



PACIFIC



UPDATE

*A Quarterly Bulletin of the Pacific El Niño-Southern Oscillation Applications Climate*

*(PEAC) Center*

2<sup>st</sup> Quarter, 2017 Vol. 23, No. 2

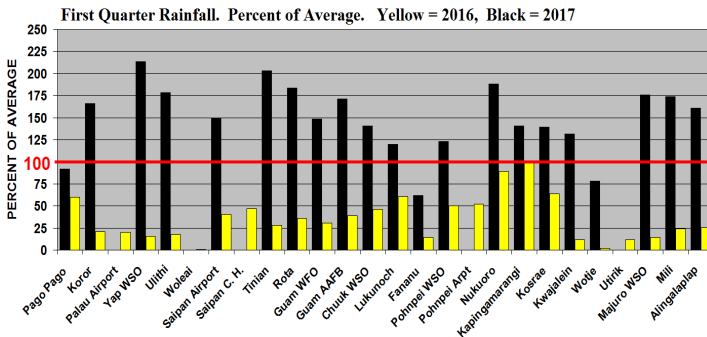
ISSUED: **May 15, 2017**

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

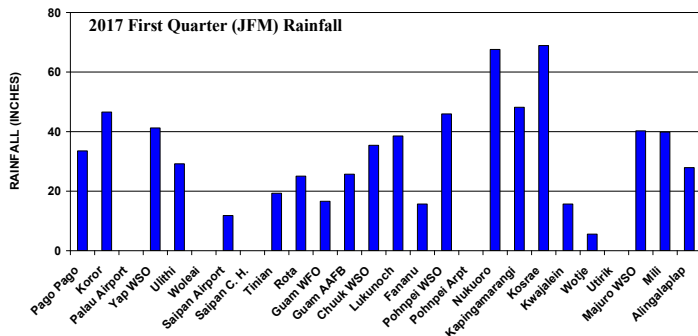
<http://www.weather.gov/peac>

**CURRENT CONDITIONS**

What a difference a year makes! Whereas the First Quarter of 2016 was very dry (with the rainfall at most island locations far below average), the First Quarter of 2017 was very wet (with the rainfall at most island groups well above average) (Fig. 1). Very wet conditions are generally welcome on most islands. Flooding and other hazards associated with heavy rainfall are generally not a problem on atolls. On high islands, heavy rainfall may cause mudslides and damaging high water levels in streams; but even on high islands, it usually requires extreme short-term (hourly to daily) heavy rain rates to initiate mudslides or bring about other problems with high water. Rainfall below 2 inches in one hour or less than 6 inches in 24 hours is usually handled without serious incident. Most often, rainfall above these short-term thresholds is associated with tropical cyclones. Despite some very high rainfall amounts at some island locations during the First Quarter of 2016 (See Figs. 2 and 3), there were no reports of any problems received by the PEAC.

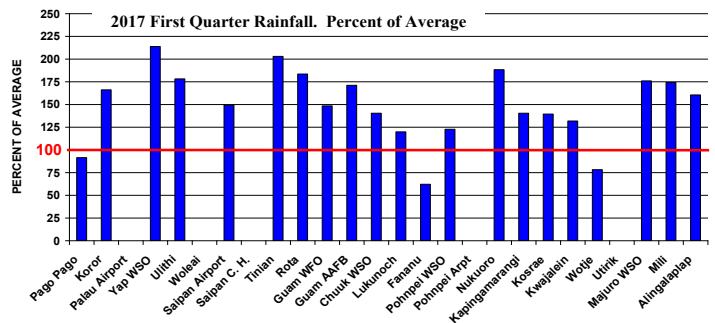


**Figure 1.** 2017 First Quarter rainfall (black bars) versus 2016 First Quarter rainfall (yellow bars) at the indicated locations.



**Figure 2.** 2017 1<sup>st</sup> Quarter rainfall amounts in inches at the indicated locations.

Although most locations were wetter than average during the First Quarter of 2017, there were some localized dry spots. Some of the atolls of the northern RMI (e.g., Wotje, Utrik and Ailuk) were very dry during the First Quarter of 2017. The same was true for Mejit Island. The RMI government shipped bottled drinking water supplies and reverse-osmosis units to some atolls to address water shortages. A drought information statement was issued by WFO Guam. Portions of the text of the statement issued by WFO Guam on 4 May 2017 are appended below.



**Figure 3.** 2017 1<sup>st</sup> Quarter rainfall as a percent of average at the indicated locations. Note that most locations in Micronesia were above average, with the notable exceptions of Pago Pago, Fananu (one of the northern-most atolls of Chuuk State), and the northern RMI atolls of Utrik and Wotje.

Portions of the text of the Drought Information Statement issued by the WFO, Guam, on Thursday, May 4, 2017:

"EXTREME DROUGHT IS AFFECTING WOTJE AND UTIRIK AND OTHER NORTHERN AND WESTERN ATOLLS. THE ATMOSPHERIC FLOW NORTHWARD FROM THE MARSHALL ISLANDS TO WAKE ISLAND HAS SHIFTED SLIGHTLY...BUT THE FAR NORTHERN MARSHALLS WILL REMAIN DRY IN THE COMING WEEKS AND ISLANDS ALONG AND NORTH OF ABOUT 8N TO 10N SUCH AS WOTJE, UTIRIK, RONGELAP, BIKINI, AND ENEWETAK ATOLLS WILL SUFFER FROM CONTINUED DROUGHT CONDITIONS. RELATIVELY DRY CONDITIONS WILL ALSO AFFECT KWAJALEIN, MALOELAP, LIKIEP, AND AILUK ATOLLS AND MEJIT ISLAND. WE WILL CONTINUE TO MONITOR THESE AREAS."

"THE MARSHALL ISLANDS GOVERNMENT INDICATES THAT UTIRIK AND ENEWETAK HAVE OPERATING REVERSE OSMOSIS (RO) SYSTEMS AND THAT SYSTEMS ARE LIKELY ON AILUK, WOTJE, AND MEJIT. EVEN WITH RO UNITS, LOCAL VEGETATION AND FOOD SOURCES WILL SUFFER FROM THE DROUGHT. LOCAL WELLS WILL CONTINUE TO BE SALTY. THE MARSHALL ISLANDS GOVERNMENT HAS ISSUED GUIDANCE FOR WATER CONSERVATION AND GOOD HYGIENE."

CURRENT CONDITIONS

The state of the Pacific climate remained in ENSO-neutral through the First Quarter of 2017. A slow drift into ENSO-neutral from weak La Niña in late 2016 continued in the First Quarter of 2017 (Fig. 3), with the CPC’s Oceanic Niño Index (ONI) now poised to cross to the warm side of ENSO-neutral, with an anticipated continued gradual warming (see the latest CPC ENSO statement appended below).

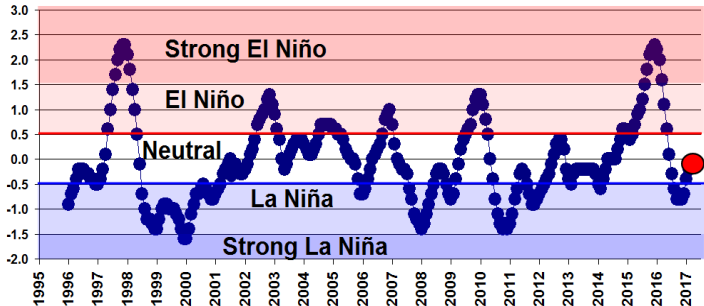


Figure 4. A plot of the CPC’s Oceanic Niño Index (ONI) for the past two decades. The red dot indicates the latest 3-month average.

Sea Level

As anticipated by the PEAC, the sea level across Micronesia returned to above average values during the 3<sup>rd</sup> Quarter of 2016. During the 4<sup>th</sup> Quarter of 2016, the sea level was above average across all of Micronesia and also at American Samoa. During the 1<sup>st</sup> Quarter of 2017, the sea level underwent a slight fall, giving back about 25% of its recent rapid rise in concert with a slight slackening of the trade winds. Note that the rise and fall of sea level closely tracks the strength of the low-latitude trade winds, and hence the very strong connection of regional sea level with ENSO. See the sea level discussion for more details and specific forecasts.

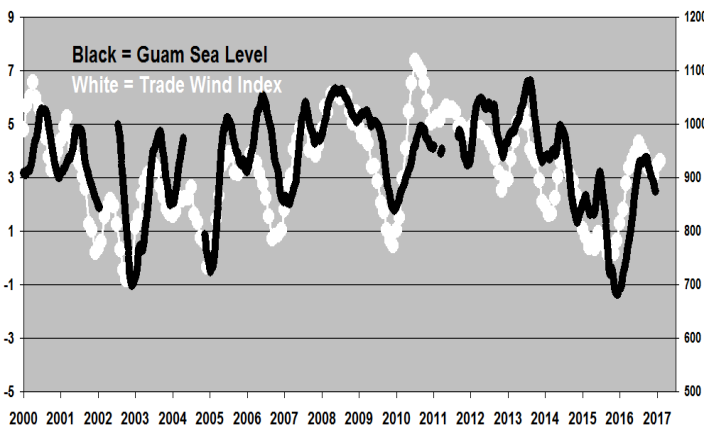


Figure 5. Time series of sea level at Guam (NOAA Sumay Cove tide gauge) from January 2000 through January 2017. The sea level at Guam and at most other locations in the region has recently given back some of the gains seen as a result of a sharp rise during 2016. Black line is a 12-month moving average of Guam’s sea level, and the white line is a 5-month moving average of NOAA’s trade wind index (5°S-5° N ; 135°E to 180°). The sea level at Guam and throughout the tropical western Pacific closely tracks the trade winds, with a small (1-2 month) lag that is perceivable in the diagram.

CURRENT STATE OF ENSO

ENSO Alert System Status: Not Active

**Synopsis:** ENSO-neutral and El Niño are nearly equally favored during the Northern Hemisphere summer and fall 2017.

1<sup>st</sup> Quarter, 2017

CURRENT STATE OF ENSO

ENSO-neutral persisted during April, with near-average sea surface temperatures (SSTs) observed across the central equatorial Pacific and above-average SSTs in the eastern Pacific. The latest weekly Niño index values were +0.5°C in the Niño-3 and Niño-3.4 regions, and +0.3 and +0.8°C in the Niño-4 and Niño-1+2 regions, respectively. The upper-ocean heat content anomaly was slightly positive during April, reflecting the strengthening of above-average temperatures at depth around the Date Line. Atmospheric convection anomalies were weak over the central tropical Pacific and Maritime Continent, while the lower-level and upper-level winds were near average over most of the tropical Pacific. Overall, the ocean and atmosphere system remains consistent with ENSO-neutral.

Most models predict the onset of El Niño (3-month average Niño-3.4 index at or greater than 0.5°C) during the Northern Hemisphere summer. However, the NCEP CFSv2 and most of the statistical models are more conservative and indicate that while Niño-3.4 index may be near or greater than +0.5°C for several months, the warmth may not last long enough to qualify as an El Niño episode (5 consecutive overlapping seasons) and/or may not significantly impact the atmospheric circulation. Relative to last month, the forecaster consensus reflects slightly lower chances of El Niño (~45%), in part due to the conflicting model guidance and lack of a clear shift toward El Niño in the observational data. In summary, while chances are slightly lower than 50%, ENSO-neutral and El Niño are nearly equally favored during the Northern Hemisphere summer and fall 2017

<sup>1</sup> Climate Prediction Center National Centers for Environmental Prediction. NOAA/National Weather Service. College Park, MD 20740

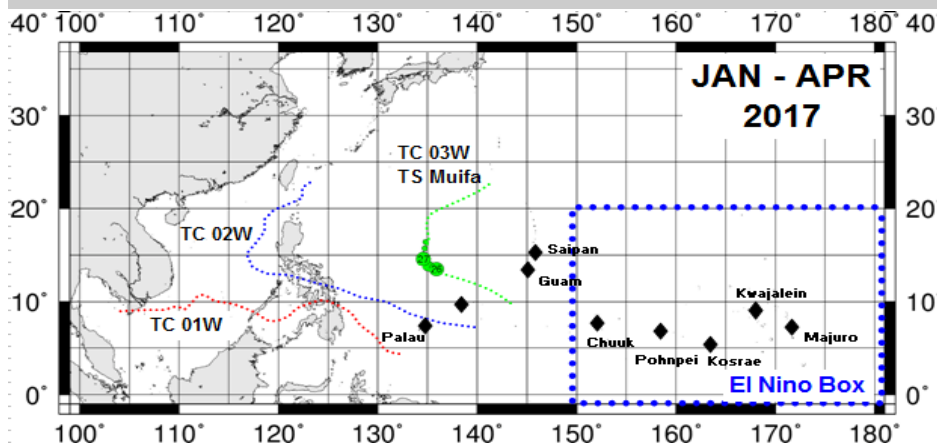
TROPICAL CYCLONE ACTIVITY

The PEAC archives western North Pacific tropical cyclone (TC) numbers, track coordinates, and 1-minute average maximum sustained wind taken from operational warnings issued by the Joint Typhoon Warning Center (JTWC) of the U. S. Air Force and Navy, located at Pearl Harbor, Hawaii. Western North Pacific tropical cyclone names are obtained from warnings issued by the Japan Meteorological Agency (JMA), which is the World Meteorological Organization’s Regional Specialized Meteorological Center (RSMC) for the western North Pacific basin. The PEAC archives South Pacific TC names, track coordinates, central pressures, and 10-minute average maximum sustained wind estimates from advisories issued by the Tropical Cyclone Warning Centers at Brisbane, Nadi, and Wellington. The numbering scheme and the 1-minute average maximum sustained wind estimates are taken from warnings issued by the JTWC. There are sometimes differences in the statistics (e.g., storm maximum intensity) for a given cyclone among the agencies that are noted in this summary.

**Western North Pacific**

So far, the first half of the western North Pacific typhoon season has been relatively inactive, with only three tropical cyclones numbered by the JTWC through April (Fig. 5). Only one of these TCs was named by the JMA: Tropical Storm Muifa (TC 03W). The other two TCs (TC 01W and TC 02W) reached only the depression stage, and were not given names by the JMA. There was a westward displacement to the early TCs of 2017, with TC 01W and TC 02W (and some other unnumbered weaker disturbances), with all forming near Yap and Palau, and then moving westward into the Philippines. Tropical Storm Muifa developed to the south of Guam and drifted slowly to a position

## TROPICAL CYCLONE ACTIVITY



**Figure 6.** Tropical cyclone tracks of 2017 in the western North Pacific. The blue “El Niño Box” is a region in which tropical cyclone occurrences are very strongly influenced by ENSO.

north of Yap and west of Guam. As the outermost rainbands of this TC lingered near Guam, heavy rainfall (4-6 inches) was experienced there over the three-day period 24-26 April (see the LVS for Guam and the CNMI for more details).

### **Southern Hemisphere**

The 2016-17 Southern Hemisphere (SH) TC season has been remarkably quiet! Through April 2017 only 17 TCs were numbered by the JTWC in the entire Southern Hemisphere. Of these, 13

were named by the responsible TC warning center. The 2016-17 South Pacific cyclone season is one of the least active South Pacific cyclone seasons on record, with only two tropical cyclones occurring within the South Pacific Ocean to the east of 160°E. Although the Australian Northwest Monsoon has had active penetrations into the South Pacific (indeed, across Samoa and into French Polynesia), there were no TCs that had any serious impacts on American Samoa.

### **Breaking News:**

On 02 May 2017, a large tropical cyclone formed in the South Pacific. JTWC warning #1 (valid time 2100 UTC 02 May 2017) placed the center at 13.0 S 171.9 E. The TC was expected to move westward towards Vanuatu and become a CAT 3 intensity TC.

### **PEAC Tropical Cyclone Assessment**

#### **Western North Pacific and American Samoa**

Only one official forecast of 2017 typhoon activity has been released: the Hong Kong Observatory issued a forecast for a near normal number (4-7) of TCs to pass within 500 km of Hong Kong. No official forecasts are yet available for 2017 seasonal typhoon projections. Mr. “Chip” Guard (Warning Coordination Meteorologist WFO Guam) recently provided the following statements to CNMI emergency managers:

1. We expect more tropical cyclone activity than in 2016 but not quite as much activity as in 2015.
2. The Northern Islands could get a tropical cyclone as early as July, but more likely in August and September.
3. Saipan and Tinian could see a nearby tropical cyclone as early as July, but more likely in September, October and November.
4. Rota could see a nearby tropical cyclone as early as July, but more likely in October, November and December.”

The UOG PEAC scientist Dr. Mark Lander added the following to the discussion:

*“I agree with Chip that the most certain statement is that activity should be higher than in 2016! It probably won't match 2015, especially eastward of Pohnpei (we are already far short of 2015 in that respect through May 1!). Later in the year, as Chip points out, there are no factors holding anything back from threatening Chuuk and islands westward, so we will at least have “normal” odds of a typhoon strike (winds 65 kt or greater) at 1-in-7, or 15-20% at each westward location. We are looking at a “good” monsoon year here on Guam and in the CNMI, with plenty of rainfall, and a few good episodes of SW winds. All islands from Pohnpei and westward will almost certainly (>75% chance at each location) experience gales in the periphery of a TC or in the monsoon. The timing should be as Chip has outlined. A stronger drift toward El Niño at any point heightens the odds of TC impacts all the way through to next January (2018).”*

Using the above as guidance, the PEAC anticipates that TC activity will be near average in the western North Pacific basin through the first half of 2017. Thereafter, any movement of the state of the climate system in the direction toward El Niño (whether from La Niña to ENSO-neutral, ENSO-neutral to El Niño, or La Niña to El Niño) increases the likelihood for above-average typhoon activity. For now, the basin TC activity should continue to exhibit a westward shift, with a near average basin count of 3 or 4 named cyclones during the first half of 2017. One or two of these TCs may pass near Guam, the CNMI, Yap or Palau, but likely move away to the west before becoming named. If the climate system makes a stronger push toward El Niño, the typhoon threat later in the year (SOND) could be higher-than-average, even for Pohnpei, Kosrae and the Marshall Islands..

The new 2016-17 South Pacific cyclone season is approaching its end. The Southern Hemisphere has experienced well below average TC activity, with a quantity known as the Accumulated Cyclone Energy<sup>1</sup> (ACE) standing at a season-to-date total of 73.4825, which is only 35% of the average year-to-date ACE of 205 (see: <http://models.weatherbell.com/tropical.php>). In its last ENSO newsletter, the PEAC called for reduced activity in the South Pacific eastward of the International Date Line. This proved to be an accurate forecast. The northwest monsoon has been active in the South Pacific, albeit with other atmospheric dynamics (e.g., vertical wind shear and regional low level vorticity) exhibiting some unfavorable values (H. Diamond, personal communication). It would be prudent to plan for at least one or two more South Pacific TCs by the 30 June finish of the 2016-17 TC season. These late-season TCs could be found in waters stretching from Fiji in the west and eastward through American Samoa, Tonga and Niue.

<sup>1</sup> ACE is an approximation of the wind energy used by a tropical system over its lifetime and is calculated every six-hour period.

## SEASONAL SEA LEVEL OUTLOOK FOR THE US-AFFILIATED PACIFIC ISLANDS

After the post-peak year of the El Niño event, we observed a sharp rise of sea level during the second half of 2016. In addition, the developing phase of weak La Niña in the end of 2016 also caused sea level to stay elevated for some time. However, starting from November 2016, consistent to ENSO-neutral state, a falling trend has been observed. The current sea level is expected to stay marginally elevated in the 2nd quarter of 2017.

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 May-June-July (MJJ), June-July-August (JJA), and July-August-September (JAS) of 2017, (ii) MJJ return values at 20 and 100-yr period, (iii) the observed monthly mean and maximum sea-level anomalies for the previous season February-March-April (FMA) of 2017, 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 MJJ, JJA, and JAS of 2017**

Forecasts of the sea-level anomalies in the USAPI (see <http://www.weather.gov/peac/sealevel>) are presented using CCA statistical model. Based on the independent SST and zonal wind (U) (SST-U) values in FMA of 2017, the resulting CCA model has been used to forecast the sea level of three consecutive seasons: MJJ, JJA, and JAS (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 2-months lead time) provided skillful forecasts for these three consecutive seasons.

**Table 1: Forecasts of sea level anomalies in inches (MJJ, JJA, and JAS)**

Tide Gauge Station	Seasonal Mean Deviations <sup>1</sup>				Seasonal Max Deviations <sup>2</sup>				
	MJJ	JJA	JAS	Seasonal Outlook <sup>3</sup>	MJJ	JJA	JAS	MJJ: Return Period <sup>4</sup>	
Lead Time <sup>5</sup>	0-M	1M	2M	Seasonal Outlook <sup>3</sup>	0-M	1M	2M	20-YR	100-YR
Marianas, Guam	+2	+1	+1	Normal	+21	+21	+20	5.6	6.7
Malakal, Palau	+1	+1	+2	Normal	+36	+38	+40	9.6	14.3
Yap, FSM	+1	+1	+1	Normal	+30	+31	+32	16.7	33.0
Chuuk, FSM**	+1	+1	+1	Normal	+31	+31	+32	n/a	n/a
Pohnpei, FSM	+3	+3	+3	Above	+34	+34	+32	5.8	7.1
Majuro, RMI	+3	+3	+4	Above	+42	+43	+44	4.1	5.1
Kwajalein, RMI	+3	+3	+3	Above	+41	+42	+42	4.5	5.9
Pago Pago, Am. Samoa***	+2 (-3)	+3 (-2)	+3 (-2)	Normal	+31 (+26)	+31 (+26)	+31 (+26)	3.9	5.4
Honolulu, Hawaii	+3	+3	+3	Above	+23	+22	+21	4.1	5.9
Hilo, Hawaii	+3	+2	+2	Above	+26	+25	+24	7.9	11.4

**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.

The current sea level forecasts indicate that most of north and south Pacific stations are likely to be slightly elevated in the forthcoming MJJ, JJA, and JAS seasons. Despite some rise during the later half of 2016, current observations revealed that all the stations are coming back to normal. This fall is somewhat expected and it corresponds very well with the current transitional phase of ENSO-neutral-to-weak El Niño condition. However, even as the tropical Pacific Ocean returns to ENSO-neutral or weak El Niño conditions, the atmospheric impacts will cause sea level to stay slightly elevated during the upcoming months. However, at any stage, no further rise is anticipated now. In Hawaii, both Honolulu and Hilo are likely to be moderately elevated.

The affect of astronomical kind tides during the 3rd week of June-July may also cause sea level to stay elevated. View your dates and times for king-tides (below) (also see <http://csr.seagrant.soest.hawaii.edu/king-tides>)(accessed on May 15, 2017).

American Samoa (June 23-24; July 22-23); Guam (June 24-25; July 23-24); Marshall Islands (Majuro - June 25-26; July 24-25). Hawaii'i, Maui, Moloka'i, Lana'i, O'ahu, Kaua'i (June 23-24; July 21-22).

**1<sup>st</sup> Quarter, 2017**



SEASONAL SEA LEVEL OUTLOOK FOR THE US-AFFILIATED PACIFIC ISLANDS

**Observed Monthly Mean Sea Level Anomalies (with respect to climatology) for May-Jun-Jul (MJJ) of 2016**

The monthly time series (January to March) for sea level anomalies have been taken from the UH Sea Level Center. The full time series (in mm) for monthly mean is available at: <ftp://ilikai.soest.hawaii.edu/islp/slpp.anomaliess>. Locations of all these stations can be found at <http://www.prn.noaa.gov/peac/map.php>.

**Current Conditions/Impacts:** Since February/2017, sea level started to fall, and the falling trend continued in March and April. Honolulu and Hilo recorded further rise and these two stations are moderately elevated. As of April 2017, all stations are steady but stays slightly above normal.

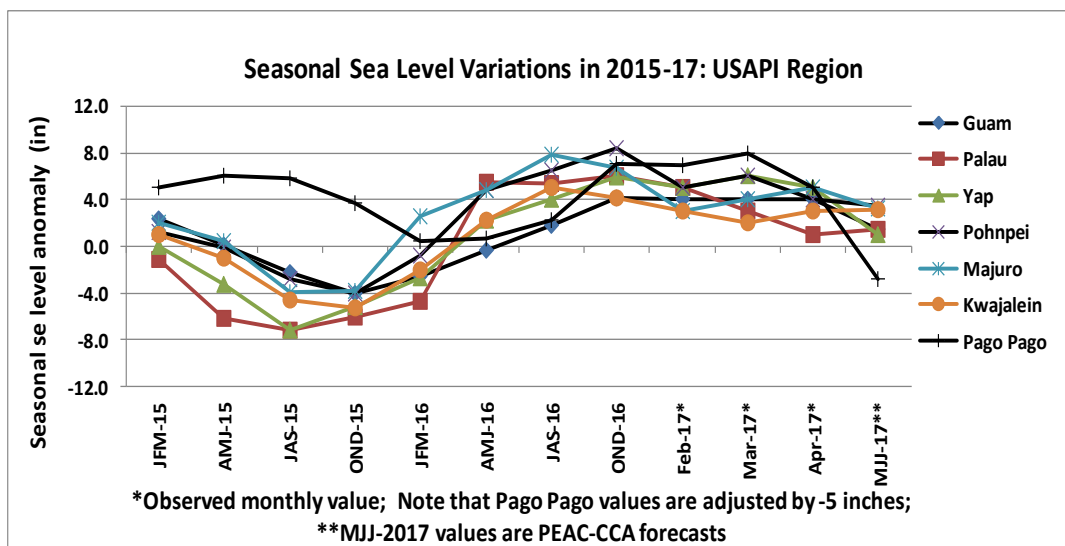
**Table 2: Monthly observed mean/maximum sea-level anomalies in inches**

Tide Gauge Station	Monthly Mean Deviations <sup>1</sup>				Monthly Max Deviations <sup>2</sup>			
	Feb	Mar	Apr	Standard Deviations	Feb	Mar	Apr	Sea level Trend
Marianas, Guam	+4	+4	+4	4.2	+20(2)	+19(1)	+20(2)	Above-Stable
Malakal, Palau	+5	+3	+1	4.8	+52(12)	+37(-3)	+39(-1)	Above-Stable
Yap, FSM	+5	+6	+5	4.7	+29(-1)	+33(3)	+35(5)	Above-Stable
Chuuk, FSM*	+4	+4	+4	4.2	**	**	**	Above-Stable
Pohnpei, FSM	+5	+6	+4	2.6	+32(2)	+30(0)	+31(1)	Above-Stable
Majuro, RMI	+3	+4	+5	2.0	+44(4)	+46(6)	+45(5)	Above-Stable
Kwajalein, RMI	+3	+2	+3	2.8	+42(6)	+38(2)	+42(6)	Above-Stable
Pago Pago, American Samoa***	+12 [7]	+13 [8]	+10 [5]	3.9	+36(6) [31]	+35(5) [30]	+33(3) [28]	Above-Stable
Honolulu, Hawaii	+4	+5	+8	1.7	+24(4)	+22(2)	+28(8)	Above-High Tides
Hilo, Hawaii	+6	+6	+6	1.9	+28(5)	+25(2)	+28(5)	Above-High Tides

**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. \* Experimental Satellite Aviso Altimetry data, \*\* 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. \*\*\* In Pago Pago, there was a level shift (approximately 5 inches) at the time of September 2009 earthquake (adjusted values are shown in parenthesis [ ]).

**Synopsis of 2-years Sea Level Variability and Forecasts**

Starting from JFM of 2015, a comparative perspective of two years of seasonal sea level variations is given below (Fig. 7). The sea level in the western Pacific started to fall from JFM of 2015. This falling trend continued up to JAS of 2015. Again it started to rise from OND of 2015 and, starting from JFM of 2016, sea level recorded an abrupt rise and remained high until OND of 2016. It started to fall from November 2016, and a falling trend has been observed in JFM of 2017. It is likely to stay marginally elevated in MJJ of 2017.



See page 15 for sea level observations from Jason-3 satellite picture (Fig. 8).

**Figure 7.** A comparative perspective of Island-wise seasonal sea level variations (JFM 2015 to MJJ 2017) (Note that Pago Pago data adjusted (approx. -5 inches) to 2009 level.

LOCAL SUMMARY AND FORECAST



**American Samoa:** During the November and December onset of the 2016/17 rainy season, rainfall amounts were near average at Pago Pago WSO. During the 1<sup>st</sup> Quarter of 2017 (essentially the heart of the rainy season across American Samoa), the total rainfall was also near average, but was comprised of one wet month (February) and two dry months (January and March). April 2017 was dry, except at the interior higher-elevation station at Siufaga Ridge where the rainfall amount in April was 6.35 inches.

During the course of the 2016-17 rainy season (and concurrent cyclone season) for the 6-month period of (NOV + DEC 2016) and (JAN + FEB + MAR + APR 2017), one of the most noteworthy climatic anomalies was an unusual lack of TCs (see the TC description in the Current Conditions Section). The lack of TCs in the Southern Hemisphere during the 2016-17 cyclone season has been profound, and set some new historical records for inactivity (e.g., latest first hurricane in the South Pacific, lowest accumulated cyclone energy to-date). The dearth of TCs has been widespread, with low-end statistics found from the South Indian Ocean all the way across into central South Pacific. During mid-February, a tropical low with east-side gales formed in French Polynesia, but was considered tropical-sub-tropical hybrid by the local TC warning agencies. Late in February, two other similar hybrid TCs formed in the SPCZ, this time a bit closer to American Samoa, but they moved rapidly to the SE away from Samoa, did not significantly intensify, and did not last long. During the first week of April, the northwest monsoon extended into the region of American Samoa to bring gales to local waters accompanied by heavy showers. On the 4<sup>th</sup> of April, the WSO Pago Pago recorded a wind gust to 52 mph from the north. At this same time, a cyclonic circulation was embedded in the monsoon cloud band well to the south of American Samoa that was tracked by the Fiji Meteorological Service as Tropical Disturbance 19F. This disturbance was not named.

The following are excerpts from a Special Weather Statement issued by the WSO Pago Pago, American Samoa on the 4<sup>th</sup> of April:

“HAZARDOUS WEATHER CONDITIONS WILL CONTINUE FOR ALL ISLANDS OF AMERICAN SAMOA THROUGH TUESDAY...

TROPICAL DISTURBANCE 19F LOCATED ABOUT 160 MILES SOUTH-SOUTHEAST OF MANU'A...180 MILES SOUTH-SOUTHEAST OF TUTUILA...IS FORECAST TO MOVE FURTHER SOUTH-SOUTHEAST THROUGH THE WEEK. THE TRAILING MONSOON TROUGH WILL CONTINUE TO REMAIN ACROSS THE SAMOAN ISLANDS...BRINGING OCCASIONAL SHOWERS...HEAVY AT TIMES...WITH EMBEDDED THUNDERSTORMS. THIS TROUGH IS FORECAST TO MOVE SOUTH OF THE ISLANDS BY WEDNESDAY. HENCE...THE POTENTIAL FOR FLASH FLOODING WILL REMAIN UNTIL WEDNESDAY.

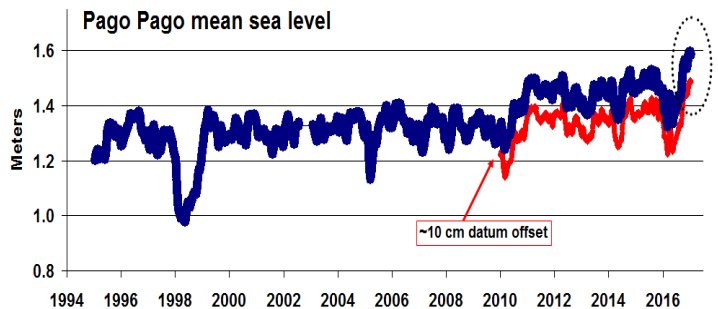
GALE FORCED WINDS ARE OBSERVED ACROSS SURROUNDING WATERS AND ARE FORECAST TO CONTINUE TO IMPACT COASTAL WATERS THROUGH AT LEAST TUESDAY EVENING.”

**Breaking News:**

The first named south Pacific (east of 180°) tropical cyclone of the 2016-17 cyclone season (TC 19P, Ella) formed just south of American Samoa on the 8<sup>th</sup> of May. It tracked westward toward Fiji, and apart from some heavy rain showers across American Samoa, winds were relatively light, and seas were unremarkable.

LOCAL SUMMARY AND FORECAST

The mean sea level in American Samoa fell during the first half of 2016 to a low level that has not been recorded since the first half of 2010 (see Fig. AS-1). Lowered sea level is a typical response to El Niño in American Samoa. By the end of 2016, the sea level had risen to new historic highs at the Pago Pago tide gauge. The very high mean sea level of recent years has been exacerbated by a datum shift of the tide gauge following the earthquake and destructive tsunami of 29 September 2009. Another time series representing a 10-cm shift of the reported sea level also appears on Fig. AS-1. Even with the shift, the sea level by early 2017 was still at an historical high stand (see the sea level section for sea level forecasts).



**Figure AS-1.** A time series of the 30-day moving average of the daily sea level recorded at the Pago Pago tide gauge for the period during January 1995 through January 2017. Note the substantial lowering of the sea level in response to the epic 1997-98 El Niño event. The abrupt rise of sea level in late 2009 is an artifact of a datum shift. The red line is a 10-cm correction applied to the raw data. Note that even with the applied correction, the sea level at the beginning of 2017 was at an historical high stand. Sea level units are in meters above gauge benchmark.

American Samoa Rainfall Summary: JFMA 2017 & 1 <sup>st</sup> QTR						
Station		Jan	Feb	Mar	Apr	1 <sup>st</sup> QTR
Pago Pago WSO	Rain (in)	9.57	18.18	5.60	8.14	33.35
	% Avg.	76%	142%	50%	68%	91%
Siufaga Ridge*	Rain (in)	.	.	6.70	6.35	.
	% Avg.	%	%	52%	184%	%

\* Station temporarily out of service, data resuming in 10 February 2017.

**Climate Outlook:**

Computer model forecasts are now indicating average to slightly below average rainfall over the next three months at Pago Pago, and the PEAC concurs with these projections. Rainfall in American Samoa is only weakly related to the state of ENSO, with dryness immediately following a strong El Niño being the most consistent relationship. With the current status of ENSO at ENSO-neutral, there are no compelling reasons at this time to manually intervene in the computer forecasts of rainfall for the region.

Tropical cyclone activity during the ongoing 2016-17 cyclone season was anticipated to be shifted westward, with highest TC activity in Australian waters eastward into the Coral Sea. The Australian Bureau of Meteorology called for above average TC activity in the Australian region (see: water <http://www.bom.gov.au/cyclone/outlooks/seasonal/qld.shtml>). In the South Pacific, eastward of the International Date Line, TC activity was forecast to be reduced, with American Samoa seeing a slight reduction to its risk of damaging effects from cyclones.

LOCAL SUMMARY AND FORECAST

These forecasts proved to be correct. The South Pacific TC season is nearing its end, and it would seem a natural choice to forecast no more activity across Samoan waters. But historically, there still is a small risk (less than 10% chance) for another TC (not including Ella) to affect American Samoa through the end of June.

*Predicted rainfall for American Samoa from April 2017 through March 2018 is:*

Inclusive Period	% of long-term average / Forecast rainfall (inches) <sup>1</sup>
April - June 2017 (Onset of Next Dry Season)	90%
Jul - Sep 2017 (Heart of Next Dry Season)	90%
Oct - Dec 2017 (Onset of Next Rainy Season)	100%
Jan - Mar 2018 (Onset of Next Rainy Season)	100%

<sup>1</sup> Forecast rainfall quantities represent BEST ESTIMATES given the probabilistic forecast for each particular season and station.



**Guam/CNMI:** Rainfall throughout Guam and the CNMI was generally above average during the 1st Quarter of 2017 (Fig. G1). Some of the monthly values were at least double the monthly averages, but since it occurred during the heart of the dry season, the actual magnitude of the rainfall was not excessive (e.g., whereas 5.00 inches is a whopping 200% of an average of 2.50, it is certainly a different experience to have a month that gets 30 inches when the average is 15!). There was indeed a perception among local residents that the ongoing dry season has been very wet. Some of this perception is based on the nature of the shear-line weather systems that caused some of

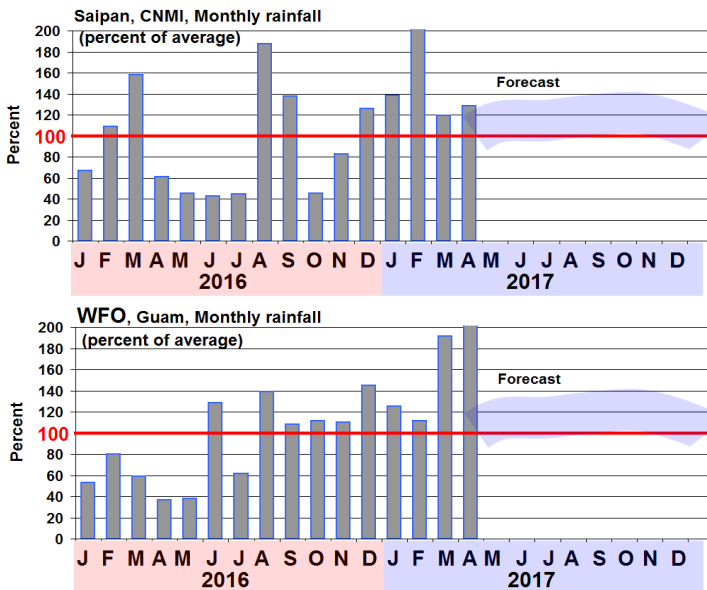


Figure G1. **Top:** A time series of monthly rainfall percentages at the Guam WFO. Note how the persistent dryness through the middle of 2016 gives way to abundant rainfall into the 1<sup>st</sup> Quarter of 2017. **Bottom:** Same as the top panel, but for monthly rainfall percentages at the Saipan International Airport. Forecast rainfall for the remainder of the year is indicated by light blue band.

LOCAL SUMMARY AND FORECAST

the rainfall over the 1st Quarter: slowly moving shear lines brought several multi-day episodes of almost continuous drizzle, dark skies and misty rain showers, albeit with surprisingly low multi-day accumulations (< 1 inch). As a result of the periodic wet spells, the islands remained relatively green through the dry season, and wildfires were not as numerous or extensive as they were during the dry season of 2016. The first three weeks of April were quite dry on Guam and in the CNMI, and there was an up-tick in the occurrences of wildfires. On Guam, the vegetation and residential lawns began to turn brown. Then, in the final week of April, the year's first named tropical cyclone – TS Muifa – sat for several days to the west of Guam and the CNMI, with its outer rainbands extending eastward to cover the islands. On Guam, there were three days with periods of steady heavy rain and rain showers, with a three-day storm-total rainfall of 4-6 inches across Guam. The island quickly became a lot greener! The islands to the north of Guam somehow escaped the heavy late April showers (though not for lack of opportunity!), so that their April monthly totals were much lower than at Guam.

Guam and CNMI Rainfall Summary: JFMA 2017 & 1 <sup>st</sup> QTR						
Station		Jan	Feb	Mar	Apr	1 <sup>st</sup> QTR
<b>GUAM</b>						
<b>GIA (WFO)</b>	<b>Inches</b>	6.22	5.06	5.30	8.60	16.58
	<b>% Avg</b>	140%	135%	178%	220%	148%
<b>AAFB</b>	<b>Inches</b>	9.25	7.22	9.21	.	25.68
	<b>% Avg</b>	162%	138%	225%	%	171%
<b>Southern Mountain</b>	<b>Inches</b>	8.37	4.34	6.57	.	19.28
	<b>% Avg</b>	147%	83%	161%	%	128%
<b>CNMI</b>						
<b>Saipan Intl. Airport</b>	<b>Inches</b>	4.61	7.17	2.48	3.74	14.26
	<b>% Avg</b>	144%	299%	124%	134%	188%
<b>Capitol Hill</b>	<b>Inches</b>	5.74	7.56	5.70	2.61	19.00
	<b>% Avg</b>	144%	252%	228%	75%	200%
<b>Tinian Airport</b>	<b>Inches</b>	7.44	9.39	2.45	5.44	19.28
	<b>% Avg</b>	186%	313%	98%	155%	203%
<b>Rota Airport</b>	<b>Inches</b>	8.63	8.75	7.65	2.82	25.03
	<b>% Avg</b>	163%	187%	207%	62%	184%

**Climate Outlook:**

Computer model forecasts are now indicating average to above average rainfall over the next three months, and the PEAC concurs with these projections. The climate is now in a state of ENSO-neutral, where it is anticipated to remain through the summer. Thereafter the odds of El Niño developing begin to rise. In general, any movement of the state of the climate system in the direction of El Niño (whether from La Niña to ENSO-neutral, ENSO-neutral to El Niño, or La Niña to El Niño) correlates well with average to above-average rainfall in our region. The stronger the move toward El Niño, the wetter and also the more serious the risk of a damaging tropical cyclone. The PEAC gives assent to the forecast recently given by Chip Guard to Saipan emergency managers:

LOCAL SUMMARY AND FORECAST

1. We expect more tropical cyclone activity than in 2016 but not quite as much activity as in 2015.
2. The Northern Islands (i.e., those islands north of Saipan) could get a tropical cyclone as early as July, but more likely in August and September.
3. Saipan and Tinian could see a nearby tropical cyclone as early as July, but more likely in September, October and November.
4. Rota [and Guam] could see a nearby tropical cyclone as early as July, but more likely in October, November and December."

Predicted rainfall for the Mariana Islands from April 2017 through March 2018:

Inclusive Period	% of long-term average / Forecast rainfall (inches) <sup>1</sup>	
	Guam/Rota	Saipan/Tinian
Apr-Jun 2017 (2nd half of next dry season)	120%	110%
Jul-Sep 2017 (Onset of next rainy season)	120%	120%
Oct-Dec 2017 (End of next rainy season)	110%	110%
Jan-Mar 2018 (1st half of next dry season)	100%*	100%*

\* This forecast for this time period is now very uncertain, and depends upon the developmental pathway of El Niño: If El Niño develops in 2017 so that it peaks in December 2017 or January 2018, then it could be dry early in 2018. If El Niño is delayed until 2018, then conditions are likely to be wet in the first half of that year.



Federated States of Micronesia

**Yap State:**

Most locations on Yap Island and at other atolls and islands in Yap State (e.g., Ulithi atoll, Fais, and Woleai) have experienced abundant rainfall since the final quarter of 2016 (Fig. Y1). The extreme dryness of mid-2015 through mid-2016 has now been replaced by very wet conditions. On Yap Island the reservoir is full (whereas, it was empty just one year ago!), and there are no reported problems with the water supply. In fact, some local residents of Yap Island have noted that the current dry season has been unusually wet, and there is some concern regarding the portent of this wet anomaly. The heavy rainfall is attributable, in large measure, to two factors: shear-line rains and tropical disturbances passing through the State. The same shear-lines that caused prolonged rainy spells on Guam during the 1<sup>st</sup> Quarter of 2017 also lingered over Yap State for days at a time. All three of 2017's early season numbered tropical cyclones (TCs 01W, 02W and 03W) also produced heavy showers across Yap State. The possible occurrence on 22 December 2016 of a damaging tornado on Falalop (one of the islets of Ulithi Atoll) is still under investigation, and a full report may be available in a few months as the PEAC team queries witnesses and undertakes a full meteorological assessment. A preliminary summary of that event was contained in the last PEAC Newsletter Yap LVS section, and a snip from a newspaper account that appeared in the 23 January 2017 issue of the Khaselelia Press is reprinted below:

**Standing with Ulithi- Tornado rips through island**

Published: Monday, 23 January 2017 09:09

Written by Katlyn Murray

...  
 "On December 22, 2016, a water spout turned tornado ripped through the island, tearing apart over 20 newly repaired homes and cook houses along its path. "It sounded like a jet was flying

1<sup>st</sup> Quarter, 2017

LOCAL SUMMARY AND FORECAST

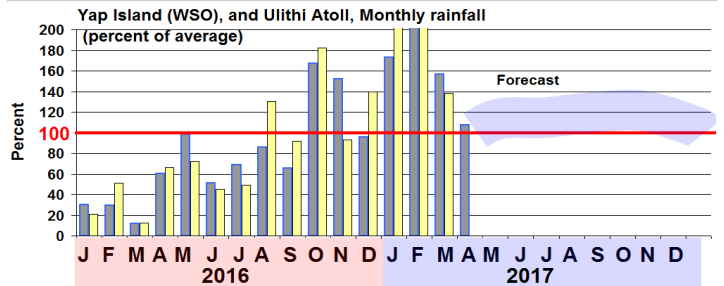


Figure Y1. Time series of monthly rainfall at the Yap Island WSO (gray bars) and Ulithi Atoll (yellow bars) for all of 2016 through April 2017. The continuous dryness at the end of 2015 through July of 2016 set a new historical record for low rainfall! October 2016 began a new regime of persistent above average rainfall. The average-to-above-average rainfall forecast for the remainder of 2017 is indicated by the light blue swath. Note: Ulithi's rainfall was estimated for February and March 2017, and left blank for April 2017.

low over the island. Luckily, we had been warned that Typhoon Nock-ten could be headed in our direction so we were prepared for a potential disaster. If we hadn't received warning about Nock-ten, this tornado would have claimed lives on Falalop," said local resident Jon Rumal Jr."

Yap State Rainfall Summary: JFMA 2017 & 1<sup>st</sup> QTR

Station		Jan	Feb	Mar	Apr	1 <sup>st</sup> QTR
Yap State						
Yap WSO	Inches	12.67	19.19	9.35	6.19	41.21
	% Norm	173%	321%	157%	107%	214%
Ulithi	Inches	16.66	12.00*	7.00*	.	35.66*
	% Norm	267%	236%	138%	%	218%
Woleai	Inches	13.54	2.74	5.55	9.13	21.83
	% Norm	127%	37%	67%	83%	82%

\* Estimated

**Climate Outlook:**

Computer model forecasts are now indicating average to above average rainfall over the next three months, and the PEAC concurs with these projections. The climate is now in a state of ENSO-neutral, where it is anticipated to remain for at least the next two or three months. Thereafter the odds of El Niño developing begin to rise. In general, any movement of the state of the climate system in the direction of El Niño (whether from La Niña to ENSO-neutral, ENSO-neutral to El Niño, or La Niña to El Niño) correlates well with average to above-average rainfall at least through the first half of the year, and an increase in the risk of a damaging tropical cyclone now through the end of the year. The stronger the move toward El Niño, the more serious the risk becomes for a damaging tropical cyclone. The passage of Typhoon Nida to the northeast of Yap State in late November 2009 is an example of the type of threat anticipated for Yap State in late 2017 (especially if El Niño conditions become established over the next few months).

Through June 2017, the basin TC activity should continue to exhibit a westward shift, with a near average basin count of 3 or 4 named cyclones during March through June 2017. One or two of these TCs may become a tropical storm or low-end typhoon while passing near Yap State. The PEAC assesses the risk of



**LOCAL SUMMARY AND FORECAST**

some damaging effects, such as high waves, gales or very heavy rainfall at 10-15% (a 1-in-10 to 1-in-7 chance).

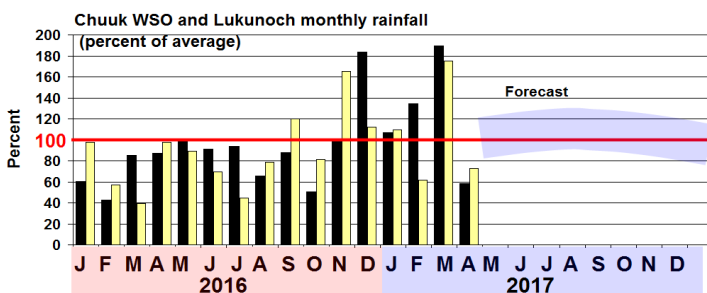
*Predicted rainfall for Yap State from January through December 2017 is:*

Inclusive Period	% of long-term average / Forecast rainfall (inches) <sup>1</sup>	
	Woleai	Yap & Ulithi
April-June 2017 (End of Dry Season)	100%	120%
July-September 2017 (Heart of next Dry Season)	110%	120%
October-December 2017 (End of next Rainy Season)	100%*	100%*
January-March 2018 (Onset of next Dry Season)	100%*	100%*

\* The uncertainty of the long-range forecasts will remain very high until the timing of the onset of El Niño conditions is known (if indeed it gets there as anticipated later in 2017).

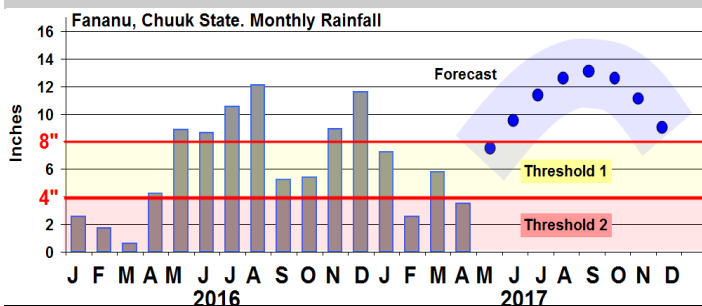
**Chuuk State:** A long period of persistent dryness across most of Chuuk State began in October 2015 and continued almost uninterrupted until November 2016 (Fig. CH-1). Finally, during November 2016 and continuing through the 1<sup>st</sup> Quarter of 2017, above average rainfall occurred throughout most of the State, with the notable exception of atolls in the far north, northwest, and west (e.g., Fananu, Ounoun, and Polowat, respectively). The month of March was very wet at many locations in Chuuk State, except in the far north. The March total of 15.74 inches at the Chuuk WSO was the 8<sup>th</sup> highest reading for March in the 61-year post-WWII climate record. Some of the atolls in the Mortlock group had over 20 inches during March (see sidebar). Meanwhile in the north, Fananu and Ounoun had only 5.82 and 6.83 inches respectively in March. The weather during March across the islands of the Chuuk Lagoon was described as “unstable” by a forecaster at the WSO. There was a chaotic mix of calm and rough days. Three days had over 2 inches of rainfall, and thunderstorms were reported on three days. Some large waves were noted, driven by a remotely generated northerly swell, but there were no reports of serious inundation.

Although much of Chuuk State had abundant rainfall during the 1<sup>st</sup> Quarter of 2017, the atolls in the far north of Chuuk State (e.g., Fananu and other atolls of the Hall Island group) were very dry (Fig. CH2). Each of the 4 months JFMA had rainfall totals that fell below the critical threshold of 8 inches for the maintenance of adequate drinking water supplies on islands and atolls that rely on household rain catchment, or shallow dug wells. For two of these four months, the rainfall was near-or-below the next critical threshold of 4 inches that is necessary to sustain plant



**Figure CH-1.** A time series of the monthly rainfall at the WSO Chuuk (black bars) and at Lukunoch (yellow bars) during 2016 and the first 4 months of 2017. The forecast for near-average to above-average rainfall over the rest of 2017 is indicated by the light-blue band.

**LOCAL SUMMARY AND FORECAST**



**Figure CH-2.** A time series of the monthly rainfall at Fananu Atoll (8.6° N : 151.9° E) during 2016 and the first 4 months of 2017. The critical water quantity thresholds of 8” per month and 4” per month are indicated. The forecast of rainfall for the remainder of 2017 is indicated by the pale blue band inlaid with blue dots. The actual rainfall will not be as smooth as this indicates, with the month-to-month values falling somewhere in (or near) the blue band while the moving average of rainfall tracks the path of the blue dots. As one can see, the rainfall begins to exceed the critical thresholds within the next month or two.

growth and non-irrigated crops. Indeed, the availability of adequate potable water recently became a problem in the northern atolls of Chuuk State, and they were added to the Drought Information Statement (DIS) issued by the WFO Guam on 4 May 2017. Excerpts of text from that DIS are:

“...CHUUK STATE FEDERATED STATES OF MICRONESIA...

FANANU AND OTHER LOCATIONS IN THE HALL ISLANDS ARE IN SHORT-TERM MODERATE DROUGHT (DROUGHT LEVEL 1 OF 4) AND COULD SOON MOVE INTO A SEVERE DROUGHT CONDITION (DROUGHT LEVEL 2 OF 4). CONDITIONS COULD ALSO SPREAD TO THE NORTHWESTERN AND THE WESTERN ISLANDS. WE WILL CLOSELY MONITOR THESE CONDITIONS. ...”

**Sidebar**

The forecast in the last PEAC newsletter calling for the possibility of a 20-inch month anytime between March and June, turned out to be correct, with two reporting sites (Lukunoch and Ta) receiving over 20 inches of rain in March.

Chuuk State Rainfall Summary: JFMA & 1 <sup>st</sup> QTR 2017						
Station		Jan	Feb	Mar	Apr	1 <sup>st</sup> QTR
<b>Chuuk Lagoon</b>						
Chuuk WSO	Inches	11.37	8.27	15.74	7.15	35.38
	% Avg	107%	134%	189%	58%	140%
<b>Southern Mortlocks</b>						
Lukunoch	Inches	11.58	5.90	21.03	9.61	38.51
	% Avg	109%	62%	175%	73%	120%
<b>Northern Mortlocks</b>						
Losap	Inches	15.65	7.22	15.89	9.15	38.76
	% Avg	147%	117%	190%	74%	154%
<b>Northern Atolls</b>						
Fananu	Inches	7.27	2.58	5.82	3.50	15.67
	% Avg	68%	42%	70%	28%	62%
<b>Western Atolls</b>						
Polowat	Inches	3.98*	2.63*	2.66*	3.04*	9.27*
	% Avg	50%	42%	43%	51%	45%

**Climate Outlook:**

**1<sup>st</sup> Quarter, 2017**

LOCAL SUMMARY AND FORECAST

Computer model forecasts are now indicating average to above average rainfall over the next three months at the Chuuk WSO. The PEAC concurs with the above-average projections for the WSO Chuuk, and anticipates that the same projections are also valid at most of the other islands and atolls of Chuuk State, except in the far north of the State (e.g., the Hall Island group), where the monthly rainfall may continue to be below average over the next two months before recovering to near average by July.

The climate is now in a state of ENSO-neutral, where it is anticipated to remain for at least the next two or three months. Thereafter the odds of El Niño developing begin to rise. In general, any movement of the state of the climate system in the direction of El Niño (whether from La Niña to ENSO-neutral, ENSO-neutral to El Niño, or La Niña to El Niño) correlates well with average to above-average rainfall across most of Chuuk State, at least through the first 9 months of the year. Also, the stronger the move toward El Niño, the higher the risk becomes for a damaging tropical cyclone.

For the remainder of 2017, the threat of a damaging TC anywhere within Chuuk State is likely to be above average: a 1-in-5 (20%) chance. The timing of the highest risk for a tropical storm or typhoon to track somewhere through the bounds of Chuuk State is most likely during mid-September through December.

Lastly, the sea level began 2017 at a moderately higher-than-average stand, but has remained stable – not rising or falling much – thereafter (see the sea level section for details).

*Predicted rainfall for Chuuk State from April 2017 through March 2018 is*

**Pohnpei State:** Monthly rainfall during 2016 on Pohnpei

Inclusive Period	% of long-term average / Forecast rainfall (inches) <sup>1</sup>			
	Chuuk Lagoon, Losap, & Nama	Polowat	Northern Is.	Southern Mortlocks
Apr-Jun 2017	110%	75%	75%	110%
Jul - Sep 2017	120%	95%	90%	110%
Oct - Dec 2017*	100%	95%	100%	100%
Jan - Mar 2018*	100%	90%	95%	100%

\* It is possible that dryness at Polowat is caused by an exposure problem with the rain gauge.

\* The evolution of El Niño could have a big impact on the rainfall amounts, so uncertainty at the long range is considered higher than average.

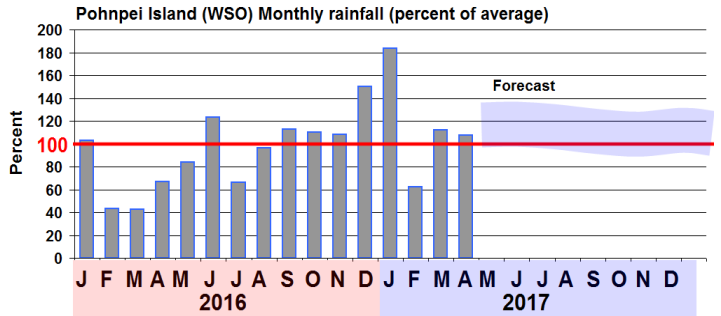
<sup>1</sup> Forecast rainfall quantities represent BEST ESTIMATES given the probabilistic forecast for each particular season and station.

Island and on most of the atolls of Pohnpei State trended from dry to wet over the course of that year (Fig. PN-1). Wet conditions commenced on Pohnpei Island in September 2016, with each of the months of SOND (2016) receiving above average amounts there. At the low-latitude atolls of Nukuoro and Kapingamarangi, the return of wet conditions was delayed until December 2016. During the first 4 months of 2017, very high rainfall was experienced at most locations. Nukuoro and Kapingamarangi were particularly wet during the first 4 months of 2017, with Kapingamarangi's 4-month (JFMA 2017) rainfall total of 69.86 inches the highest such total in that locations cli-

LOCAL SUMMARY AND FORECAST

mate record for the years 2000 to 2017. Kapingamarangi's climatic data record prior to the year 2000 has a lot of missing data. There were only nine years in the 38-year period 1962-1999 for which the records for JFMA were complete. During two of such years (1969 and 1970) the JFMA 4-month rainfall total was over 70 inches (73.53 inches and 75.6 inches for JFMA of 1969 and 1970, respectively).

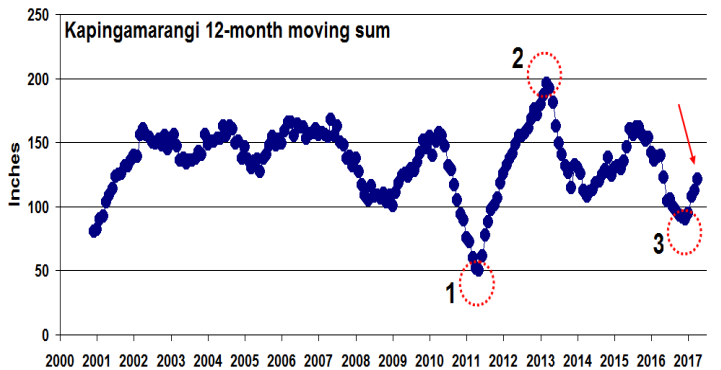
Large variations of rainfall are observed at Kapingamarangi



**Figure PN-1.** A time series of the monthly rainfall at WSO Pohnpei Island (gray bars) during the calendar-year 2016 through JFMA 2017. The forecast for near average to above-average rainfall over the rest of 2017 is indicated by the light-blue band.

(Fig. PN-2). 12-month rainfall totals there vary by a factor of 4 (50 inches to almost 200 inches!). Three particular rainfall anomalies are highlighted in Fig. PN-2. The extreme prolonged dry periods marked by “1” and “3” contain within each of them a shorter period in which a drought emergency occurred. The drought that occurred during period “1” had the most serious impact with a complete loss of locally available drinking water and damage noted to crops and island vegetation. During dry period “3”, there was a short-term (2-month) loss of drinking water supplies, but vegetation was not substantially harmed. Very wet periods such as that marked by “2” do not seem to bring about any complaints.

**Climate Outlook:** Simple persistence and computer model



**Figure PN-2.** A 17-year time series of rainfall at Kapingamarangi. Values plotted are a moving 12-month sum (looking backward from the plotted position). 3 Rainfall extremes are circled. Rainfall data is available prior to the year 2000, but it has many missing months, so it has been excluded here. Very high rainfall during the first 4 months of 2017 (red arrow) has brought about a rapid rise of the 5-year sum from its low-point “3” at the end of 2016.

forecasts indicate average to above average rainfall over the next 3 months on Pohnpei Island (and likely also at Pingelap and other atolls near the latitude of Pohnpei Island). The PEAC concurs with the average to above-average projections for these locations. At atolls farther to the south (Nukuoro and Kapingamarangi), where it was relatively dry from August to November (and is now very wet), the outlook is not as clear, but

LOCAL SUMMARY AND FORECAST

Pohnpei State Rainfall Summary JFMA & 1 <sup>st</sup> QTR 2017						
Station		Jan	Feb	Mar	Apr	1 <sup>st</sup> QTR
Pohnpei WSO	Rain (Inches)	24.00	6.76	15.16	17.68	45.92
	% of Average	184%	63%	112%	108%	123%
PNI Airport	Rain (Inches)	19.21	5.75*	11.53	13.68	36.49
	% of Average	179%	65%	104%	101%	119%
Atolls of Phonpei State						
Station		Jan	Feb	Mar	Apr	1 <sup>st</sup> QTR
Nukuoro	Rain (Inches)	18.64	26.92	22.03	13.79	67.59
	% of Average	159%	255%	162%	92%	188%
Pingelap	Rain (Inches)	12.57	6.05	14.03	15.77	32.65
	% of Average	102%	50%	97%	92%	84%
Kapinga	Rain (Inches)	14.54	19.18	14.44	21.70	48.16
	% of Average	132%	184%	112%	178%	140%

the odds for either near, or above average rainfall are likely higher than the odds for below-average rainfall.

The climate is now in a state of ENSO-neutral, where it is anticipated to remain for at least the next two or three months. Thereafter the odds of El Niño developing begin to rise. In general, any movement of the state of the climate system in the direction of El Niño (whether from La Niña to ENSO-neutral, ENSO-neutral to El Niño, or La Niña to El Niño) correlates well with average to above-average rainfall across most of Pohnpei State at least through the first half of the year. The stronger the move toward El Niño, the higher the risk becomes for a damaging tropical cyclone.

For the remainder of 2017, the threat of a damaging TC anywhere within Pohnpei State is about average (a 1-in-10 chance), but certainly there is a higher risk than during 2016. Note: any stronger-than-anticipated advance of the climate system toward El Niño carries with it a higher risk for a tropical storm or typhoon to track across the north of Pohnpei State, most likely during mid-October through December.

Lastly, the sea level began 2017 at a moderately higher-than-average stand, but has remained stable – not rising or falling much – thereafter (see the sea level section for details).

*Predicted rainfall for Pohnpei State from April 2017 through March 2018:*

**Kosrae State:** In December 2016 there was an abrupt return of abundant rainfall to Kosrae, after a prolonged period of below

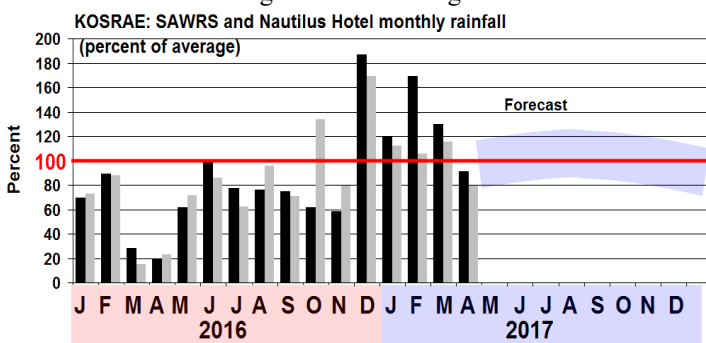
Inclusive Period	% of long-term average	
	Pohnpei Island/ atolls	Kapingamarangi
Apr – Jun 2017	120%	120%
Jul – Sep 2017	110%	110%
Oct – Sep 2017	110%	100%*
Jan – Mar 2018	110%	110%*

\* The evolution of El Niño could have a big impact on the rainfall amounts, so uncertainty at the long range is considered higher than average.

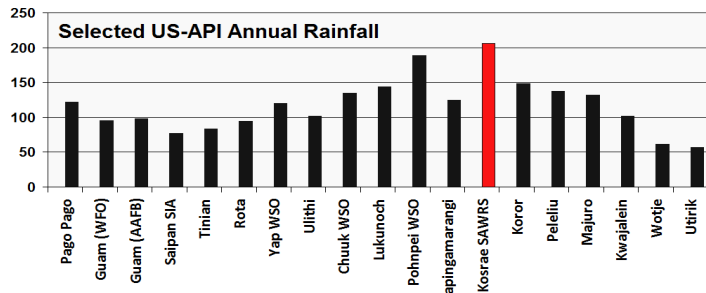
LOCAL SUMMARY AND FORECAST

-average rainfall. Above-average rainfall then continued through the 1<sup>st</sup> Quarter of 2017 (Fig. KS-1). Whereas the period from November 2015 through October 2016 was the 3<sup>rd</sup>-driest for any 12-month period at Kosrae Supplemental Aviation Weather Reporting Station (SAWRS), the 2017 1<sup>st</sup> Quarter rainfall total of 68.88 inches at that location was the highest 1<sup>st</sup> Quarter total in a 31-year climate record. Although the monthly total rainfall during April was below average, a heavy rainfall event on the 20<sup>th</sup> of April required a flood statement. There were no reports of serious flooding.

**Climate Outlook:** Simple persistence and computer model forecasts indicate average to above average rainfall over the next



**Figure KS-1.** A time series of the monthly rainfall at Kosrae Supplemental Aviation Weather Reporting Station (SAWRS) (black bars) and the Nautilus Hotel (gray bars) for the period January 2016 through April 2017. The forecast for the remainder of 2017 is for average to above-average rainfall (light blue band).



**Figure KS-2.** Annual rainfall at selected observing sites in the US-API. Note that rainfall at the Kosrae Supplemental Aviation Weather Reporting Station (SAWRS) (red bar) is the highest among all the sites. There are some second-order sites (not plotted) and other unusual locations where the annual rainfall is near-or-above that of Kosrae SAWRS.

Kosrae State Rainfall Summary: JFMA & 1<sup>st</sup> QTR 2017

Station		Jan	Feb	Mar	Apr	1 <sup>st</sup> QTR
Airport (SAWRS)	Rain (Inches)	17.21	27.51	24.16	19.57	68.88
	% of Average	120%	168%	129%	90%	139%
Nautilus Hotel	Rain (Inches)	16.09	17.21	21.50	17.18	54.80
	% of Average	112%	105%	115%	79%	111%

3 months at Kosrae. The PEAC concurs with the average to above-average projections for this location.

The climate is now in a state of ENSO-neutral, where it is anticipated to remain for at least the next two or three months.

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Thereafter the odds of El Niño developing begin to rise. In general, any movement of the state of the climate system in the direction of El Niño (whether from La Niña to ENSO-neutral, ENSO-neutral to El Niño, or La Niña to El Niño) correlates well with average to above-average rainfall at Kosrae.

Damaging TCs are rare at Kosrae, and those rare storms that do occasionally strike Kosrae do so primarily during strong El Niño events. Thus, the risk of a damaging TC on Kosrae during the remainder of 2017 is considered to be typically low (less than 1-in-10 chance). Note: any stronger-than-anticipated advance of the climate system toward El Niño carries with it a higher risk for a tropical storm or typhoon to track near Kosrae, most likely during mid-October 2017 through January 2018.

Lastly, the sea level began 2017 at a moderately higher-than-average stand, but has remained stable – not rising or falling much – thereafter (see the sea level section for details).

*Predicted rainfall for Kosrae State from April 2017 through March 2018 is:*

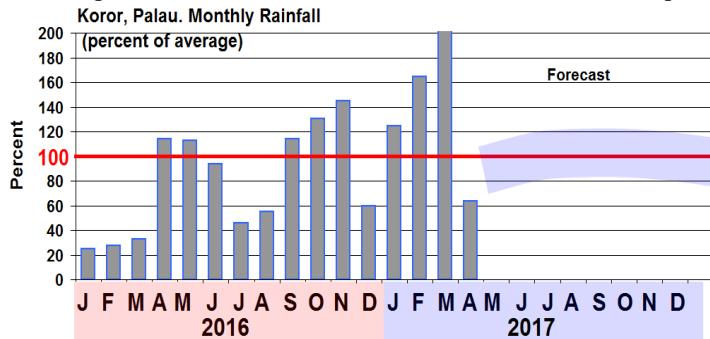
**Republic of Palau:** During the second half of 2016, the

Inclusive Period (Kosrae)	% of long-term average / Forecast rainfall (inches) <sup>1</sup>
Apr – Jun 2017	110%
Jul – Sep 2017	110%
Oct – Sep 2017	100%
Jan – Mar 2018	100%



Republic of Palau began a slow recovery from the record dry conditions that persisted continually over the previous 18 months. Thanks to abundant rainfall during September through November 2016, and then again during January through March of 2017, the 2016 4<sup>th</sup> Quarter total rainfall and the 2017 1<sup>st</sup> Quarter total rainfall at the WSO Koror were above average (Fig. PL1). To illustrate the huge impact of the 2015/16 El Niño is shown in Fig. PL2. In this chart showing a moving sum of 5-year rainfall, one can see the steep drop after 2011 that falls to an extreme minimum in late 2016. Note the recovery now underway that still has a long way to go just to reach the long-term average.

As reported in the last two newsletters, the substantial pro-



**Figure PL-1.** A bar chart of observed rainfall (percent of average) at the Koror WSO for 2016 and the first 4 months of 2017. The forecast of rainfall for the rest of 2017 is indicated by the pale-blue band.

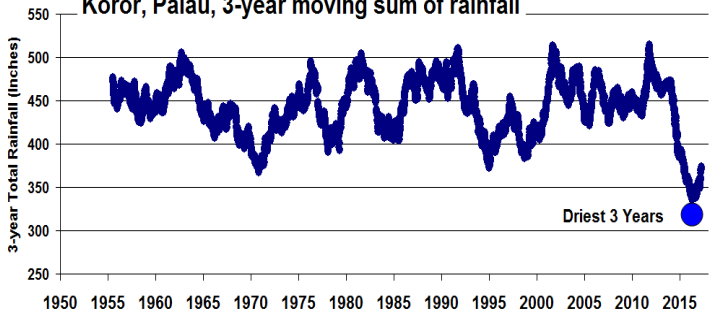
longed reduction of Palau’s rainfall caused major disruptions during late 2015 through the first half of 2016 to the municipal water supply and ecological impacts such as brush fires, reduced stream flow, yellowing of vegetation, and the death of millions of jellyfish in Palau’s world-famous Jellyfish Lake. We prom-

1<sup>st</sup> Quarter, 2017

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ised a report on the status of the recovery of Jellyfish Lake, but sad to say, there are recent reports from Palau that mature jellyfish are still absent from the lake. Some good news is that the juvenile polyps that will release the next generation of adult medusae seem to be in good shape. Also, the Rock Islands are once again lush and green.

**Climate Outlook:** Computer model forecasts are now indi-



**Figure PL2.** A time series of a 3-year moving sum of the rainfall at the Koror WSO. Values plotted are 5-year totals looking backwards from the plotted location. That is, the plotted value at January 1980 is the rainfall total for the 3-year period ending in January 1980.

Republic of Palau Rainfall summary: JFMA & 1 <sup>st</sup> QTR 2017						
Station		Jan	Feb	Mar	Apr	1 <sup>st</sup> QTR
Koror WSO	Rain (Inches)	13.30	14.99	18.26	5.54	52.09
	% of avg.	124%	164%	223%	64%	186%
Intl. Airport	Rain (Inches)	11.28	13.95	19.50	9.49	54.22
	% of avg.	96%	139%	216%	100%	176%
Nekken	Rain (Inches)	13.53	18.03	15.59	6.63	53.78
	% of avg.	126%	198%	190%	76%	192%
Peleliu	Rain (Inches)	13.12	9.57	10.67	4.91	38.27
	% of avg.	123%	105%	130%	57%	137%

ating average to above average rainfall over the next three months, and the PEAC concurs with these projections. The climate is now in a state of ENSO-neutral, where it is anticipated to remain for at least the next two or three months. Thereafter the odds of El Niño developing begin to rise. In general, any movement of the state of the climate system in the direction of El Niño (whether from La Niña to ENSO-neutral, ENSO-neutral to El Niño, or La Niña to El Niño) correlates well with average to above-average rainfall at least through the first half of the year, with a possible decrease of rainfall amounts later in the year. During El Niño, Palau is one of the first locations to experience a reduction in rainfall, as was seen during the 2015-16 El Niño event. The forecast for the state of ENSO is uncertain at this time, and the timing and strength of the next El Niño are crucial for the Palau rainfall forecasts. So, for now, we will keep the rainfall forecast at near average through the end of 2017.



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Through June 2017, the basin TC activity should continue to exhibit a westward shift, with a near average basin count of 3 or 4 named cyclones during March through June 2017. One or two of these TCs may become a tropical storm or low-end typhoon while passing north of Palau. The PEAC assesses the risk of some damaging effects, such as high waves, gales or very heavy rainfall at 10-15% (a 1-in-10 to 1-in-7 chance). The passage of destructive typhoons Bopha and Haiyan across Palau late in 2012 and 2013, respectively, shows that the status of ENSO is not a strong predictor of typhoon activity in Palau. Perhaps the biggest factor to yield a destructive typhoon in Palau is the need to have the typhoon stay far enough south to affect the island chain. This does at least narrow down the timing of greatest risk to the period mid-October to mid-January when low-latitude typhoon tracks are more common. Low-latitude typhoons Mike (1990), Bopha (2012) and Haiyan (2013) affected Palau in November or December. Notably, one major typhoon (Sally) affected Palau in March (1967).

Lastly, the sea level began 2017 at a moderately higher-than-average stand, but has remained stable – not rising or falling much – thereafter (see the sea level section for details).

Predicted rainfall for Palau from April 2017 through March 2018 is:

Palau Inclusive Period	% of long-term average / Forecast rainfall (inches) <sup>1</sup>
Apr-Jun 2017	100%
Jul-Sep 2017	110%
Oct-Nov 2017	100%
Jan-Mar 2018	100%

<sup>1</sup> Forecast rainfall quantities represent BEST ESTIMATES given the probabilistic forecast for each particular season and station.

\* The uncertainty of the long-range forecasts will remain very high until the timing of the onset and the anticipated strength of El Niño is known with more certainty.

**Republic of the Marshall Islands (RMI):**

The RMI continues to experience an extraordinary variability of rainfall, both in time and south-to-north across country. It was very wet in the spring of 2015, followed by a long period of very dry weather that began during September 2015 and lasting through the summer of 2016. Beginning in the summer of 2016, most locations began a long and steady climb out of dry conditions to end 2016 and begin 2017 with a string of wet months (Fig. RMI-1 and RMI-2). Some of the atolls from Majuro, and southward, experienced very wet conditions during the first four months of 2017, with 1<sup>st</sup> Quarter rainfall totals ranking the 2<sup>nd</sup> and 9<sup>th</sup> wettest at Mili and Majuro, respectively.

While most of the RMI atolls from Kwajalein and southward experienced a similar distribution of abundant rainfall over the first 4 months of 2017, there was a sharp decline of rainfall at many of the locations (e.g., Wotje, Utirik, Mejit, and Ailuk) north of the latitude of Kwajalein (8.7° N). Potable water supplies were quickly impacted, with household rain catchment tanks depleted. Emergency short-term assistance was provided by the RMI government to the drought-impacted northern is-

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lands.

Drought Update: Persistent dryness continued in the northernmost atolls into early May 2017. On the 24<sup>th</sup> of April, the President of the RMI declared a "State of Emergency" for the northern atolls and islands affected by the dry conditions. On the 4<sup>th</sup>

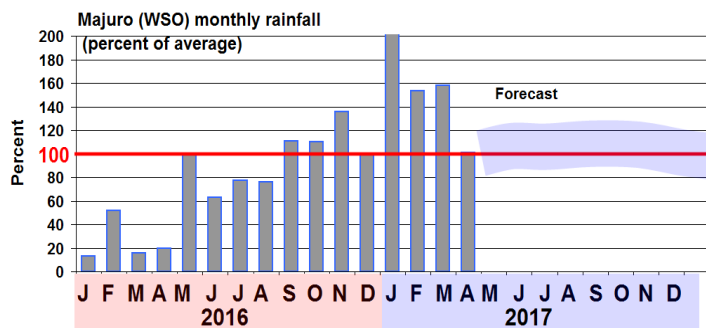


Figure RMI-1. A time series of rainfall at the WSO Majuro (gray bars) during 2016 and the first four months (JFMA) of 2017. Average to above average rainfall is forecast for the remainder of 2017 (light blue band).

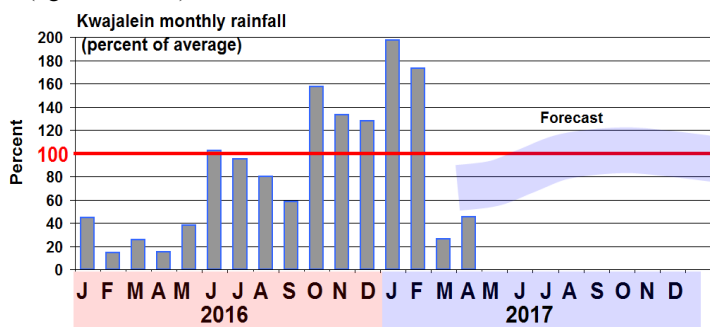


Figure RMI-2. A time series of rainfall at Kwajalein Atoll (gray bars) during 2016 and the first four months (JFMA) of 2017. All RMI atolls northward of Kwajalein experienced some version of dry conditions during the first four months of 2017. A gradual return to near average rainfall is anticipated through June, with near average rainfall thereafter (light blue band).

of May, a Drought Information Statement (DIS) was issued by the WFO Guam. Excerpts from the 4 May DIS include:

“VERY DRY WEATHER REMAINS ALONG AND NORTH OF 10N FROM THE DATE LINE WESTWARD OVER THE MARSHALL ISLANDS. ...

THE EXPERIMENTAL DROUGHT ASSESSMENT OF THE U.S. DROUGHT MONITOR STILL INDICATES THAT WOTJE AND UTIRIK OF THE NORTHERN MARSHALL ISLANDS ARE IN SHORT-TERM EXTREME DROUGHT (DROUGHT LEVEL 3 OF 4). ALSO...KWAJALEIN ATOLL ALONG WITH LOCAL COMMUNITIES...ESPECIALLY ENEBOUJ AND EBADON HAVE WORSENERED AND ARE NOW IN SHORT-TERM MODERATE DROUGHT (DROUGHT LEVEL 1 OF 4). ...

EXTREME DROUGHT IS AFFECTING WOTJE AND UTIRIK AND OTHER NORTHERN AND WESTERN ATOLLS. THE FAR NORTHERN MARSHALLS WILL REMAIN DRY IN THE COMING WEEKS AND ISLANDS ALONG AND NORTH OF ABOUT 8N TO 10N SUCH AS WOTJE...UTIRIK...RONGELAP...BIKINI AND ENEWETAK ATOLLS WILL SUFFER FROM CONTINUED DROUGHT CONDITIONS. RELATIVELY DRY CONDITIONS WILL ALSO AFFECT KWAJALEIN...MALOELAP... LIKIEP AND AILUK ATOLLS AND MEJIT ISLAND. WE WILL CONTINUE TO MONITOR THESE AREAS. ...

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THE MARSHALL ISLANDS GOVERNMENT INDICATES THAT UTIRIK, ENEWETAK, AILUK, WOTJE, AND MEJIT HAVE OPERATING REVERSE OSMOSIS (RO) SYSTEMS. DESPITE THESE SYSTEMS, LOCAL VEGETATION AND FOOD SOURCES WILL SUFFER FROM THE DROUGHT. LOCAL WELLS WILL CONTINUE TO BE SALTY. THE MARSHALL ISLANDS GOVERNMENT HAS ISSUED GUIDANCE FOR WATER CONSERVATION AND GOOD HYGIENE. ...”

RMI Rainfall Summary: JFMA & 1 <sup>st</sup> QTR 2017						
Station		Jan	Feb	Mar	Apr	1 <sup>st</sup> QTR
<b>RMI Central and Southern Atolls</b>						
Majuro WSO	Inches	17.65	9.43	13.07	10.36	40.15
	% Avg	209%	153%	158%	101%	176%
Ailing	Inches	12.75	7.39	7.76	9.82	27.90
	% Avg	196%	158%	125%	110%	161%
Jaluit	Inches	9.94	13.50	11.23	9.58	34.67
	% Avg	118%	220%	136%	93%	152%
Mili	Inches	17.09	9.50	20.15	12.99	46.74
	% Avg	203%	154%	243%	126%	204%
<b>RMI Northern Atolls</b>						
Kwajalein	Inches	9.00	5.60	1.07	3.44	15.67
	% Avg	197%	173%	26%	46%	132%
Wotje	Inches	0.08	4.48	0.99	5.23	5.55
	% Avg	4%	213%	35%	134%	78%
Utirik	Inches	0.63	.	.	T*	.
	% Avg	31%	%	%	<1%	%

\* T indicates a “trace” of rain reported. There were many missing days at this site, and recovery of data is being attempted.

**Climate Outlook:** Computer model forecasts indicate average to above average rainfall over the next 3 months on all RMI atolls south of the latitude of Kwajalein (8.7° N). At Kwajalein, the rainfall should climb back to near average by late May or June. At atolls located at latitudes north of Kwajalein, rainfall is also expected to climb back to near average over the next three months. Thereafter, rainfall throughout the RMI is anticipated to be at or above average for the remainder of 2017.

The climate is now in a state of ENSO-neutral, where it is anticipated to remain for at least the next two or three months. Thereafter, the odds of El Niño developing begin to rise. In general, any movement of the state of the climate system in the direction of El Niño (whether from La Niña to ENSO-neutral, ENSO-neutral to El Niño, or La Niña to El Niño) correlates well with average to above-average rainfall across most of the RMI, at least through the first half of the year. The extreme dryness during early 2017 in the northernmost atolls of the RMI is considered to be a regional anomaly lacking a clear connection to ENSO.

For the remainder of 2017, the threat of a damaging TC anywhere within the RMI is low (a 1-in-15 chance), but certainly there is a higher risk than during 2016. Note: any stronger-than-anticipated advance of the climate system toward El Niño carries with it a higher risk for a tropical storm or typhoon to track near or through the RMI. Three scenarios arise: in August and September, a TC from the Central Pacific tracks westward at relatively higher latitudes (~ 15° N) with minimal effects at most atolls; from October to December, a TC from the Central Pacific tracks westward at lower latitudes (~ 7-12° N) with potentially

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sever effects at many atolls; or the disturbance or tropical depression stage of one or two western Pacific TCs occurs within the bounds of the RMI, with intensification to tropical storm or typhoon taking place farther to the west.

Lastly, the sea level began 2017 at a moderately higher-than-average stand, but has remained stable – not rising or falling much – thereafter (see the sea level section for details).

*Predicted rainfall for the atolls of the RMI from April 2017 through March 2018:*

Inclusive Period	% of long-term average		
	South of 6°N	6°N to 8°N	North of 8°N*
Apr –Jun 2017	110%	110%	70%
Jul –Sep 2017	100%	110%	100%
Oct—Dec 2017	100%	110%	100%
Jan—Mar 2018	100%	100%	90%

\* With the establishment of typical summer upper-air patterns in June, even the northernmost atolls of the RMI should return to at least near average rainfall by that time.



**Hawaii:**

The following information was taken from the NWS Honolulu Office April 2017 Precipitation Summary and May 4<sup>th</sup> Drought Information Statement found at : <http://www.prh.noaa.gov/hnl/pages/hydrology.php>.

The October 2016 through April 2017 Hawaiian Islands wet season concluded in dramatic fashion with the passage of a sub-tropical cyclone, or kona low, near the state. The presence of this type of weather system near the island chain in mid-spring is rather unusual with less than 10 percent of all kona lows occurring in April and May. While unusual, it fits perfectly into what has been quite an erratic wet season across the State of Hawaii.

While the late April kona low had the most significant flooding impacts, other weather systems during the month also produced periods of enhanced rainfall. From April 13 through April 15, an upper level low pressure trough to the northwest of Kauai helped boost rainfall within the moderate trade wind flow. Windward areas of Kauai, Oahu, and the Big Island received about 1 to 3 inches of rain but no significant flooding problems were noted. This was followed by a weak cold front which moved across the state on April 16 but produced only a small increase in rainfall. However, its remnant moisture embedded within the trade winds generated 2-day rainfall totals of 5 to 10 inches on the windward slopes of Maui (April 17 and 18) and the Big Island (April 18 and 19).

Weather systems during the latter half of April helped end the Hawaiian Islands wet season with drought conditions still present but improving. The only remaining drought areas in the state were on the Big Island where severe drought, or the D2 category on the U.S. Drought Monitor map, covered portions of the North Kona, South Kona, and Kau Districts. The rest of the leeward areas on the Big Island were mostly under moderate drought, or D1 category conditions. A late season kona low that affected the state at the end of April may have provided enough rainfall to pull out of the severe drought category but some time is needed to see if sufficient regrowth and follow-up rainfall

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occur. Moderate drought that covered portions of Maui and Mokolai were erased as a result of the recent rainfall.

**Climate Outlook:** The National Multi-Model Ensemble (NMME) favors above median precipitation for much the boreal summer. The CPC constructed analog (CA) tool favors below median rainfall for each of the next 12 seasons. The outlook favors the dynamical guidance for the first lead, in the regions where the signal is strongest. Some dynamical models predict a warm event (El Niño) by the northern hemisphere autumn, continuing into winter 2017-18. If correct, historical El Niño composites favor increased odds for dry conditions for Hawaii in winter, which is consistent with the forecast from the ca tool. The middle leads reflect the uncertainty implied by the disagreement in the dynamical models and the ca tool. The latter portions of the outlook reflect the consistency among the ca and implications of dynamical model outlooks favoring El Niño.

**Seasonal Drought Outlook for Hawaii:** The CPC drought outlook issued in May 18th ([http://www.cpc.ncep.noaa.gov/products/expert\\_assessment/sdo\\_discussion.php](http://www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_discussion.php)) had expanded drought (D1 or drier) into

Predicted rainfall for Hawaii State from December 2016 through August 2017 is:

Inclusive Period	Station			
	Hilo	Honolulu	Kahului	Lihue
Apr –Jun 2017	Equal probabilities of below, average or above average rainfall	40% chance of Above Median rainfall	Equal probabilities of below, average or above average rainfall	40% chance of Above Median rainfall
Jul –Sep 2017	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
Oct—Dec 2017	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
Jan—Mar 2018	40% chance of Below Median rainfall	40% chance of Below Median rainfall	40% chance of Below Median rainfall	40% chance of Below Median rainfall

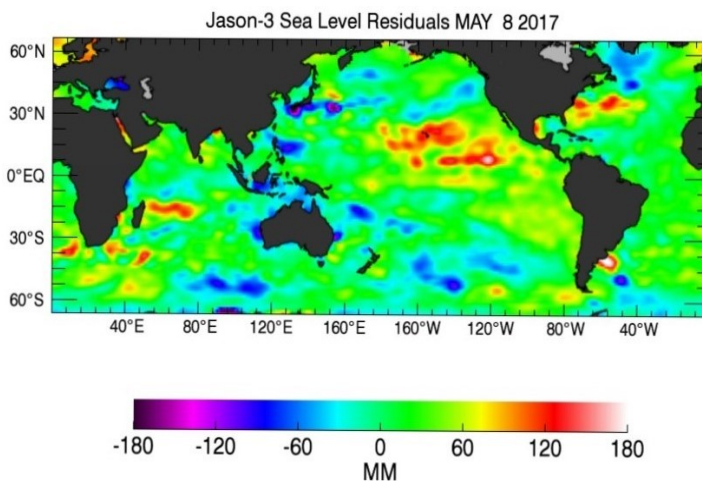
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eastern Maui and the western Big Island of Hawaii while the remaining islands awhere and still are in D0. Coming out of the winter wet season, odds favored persistence of drought during the late spring and early summer months as monthly rainfall totals typically decrease. The Hawaii May and MJJ precipitation outlooks called for Equal Probabilities. With respect to development, models favor slight above-normal rainfall odds across the northern islands (Kauai and Oahu) based upon possible El Niño development later this year, thus no development introduced. Similarly in the central islands (Molokai, Lanai, eastern Maui), with no tilt either way for above or below median rainfall (EC), no development was added. Farther south on the Big Island, with EC forecast, persistence was noted for the western (leeward) side. For the eastern (windward) side, the trade winds are expected to return and bring typical showers which should be enough to stave off development during MJJ.

**SEASONAL SEA LEVEL OUTLOOK Cont.**

**Sea Level Observation from the Global Satellite Picture:**

Observations from the recent global satellite picture (Fig. 8, below) revealed that the sea levels have been high over the western part of the Pacific Basin. **The tropical Pacific atmosphere and ocean are currently at ENSO-neutral state.** This satellite data are supportive to tide-gauge observations, and revealed that some of the stations located in Micronesia and Marshalls Islands is falling and coming closer to normal. This is a turning point when sea level transitions to normal/below normal from its year-long above normal state.

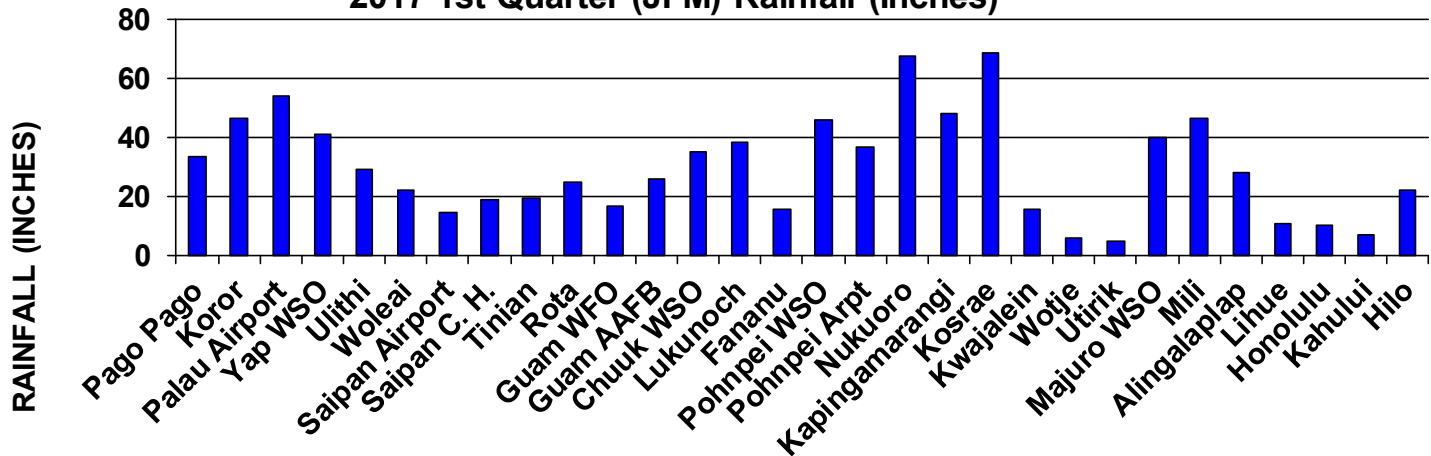


**Figure 8.** Jason-3 sea level residuals (May 8, 2017). (Source: [https://sealevel.jpl.nasa.gov/images/latestdata/jason/2017/20170508\\_G.jpg](https://sealevel.jpl.nasa.gov/images/latestdata/jason/2017/20170508_G.jpg) )

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To receive notification when the newsletter is available online visit:  
<http://www.weather.gov/peac/update.php>

SEASONAL RAINFALL OUTLOOK FOR THE US-AFFILIATED PACIFIC ISLANDS

9) 2017 1st Quarter (JFM) Rainfall (Inches)



10) 2017 1st Quarter Rainfall. Percent of Average

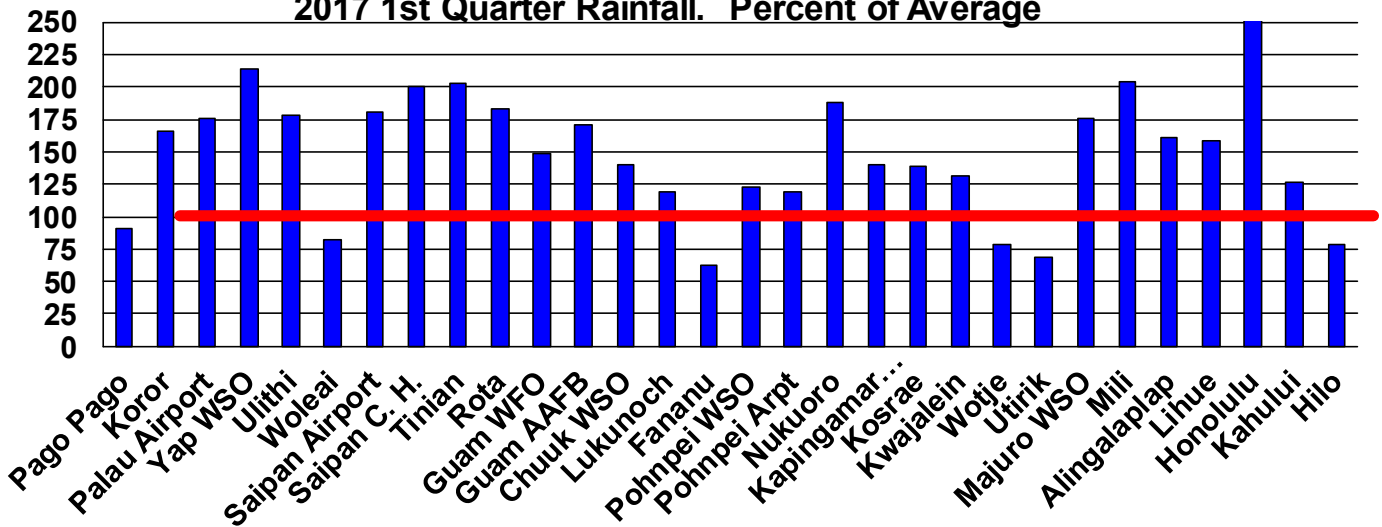


Figure 9 and 10, 2017 First Quarter Percent of Average rainfall amounts in inches at the indicated locations and rainfall departure from average (in percent) at the indicated locations.

ACKNOWLEDGEMENTS AND FURTHER INFORMATION

**Pacific ENSO Applications Climate (PEAC) Center:**  
 HIG #340, 2525 Correa Road, Honolulu, Hawaii'i 96822  
 Contact at 808-956-2324: for information on PEAC, the Pacific ENSO Update and ENSO-related climate data for the Pacific Islands.

Dr. Rashed Chowdhury,  
 Principal Research Scientist, at 808-956-2324: for information on ENSO and sea level variability in the USAPI.  
 Alejandro Ludert, Graduate Research Assistant and Webmaster, at 808-956-2324 for: information related to the PEAC website.

**University of Hawai'i - Joint Institute of Marine and Atmospheric Research (JIMAR), School of Ocean and Earth Science and Technology (SOEST), Department of Oceanography:**  
 MSB #317, 1000 Pope Road, Honolulu, Hawaii'i 96822  
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**NOAA National Weather Service Weather Forecast Office (WFO) Honolulu:**  
 HIG #250, 2525 Correa Rd., Honolulu, HI, 96822  
 Tom Evans, PEAC Director, at 808-973-5270: for information related to NWS.

**NOAA National Weather Service—Weather Forecast Office (WFO) Guam:**  
 3232 Hueneme Road, Barrigada, Guam, 96913  
 Chip Guard, Warning Coordination Meteorologist, at 671-472-0900: for information on tropical cyclones and climate in the USAPI.

**University of Guam - Water and Environmental Research Institute (WERI):**  
 UOG Station, Mangilao, Guam 96913  
 Dr. Mark Lander, PEAC Meteorologist, at 671-735-2685 for: information on tropical cyclones and climate in the USAPI.

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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](mailto:peac@noaa.gov) or at the address listed below.

PEAC is part of the Weather Forecast Office (WFO) Honolulu's mission and roles/responsibilities. All oversight and direction for PEAC is provided by the Weather Forecast Office Honolulu in collaboration with the Joint Institute for Marine and Atmospheric Research (JIMAR) at the University of Hawaii. Publication of the Pacific ENSO Update is supported by the National Oceanic and Atmospheric Administration (NOAA), National Weather Service-Pacific Region Climate Services. The views expressed herein are those of the authors and do not necessarily reflect the views of NOAA, any of its sub-agencies, or cooperating organizations.