue through the Northern Hemisphere winter 2018-19 (~80% chance) and into spring (55-60% chance).

ENSO-neutral continued during October, despite widespread above-average sea surface temperatures (SSTs) across the equatorial Pacific Ocean. All four Niño regions showed increased SST anomalies in October, with the latest weekly values near +1.0°C in the Niño-4, Niño-3.4 and Niño3 regions, and +0.2°C in the Niño-1+2 region. Positive subsurface temperature anomalies (averaged across 180°-100°W) also continued, due to the persistence of above-average temperatures at depth across the eastern half of the equatorial Pacific Ocean. However, atmospheric convection remained slightly suppressed near the Date Line and over Indonesia.

Low-level westerly wind anomalies were observed over the eastern Pacific during October, while weak upper-level westerly wind anomalies were present over the far western Pacific. The traditional and equatorial Southern Oscillation indices were near zero. Despite the above-average ocean temperatures across the equatorial Pacific Ocean, the overall coupled ocean-atmosphere system continued to reflect ENSO-neutral.

The majority of models in the IRI/CPC plume predict a Niño3.4 index of +0.5°C or greater to continue through the rest of the fall and winter and into spring. The official forecast favors the formation of a weak El Niño, with the expectation that the atmospheric circulation will eventually couple to the anomalous equatorial Pacific warmth. In summary, El Niño is expected to form and continue through the Northern Hemisphere winter 2018-19 (~80% chance) and into spring (55-60% chance): (http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-cpc_plume)."

[1] Climate Prediction Center National Centers for Environmental Prediction, NOAA/National Weather Service, College Park, MD 20740.

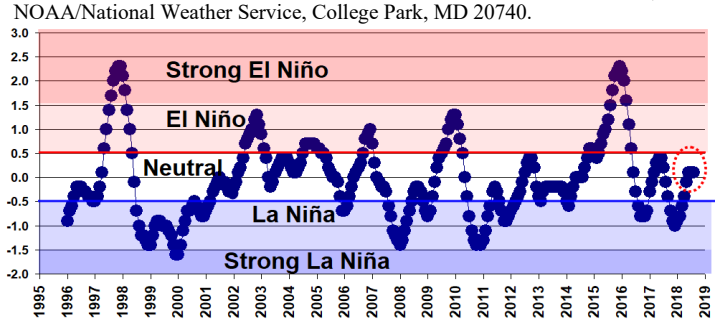


Figure CC-3. A plot of the CPC's Oceanic Niño Index (ONI) for the past two decades. Note that it made a run toward El Niño early in 2017, but then reversed and entered the La Niña category at mid-2017. During the first half of 2018, the ONI began a move through ENSO-neutral and toward El Niño, but has lately stalled near the center of the ENSO-neutral category. Very recent warming has moved the equatorial Pacific closer to El Niño. This warming is expected to continue for the next few months, with the climate system likely moving into El Niño. The CPC issued its final La Niña advisory on 10 May 2018, and established an El Niño Watch that continues to be been in-effect.

TROPICAL CYCLONE ACTIVITY

Western North Pacific

Western North Pacific tropical cyclone activity through October 2018 was about average, with a particular abundance of TC formation during July and August. The 31 TCs numbered by the JTWC during January through October of 2018 are well above average. The JMA named 26 of these, which is three above their average of 13 named storms through the same time period. See Table CC-1 for a summary of Northern Hemisphere TC activity (through October), by basin and for the Northern Hemisphere. Although the JTWC number of TCs in the western North Pacific basin was well above average, many of the storms were weaker systems that formed in subtropical latitudes and interacted with a strong and persistent monsoon system displaced to the north and west of the usual location of the monsoon trough. Thus, while the count of numbered systems was high, the count of WNP typhoons was near average.

Although the 2018 to-date distribution of TC tracks is not typical of El Niño (there was not an unusual abundance of formation and movement of TCs within and through the "El Niño Box" on Figure CC-4), there was indeed a notable eastward shift

Basin	Named Storms	Named Storm Days	Hurricanes/ Typhoons	Hurricane Days	Major Hurricanes	Major Hurricane Days	ACE
NAtl	15 (11.3)	87.25 (54.8)	8 (5.9)	26.75 (22.7)	2 (2.6)	5.0 (6.0)	128.9 (99.0)
ENP	**23 (16.3)**	**125.50 (72.1)**	**13 (8.7)**	**67.5 (29.7)**	**10 (4.3)**	**35.0 (8.9)**	**315.3 (130.5)**
WNP	**26 (23.0)**	**130.5 (119.1)**	**14 (14.7)**	**60.25 (58.4)**	**9 (7.6)**	**29.0 (19.6)**	**322.6 (257.6)**
NIO	5 (3.1)	15.75 (8.3)	3 (0.8)	5.75 (1.7)	1 (0.5)	0.50 (0.7)	23.2 (10.9)
N Hemi	69 (53.7)	359.0 (254.3)	38 (30.1)	160.25 (112.5)	22 (15)	69.5 (35.2)	790.0 (498.0)

Table CC-1. Northern Hemisphere Tropical Cyclone Activity for 2018 (through October 2018), by basin and Northern Hemisphere totals (http://tropical.atmos.colostate.edu/Realtime/). Numbers in parentheses are long-term averages.

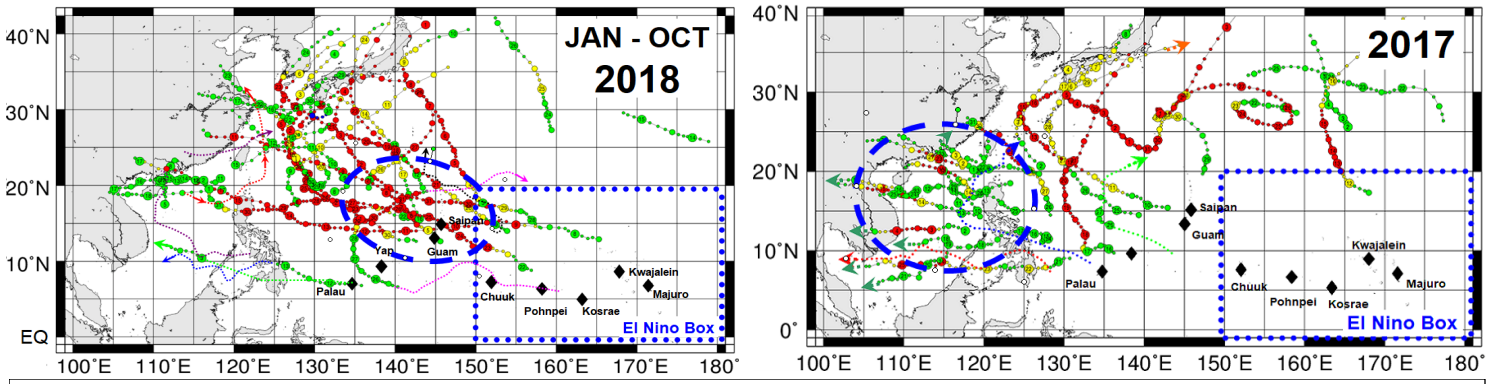
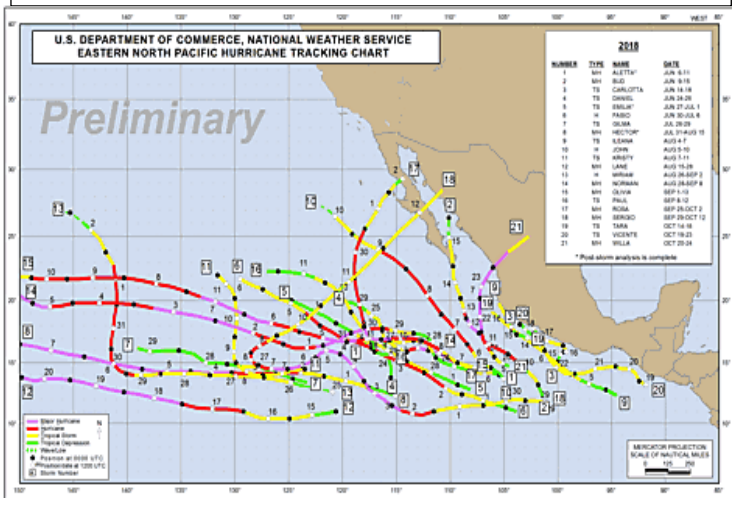


Figure CC-4. Tropical cyclone tracks during JAN-AUG 2018 (top) and JAN-AUG 2015 (an El Niño year) (bottom). Dotted lines on the 2018 chart show disturbance stages tracked by the JTWC in the pre- and post-storm stages and some TCs that were numbered by the JTWC but not named by the JMA. Large-dot box encloses the region where TCs occur almost exclusively during El Niño. Charts adapted from the "digital typhoon" web site: http://agora.ex.nii.ac.jp/digital-typhoon/year/wnp/

of the TC formation region between 2017 and 2018. Because of this shift, Guam and the islands of the Northern Marianas were affected by several TCs. Among these were direct strikes on several islands by typhoons. One of these typhoons – Super Typhoon Yutu – caused catastrophic damage on Tinian and Saipan (see the LVS for Guam and the CNMI for more details.)

Abundant TC formation in all basins pushed the Northern Hemisphere total to well above average (Table CC-1). The eastern North Pacific (EPac) is the real stand-out basin this year, with a high number of named TCs and a high number of intense TCs. The very abundant EPac hurricane season included several high-impact storm events in the Hawaiian Islands (see the EPac TC summary below).

Figure CC-5 Preliminary Eastern North Pacific Tropical Cyclone Tracks



EastPac

The 2018 Pacific hurricane season produced the highest Accumulated Cyclone Energy (ACE) value on record in the Eastern Pacific basin and is the fourth-most active season on record, tied with 1982. In addition, the season featured the most named storms in the East Pacific proper since 1992, and tied 1994 and 2002 for the most Category 5 hurricanes in a season, with three hurricanes (Lane, Walaka, and Willa) reaching that intensity. The eastern Pacific season officially began on May 15th and ended on November 30th.

Southern Hemisphere

The 2017-18 Southern Hemisphere (SH) TC season ended on 30 June 2018. With the imminent onset of El Niño conditions, the upcoming 2018-19 SH TC, the genesis region of South Pacific TCs will likely see activity displaced farther to the east, resulting in above average numbers of TCs in the South Pacific to the east of 180°.

PEAC tropical cyclone assessment

Western North Pacific and American Samoa

Two organizations routinely provide forecasts of western North Pacific typhoon activity: (1) The Guy Carpenter Asia-Pacific Climate Impact Centre (GCACIC) at the School of Energy and Environment, City University of Hong Kong; and, (2) Tropical Storm Risk (TSR), Dr Adam Lea and Professor Mark Saunders, Department of Space and Climate Physics, UCL (University College London). On

TROPICAL CYCLONE ACTIVITY

11 May 2018, the TSR issued its outlook for the western North Pacific typhoon season; it then issued an update to its outlook on 7 August 2018.

In retrospect, the forecast of the GCACIC forecast for below-normal TC landfalls in all regions of East Asia was likely too low. The TSR forecast for slightly above average basin-wide TC activity was more in-line with the observed abundant activity.

The PEAC forecast made in the last newsletter was actually quite good; it is repeated below:

PEAC (an active fall ahead in Micronesia)

Given the very high activity of the western North Pacific to-date, it is likely that the TSR estimate of total storms (27) is low. But also given the over abundance of weaker storms and near average number of typhoons and intense typhoons to-date, the TSR forecasts for the statistics of these may be accurate. Taking into account outside guidance, and considering current weather patterns and the evolution of ENSO, the PEAC will adopt the press-release forecast by the WFO Guam (Mr. Charles P. Guard and collaborators) for the 2018 typhoon season for Guam and the CNMI, wherein the odds for a severe tropical storm at each location is given as 50% (about average); the odds of a CAT 1 typhoon is set at 25% (above average); and the odds for a major typhoon (CAT 3 or higher) is set at 15% (slightly above average). Elsewhere in Micronesia, the odds for damaging TC strikes are set to slightly above average (for example, the average annual number of named tropical cyclones passing within 180 n mi of Yap or Palau is four, with a 10-15% chance of a damaging strike). Eastward of Chuuk State, the risk of a tropical storm or typhoon is much lower than at locations farther to the west, except during strong or some moderate El Niño events. During 2016 and 2017, the PEAC set very low odds (< 10%) for TC activity eastward of Chuuk State. This year, the PEAC anticipates an enhancement of TC development at locations to the east of Chuuk State, with the odds of some damaging effects from a TC (high surf; gale-force or stronger wind; and extreme rainfall > 10 inches in 24 hours) set at 25% (1-in-4) for all locations. This is an above average risk and is well above the level of activity seen throughout Micronesia in both 2016 and 2017.

For the TC-weary Mariana Island chain, Dr. Lander and Mr. Guard have informed local stakeholders and disaster response agencies that the TC season is not yet over, and that for the remainder of 2018 and into early 2019, at least two more named TCs will pose a serious threat. This level of threat also exists for all Micronesian islands and atolls westward of Pohnpei State.

Table CC-2. Australian BoM 2018-19 regional TC outlooks. For example, the Eastern region (i.e., from Australia's east coast out to 160°E) outlook shows a below-average season is most likely, with a 40% chance of more tropical cyclones than average and a 60% chance of fewer.

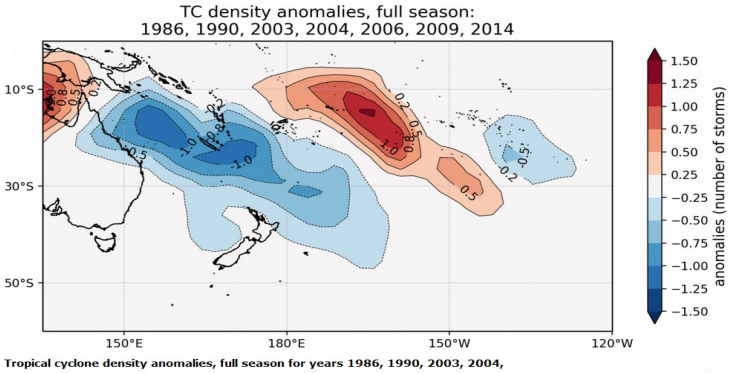
Region	Average count	Chances for > avg
Australian	11	37%
Western	7	44%
Northwestern sub-region	5	41%
Eastern	4	40%
Northern	3	46%

American Samoa

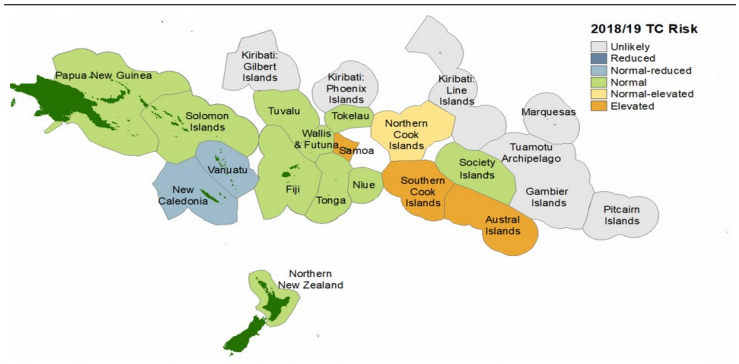
There are indications that the upcoming 2018/2019 TC season in American Samoa could be busy. Two agencies, the Australian Bureau of Meteorology and the National Institute for Water and Atmospheric Research (NIWA) of New Zealand, have issued TC outlooks relevant to American Samoa. The Australian BoM, while not directly providing a forecast for American Samoa, predicts below average activity across all Australian TC regions including in the Coral Sea west of 160° E. The implication of this is that the South Pacific TC activity will be shifted to the east, providing a higher risk to islands near and eastward of the International Date Line.

NIWA has also provided an outlook for TC activity in the Southwest Pacific for the 2018-19 cyclone season. They anticipate that tropical cyclone activity will be lower than normal around the northern and eastern Coral Sea margin and elevated east of the International Date Line.

Islands on the fringe of the northern and eastern Coral Sea, including the Solomon Islands, Vanuatu, and New Caledonia may experience slightly decreased tropical cyclone activity. Increased TC activity is expected in some islands east of the International Date Line, especially those east of 160°W longitude, including Samoa, the Cook Islands, and the Society and Austral Islands (see Figure CC-6.)



Tropical cyclone density anomalies, full season for years 1986, 1990, 2003, 2004, 2006, 2009, 2014 [Map: NIWA]



Map of tropical cyclone risk based on the 2018-19 Island Climate Update tropical cyclone guidance. [Map: NIWA]

Figure CC-6. Projections of tropical cyclone activity in the South Pacific during the upcoming 2018-19 cyclone season. Figures are from NIWA: https://www.niwa.co.nz/climate/southwest-pacific-tropical-cyclone-outlook/southwest-pacific-tropical-cyclone-outlook-october-2018.

SEASONAL SEA LEVEL OUTLOOK FOR THE US-AFFILIATED PACFIC ISLANDS

Executive Summary: *The recent fall of sea level in the USAPI region may be explained as Warm Pool El Niño (WPE), the positive sea level anomaly is located over the central Pacific. In this regard, the sea level anomaly in the tropical central Pacific may not efficiently produce a warm SST anomaly. Furthermore, anomalous easterlies over the tropical eastern Pacific induce shoaling of the thermocline and play a role of cooling, rather than warming, over the tropical eastern Pacific. In addition, there are anomalous easterlies over the eastern Pacific; as a result, the sea level anomaly is small over the eastern Pacific, indicating that the thermocline there does not support SST warming.*

The following sections describe: (i) the Canonical Correlation Analysis (CCA) forecasts for seasonal (mean and maxima) sea level anomalies (seasonal cycle removed) for the forthcoming seasons December-January-February (DJF) of 2018-19 to March-April-May (MAM) of 2019, (ii) DJF-return values at 20 and 100-yr period, (iii) the observed monthly mean and maximum sea-level anomalies for the previous season August to October (ASO) of 2018, and (iv) synopsis of last 2-years Sea Level variability and forecasts. *Note that, seasonal cycles have been removed for the data anomalies that are defined as 'deviations or departures from the normal' using the 1983 through 2001 mean sea level value computed at each station. Also note that CCA-forecasting technique adopted here does not account for sea level deviations created by other atmospheric or geological factors.*

Seasonal Sea Level Forecast (anomalies with respect to climatology) for DJF, JFM, FMA, and MAM of 2018-19

Forecasts of the sea-level anomalies in the USAPI are presented using CCA statistical model (see Chowdhury M. R., Chu P-S, and Guard C. (2014): *An Improved Sea Level Forecasting Scheme for Hazards Management in the U.S.-Affiliated Pacific Islands.* ***Int. Journal of Climatology*** *6, 2320-2329.*). Based on the independent SST and zonal wind (U) (SST-U) values in ASO of 2018, the resulting CCA model has been used to forecast the sea level of four consecutive seasons: DJF, JFM, FMA, and MAM (see Table 1: left panel shows values for seasonal mean while the right panel shows the seasonal maxima). All the tide gauge stations (at 0 to 3-months lead time) provided skillful forecasts for these three consecutive seasons.

Table 1: Forecasts of sea level anomalies in inches (DJF, JFM, FMA, and MAM)

	Seasonal Mean Deviations [1]					Seasonal Max Deviations [2]					
Tide Gauge Station	**DJF**	**JFM**	**FMA**	**MAM**	**Seasonal Outlook[3]**	**DJF**	**JFM**	**FMA**	**MAM**	**DJF: Return Period[4]**	
Lead Time [5]	**0-M**	**1M**	**2M**	**3M**	**Seasonal Outlook[3]**	**0-M**	**1M**	**2M**	**3M**	**20-YR**	**100-YR**
Marianas, Guam	-1	-1	0	+1	**Normal**	+18	+18	+20	+17	6.5	9.1
Malakal, Palau	-2	-2	-2	-1	**Below**	+36	+37	+37	+36	6.1	6.4
Yap, FSM	-1	-1	0	0	**Below**	+29	+29	+31	+30	8.2	11.0
Chuuk, FSM**	-1	-1	0	0	**Normal**	+28	+28	+29	+29	n/a	n/a
Pohnpei, FSM	+2	+2	+2	+2	**Normal**	+33	+33	+34	+33	9.1	11.8
Majuro, RMI	+2	+2	+2	+2	**Normal**	+45	+45	+44	+43	5.7	6.4
Kwajalein, RMI	+1	+1	+1	+2	**Normal**	+40	+41	+41	+41	6.6	8.4
Pago Pago, Am. Samoa***	+1 (+6)	+1 (+6)	0 (+5)	0 (+5)	**Above**	+26 (+31)	+25 (+30)	+27 (+32)	+23 (+28)	4.9	6.1
Honolulu, Hawaii	+1	+2	+2	+3	**Normal**	+20	+20	+20	+21	3.0	3.7
Hilo, Hawaii	+2	+2	+3	+3	**Normal**	+24	+24	+24	+24	3.2	5.2

Table 1 and Supporting Statistics: : (-) indicate negative anomalies (fall of sea level from the mean), and (+) indicate positive anomalies (rise of sea level from the mean), n/a: data not available. Anomalies from -1 to +1 inches are considered negligible and anomalies from -2 to +2 inches are unlikely to cause any adverse climatic impact. Forecasts for Chuuk (**) are estimated subjectively based on information from WSO Chuuk and observations from neighboring stations of Pohnpei and Yap. *** There was a level shift (approximately 5 inches) in American Samoa at the time of September 2009 earthquake. So, -5 inches needs to adjust to the current tide-gauge values of Pago Pago. See PEAC website for the explanations of footnote (1 to 5). Also note that all information is based upon the 1983-2001 epoch.

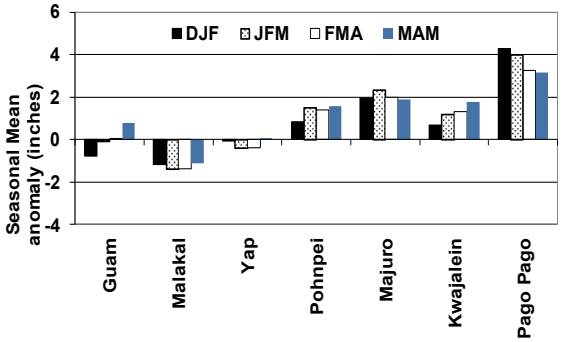


Figure 1. Seasonal mean sea level (MSL) forecasts for DJF to MAM of 2019

The current sea level forecasts (Table 1; Fig. 1) indicate that most of north Pacific stations will stay near normal (lies between -/+ 2 inches) and the islands in FSM and RMI will stay slightly elevated in the forthcoming DJF-MAM seasons. If warm pool El Niño (WPE) develops as per projections, then some more deviations (fall) may likely to happen during early 2019, without any significant impacts. Note that only the south Pacific station (i.e., Pago Pago) will be elevated during the same time periods. This happens as Pago Pago maintains a 4-6 months' time-lag with respect to north Pacific stations (i.e., Guam and the Marshalls).

In Hawaii, both Honolulu and Hilo are likely to be slightly elevated, but still close to normal.

SEASONAL SEA LEVEL OUTLOOK FOR THE US-AFFILIATED PACFIC ISLANDS

Observed Monthly Mean Sea Level Anomalies (with respect to climatology) for Jul-Oct (JASO) of 2018

Current Conditions: Current Conditions: Consistent to forthcoming Warm Pool El Niño (WPE), all of the north Pacific stations displayed marginal fall in October. Some of the stations (e.g., Pohnpei, Majuro, and Kwajalein) recorded rise too. Hawaii sea levels are also elevated—Hilo recorded slight fall in October. Note that the south Pacific station (i.e., Pago Pago) is elevated (+6). This station maintains 4-6 months' time-lag w.r.t north Pacific stations (i.e., Guam and the Marshalls).

Impacts: While the MSL is normal or falling (e.g. significant fall in Guam), tides have been high with high waves in some of the islands. However, there is no noticeable inundation in low-lying atolls and there is no report for damage, so far.

Table 2: Monthly observed mean/maximum sea-level anomalies in inches

Tide Gauge Station	Monthly Mean Deviations[1]					Monthly Max Deviations[2]				
	Jul	Aug	Sep	Oct	Standard Deviations	Jul	Aug	Sep	Oct	Sea level Trend
Marianas, Guam	+2	+2	+1.8	-1.8	3.5	+20	+19	+26	+15	Below
Malakal, Palau	-3	-3	-4	-4.2	4.3	+31	+33	+33	+31	Below
Yap, FSM	-1.5	-1.5	-2	-2.5	4.7	+27	+28	+26	+24	Below
Chuuk, FSM*	+1	+1.1	+1.1	-1	3.5					Normal
Pohnpei, FSM	+2.5	+1	+1	+3.3	3.8	+35	+30	+27	+31	Above
Majuro, RMI	+2	+2.5	+5	+5.5	2.8	+43	+47	+46	+43	Above
Kwajalein, RMI	+2	-1	+1.7	+3.3	3.2	+29	+37	+38	+38	Above
Pago Pago, American Samoa***	+12 [+7]	+12 [+7]	+11 [+6]	+10 [+5]	3.2	+37	+38	+36	+33	Above
Honolulu, Hawaii	+3	+4	+3.8	+3	1.8	+25	+24	+23	+19	Above
Hilo, Hawaii	+4	+3	+7	+5	1.8	+30	+25	+28	+25	Above

Table 2. +/- indicate positive anomaly (rise) and negative anomaly (fall) respectively. Note that any changes between (0~ ±1) inch is considered to be negligible. Also note that changes within the range of (+/-) 2 inches are unlikely to cause any adverse climatic impact. *** Guesstimated values, ** Data currently unavailable; Figures in parenthesis are year-to-year seasonal anomaly. 1: Difference between the mean sea level for the given month and the 1983 through 2001 mean sea level value at each station (seasonal cycle removed); 2: Same as 1 except for maxima; SD stands for standard deviations. Red: Falling trend, Black: Stable SL, and Blue: Rising trend. * In Pago Pago, there was a level shift (approximately 2-4 inches) at the time of September 2009 earthquake. *Data Source: University of Hawaii Sea Level Center (UHSLC). ftp://ilikai.soest.hawaii.edu/islp/slpp.anomalies.*

Synopsis of 2-years Sea Level Variability and Forecasts

Starting from OND of 2016, a comparative perspective of two years of seasonal sea level variations is given below (Fig. 2). The sea level in the western Pacific stayed elevated until OND of 2017. It started to fall from FMA of 2018 and recorded a significant fall until MJJ of 2018. The falling trend lasted until October 2018. Most of the north Pacific stations are currently near-normal while the lone south Pacific stations Pago Pago is moderately elevated.

See page 17 for sea level observations from Jason-2 satellite picture (Fig. 3).

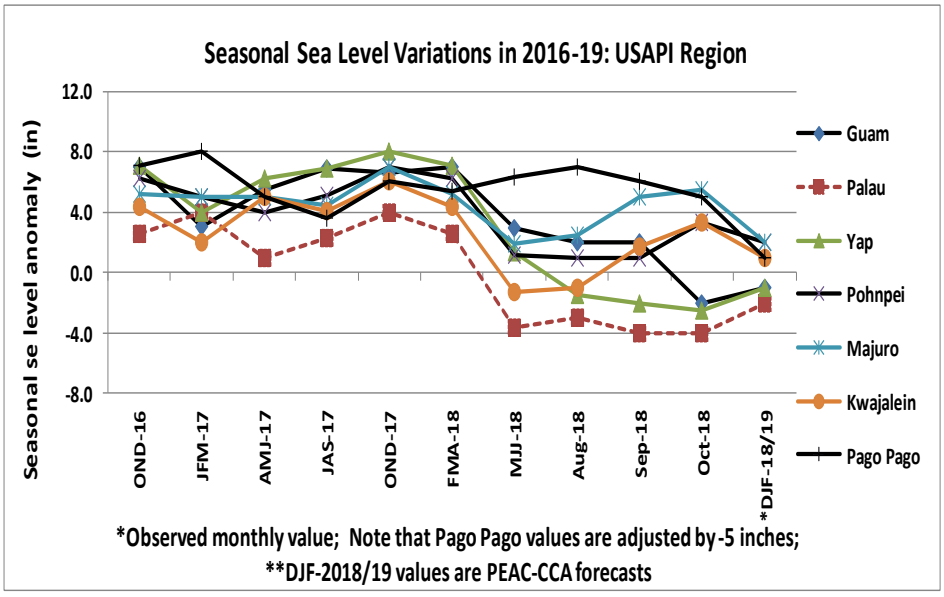


Figure 2. A comparative perspective of Island-wise seasonal sea level variations (OND 2016 to DJF 2018-19) (*Note that Pago Pago data needs correction because of level shift after 2009 earthquake. ,There was a level shift (approximately 2-4 inches) at that time which has not been adjusted).

LOCAL SUMMARY AND FORECAST

American Samoa:

During the 1st half of 2018, very high rainfall in some of the wet months (notably May 2017, October 2017, February 2018, and April 2018) more than compensated for deficits accrued during any of the below-average months (Figures AS-1 and AS-2). Every month of the 3rd Quarter (and also October 2018) had above-average rainfall. The total of 10.68 inches during July 2018 was the 5th wettest July in the Pago Pago post WW-II historical record. Although the 3rd Quarter sum of 29.04 inches was relatively high in terms of percent of average (148%), it was only the 13th wettest 3rd Quarter in the 63 - year climate record.

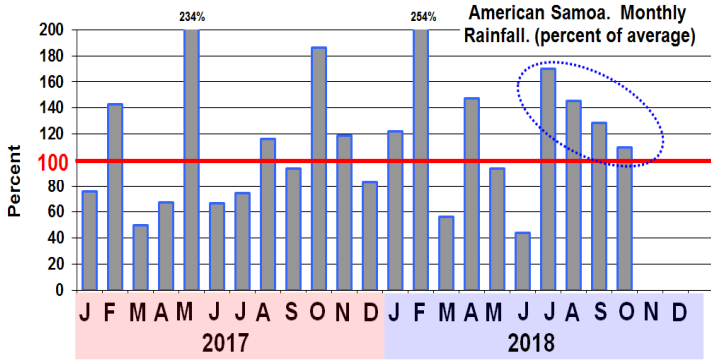


Figure AS-1. A time series of the monthly rainfall at Pago Pago from January 2017 through October of 2018. Note the high month-to-month variability, which overall yielded above average rainfall when summed over time periods of 6-12 months. The blue oval highlights the recent string of four consecutive months with above-average rainfall.

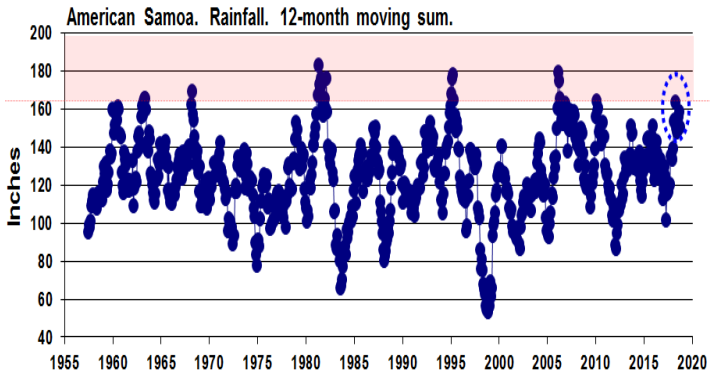


Figure AS-2. A 12-month moving sum of the monthly rainfall at Pago Pago. Note that the data for the most recent cluster of points (AMJJASO) (inside the dotted blue circle) indicate a relatively high value of rainfall that has been exceeded only a few times over the historical record.

Pago Pago Sea Level

While the sea level across Micronesia has fallen over the past few months (and is now near average at many locations), the sea level at Pago Pago remains elevated above its long-term average, even after accounting for the approximately 10-cm shift of the datum during the 2009 earthquake-tsunami event (Figure AS-3).

LOCAL SUMMARY AND FORECAST

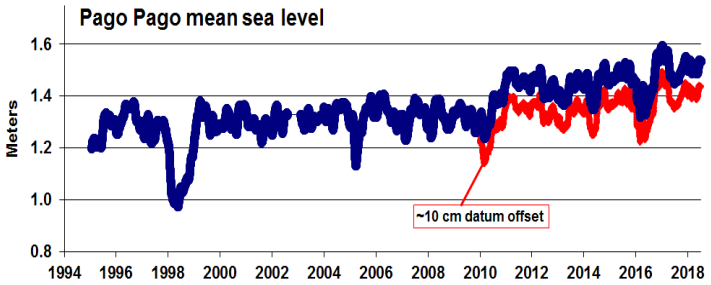


Figure AS-3. A 12-month moving average of the mean sea level at Pago Pago (dark blue time series). A sudden jump in 2009 was the result of a datum change (a land subsidence) that occurred during the large earthquake/tsunami event of 29 September 2009. The red line shows the time series with the 10-cm land movement removed. Even with the correction made for land subsidence, the recent stand of the sea level is near its historical high (see the sea level section for more details).

American Samoa Rainfall Summary: 2018, 3rd QTR (JAS), with Oct & 3Q Totals

Station		Jul	Aug	Sep	Oct	3rd QTR
Pago Pago WSO	Rain (in)	10.68	9.76	8.60	11.83	29.04
	% Avg.	170%	145%	129%	110%	148%
Siufaga Ridge*	Rain (in)	11.74	7.82	8.21	12.45	27.77
	% Avg.	184%	116%	123%	116%	141%

*Percent of Pago Pago rainfall.

Climate Outlook:

Statistical and dynamic computer model forecasts are now split between below average and above average rainfall amounts over the next three months at Pago Pago. Given the continued above normal rainfall in November, the PEAC has settled on average to above average for the period.

The 2018-2019 South Pacific hurricane season is has begun. Official projections from Australia's BoM, and New Zealand's NIWA indicate above average TC activity at American Samoa over the course of this year's cyclone season (see the TC discussion in the Current Conditions section). Two or three potentially damaging cyclones are likely to affect American Samoa through April 2019. The Northwest Monsoon should see two or three strong surges in the region, contributing to above-average rainfall and possible tropical cyclone development.

Predicted rainfall for American Samoa from October 2018 - September 2019

Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]
Oct - Dec 2018 (Onset of Rainy Season)	120%
Jan - Mar 2019 (Heart of Next Rainy Season)	115%
Apr - Jun 2019 (Onset of Next Dry Season)	100%
Jul - Sep 2019 (Heart of Next Dry Season)	90%

[1] Forecast rainfall quantities represent BEST ESTIMATES given the probabilistic forecast for each particular season and station.

LOCAL SUMMARY AND FORECAST

Guam/CNMI:

Wet and windy! Tropical cyclones dominated the weather of Guam and the CNMI during the months of July through October. During the past several months, the Mariana island chain has been the nexus for the tracks of several of the basin's TCs — please see the track map in the TC Section above. Individual summaries of eight TCs affecting the region follow:

(1) Jelewat. (Late March). Typhoon Jelawat rapidly intensified while drifting slowly northward when it was located to the north of Yap Island. Heavy rainfall was experienced on Yap Island, and hazardous surf on Guam arriving from Jelawat likely contributed to a drowning.

(2) Maria. (Early July). Possessing a transient, but potent, embedded meso-vortex circulation, Maria, while still a tropical storm, swept across Guam with storm force (48 – 63 kt) sustained winds across much of the island. However, a narrow swath of typhoon force winds were observed across the very top-end of the island directly associated with the meso-vortex. This unusual phenomenon is still under investigation. The strong winds crushed portions of the limestone forest at the Wildlife Preserve at extreme northwest Guam.

(3) Cimaron: (Mid-August). Typhoon Cimaron began as a disturbance some 400 miles north of Pohnpei on 17 August and was designated a Tropical Storm a day later around 535 miles east of Saipan. Cimaron intensified slowly on a general west-northwest track, and finally reached minimal typhoon intensity on 20 August about 200 miles east of the Northern Islands of the Commonwealth of the Northern Mariana Islands (CNMI). The Guam Weather Forecast Office (WFO) placed the Northern Islands under a Typhoon Warning, and the typhoon passed 45 miles northeast of Agrihan Island on the 21st. The small settlements on Agrihan, Pagan and Alamagan were safe with damages mostly to agriculture.

(4) Jebi. (Late August) Typhoon Jebi raked the islands of Pagan, Alamagan, and Agrihan in the Northern Mariana Islands with wind gusts over 100 mph, according to the National Weather Service in Guam. Northern Islands Mayor Vicente B. Santos confirmed that people on the Northern Islands of Alamagan, Pagan, and Agrihan were safe, soon after Super Typhoon Jebi threaded its way through the region on its way to Japan. "The people in the Northern Islands are safe and all infrastructure is intact despite of the reported intensity of Typhoon Jebi," said Santos. This comes just two weeks after Typhoon Cimaron thrashed the Northern Islands.

(5) Manghkut. (Early September). During the late afternoon of September 10, 2018, Typhoon Mangkhut passed directly over the island of Rota. The level of damage to vegetation and older wooden homes made of plywood and weathered corrugated metal roofing was notably below the devastating or catastrophic effects of a major (i.e., Category 3 or higher) hurricane/typhoon. A NOAA-sponsored assessment team (including PEAC scientist Dr. Mark Lander and two WFO Guam forecasters) examined the damage on Rota and the preliminary conclusion of the team was an intensity estimate for Mangkhut during eye passage over Rota of 90-kt sustained winds with gusts to 110 kt (strong CAT 2) (i.e., 103 mph G 127 mph, rounding up to 105 mph G 130 mph). Measured rainfall at the Rota International Airport (4.84 inches) was relatively light for the direct eye passage of a typhoon (but, was likely underestimated during winds from a north direction due to the instrument proximity to a 3-story building). Damage to infrastructure was moderate, with only a few wooden power poles blown down, and isolated incidences of electrical and phone wires stripped away from poles and lying in the road-

LOCAL SUMMARY AND FORECAST

ways. Rota Island has not had a devastating strike by a typhoon since the eye of Typhoon Chaba passed nearby on the night of August 22, 2004. Residents of Rota Island (who experienced both typhoons) generally indicated that Chaba was a stronger typhoon there than Mangkhut. On Saipan, the winds in Mangkhut rose to severe tropical storm force (50 – 63 kts). Damage was relatively light, and the power was out only for a day or two at most locations. The peak gust at the Saipan International Airport during Mangkut was 82 mph. On Guam, Mangkhut's winds also rose to sustained severe tropical storm force, with a peak gust to 74 mph at the Guam WFO and to 86 mph at Andersen Air Force Base (AAFB). The big story on Guam during Mangkhut's passage was the extreme amount of rainfall over 24 hours that approached 10 inches in some locations.

(6) Trami. (Late September) On September 19, the JTWC opened an "Investigation area" in order to monitor a large tropical disturbance that formed near Chuuk in the Federated States of Micronesia. The system drifted westward and strengthened into a tropical depression on September 20 according to the Japan Meteorological Agency, while the JTWC issued a Tropical Cyclone Formation Alert. On September 21, it gained tropical storm status and was named Trami. PEAC scientist Dr. Mark Lander was on an inbound flight to Saipan on the morning that Trami became a tropical storm just to the west of Saipan. A brief period of gales was experienced, and an inspection of eastern beaches (Tank Beach and the beach at Forbidden Island) revealed that large ocean waves had caused white-water inundation from breaking waves to reach 10-12 feet elevation (about half the height of Mangkhut's inundation). The peak wind gust at the SIA was 47 mph. The rainfall was heavy in the morning, with a 24-hour total on the 21st of September of 4.45 inches.

(7) Kong-rey. (Late September). Kong-rey began as a tropical disturbance south of Pohnpei on 26 September. Intensification was slow, and the system was finally declared a Tropical Depression just west of Chuuk on 28 September, .and began tracking toward the Mariana Islands. Tropical Storm Kong-rey passed 75 miles south of Guam on 29 September. A wind gust to 44 mph at WFO Guam. Kong-rey finally reached typhoon intensity on 30 September about 360 miles north of Yap, where the monsoon tail produced heavy rainfall on Yap Island.

(8) **Yutu.** (Late October). Super Typhoon Yutu passed directly over the island of Tinian on the night of 24 October and early morning hours of 25 October. The impacts to Tinian and the southern half of Saipan were catastrophic. Yutu's satellite intensity estimate peaked at 155 kt (178 mph) (Category 5) just prior to landfall over Tinian and the southern half of Saipan. All official ground-based instrumentation failed on Tinian and Saipan as the winds in the storm surged well-above 100 mph. PEAC scientist Dr. Mark Lander was on Saipan during the passage of the typhoon (Figure G1). He had, earlier in the day, set-up a rain gauge and a barometer at his location. The pressure at his location dropped to 921.7 mb. This was at 90-meter elevation, and after adjustments, it was used to estimate the central pressure of Yutu to be somewhere in the range of 915-920 mb. His rain gauge recorded about 10 inches of rainfall during the storm, which will be used to supplement the 2.66 inches of rainfall recorded up to midnight at the Saipan airport. Hundreds of power poles were toppled or leaning over at high angles. Hundreds of homes were severely damaged. All the buildings at the College of the Marianas lost most or all of their roofing. Recovery is still underway, and the complete restoration of water and power may take several months. Infrastructure repair may also take several months. Dr. Mark Lander and Mr. Charles P. (Chip)

LOCAL SUMMARY AND FORECAST

Guard (Guam WFO Warning Coordination Meteorologist) went to Saipan and Tinian to complete the damage survey, and arrive at a final intensity estimate for the typhoon at its landfall.

Figure G1. A spectacular picture taken by a NOAA polar orbiting satellite using moonlight! The nearly full moon was almost overhead at midnight when Yutu passed over Tinian. Low-light cameras on the satellite were able to capture the image using the dim light of the moon. Dr. Mark Lander's location on Saipan is indicated on the image. At this time, Tinian was almost directly in the middle of the eye, experiencing light winds for about an hour. Dr. Lander meanwhile was in the peak winds of the typhoon, with his patio-deck sliding glass doors being blasted inward by the wind.

Apart from the big news of all the typhoons in the region, the rainfall totals on Guam and in the CNMI were generally above average (as one might expect) (Figure G2, top and bottom). Extensive roadway flooding occurred on Saipan on the the 4th of October when an isolated slow-moving meso-scale convective system stalled over the island. The 24-hour rainfall total at the SIA on the 4th of October was 3.25 inches, but was likely higher in the central part of the island where flooding was more severe:

"Saipan saw a lot of soil erosion incidents yesterday following flash flooding that was caused by a sudden midday downpour. The flooding was so severe that it prompted the CNMI Homeland Security and Emergency Management Agency to issue a flood advisory at 1:30pm.

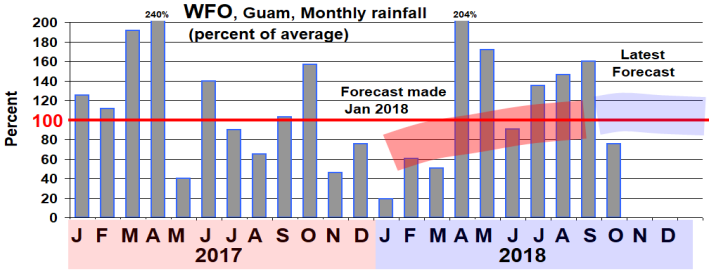
The sudden rainstorm lasted from around 12pm to 5pm.

According to HSEM public information officer Nadine Deleon Guerrero, the rain was a result of a stationary rain cloud that was hovering above the Commonwealth longer than usual.

Due to the duration of the cloud's stay and the massive amount of continuous rain it brought with it, Saipan experienced flash flooding in several spots and in low-lying areas like Garapan, Gualo Rai, and even at the intersection going up to Dandan.

Saipan Tribune observed that the flash flooding eroded massive amounts of soil along Beach Road and the mudwaters overflowed from the streets into the beaches.

Also on Middle Road and Chalan Monsignor Guerrero Road, heavy erosion was seen and mudwaters flooded the busy streets."



LOCAL SUMMARY AND FORECAST

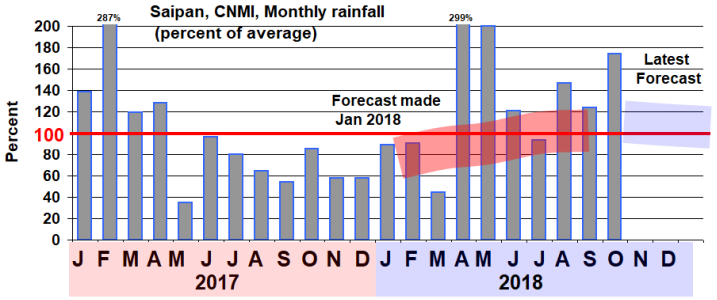


Figure G2. **Bottom Left**: A time series of monthly rainfall percentages at the Guam WFO. **Above**: Same as the top panel, but for monthly rainfall percentages at the Saipan International Airport. Prior forecasts of rainfall made in January 2018 by the PEAC (just for illustration) are indicated by light red bands. The forecast rainfall going forward from October 2018 is indicated by the light blue bands. Note that the rainy season on Guam and in the CNMI has been very wet, in large measure from many passing tropical cyclones.

Guam and CNMI Rainfall Summary: JASO 2018, 3rd QTR						
Station		**Jul**	**Aug**	**Sep**	**Oct**	**2nd QTR**
GUAM						
GIA (WFO)	**Inches**	**14.84**	**21.89**	**23.17**	**8.87**	**59.90**
	% Avg	**141%**	**159%**	**172%**	**74%**	**159%**
AAFB	**Inches**	**17.36**	**16.66**	**17.46**	**10.40**	**51.48**
	% Avg	**159%**	**124%**	**131%**	**81%**	**137%**
Southern Mountain	**Inches**	**13.42**	**26.13**	**21.70**	**9.16**	**61.25**
	% Avg	**123%**	**195%**	**163%**	**71%**	**163%**
CNMI						
Saipan Intl. Airport	**Inches**	**7.88**	**19.12**	**17.39**	**19.59***	**44.39**
	% Avg	**97%**	**153%**	**129%**	**181%**	**130%**
Capitol Hill	**Inches**	**7.08**	**19.70**	**15.63**	**17.39****	**42.41**
	% Avg	**79%**	**158%**	**116%**	**145%**	**121%**
Tinian Airport	**Inches**	**8.42**	**18.83**	**26.30**	**19.67#**	**53.55**
	% Avg	**94%**	**151%**	**195%**	**176%**	**153%**
Rota Airport	**Inches**	**15.27**	**17.13**	**19.59**	**14.90**	**51.99**
	% Avg	**146%**	**130%**	**147%**	**118%**	**141%**

* 10 inches added to total to account for rainfall inYutu. Very little rainfall after Yutu during 25-31 October.
** Was 9.39 for 1-24. Added 8 inches more for Yutu.
# 11-31 October Missing; used Tinian 1-10 (5.27") + SIA 11-24 (14.40) + 0.00 25-31= 19.67"

Climate Outlook:

The state of the Pacific climate remains ENSO-neutral, but in the past few weeks, the SST across the central equatorial Pacific has climbed to values that could soon push the state of the climate to official El Niño status. The Climate Prediction Center (CPC) has continued its El Niño watch (see the November 9 statement from the CPC), with an 80% chance that El Niño will soon form and continue at least through the upcoming Northern Hemisphere winter. The latest computer model forecasts of the rainfall patterns across Micronesia over the next three months

LOCAL SUMMARY AND FORECAST

(NDJ) are not entirely consistent with the development of El Niño, with below average rainfall predicted across most of western and central Micronesia; average to above average rainfall predicted for Guam, the CNMI, and Hawaii; and a split forecast for the RMI, with Kwajalein wet and Majuro near average. For Guam and the CNMI, the PEAC team concurs with forecasts of at least average rainfall for at least the next three months, with the possibility of above average rainfall for any island impacted by a tropical storm or a typhoon. Thereafter, the long-term rainfall forecast (winter 2018-2019 into spring 2019) is contingent upon the evolution of ENSO: (1) dry if El Niño conditions were to fade after the spring of 2019; and wetter if El Niño conditions were strengthen through the spring of 2019.

Using a combination of persistence and the known effects of an El Niño pattern of SST, it is likely that the threat of a typhoon on Guam and in the CNMI will be elevated through January 2019. At least two additional typhoons are anticipated (> 50% chance) to pass near Guam or one of the southern islands of the CNMI, with a plausible scenario of one such typhoon in each of November and December.

Predicted rainfall for the Mariana Islands from October 2018 through September 2019:

Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]	
	Guam/Rota	Saipan/Tinian
Oct-Dec 2018 (End of rainy season)	110%	110%
Jan-Mar 2019 (1st half of next dry season)	100%	100%
Apr-Jun 2019 (2nd half of next dry season)	100%	100%
Jul-Sep 2019 (Onset of next rainy season)	100%	100%

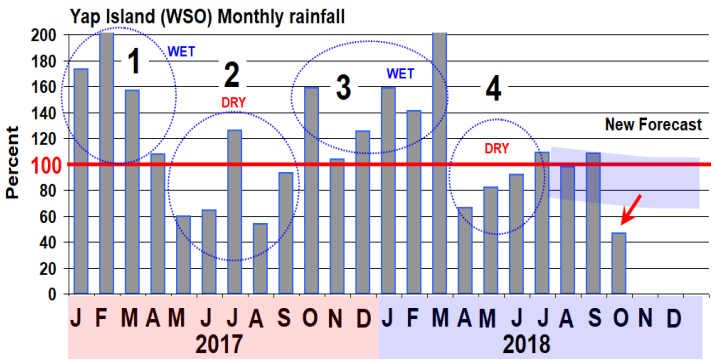
* Heavy rainfall at this time of the year is contingent on TC activity, and a direct strike by another typhoon could yield at least 20 inches of rainfall in a day.

** The evolution of ENSO is the key to rainfall at this time of the year. An El Niño onset would lead to the most rainfall, and a continuation of ENSO neutral conditions or a return to La Niña (however unlikely they appears at this time) would favor average or below-average rainfall.

Federated States of Micronesia

Yap State:

Heavy rainfall in October 2017 signaled the onset of a prolonged period of wet weather throughout much of Yap State that continued through March of 2018; then, during April, May and June, conditions became dry again. The rainy season months of July, August and September 2018 had near-average rainfall. October 2018 was abruptly very dry.



LOCAL SUMMARY AND FORECAST

Figure Y1. Time series of monthly rainfall at the Yap Island WSO (gray bars) for January 2017 through October 2018. Four prominent and prolonged rainfall extremes appear within the dotted blue circles: (1) a very wet period extending across the first four months of the year; (2) a prolonged dry period from May through September; (3) another period of wet weather to finish off the final 4 months of 2017 continuing into the 1st Quarter of 2018; and (4) another period of dryness commencing in April 2018 that graded upward to near-average rainfall during July, August and September. The red arrow highlights abrupt short-term dryness during October. The current PEAC forecast (blue-shaded bar) anticipates average to below-average rainfall through the remainder of 2018, with possible continued dryness continuing into the first few months of 2019 (not shown in this figure, but see climate outlook below).

No reports were received by the PEAC concerning problems with water supply anywhere in Yap State through October 2018. During the 1st Quarter of the year the PEAC received an anecdotal report from a resident of Yap Island indicating that the typical dry season this year was unusually wet, and that temperatures were uncomfortably cool at times (by Yap standards).

Yap State Rainfall Summary: JASO 2018, 3rd QTR						
Station		Jul	Aug	Sep	Oct	3rd QTR
Yap State						
Yap WSO	Inches	15.81	14.82	14.65	5.56	45.28
	% Norm	109%	98%	108%	46%	105%
Ulithi	Inches	12.98	13.58	18.51*	.	45.17
	% Norm	105%	105%	162%	77%	123%
Woleai	Inches	16.61	11.27	10.29	3.22	38.17
	% Norm	119%	77%	88%	24%	94%

* 16-30 missing. Was 13.61, but 5 inches added for 16-30 based on 7 inches then at Yap.

Climate Outlook:

Computer model forecasts continually indicated wet conditions for Yap State for all of the monthly forecast cycles for 2017 and continued to do so for each monthly step of the 3-month forecast cycle for 2018; that is, until the 3-month forecast for JAS, which trended lower to average-to-below average rainfall amounts over those months. While the observed rainfall during JAS was near average, the abrupt dryness of October may signal the start of prolonged period of mostly below average rainfall.

With the current status of ENSO now near the El Niño threshold, the rainfall forecast depends on the subsequent movement of the climate system. At this time, the PEAC favors a short (3-month) stay at weak El Niño followed by a fade-away from El Niño back to ENSO-neutral by the late spring of 2019. If this scenario occurs, then the rainfall throughout Yap State would likely be below average for at least the remainder of 2018 into the first three months of 2019. The scenario is reflected in the predicted rainfall totals shown below.

Whereas it is now late in the year, and the typhoon season is nearing its end, there is still a small risk (10-15%) of a passage through Yap State of a tropical storms and/or typhoon, with the risk continuing through January 2019; after this, the risk of a damaging TC becomes negligible (but not zero!)

LOCAL SUMMARY AND FORECAST

Predicted rainfall for Yap State from October 2018 through September 2019

Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]	
	Woleai	Yap & Ulithi
October-December 2018 (End of next Rainy Season)	80%	85%
January-March 2019 (Onset of Dry Season)	70%	70%
April-June 2019 (End of Dry Season)	80%	80%
July-September 2019 (Heart of next Rainy Season)	95%	90%

Chuuk State:

The following anomalies are apparent on the time series of monthly rainfall at the Chuuk WSO, Weno Island, Chuuk Lagoon, and Lukunoch in the Mortlock Island group (Figure CH-1)
(1) A period of high rainfall to start 2017 – JFM (2017);
(2) A period of persistent dryness during the 5-month period AMJJA (2017);
(3) A prolonged period of abundant rainfall to finish 2017 (SOND), with a continuation of above average rainfall through March 2018 (particularly in the Chuuk lagoon);
(4) Some dryness was evident in March through June 2018 in the northern atolls, with Lukunoch having its driest 2nd Quarter (AMJ) rainfall total in its 31 year historical record; and
(5) Abundant rainfall through the summer and fall of 2018, particularly at Chuuk Lagoon.

After some dryness during the first half of 2018 at some of the northern atolls (e.g., Fananu and Onoun) and at some of the atolls in the southern Mortlock Island group (e.g., Lukunoch, Ettal and Ta), rainfall amounts trended upward in June and July and were near average to above average at most locations through October. In recent PEAC teleconferences, the weather in Chuuk has been described by WSO Chuuk staff as: *"warm, but not too bad"* and *"plenty wet"*. Municipal water supplies and rain catchment have been adequate. There have been no excessive rainfall events, and there were no reports of any recent significant sea inundation; in fact, some of the lower low tides of September occurring during the AM hours were noted by some to appear very low. The sea level across most of Micronesia has fallen several inches during 2018, but having been well above average is now near average to slightly below average (see the sea level discussion for more details).

Sidebar: Plane crash at Chuuk International Airport

One man died and four people were seriously injured after an Air Niugini flight from Pohnpei crashed into the Chuuk Lagoon just short of the runway while attempting to land at the airport in Weno, Chuuk, Friday morning September 28. Within an hour of the crash, the plane sank in the lagoon, but not before all aboard were thought to be safely on shore. A missing passenger who officials previously thought was safe was found dead on Monday, after divers searched the submerged aircraft. Air Niugini released a statement on the crash and said the weather was poor with heavy rain and reduced visibility at the time of the incident.

LOCAL SUMMARY AND FORECAST

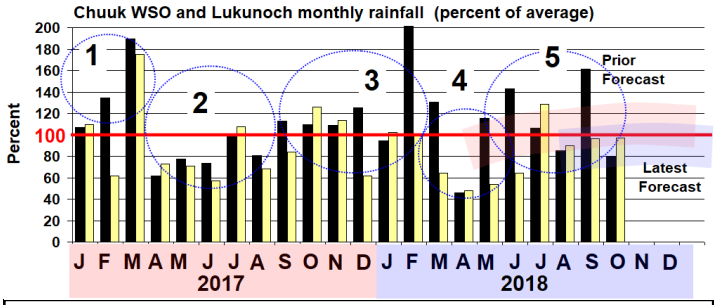


Figure CH-1. A time series of the monthly rainfall at the WSO Chuuk (black bars) and at Lukunoch (yellow bars) during 2017 and continuing through October 2018. The light blue band is the latest rainfall prediction for the next several months. The light red band is the rainfall forecast made in April 2018. Numbered blue circles indicate prolonged wet periods ("1", "3" and "5") and prolonged dry periods ("2" and "4").

Chuuk State Rainfall Summary: JASO 2018, 3rd QTR

Station		Jul	Aug	Sep	Oct	3rd QTR
Chuuk Lagoon						
Chuuk WSO	Inches	12.77	12.33	18.55	10.66	43.65
	% Avg	106%	85%	161%	79%	114%
Southern Mortlocks						
Lukunoch	Inches	19.66	11.70	9.79	10.06	41.15
	% Avg	128%	90%	96%	97%	107%
Northern Mortlocks						
Nama	Inches	8.43	12.09	.	.	.
	% Avg	70%	83%	%	%	%
Northern Atolls						
Fananu	Inches	11.28	19.22	11.65	8.03	42.15
	% Avg	93%	93%	101%	60%	110%
Ounoun	Inches	14.62	14.62	13.37	6.98	34.47
	% Avg	121%	121%	116%	52%	90%
Western Atolls						
Polowat	Inches	9.01*	3.44*	3.19*	3.73*	15.64
	% Avg	64%	23%	24%	31%	37%

* It is possible that persistent dryness at Polowat is exaggerated by an exposure problem with the rain gauge.; although February and March appeared reasonable.

Climate Outlook:

Computer model forecasts continually indicated wet conditions for WSO Chuuk for nearly all of the monthly forecast cycles for 2017 and continued to do so through the 3rd Quarter of 2018. Up until now, the PEAC team has concurred with the computer forecasts, and let stand projections for near average to above average rainfall. However, with the current status of ENSO now near the El Niño threshold, the rainfall forecast depends on the subsequent movement of the climate system. At this time, the PEAC favors a short (3-month) stay at weak El Niño followed by a fade-away from El Niño back to ENSO-neutral by the late spring of 2019. If this scenario occurs, then the rainfall throughout Chuuk State would likely be below average for at least the remainder of 2018 into the first three months of 2019.

LOCAL SUMMARY AND FORECAST

The scenario is reflected in the predicted rainfall totals shown below.

Whereas it is now late in the year, and the typhoon season is nearing its end, there is still a small risk (10-15%) of a passage through Chuuk State of a tropical storms and/or typhoon, with the risk continuing through January 2019; after this, the risk of a damaging TC becomes negligible (but not zero!)

Predicted rainfall for Chuuk State from October 2018 through September 2019 is:

Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]			
	Chuuk Lagoon, Losap, & Nama	Polowat	Northern Is.	Southern Mortlocks
Oct - Dec 2018	95%	85%	90%	95%
Jan - Mar 2019	70%	70%	70%	70%
Apr - Jun 2019	85%	75%	80%	85%
Jul - Sep 2019	95%	90%	95%	95%

* Dryness is predicated on the climate system reaching the mature state of a weak El Niño late in 2018/early 2019. If a late-season tropical cyclone passes through the State in December 2018 or January 2019, the rainfall could be much higher.

Pohnpei State:

Rainfall during the 3rd Quarter of 2018 was generally near normal at Pohnpei Island, slightly drier than normal at the eastern atolls, also slightly drier than normal at atolls southward to Nukuoro, and wetter than normal at Kapingamwaragi (Figure PN-1 and tabular rainfall summaries). Pohnpei Island had near normal rainfall thanks to an August that had 143% normal rainfall. Kapingamwrangi, on the other hand, would have been much wetter if not for an August that had only 62% rainfall.

The big story of the 3rd Quarter of 2018 was the number of tropical systems that directly or indirectly affected Pohnpei State, increasing . While these disturbances were not significant wind events for Pohnpei State, they did increase the rainfall slightly, most passing to the north of the State, bringing temporary southwest monsoon conditions to the State. From July to October, the Pacific weather pattern was certainly El Ninoish, with many disturbances developing in the Marshall Islands and intensifying as they moved westward. During this period, the US Climate Prediction Center (CPC) issued an El Nino Watch, indicating that the equatorial Pacific region climate pattern was close to reaching the threshold of an El Nino event. The tropical cyclone activity included the early stages (with respect to Pohnpei Island) of: Super Typhoon Cimaron (400 miles north on 17 August), Super Typhoon Jebi (460 miles north on 27 August), Typhoon Mangkhut (500 miles north on 8 September), Super Typhoon Kong-rey (180 miles south-southwest on 26 September), and Super Typhoon Yutu (100 miles northwest on 22 October). There were even additional disturbances in November.

Despite the tropical cyclone activity, the rainfall summaries below do show a general drying at Pohnpei Island and at the eastern islands (e.g., Mokil) from September to October and a general wetting trend at the more equatorial atolls of Nukuoro and Kapingamwarangi.

In July, President Donald Trump declared a disaster under the Compact of Free Association for the FSM due to severe storms, flooding and mudslides that occurred on Pohnpei on 16 and 17 March 2018.

LOCAL SUMMARY AND FORECAST

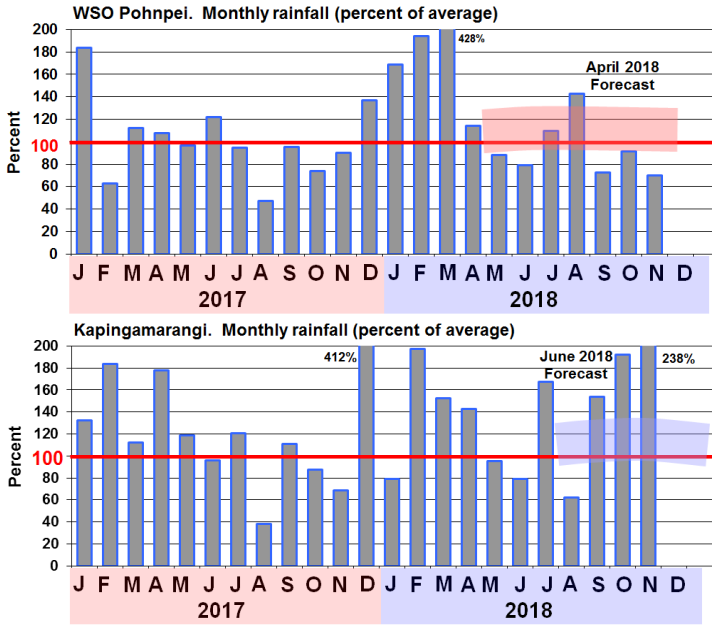


Figure PN-1. A bar chart of the monthly rainfall at WSO Pohnpei Island (top) and at Kapingamarangi (bottom) during the calendar-year 2017 through July 2018. The heavy December 2017 rainfall at Kapingamarangi and the heavy rainfall at the WSO Pohnpei in March 2018 are extreme values that would seem impossible to anticipate. The latest forecast (light blue band) now indicates an expectation for average to above-average rainfall throughout Pohnpei State. The light-red band is the PEAC forecast made in April 2018. (Graph not updated for August, September and October.)

Pohnpei State Rainfall Summary JASO 2018, 3rd QTR						
Station		Jul	Aug	Sep	Oct	3rd QTR
Pohnpei WSO	Rain (Inches)	20.11	23.61	11.70	15.31	55.42
	% of Average	109%	143%	73%	92%	109%
PNI Airport	Rain (Inches)	10.39	20.21	10.49	9.01	41.09
	% of Average	69%	149%	80%	66%	98%
Atolls of Phonpei State						
Station		Jul	Aug	Sep	Oct	3rd QTR
Nukuoro	Rain (Inches)	19.80	5.50	7.08	10.44	32.38
	% of Average	138%	48%	64%	97%	88%
Mwoakil	Rain (Inches)	13.01	11.07	9.89	8.05	33.97
	% of Average	86%	82%	75%	59%	81%
Kapinga	Rain (Inches)	20.15	5.47	18.67	12.98	38.29
	% of Average	168%	62%	154%	192 %	132%

Climate Outlook:

Computer model forecasts continually indicated wet conditions for Pohnpei Island and nearby atolls for all of the monthly forecast cycles for 2017, and continued to do so for 2018 through the August-September-October seasonal forecast. While high rainfall during the 1st Quarter of 2018 was successfully anticipated by the models, the dryness in May and June of the 2nd Quarter was not forecast by the models, and was not anticipated by the PEAC. The latest computer models are not at all in agreement, with one European model indicating Above Nor-

mal and another indicating Below Normal rainfall for the December-January-February (DJF) season. US models showed similar variability and range. The overall computer consensus for Pohnpei for the period was Average-Above (30:35:35 tercile probabilities for below, average and above rainfall terciles). The PEAC adjusted the its forecast for the period for Pohnpei to 30:40:30, or average for the DJF period.

With the long-range evolution of ENSO unsure but continuing to move in the direction of El Niño, and with some climatic signals indicating the continuation of enhanced typhoon activity in Micronesia (see the TC section of the Current Conditions section), the PEAC anticipates some elevated risk of impacts to Pohnpei Island and atolls by the near passages of tropical storms into the first two weeks of January 2019.

Predicted rainfall for Pohnpei State from October 2018 through September 2019 is:

Inclusive Period	% of long-term average	
	Pohnpei Island/ atolls	Kapingamarangi
Oct – Dec 2018	110%	105%
Jan – Mar 2019	100%	100%
Apr – Jun 2019	110%	105%
Jul – Sep 2019	100%	100%

Kosrae State:

After a prolonged period of abundant rainfall from the latter half of 2017 through August 2018, conditions across Kosrae became dry (see Figure KS-1). The 3-month (SON) total of 20.98 inches at Kosrae International Airport was the lowest such total in the airport record (1986-present), although there was one lower 3-month total of 19.68 inches during the SON of 1969 when the rainfall was recorded at Lelu Island. The rainfall at the airport (on the northwest side of the island) tracks closely with the rainfall at the Nautilus Kosrae Resort (located on the east-northeast side of the island) (Figure KS-2). Note that the sudden onset of dry periods often accompanies the latter stages of El Niño (depicted on Figure KS-2). Despite the drier conditions, the Official in Charge of the Pohnpei Weather Service Office (WSO), a native of Kosrae, indicated that there were no reports of water rationing or outages or grass fires, and that the island maintained its lush green appearance.

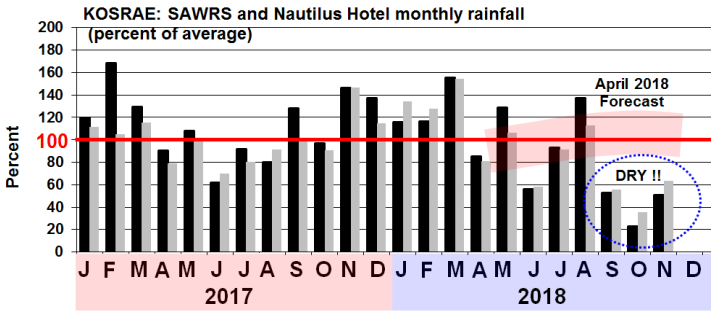


Figure KS-1. A time series of the monthly rainfall at the Kosrae International Airport Aeronautical Information System Replacement (AISR) (labeled as the former Supplemental Aviation Weather Reporting Station (SAWRS)) (black bars) and the Nautilus Kosrae Resort (gray bars) for the period January 2017 through November 2018. The PEAC rainfall forecast made in April 2018 (light red band) was reasonably accurate through the 2nd Quarter of 2018, but missed by a wide margin the sudden dryness that began in September. The Airport is located on the northwest side of the island, while the Nautilus Resort is located on the east-northeast side.

LOCAL SUMMARY AND FORECAST

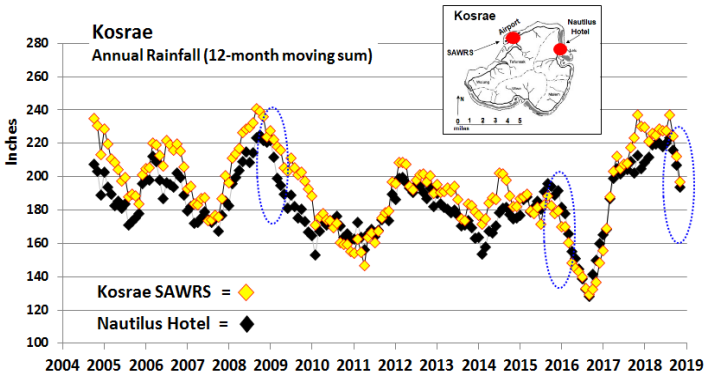


Figure KS-2. A plot of the 12-month moving sum of rainfall at the Kosrae Airport (labeled SAWRS), and at the Nautilus Hotel, through November 2018 (locations indicated by the red dots in the inset). Rainfall across the relatively small island seems to be coherent. Dotted blue ovals highlight big dips of rainfall amounts: two in response to El Niño (2009 and again in 2015), and the most recent beginning in September 2018, with an uncertain link to El Niño at this time.

Kosrae State Rainfall Summary: JASO 2018, 3rd QTR						
Station		Jul	Aug	Sep	Oct	3rd QTR
Airport (SAWRS)	Rain (Inches)	15.83	22.60	9.19	3.70	47.62
	% of Average	99%	153%	59%	32%	104%
Nautilus Hotel	Rain (Inches)	15.58	18.59	9.62	5.78	43.79
	% of Average	97%	126%	62%	50%	95%

Climate Outlook:

For many months (from late 2017 through the first half of 2018), computer models favored above average rainfall at Kosrae. By September 2018, however, these same models started to be mixed: with some above-average, some near average, and some below average. The PEAC team in September decided to favor near average rainfall for Kosrae, but in doing so, missed the abrupt start of very dry conditions during SON. With the climate system now at the threshold of El Niño, the rainfall forecast has two scenarios: continued dryness into the first few months of 2019 if El Niño peaks in the next few months; or a resumption of average to above-average rainfall in early 2019 if El Niño is prolonged, as it was during 1986-1987, and again in 2014-2015. For now, as a prudent measure, the PEAC will stay with the former scenario, and call for average to below-average rainfall over the next few months.

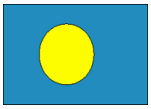
Damaging TCs are rare at Kosrae, and those rare storms that do occasionally strike Kosrae do so primarily during strong El Niño events. With the climate system now at the threshold of El Niño, there may yet be a late season (December through the end of January 2019) tropical storm forming near, or east of the International Date Line, which could bring some impacts for Kosrae (high waves, heavy rainfall and rough seas) as it passes north of the island.

Lastly, because of the easing of the Pacific trade wind system during the recent trend of the climate system toward El Niño, the sea level at Kosrae, which was likely well above average in early 2018, dropped by several inches over the 2nd Quarter of 2018 to stand near average to slightly above average. The trend of sea level going forward into 2019 is somewhat uncertain at this time (see the sea level section for details).

LOCAL SUMMARY AND FORECAST

Predicted rainfall for Kosrae State from Oct 2018 through Sep 2019:

Inclusive Period (Kosrae)	% of long-term average / Forecast rainfall (inches) [1]
Oct – Dec 2018	65%
Jan – Mar 2019	75%
Apr – Jun 2019	90%
Jul – Sep 2019	95%



Republic of Palau:

Palau experienced a record-breaking drought during the course of the epic 2015-2016 El Niño event. By August 2016, a prolonged period of monthly rainfall deficits had accumulated to an integrated shortfall of 85.13 inches (see Figure PL-1). This amount is worth well over half-a-year's average rainfall of approximately 148 inches. With the return of some above-average monthly totals during 2017, the long-term deficit had recovered to -49.24 inches by the end of December 2017. However, dryness throughout 2018 (Fig. PL-1 and Fig. PL-2) led to a renewed increase in the long-term accumulated deficit of rainfall, which worsened from -57.52 inches in April to -72.57 inches by the end of September. An extreme rainfall event at Koror of 14 inches over two days (17 and 18 November), single-handedly erased 10 inches from the deficit! This extreme event occurred as the center of the tropical disturbance that became Typhoon Usagi (TC 33W) passed just to the south of Koror.

Sidebar: Jellyfish Lake

An ecological impact of the 2015-16 El Niño was a severe die-off of jellyfish in Palau's famous Jellyfish Lake (see Figure PL-3). The lake remained closed to tourists as per official statement of the Palau Ministry Natural Resources Environment and Tourism (Ongeim'l Tketau, Jellyfish Lake, 18 May 2017). As recently as February 2018, a dive team sighted only one adult medusa in the lake. A recent web posting from a tourist on 17 September 2018 suggests that the Jellyfish Lake is again open (https://www.tripadvisor.co.uk/Attraction_Review-g294136-d795830-Reviews-Jellyfish_Lake-Koror_Koror_Island.html):

"The access was closed for a time due to the decline of jellyfish from the change in water temperatures. The jellyfish are beginning to rebound, and I was able to purchase the Jellyfish Lake permit from the government earlier this week."

Although the following report from a Palau dive tour business indicates that conditions are still not fully recovered in the lake

Figure PL-3. Hundreds of jellyfish engulf a tourist swimming in Palau's famous Jellyfish Lake. This file photo (from https://feel-planet.com/jellyfish-lake-palau/) shows the abundance of jellyfish before they all disappeared during the 2015/16 El Niño)

LOCAL SUMMARY AND FORECAST

(https://palaudiveadventures.com/palau-jellyfish-lake/#glimmer):

"The lake is technically 'open' to tourists at this time (October 2018) but, with very few jellies in there, we prefer to let the jellyfish have a full recovery and we are not running trips here."

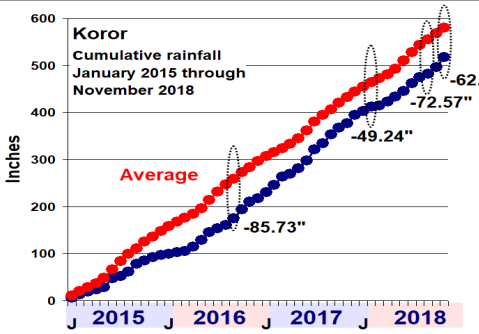


Figure PL-1. Nearly four years of cumulative rainfall at Koror. The red line shows the normal accumulated rainfall from JAN 2015 through NOV 2018, and the dark blue line shows the observed accumulated rainfall over the same time period. The accumulated deficit reached its extreme low of -85.73 inches in August 2016. Abundant rainfall in late 2016 and through 2017 erased 36 inches of the deficit which stood at -49.24 inches in December 2017. Dryness throughout most of 2018 once again increased the long-term deficit by about 23 inches to a deficit of -72.57 inches as of September 2018. An extreme 2-day rain event of 14 inches over the 17th and 18th of November single-handedly wiped 10-inches off the deficit!

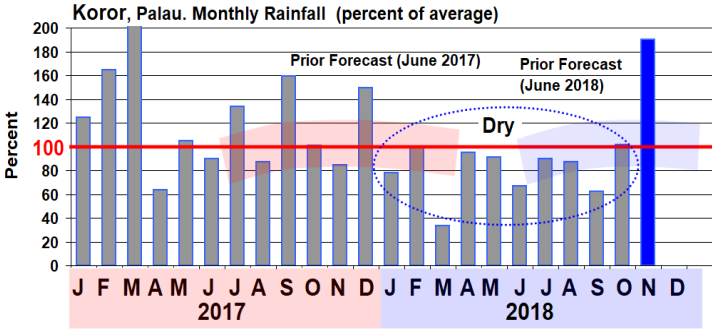


Figure PL-2. A bar chart of observed monthly rainfall (percent of average) at the Koror WSO during 2017 and 2018 through November. The forecast presented in the June 2017 Newsletter for the rest of 2017 is shown by the light-red band. The forecast presented in the June 2018 Newsletter for the rest of 2018 is shown by the light-blue band. Note that the magnitude of dryness throughout most of 2018 was not fully anticipated. An extreme 2-day rainfall of 14 inches over the 17th and 18th of November pushed the November total to over 21 inches (blue bar).

Republic of Palau Rainfall summary: JASO 2018, 3rd QTR

Station		Jul	Aug	Sep	Oct	3rd QTR
Koror WSO	Rain (Inches)	16.19	12.99	7.37	14.12	36.55
	% of avg.	89%	93%	61%	117%	83%
Intl. Airport	Rain (Inches)	19.16	11.76	7.47	7.81	38.39
	% of avg.	116%	91%	56%	59%	79%
Melekeok*	Rain (Inches)	17.30	12.06	8.42	7.16	37.78
	% of avg.	95%*	87%*	70%*	59%*	86%*
Peleliu	Rain (Inches)	15.67	10.46	10.46**	4.77	36.59
	% of avg.	109%	92%	96%	51%	100%

Climate Outlook:

Computer model forecasts continually indicated wet conditions for the Republic of Palau for nearly all of the monthly forecast cycles for 2017 and continued to do so for all of 2018, until the forecast cycle made in July indicated average to below-average rainfall for the next three months (ASO). Observed low rainfall throughout most of the 1st half of 2018 was unsuccessfully anticipated by the models, but aggressive forecasts for above-average rainfall were tempered in the right direction by the PEAC team. The most recent computer projections have lowered their rainfall projections from earlier forecast cycles. The PEAC concurs with these lowered forecasts and anticipates that the rainfall throughout Palau should be average to below-average through the remainder of 2018, with a continuation of average to below-average rainfall for the first few months of 2019. Note: and extreme rainfall of 14 inches over the 17th and 18th of November have busted this forecast, but the PEAC will still adhere to the forecast of average to below-average rainfall for December 2018 and beyond (notwithstanding another tropical cyclone passage).

With the current status of ENSO now near the El Niño threshold, the rainfall forecast depends on the subsequent movement of the climate system. At this time, the PEAC favors a short (3-month) stay at weak El Niño followed by a fade-away from El Niño back to ENSO-neutral by the late spring of 2019. If this scenario occurs, then the rainfall throughout the Republic of Palau would likely be below average for at least the remainder of 2018 into the first three months of 2019. The scenario is reflected in the predicted rainfall totals shown below.

Whereas it is now late in the year, and the typhoon season is nearing its end, there is still a small risk (10%) of a passage near Palau of a tropical storms and/or typhoon, with the risk continuing through January 2019; after this, the risk of a damaging TC becomes negligible (but not zero!)

Lastly, with the demise of La Niña and trend to El Niño over the course of 2018, the regional sea level fell quite dramatically from 6 inches above average in March to 3 inches below average in July. Sea level throughout Palau should remain at-or-below average until the trade wind system of the Pacific strengthens again (see the sea level section for details).

Predicted rainfall for Palau from October 2018 through September 2019 is:

Palau Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]
Oct - Dec 2018	90%
Jan - Mar 2019	85%
Apr - Jun 2019	95%
Jul - Sep 2019	100%

[1] Forecast rainfall quantities represent BEST ESTIMATES given the probabilistic forecast for each particular season and station.

* This forecast will likely be inaccurate in that it did not anticipate the occurrence of the extreme daily rainfall that occurred at some locations in Palau during the 2-day passage of the storm system that would later become Typhoon Usagi.

Republic of the Marshall Islands (RMI

Wet! Wet! Wet! (Then starting to dry)

Over the past three years (2016, 2017 and to-date in 2018) the RMI has undergone substantial variations of rainfall (Figure RMI-1 top and bottom panels). The pattern of rainfall

LOCAL SUMMARY AND FORECAST

variation was very similar during both 2016 and 2017; with both years beginning very dry and then ending very wet. During 2018, the pattern appears to have stretched, with very wet conditions in the first half of the year, yielding to drier conditions in the second half of the year. In early 2018, some of the northern atolls (e.g., Utirik and Wotje) became very dry. A Drought Information Statement was issued by the WFO Guam, but was short-lived as high rainfall occurred in the northern RMI in both March and April. No impacts from this early dry period were reported. Then, the story turned to one of very high rainfall, with both Majuro and Kwajalein experiencing new historical records for high rainfall. March and April 2018 were particularly wet, with over 20 inches of rain in each of these months at Majuro, and over 20 inches of rain at Kwajalein during April. Summed over periods of 6 or 12 months (Figure RMI-2), new historical records emerge. The high rainfall didn't just edge-out previous highs; it crushed the old high marks by large margins! In the latter half of 2018, conditions became drier, with the trend to dryness at Majuro (Figure RMI-1, top panel) exhibiting an unusually well-behaved steady decline (i.e., unusually low month-to-month variation).

Very heavy rainfall in the RMI early in the year is often associated with El Niño onset; however, a wet spring has also occurred during other phases of ENSO, thus limiting the usefulness of this phenomenon as a predictor of El Niño. In retrospect, the heavy spring rains in the RMI may indeed have been related to the onset of El Niño in 2018, with implications for relooking at Index-based definitions of El Niño versus pattern-based determinations of the status of ENSO.

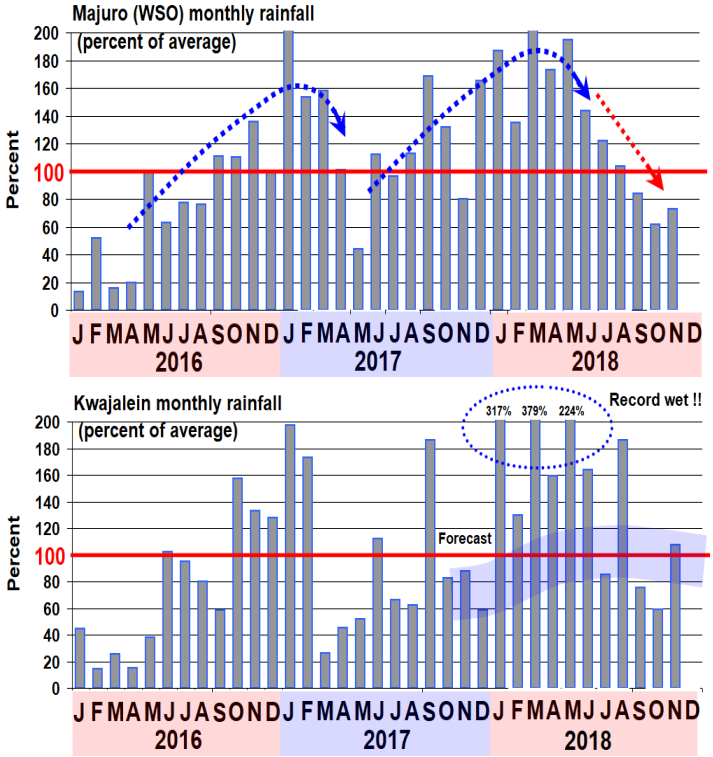


Figure RMI-1. (Top panel) A time series of rainfall at the WSO Majuro (gray bars) during 2016 through November 2018. Note two repeated dramatic rises from dry conditions early in the year to the return of abundant rainfall in the both fall of 2016 and the fall of 2017. (Bottom panel) A time series of rainfall at Kwajalein (gray bars) during 2016 through November 2018. Long-term fluctuations at Kwajalein are similar to those seen at Majuro in the top panel. Amounts of rainfall in January, March and May at Kwajalein exceed the upper bound of the scale.

LOCAL SUMMARY AND FORECAST

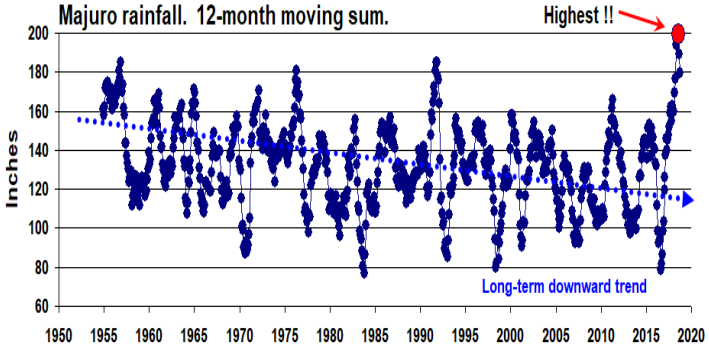


Figure RMI-2. A 12-month moving sum of rainfall at Majuro Atoll. Note that by July 2018 the sum had risen to its highest value in the historical record (red dot). Very recent dryness has begun to show in the past two months as a small decline of the 12-month moving sum. Note that prior to the current "spike" of heavy rainfall, Majuro, and other atolls of the RMI, had undergone a continual decline in rainfall over the span of their post-WWII historical record (blue dotted line).

RMI Rainfall Summary: JASO 2018, 3rd QTR						
Station		Jul	Aug	Sep	Oct	3rd QTR
RMI Central and Southern Atolls						
Majuro WSO	Inches	15.88	11.96	10.46	8.53	38.30
	% Avg	122%	104%	84%	62%	104%
Ailing	Inches	11.94	6.32	8.99	14.25	27.25
	% Avg	102%	58%	74%	111%	79%
Jaluit	Inches	11.22	4.77	5.47	3.66	21.46*
	% Avg	86%	41%	44%	26%	58%
Mili	Inches	9.29**	12.97	11.44	12.06	33.70
	% Avg	71%	113%	92%	87%	91%
RMI Northern Atolls						
Kwajalein	Inches	8.88	18.81	8.65	7.05	36.34
	% Avg	85%	186%	73%	59%	112%
Wotje	Inches	8.00***	10.23	4.38	5.37	22.61
	% Avg	133%	150%	56%	65%	110%
Utirik	Inches	10.54	5.99	10.97	14.10	27.50
	% Avg	190%	95%	152%	183%	144%

* The dryness at Jaluit may be due to some missing days.
** Estimated value: 1-11 Jul was 2.42"; 12-31 Missing due to observer off-island. Used Majuro for missing days = 6.87".
*** Estimated from nearby stations.

Climate Outlook:

Recent computer model forecasts are projecting average to above-average rainfall over the final three months (OND) of 2018. The PEAC team, in coordination with RMI partners, accepts these projections. However, with the current status of ENSO now near the El Niño threshold, the rainfall forecast beyond the end of 2018 depends on the subsequent movement of the climate system. At this time, the PEAC favors a short (3-month) stay at weak El Niño followed by a fade-away from El Niño back to ENSO-neutral by the late spring of 2019. If this scenario occurs, then the rainfall throughout most of the RMI could fall below average during first few months of 2019. The scenario is reflected in the predicted rainfall totals shown below.

Damaging TCs are rare in the RMI, and those rare storms that pass through the RMI do so primarily during strong El Niño

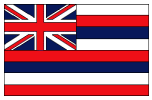
LOCAL SUMMARY AND FORECAST

events. During 2018, some of the western North Pacific basin's TCs originated from disturbances that emerged and moved westward from the RMI. In any case, the PEAC expects a slightly higher-than-average risk from now through January of 2019 for a TC to form near-or-east-of the International Date Line and then to move westward through some of the RMI.

Lastly, because of the easing of the Pacific trade wind system during the current slow progression of the climate system toward El Niño, the sea level at Kwajalein and Majuro fell rapidly in the first half of 2018 (e.g., Kwajalein + 7 inches in February to +1.7 inches in April). The rate of sea level decline thereafter stalled, and the level has since remained near average to slightly above average (see the sea level section for details).

Predicted rainfall for the atolls of the RMI from October 2018 through September 2019:

Inclusive Period	% of long-term average		
	South of 6°N	6°N to 8°N	North of 8°N*
Oct - Dec 2018	100%	95%	95%
Jan - Mar 2019	85%	85%	80%
Apr - Jun 2019	95%	90%	90%
Jul - Sep 2019	100%	100%	100%



Hawaii: The following information was summarized from the NWS Honolulu Office Monthly Hydrology Precipitation Summaries and Drought Information Statements found at http://www.prh.noaa.gov/hnl/pages/hydrology.php.

The main hydrologic event of the month occurred on August 22 through August 28 associated with the close passage of Hurricane Lane to the state. During this period, heavy rainfall affected all of the main Hawaiian Islands with damaging floods occurring on the Big Island, Maui, Oahu, and Kauai. The initial rain bands reached the windward slopes of the Big Island and Maui on the morning of August 22 as Lane approached the state from the south. The rain bands intensified that night over the Big Island which caused the initial flood impacts on the windward side of the island. Lane's very slow northward movement kept rain bands nearly stationary and focused on the Big Island through August 25. Lane began to move away from the state on August 25 and weakened to a tropical depression on August 26. As it moved westward, the trailing rain bands shifted westward as well, resulting in heavy rainfall on Kauai and Oahu on August 27 and 28. More normal trade winds finally resumed on August 29 and remained through the rest of the month.

September marked the end of the 2018 Hawaiian Islands "dry season", and for the second consecutive month it was anything but dry in many areas of the state. A big reason for the wet conditions was the continued active tropical cyclone period in the Central North Pacific basin that started in August. There was one direct hit, Tropical Storm Olivia, which made a double landfall in Maui County on September 12. This was the third direct hit by a tropical cyclone in the main Hawaiian Islands in 5 years and the first impact by a tropical cyclone stronger than a tropical depression in Maui County in well over 100 years. The worst flooding occurred over the slopes of the West Maui Mountains in the Waihee River basin, Honokohau Stream basin, and the Napili area. Several homes in these areas were damaged by flood waters. The other main source of enhanced rainfall during the month was a persistent and nearly stationary low pressure system northwest of the main Hawaiian Islands. While

LOCAL SUMMARY AND FORECAST

this was not a tropical cyclone, it was still very effective at drawing deep tropical moisture over the island chain from the south.

The 2018 – 2019 Hawaiian Islands wet season started in a big way with several heavy rain events and flash floods across the state, and many records broken for the highest October rainfall totals. The month started with light to moderate easterly to east-southeasterly winds that brought deep tropical moisture into the local area. This moisture helped fuel enhanced rainfall along the windward slopes of the state, peaking with 2-day totals of 7 to 10 inches in the Hilo and Puna sections of the Big Island on October 7 and 8. After a brief return to more normal trade winds, a low pressure system disrupted the trades on October 12 and produced heavy rainfall on Oahu, Maui, and the Big Island. Heavy rainfall over Oahu's leeward urban corridor resulted in flooding during the afternoon rush hour. Several lanes of the H-1 Freeway were briefly impassable due to flooding near Pearl City. The final heavy rain event of the month was the most impactful, especially for residents on Oahu. On October 29 and 30, a strong low pressure system moved over the state from the northwest, pulling up very moist conditions from the deep tropics and creating very unstable conditions favorable for intense rainfall. As a preamble to the event, the approaching low pressure system pulled up a band of moisture into Big Island that triggered heavy rainfall and some thunderstorms over the Kau, Puna, and South Hilo Districts in the early evening hours of October 29. Several gages picked up 5 to 7 inches of rainfall which produced minor flooding and briefly covered Highway 11 with 6 inches of water in the area known as Kawa Flats. The main rain bands reached Kauai during the night of October 29 and produced 1 to 3 inches of rainfall and minor flooding across most of the island. The band of heavy rainfall moved slowly eastward and impacted Oahu on the morning of October 30. Rain rates of 3 to 4 inches per hour hit the Waianae Coast and caused flooding on Upena Street that affected several homes. As the rain bands shifted eastward, heavy rainfall impacted the windward Koolau basins and flooded Kamehameha Highway near Waikane Stream. Several Oahu totals were in the range of 3 to 5 inches.

	Station			
Inclusive Period	**Hilo**	**Honolulu**	**Kahului**	**Lihue**
Dec – Feb 2018-19	65% chance of Below Median rainfall	65% chance of Below Median rainfall	65% chance of Below Median rainfall	65% chance of Below Median rainfall
Mar – May 2019	65% chance of Below Median rainfall	65% chance of Below Median rainfall	65% chance of Below Median rainfall	65% chance of Below Median rainfall
Jun – Aug 2019	Equal probabilities of below, average or above average rainfall	Equal probabilities of below, average or above average rainfall	Equal probabilities of below, average or above average rainfall	Equal probabilities of below, average or above average rainfall

LOCAL SUMMARY AND FORECAST

Climate Outlook: From CPC Long-Lead Hawaii Outlooks. Dynamical tools favor 65% chance of below median precipitation for all Hawaiian Islands during DJF of 2018-19. During JJA of 2019, equal probabilities of below, average or above average rainfall is projected for all Hawaiian Islands.

Seasonal Drought Outlook for Hawaii: Severe drought is no longer present in Hawaii (http://w1.weather.gov/data/HFO/DGTHFO)

Above average rainfall during September, which included the impact of Tropical Storm Olivia, brought continued relief to the leeward areas affected by drought conditions. Thus, severe drought, or the D2 category on the U.S. Drought Monitor Map, has eased to moderate drought, or the D1 category over the lower leeward slopes of west Maui and the South Kohala and North Kona Districts of the Big Island. It is expected that even these remaining D1 areas will be removed soon as vegetation continues to recover (Source: https://w1.weather.gov/data/HFO/DGTHFO).

However, according to U.S Drought Monitor, with the prediction of a weak El Niño for this upcoming winter season (DJF 2018-19), drought development is again favored for the more vulnerable west-facing slopes of the Big Island, Maui, and Molokai.

Seasonal Sea Level Outlook (Cont.)

From the Global Satellite Picture: *Observations from the recent global satellite picture (Fig. 8, below) revealed that the sea levels have been lower over the western part of the Pacific Basin.*

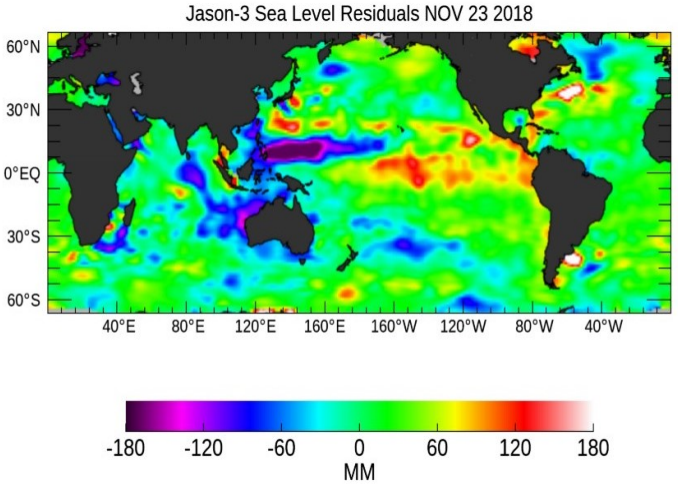


Figure 3. Jason-3 sea level residuals (Nov 23, 2018). (Source: https://sealevel.jpl.nasa.gov/images/latestdata/jason/2018/20181123G.jpg

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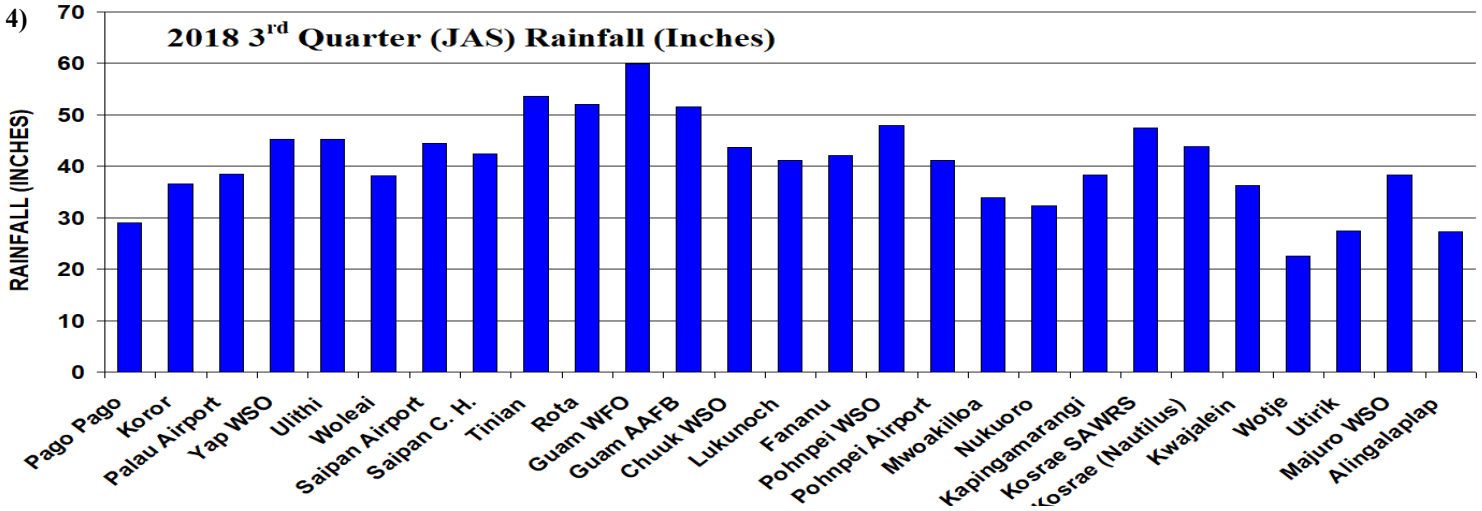
SEASONAL RAINFALL OUTLOOK FOR THE US-AFFILIATED PACFIC ISLANDS

4)



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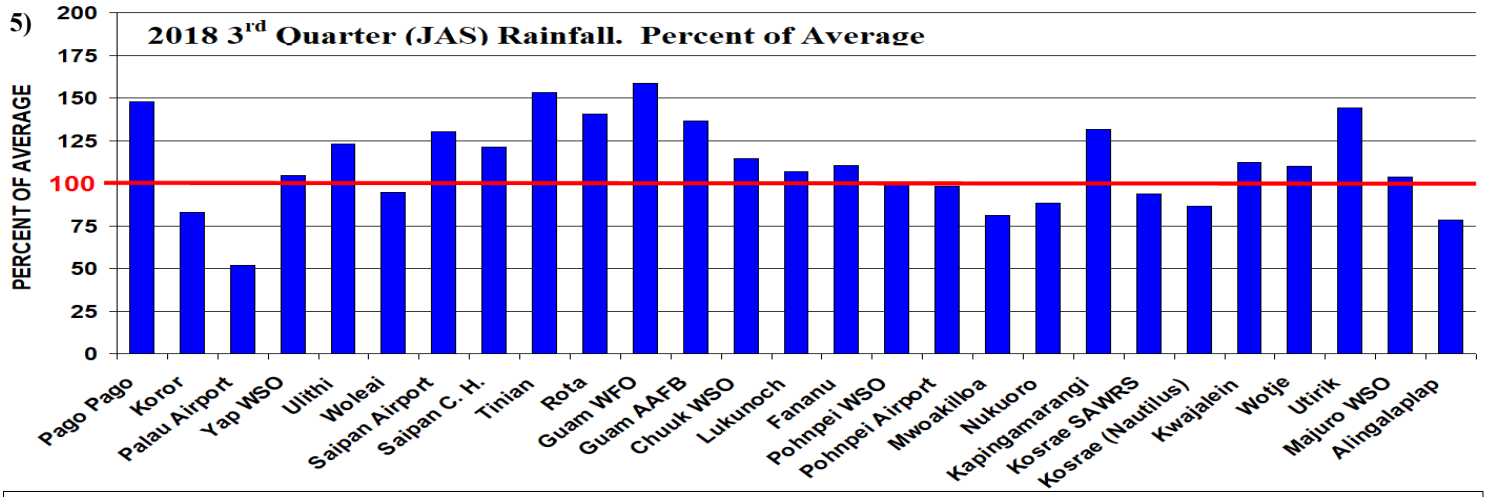

Figure 4: 2018 Third Quarter (JAS) rainfall amounts in inches at the indicated locations.
[1] Very high rainfall during the first half of 2018 and continuing through August 2018 pushed multi-month rainfall totals at Majuro and Kwajalein to ever higher record magnitudes, exceeding prior high marks by wide margins.
Figure 5: 2018 Third Quarter (JAS) rainfall as a percent-of-average at the indicated locations. Note the unusual condition of the Mariana Islands (Guam and islands of the CNMI) having the highest rainfall total throughout Micronesia. Dry conditions were noted in Palau and recently have developed in eastern Micronesia (e.g. some of the atolls of Pohnpei State and at Kosrae).

ACKNOWLEDGEMENTS AND FURTHER INFORMATION

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The Pacific ENSO Update is a bulletin of the Pacific El Niño-Southern Oscillation (ENSO) Applications Climate (PEAC) Center. PEAC conducts research & produces information products on climate variability related to the ENSO climate cycle in the U.S. Affiliated Pacific Islands (USAPI). This bulletin is intended to supply information for the benefit of those involved in such climate-sensitive sectors as civil defense, resource management, and developmental planning in the various jurisdictions of the USAPI.

The Pacific ENSO Update is produced quarterly both online and in hard copy, with additional special reports on important changes in ENSO conditions as needed. For more information about this issue please contact the PEAC Center at peac@noaa.gov or at the address listed below.

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