PACIFIC ENSO UPDATE

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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

Weather conditions across Micronesia during 2017 were mostly unremarkable. Annual rainfall was near average to above average at most locations and tropical cyclone activity was much lower than average. The western North Pacific summer monsoon system was displaced to the west and north of Micronesia, accompanying a similar westward and northward displacement of the basin's tropical cyclones. These patterns of rainfall, wind and typhoon distribution were typical of an ongoing La Niña. The regional oceanic response to La Niña climate conditions (e.g., increased trade-wind strength) was a sustained high stand of the mean sea level

Temperature

The temperatures across Micronesia in 2017 were mostly above average. The warmth was persistent, with above-average readings occurring during most or all the months of the year. Only Yap Island and Pohnpei Island reported moderate negative departures of temperature. Saipan reported extraordinary warmth with daytime highs +3.42°C above average during the 2nd half of the year. The reason for Saipan's excessive warmth (with many records set for highest daily maximum, highest nighttime minimum, and an all-time high temperature of 96°F) is uncertain. WFO Guam is investigating the performance of Saipan's ASOS[1] temperature sensor.

[1] Automated Surface Observing System (ASOS)

Precipitation

Annual rainfall totals during 2017 were mostly higher than average throughout Micronesia (**see Figure 5 and Figure 6 on page 16)**, with below average seasonal and annual rainfall amounts restricted to the Northern Mariana Islands (Rota, Tinian and Saipan), a few of the northern atolls of Chuuk State and the northern atolls of the Republic of the Marshall Islands (RMI). The dryness in the northern RMI from late 2016 into early 2017 was of such severity that emergency supplies of potable water and supplemental food had to be brought to several of the atolls. During late 2017 (November and December) and continuing into January 2018, dry conditions affected the Mariana Islands, with the 0.96 inch January total at the WFO Guam setting a new historical low for the month.

Sea Level

The sea level across Micronesia exhibits large fluctuations related to ENSO. During the 2015 El Niño, the sea level dramatically fell across Micronesia. During 2016, with the demise of El Niño, the sea level began a steep climb to become 6-8 cm above average by the end of the year. For all of 2017 the sea level remained well above average throughout Micronesia, Hawaii and American Samoa (Fig.1), as La Niña became established in the 2nd half of the year. Variations of sea level across Micronesia are almost entirely an artifact of forcing by the Pacific trade wind system (blue line in Fig.2). Fortunately, because of a general lack of very high surf and swell, the high sea level in 2017 contributed to mostly nuisance inundations at times of unusually high astronomical tides. Two incidents of moderate inundation (both related to brief episodes of high wind and waves) occurred on the lagoon side of Majuro and on the northeast coast of Kosrae (see the LVS for these locations for more details).

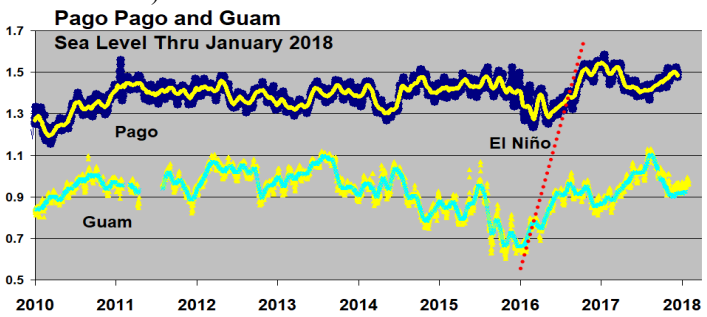


Figure 1. Sea level recorded at Guam and at American Samoa during 2010 to present. During El Niño, there is a sharp drop in sea level at most locations followed by a steep rise thereafter. The lowest sea level occurs at Guam a few months before the minimum is observed at American Samoa.

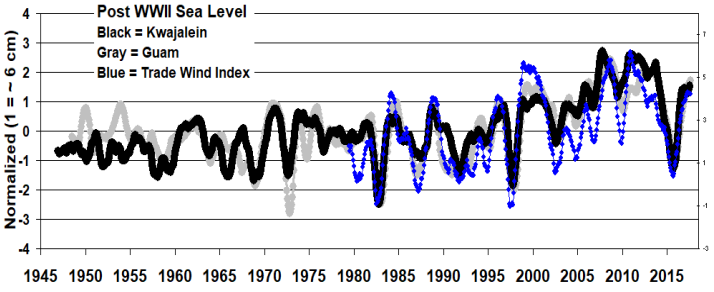


Figure 2. Post-WWII time series of sea level at Guam (NOAA Sumay Cove tide gauge) and at Kwajalein through January 2018. Black line is a 12-month moving average for Kwajalein and the gray line is the time series of Guam's sea level. The blue line is a 5-month moving average of NOAA's trade wind index (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. The trade-wind index commences in 1979 with the advent of geostationary satellite-derived low-level cloud-drift winds.

CURRENT CONDITIONS

CURRENT STATE OF ENSO

ENSO evolution

During the first few months of 2017, there were indications that El Niño conditions might develop as early as the summer months, and even more likely to do so by the fall months. Indeed, the SST in the Niño 3.4 region of the central equatorial Pacific warmed to near the threshold of El Niño by the end of the 2nd Quarter (Fig. 3). However, as the SST exhibited a warming trend, the atmosphere was unresponsive to it, and continued to exhibit behaviors consistent with ENSO-neutral or even with La Niña (e.g., a westward bias to TC formation and a delay-of-onset and westward shift of the western North Pacific monsoon trough). The La Niña-like weather patterns persisted through the 4th Quarter of 2017, as the climate system backed away from El Niño, with an onset of ocean cooling that now continues to be within the SST bounds of La Niña (see again Fig. 3). The CPC's latest ENSO advisory (appended below) continues the ongoing La Niña Advisory; however, it is now thought that the odds favor the demise of La Niña over the next few months.

ENSO Alert System Status: La Niña Advisory

Synopsis: *A transition from La Niña to ENSO-neutral is most likely during the Northern Hemisphere spring (~55% chance of ENSO-neutral during the March-May season).*

""During January 2018, La Niña was evident in the pattern of below-average sea surface temperatures (SSTs) across the central and eastern equatorial Pacific Ocean. The latest weekly index values were close to -1.0°C in the Niño-1+2, Niño-3, and Niño-3.4 regions, while the western-most Niño-4 region was -0.5°C. While negative anomalies were maintained near the surface, the sub-surface temperatures in the eastern Pacific Ocean returned to near average during the last month. This was due to the eastward propagation of above-average temperatures in association with a downwelling equatorial oceanic Kelvin wave, which undercut the below-average temperatures near the surface. The atmospheric conditions over the tropical Pacific Ocean also reflected La Niña, with suppressed convection near and east of the International Date Line and enhanced convection around Indonesia. Also, the low-level trade winds remained stronger than average over the western and central Pacific, while upper-level winds were anomalously westerly. Overall, the ocean and atmosphere system remained consistent with La Niña."

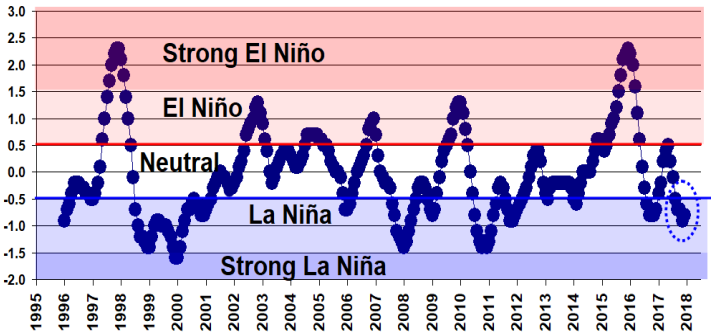


Figure 3. A plot of the CPC's Oceanic Niño Index (ONI) for the past two decades. Note that it made a run toward El Niño early in 2017, but then reversed and entered the La Niña category at mid-year (where it remains at the time of this writing).

"Most models in the IRI/CPC plume predict La Niña will decay and return to ENSO-Neutral during the Northern Hemisphere spring 2018. The forecast consensus also favors a transition during the spring with a continuation of ENSO-neutral conditions thereafter. In summary, a transition from La Niña to ENSO-neutral is most likely during the Northern Hemisphere spring (~55% chance of ENSO-neutral during the March-May season) (click CPC/IRI consensus forecast for the chance of each outcome for each 3-month period):

(http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-cpc_plume)."

[2] 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, Wellington, and RSMC-Nadi (Fiji). 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

For all the wild and crazy hurricane activity in the Atlantic basin, the TC activity in the Pacific was well below average in many categories (Table 1). The inactivity of the Pacific was enough, and in some cases, more than enough, to cancel the influence of Atlantic high activity on the summation of TC activity for the whole Northern Hemisphere!

The first half of the 2017 typhoon season of the western North Pacific (WNP) was relatively inactive, with only seven systems developing, of which only two intensified into tropical storms. Activity picked-up in late July, but by the end of the year, most number and intensity statistics remained below normal (see Table 1). For all of 2017, the JMA named 26 storms, including 10 typhoons. The JTWC numbered 33 TCs during 2017, but this relatively large number included an unusually high number of TCs that only reached the tropical depression stage, and were thus not named by the JMA. Until mid-October, when the developing typhoons Lan and Saola formed west of Guam and north of Yap Island, the WFO Guam had issued no tropical cyclone warning products (e.g. TS or TY watch/warnings) for Micronesia.

Throughout 2017, there was a westward and northward displacement of the TC activity. This was similar to the TC distribution during 2016, but starkly different than the TC distribution during the 2015 El Niño year (Figure 6). A particular characteristic of the 2017 typhoon season was a clustering of activity across the South China Sea. The westward and northward displacement of the 2017 TCs is consistent with the occurrence of La Niña. (See the LVS for each island group for specific TC details).

TROPICAL CYCLONE ACTIVITY

Table 1. Northern Hemisphere Tropical Cyclone Activity for 2017, by basin and hemisphere totals http://tropical.atmos.colostate.edu/Realtime/). Numbers in parentheses are long-term averages.

Basin	Named Storms	Named Storm Days	Hurricanes/ Typhoons	Hurricane Days	Major[3] Hurricanes	Major Hurricane Days	ACE
NAtl	17 (11.5)	91.25 (56.3)	10 (6.2)	51.25 (24.0)	6 (2.5)	19.25 (5.8)	226.0 (101.8)
ENP	18 (16.6)	66.00 (73.5)	9 (9.3)	19.75 (29.8)	4 (4.5)	4.75 (8.3)	98.2 (129.9)
WNP	**26 (25.8)**	**97.75 (134.8)**	**12 (16.7)**	**37.25 (67.8)**	**4 (9.4)**	**6.00 (24.4)**	**154.5 (304.1)**
NIO	4 (4.7)	10.75 (14.2)	2 (1.6)	4 (3.3)	1 (0.6)	0.25 (1.0)	16.1 (19.1)
N Hemi	65 (58.6)	265.75 (278.8)	33 (33.8)	112.25 (124.9)	15 (17.0)	30.25 (39.5)	494.8 (554.9)

[3] A major hurricane/typhoon has an intensity of CAT 3, or higher, on the Saffir-Simpson Hurricane Damage Potential Scale (i.e., maximum sustained winds greater than 110 mph).

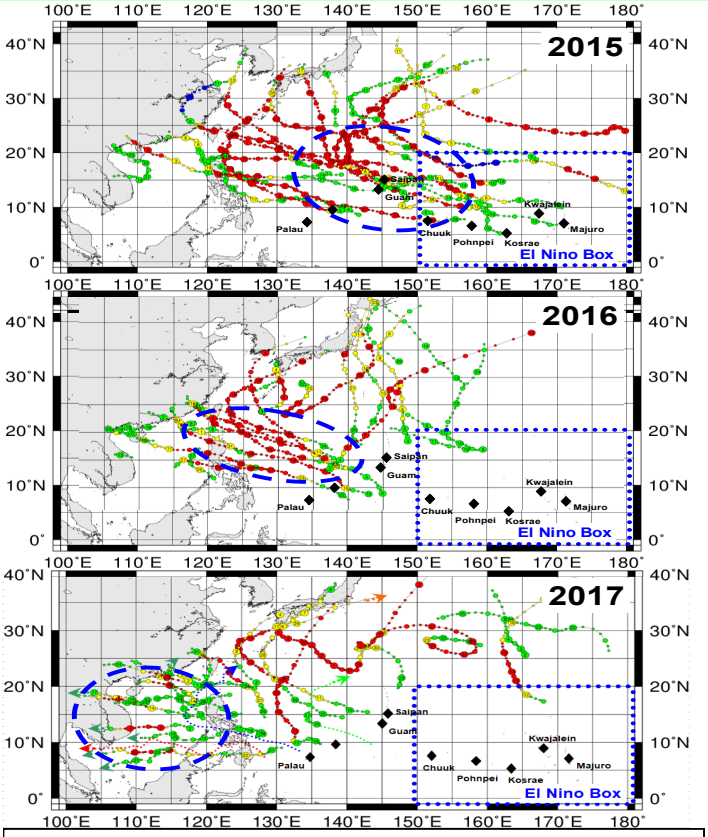


Figure 4. Tropical cyclone tracks during 2015, 2016 and 2017 in the western North Pacific. TCs 01W and 02W of 2017 were not named by the JMA. The blue "El Niño Box" is a region in which tropical cyclones occur primarily during El Niño.

EastPac

The eastern North Pacific (ENP) hurricane season was near average to below average in most number statistics (Table 1). There were no TCs having any serious impact to the state of Hawaii, and there were no TCs named by the CPHC in the central North Pacific.

Southern Hemisphere

The 2016-17 Southern Hemisphere (SH) TC season (ending on 30 June 2017) was remarkably quiet! Only 17 TCs were numbered by the JTWC in the entire Southern Hemisphere. The new 2017–18 Southern Hemisphere cyclone season (beginning 1 July 2017), now past its mid-point, has been well below average in overall numbers (10 named storms to-date versus an average of 17). Despite the low activity, one long-lasting and very intense cyclone (Gita) meandered across the South Pacific with serious impacts occurring throughout the region from American Samoa through Tonga, Fiji and on southward to New Zealand. (The TC forecast discussion is found below.)

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, Tropical Storm Risk (TSR), Dr Adam Lea and Professor Mark Saunders, Department of Space and Climate Physics, UCL (University College London). Neither of these entities has yet released an outlook for the 2018 western North Pacific typhoon season, although the first of the 2018 seasonal outlooks are scheduled to be released on, or about, March 1st.

Despite the lack of customary guidance, the PEAC anticipates that TC activity numbers will be at least near average during 2018. For example, the average annual number of named tropical cyclones passing within 180 n mi of each of either Guam, the CNMI, Yap or Palau is four. The average yearly threat of a damaging typhoon strike on Guam is roughly 1-in-7, or 15%. This will be the PEAC forecast until such time as other available forecasts provide a diverging outlook, or the forecast of the behavior of ENSO radically changes. 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.

The 2016-17 South Pacific cyclone season ended on June 30, 2017, with record low activity across several categories (cyclone numbers, major cyclone numbers and the quantity known as the Accumulated Cyclone Energy[1] (ACE)). The end-of-season total of 101.4 ACE units was only 48% of the average (see: http://models.weatherbell.com/tropical.php).

[1] ACE is an approximation of the wind energy used by a tropical system over its lifetime and is calculated every each six-hour period.

Late in 2017, two local agencies -- Australia's Bureau of Meteorology (BoM) and the New Zealand National Institute of Water and Atmospheric research (NIWA) issued seasonal outlooks for 2017-18 Southern Hemisphere TC activity. The BoM is called calling for near-average to slightly above average activity in each of the Australian TC regions. NIWA is calling for a slightly above average risk for a TC to move into New Zealand waters, a quote follows:

"Islands on the fringe of the north Coral Sea, including Papua New Guinea, the Solomon Islands, Vanuatu, New Caledonia and Tonga may experience slightly increased activity. Reduced activity is expected in some islands, especially those east of 160°W longitude, including the Cook Islands, the Marquesas and French Polynesia."

With due consideration to these local agency forecasts and the recent track of Cyclone Gita near American Samoa and Tonga, the PEAC foresees near average TC activity for the remainder of the cyclone season (ending 30 June 2018) for American Samoa. This translates to at least one more named TC passing near enough to American Samoa to bring marine gales, high waves and heavy rainfall. (See the American Samoa LVS for more details).

SEASONAL SEA LEVEL OUTLOOK FOR THE US-AFFILIATED PACFIC ISLANDS

The sea levels have been above-normal in the tropical western and central Pacific including most islands in southern Micronesia, Marshalls, Hawaii, and American Samoa. Satellite and model analyses continue to show high sea levels (>4 inches) across the North Pacific. Currently, the atmospheric and oceanic signals are leaning towards weak La Niña. La Niña means higher-than-average sea level in the USAPI region. Therefore, currently all stations are 4-10 inches above normal. However, as the La Niña is weak, so the elevated sea level may not last long and will get back to normal soon.

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 January-February-March (JFM), February-March-April (FMA), March-April-May (MAM), and April-May -June (AMJ) of 2018 , (ii) JFM return values at 20 and 100-yr period, (iii) the observed monthly mean and maximum sea-level anomalies for the previous season October-November-December (OND) 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 JFM, FMA, MAM, and AMJ of 2018

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 NDJ of 2017-18, the resulting CCA model has been used to forecast the sea level of four consecutive seasons: JFM, FMA, MAM, and AMJ (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 (JFM, FMA, MAM, and AMJ)

	Seasonal Mean Deviations [1]					Seasonal Max Deviations [2]					
Tide Gauge Station	**JFM**	**FMA**	**MAM**	**AMJ**	**Seasonal Outlook[3]**	**JFM**	**FMA**	**MAM**	**AMJ**	**JFM: 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	+4	+5	+5	+4	**Above**	+22	+21	+21	+21	5.6	6.7
Malakal, Palau	0	+3	+1	0	**Above**	+42	+41	+38	+36	9.6	14.3
Yap, FSM	+3	+4	+5	+3	**Above**	+33	+35	+35	+33	16.7	33.0
Chuuk, FSM**	+4	+4	+4	+4	**Above**	+33	+33	+32	+32	n/a	n/a
Pohnpei, FSM	+2	+4	+3	+3	**Above**	+33	+33	+32	+32	5.8	7.1
Majuro, RMI	+3	+3	+3	+3	**Above**	+45	+44	+43	+42	4.1	5.1
Kwajalein, RMI	+4	+4	+3	+3	**Above**	+45	+43	+41	+40	4.5	5.9
Pago Pago, Am. Samoa***	+7 (+2)	+6 (+1)	+6 (+1)	+6 (+1)	**Normal**	+32 (+27)	+32 (+27)	+33 (+26)	+33 (+26)	3.9	5.4
Honolulu, Hawaii	+2	+2	+2	+2	**Normal**	+20	+30	+20	+22	4.1	5.9
Hilo, Hawaii	+2	+2	+2	+2	**Normal**	+25	+23	+23	+25	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 2-4 inches) in American Samoa at the time of September 2009 earthquake. So, -2 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 above-normal (4-6 inches) *(normal and average are synonymously used throughout the sea level section)* in the forthcoming JFM-AMJ seasons. In Hawaii, both Honolulu and Hilo are likely to be slightly elevated, but still close to normal. Despite some rise during the later half of 2017, current observations revealed that all the stations are stable now. This rise is somewhat expected and the stable condition also corresponds very well with the current decaying phase of weak La Niña. However, even as the tropical Pacific Ocean returns to ENSO-neutral conditions, the atmospheric impacts from La Niña could persist during the upcoming months MAM to AMJ. So, sea level will still remain slightly elevated for the next couple of months. However, no further rise is anticipated.

Complementary to PEAC CCA statistical forecasts, some dynamical models *(see https://uhslc.soest.hawaii.edu/sea-level-forecasts/)* are also predicting higher sea levels. At longer leads (four to six months) these models suggest an increase in sea levels (likely again exceeding 6 inches above-normal for Majuro, Pohnpei, and Chuuk. This could potentially impact islands with minor coastal flooding or salt water intrusions and increase vulnerability to flooding from storms or large waves.

SEASONAL SEA LEVEL OUTLOOK FOR THE US-AFFILIATED PACFIC ISLANDS

Observed Monthly Mean Sea Level Anomalies (with respect to climatology) for Oct-Nov-Dec-Jan of 2017-18

The monthly time series (October to December) 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: After significant rise in September-October, the sea level recorded marginal fall in November and December of 2017. Only Pago Pago recorded further rise in December. As of December 2017, all stations are steady but stays well above normal. Other than Pohnpei and Majuro, there were no inundation recorded, so far *(See PEAC's monthly conference call notes for December-February).* Majuro suffered severe inundations in October, which was due to strong south winds across the lagoon placing the inundation on the south facing islet on the north side of the lagoon. It has been noted that when the sea state increases, possibility of inundation increases regardless of tide or sea level. However, high tide makes inundation worse.

Table 2: Monthly observed mean/maximum sea-level anomalies (inches) during Oct-Nov-Dec of 2017

Tide Gauge Station	Monthly Mean Deviations[1]					Monthly Max Deviations[2]				
	Oct	Nov	Dec	Jan	Standard Deviations	Oct	Nov	Dec	Jan	Sea level Trend
Marianas, Guam	+6.3	+6.6	+7	+8	**4.1**	+22(0)	+22(0)	+22(0)	+25(3)	Above-Stable
Malakal, Palau	**	**	+4	+3	**4.3**	+41(5)	+42(6)	+44(8)	+39(3)	Above-Stable
Yap, FSM	+7.3	+7.4	+9	+9.5	**4.6**	+35(8)	+34(7)	+4(13)	+37(9)	Above-Stable
Chuuk, FSM*	+6	+8	+9	+6	**	**	**	**	**	**
Pohnpei, FSM	**+9.2**	**	**+5**	**+7.5**	**4.7**	+33(3)	**	**	**	Above-Stable
Majuro, RMI	**+8.2**	**	**+8**	**+8**	**3.5**	+45(5)	**	**	**	Above-Stable
Kwajalein, RMI	+5.8	+7	+6	+9	**3.6**	+41(4)	+43(6)	+4(10)	+47(10)	Above-Stable
Pago Pago, American Samoa***	+10.2 [+5]	+11.2 [+6]	+11.5 [+6.5]	+11.5 [+6.5]	**3.1**	+30(-3) [25]	+34(1) [29]	+38(5) [33]	+38(5) [33]	Above-Stable
Honolulu, Hawaii	+4.8	+4	+4.7	+4.7	**1.7**	+21(1)	+24(4)	+26(6)	+27(7)	Above-Stable
Hilo, Hawaii	+6	+5.5	+5.5	+3.5	**1.8**	+23(0)	+26(3)	+28(5)	+31(8)	Above-Stable

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.

Synopsis of 2-years Sea Level Variability and Forecasts

Starting from OND of 2015, a comparative perspective of two years of seasonal sea level variations is given below (Fig. 7). The sea lever in the western Pacific started to rise from JFM of 2016. This rising trend continued up to JAS of 2016 and stayed elevated since then.

See page 15 for sea level observations from Jason-2 satellite picture (Fig. 8).

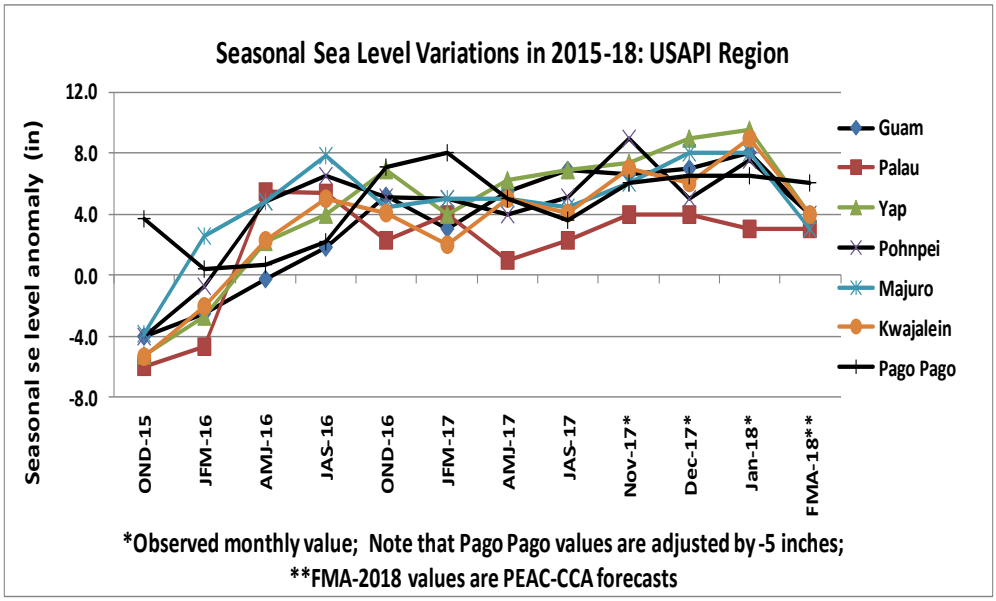


Figure 7. A comparative perspective of Island-wise seasonal sea level variations (OND 2015 to OND 2018) (*Note that Pago Pago data needs correction because of level shift after 2009 earthquake. ,There was a level shift (approximately 2-4 inches) at that time which has not been adjusted).

LOCAL SUMMARY AND FORECAST

American Samoa: The 2017 annual rainfall at the WSO Pago Pago was moderately above average despite seven months of the year having below average rainfall. Very high rainfall in some of the wet months (notably May and October) more than compensated for the deficit accrued during the below-average months (Figure AS-1). The 23.23 inches of rainfall at Pago Pago during May 2017 was the 2nd highest May total in its modern historical climate record, with the 20.11 inches recorded there in October ranking as the 3rd highest in the historical record. Whereas the weather in American Samoa was generally tranquil and unremarkable during 2017, a heavy daily rainfall event in May caused severe flooding across American Samoa and also in Independent Samoa (formerly Western Samoa).

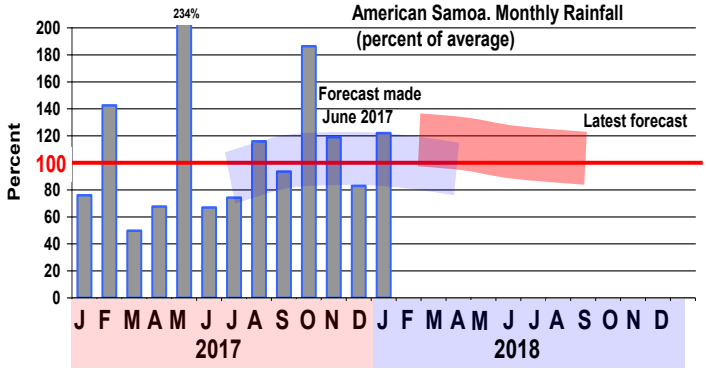
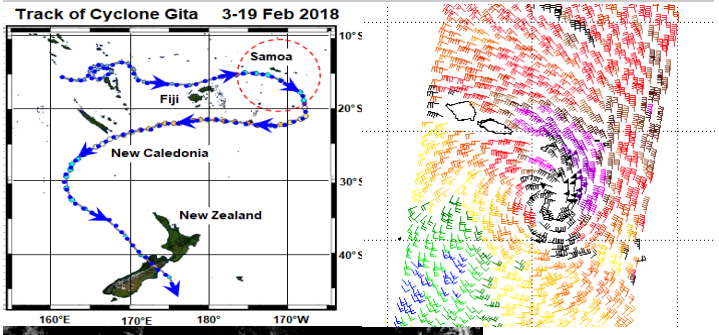


Figure AS-1. A time series of the monthly rainfall at Pago Pago from January 2017 through January 2018. Note that most of the months of 2017 had below average rainfall with the spectacular exceptions of May 2017 and October 2017. An earlier rainfall forecast made by the PEAC in June 2017 is shown in light blue, and a new forecast for the next several months of 2018 is shown in light red. Note that the earlier forecast was accurate. The latest forecast continues to call for above average rainfall for the next few months, with a gradual return to average to slightly above-average rainfall during the upcoming dry season.

Breaking news: Cyclone Gita

Early on the morning of 09 February, Cyclone Gita swept past American Samoa (Figure AS-2) bringing a period of damaging west-northwesterly wind, with a peak gust of 63 mph recorded at the WSO Pago Pago. The cyclone was tracking to the east-southeast along the axis of the monsoon trough during its passage to the south of American Samoa. Very heavy flooding monsoonal rains occurred in American Samoa during the two days prior to the direct passage. The WSO Pago Pago reported 5.24 inches of rainfall on the 7th and 2.60 inches on the 8th. The peak wind occurred in the early morning of the 9th, but only a further 0.67 inches of rain accompanied the surge of wind at Gita's closest point of approach (CPA) to American Samoa. At the CPA, the JTWC intensity of Gita was diagnosed to be 45 kt G55kt (55 mph G65 mph). The peak gust of 63 mph at the WSO Pago Pago fits well with the diagnosed intensity and with the scatterometer-derived wind speeds near this time (Figure AS -2). Damage included destruction of some homes, roofs blown away, and many trees blown down. Some residents perceived the wind to be at hurricane intensity. An investigation of the intensity and damage characteristics of Cyclone Gita on American Samoa is underway, and at the time of this writing the warning coordination meteorologist of the WFO Guam has travelled to American Samoa to help in the meteorological assessment. A more complete report will be available at a later time.

LOCAL SUMMARY AND FORECAST



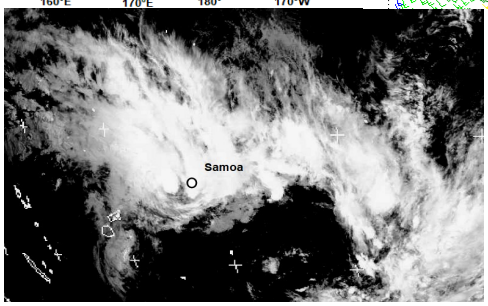


Figure AS-2. The long upside-down "S"-shaped track of Cyclone Gita is shown on the left. Gita was a long-lived storm that at first was swept eastward along the axis of the monsoon trough to pass to the south of American Samoa as a tropical storm. Much of the heavy rainfall occurring in American Samoa over the two days leading up to the nearby passage of Gita was of monsoonal origin (see picture on the upper right). The ASCAT scatterometer pass over Gita around 10 AM (American Samoa time) on the 9th shows a wide swath of gales on the cyclone's north side (purple wind barbs) with peak winds of storm force (50 kt, or 60 mph).

American Samoa Rainfall Summary: OND 2017, 4th Qtr. & 2017 Annual

Station		Oct	Nov	Dec	4thQtr	Annual
Pago Pago WSO	Rain (in)	20.11	12.89	12.06	45.06	133.42
	% Avg.	186%	119%	83%	125%	110%
Siufaga Ridge*	Rain (in)	18.09	12.00	8.26	38.35	153.18
	% Avg.	89%	68%	43%	67%	85%

Climate Outlook: Computer model forecasts are now indicating above-average rainfall over the next three months at Pago Pago, and the PEAC concurs with these projections.

In the previous newsletter, the forecast for TC activity for American Samoa was considered to be below average for the 2017-18 cyclone season. The official forecast issued by the WSO Pago Pago anticipated 0-2 TCs passing within 300 n mi of the Samoan Islands. Now, with one TC having passed close to Samoa, it would be prudent to consider that in the remaining months of the cyclone season at least one more cyclone will affect American Samoa, with the twin threats of heavy rainfall and gales. The heavy rainfall can lead to flash floods and mudslides

Predicted rainfall for American Samoa from January 2018 through December 2018 is:

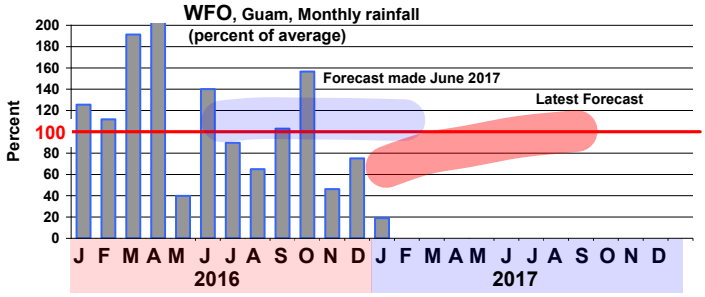
Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]
January - March 2018 (Heart of Rainy Season)	115%
April - June 2018 (Onset of Next Dry Season)	110%
Jul - Sep 2018 (Heart of Next Dry Season)	100%
Oct - Dec 2018 (Onset of Next Rainy Season)	110%

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

LOCAL SUMMARY AND FORECAST

Guam/CNMI: The 2017 annual rainfall on Guam and in the CNMI was generally near average (Figure G1), with numerical totals and percentages falling from south-to-north in the following order:

Guam = 97.17 inches (107%), Rota = 92.77 inches (98%), Tinian = 80.22 inches (96%) and Saipan = 62.30 inches (84%). The character of the weather throughout 2017 was rather mellow and unremarkable. The monsoon was late, and then either weak or absent through the rainy season. Tropical cyclone activity was below average. October was the wettest month of the year across the region as the monsoon and two accompanying tropical cyclones made a push, at last, into the region. The wettest storm event of the year on Guam was a wind-driven island-wide heavy rainfall of 4-6 inches over the 17th and 18th of October. Persistent southwesterly winds gusted to 35-40 mph for three days. Saipan also had gusty winds and heavy rainfall during this event, albeit with less rainfall (1.97 inches at the SIA), but with more wind (at the SIA, the winds reached a sustained value of 45 mph with a peak gust to 59 mph). Dry conditions became established in November and December, as the monsoon departed and TC activity in the basin shifted far to the west (see the TC discussion).



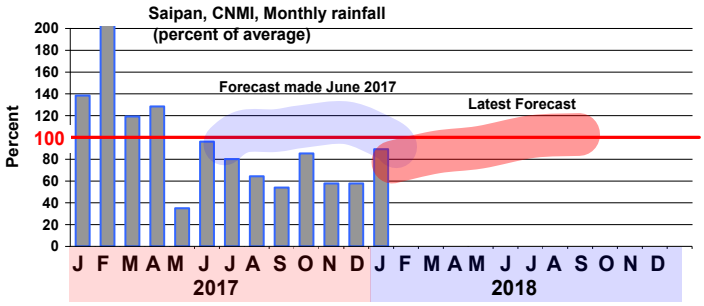


Figure G1. A time series of monthly rainfall percentages at the Guam WFO. **Bottom**: Same as the top panel, but at the Saipan International Airport. Prior forecasts of rainfall made in June 2017 by the PEAC (just for illustration) are indicated by light blue bands. The forecast rainfall going into 2018 is indicated by the light red bands. Note that the rainfall on Guam and Saipan was much drier than forecast, with a particularly long shortfall at Saipan.

Sidebar: The personal drought

The dry conditions of November and December were unanticipated. Computer forecasts used by the PEAC consistently indicated above average rainfall in the region for several of monthly forecast cycles. The dry conditions continued into 2018, with the 0.94 inches at the Guam WFO during January 2018 setting a new historical low for the month of January. Impacts of dry conditions emerged by late December with an uptick of wildfires on Guam, and an early drawdown of potable water supplies on Saipan (e.g. the Donne Spring). Guam and the islands of the CNMI were moved into the drought categories of D0 (unusually dry) and D1 (moderate drought) on the U.S. drought monitor

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(author: Mr. Richard Heim) as impacts intensified. Whereas Guam and the CNMI were unusually dry at the end of 2017 and continuing into early 2018, most of the rest of Micronesia had abundant rainfall. These small scale "personal" droughts, covering, at most, a geopolitical state, such as the Mariana Islands, or a subset of atolls of the RMI, are hard to forecast. Micronesia region-wide droughts that are associated with El Niño are much easier to forecast, with the PEAC perfect forecast for below average rainfall across all of Micronesia during early 2016 a good example.

Guam and CNMI Rainfall Summary: OND 2017, 4th Qtr. & 2017 Annual

Station		Oct	Nov	Dec	4th Qtr	Annual
GUAM						
GIA (WFO)	Inches	18.47	4.23	4.49	27.19	97.17
	% Avg	153%	52%	83%	106%	107%
AAFB	Inches	14.74	5.05	4.33	24.12	93.45
	% Avg	114%	56%	73%	86%	95%
Southern Mountain	Inches	15.49	4.71	5.53	25.73	103.44
	% Avg	120%	52%	93%	92%	105%
CNMI						
Saipan Intl. Airport	Inches	9.58	3.48	2.31	15.37	62.30
	% Avg	89%	60%	60%	75%	84%
Capitol Hill	Inches	10.67	3.48	2.31	16.46	77.18
	% Avg	89%	48%	48%	68%	93%
Tinian Airport	Inches	16.63	3.04	2.96	22.63	80.22
	% Avg	139%	42%	62%	94%	96%
Rota Airport	Inches	22.91	2.92	3.41	29.24	92.77
	% Avg	181%	34%	60%	108%	98%

Climate Outlook: La Niña is here! During La Niña, rainfall across Guam and in the CNMI follows the rules below:

(1) During the year directly following El Niño (e.g., 2016), it is dry, even if the onset of La Niña conditions occurs in that year (e.g., 1998);
(2) During La Niña conditions in a year that does not directly follow El Niño (e.g., 2017), whether making an onset or persisting from a prior year, the rainfall is typically near average, with few extremes of heavy rainfall (this was largely correct for 2017!);
(3) Any movement of the climate system in the direction of El Niño (whether from La Niña to ENSO-neutral, or La Niña to El Niño or ENSO-neutral to El Niño tends, to be wetter than average).
(4) During a year in which La Niña or ENSO-neutral conditions aggressively give way to strong El Niño conditions later in the year, it is very wet, and the chances for extremes of heavy rainfall (and tropical cyclone impacts) are high.

With weak La Niña now in-place, and expected to transition to ENSO-neutral over the next few months, it is not surprising that computer model forecasts are aggressively indicating above average rainfall over the next three months across Guam, the

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CNMI, and, indeed, across most of the rest of Micronesia. For the past three months, such aggressive forecasts for wetter than average rainfall for Guam and the CNMI have been incorrect; instead, a "personal" drought occurred in the region. The PEAC has manually tempered the current model aggressiveness for above average rainfall for Guam and the CNMI, and shows a gradual movement out of dry conditions to near-average rainfall by the spring (MAM).

The threats of impacts in the region from a TC during the first half of 2018 are considered to be near average. This means that through June, one or two numbered or named TCs may pass to the south of Guam bringing some rain, gusty winds and high seas to all islands (25% chance), while the risk of a damaging strike is also near average at 5-10%. The remainder of 2018 should see 2 or 3 additional TCs in the region bringing at least some heavy rain, marine gales and high seas, with the risk of a damaging strike rising to 15-20% (near average).

Predicted rainfall for the Mariana Islands from January through December 2018:

Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]	
	Guam/Rota	Saipan/Tinian
Jan-Mar 2018 (1st half of next dry season)	75%	80%
Apr-Jun 2018 (2nd half of next dry season)	95%	95%
Jul-Sep 2018 (Onset of next rainy season)	110%	110%
Oct-Nov 2018 (End of next rainy season)	100%	100%

* That the CNMI is indicated to be having a higher percentage of rainfall than at Guam is an artifact of the typical very low average value of rainfall in the CNMI during the dry season.

** The high rainfall in these months is predicated on occurrence of an active monsoon and a near-average value of TCs in the region.

Federated States of Micronesia

Yap State: Extreme variation of monthly rainfall continued at Yap Island during 2017 (Figure Y1). Since late 2015 and continuing to the present, there have been four extended periods of extreme rainfall: two very wet and two very dry. The year 2017 began with a wet spell that was then followed by an extended period of dry weather during the spring and summer months (the 6-month period AMJJAS 2017 was the 11th driest such period in the 65-year climate record at the Yap WSO). Heavy rainfall in October 2017 signaled the onset of another prolonged period of wet weather. The 4th Quarter total rainfall at the Yap Island WSO of 39.66 inches was 132% of the average value. The rainfall anomalies were coherent across most of Yap State as the time series of monthly rainfall at Ulithi shows (also plotted on Figure Y1).

The dryness of the 2nd and 3rd quarters was unforeseen, and the PEAC 3-month outlooks (made in early April and again in early July) for the 2nd and 3rd Quarter rainfall, respectively, had called for near-average to above-average rainfall. The rainfall was, instead, below average, until a very wet October began a prolonged period of wet weather that then tracked the long-range forecasts much better (Figure Y1).

The 2017 onset of the western North Pacific monsoon was delayed until July, and thereafter the monsoon remained weak through September. The axis of the monsoon trough was continually south and west of its usual position with light easterly trade winds dominating the weather pattern across Yap State. The delayed and weak monsoon and lack of tropical cyclones in the region likely contributed to the dryness of the 2nd and 3rd quarters. A surge in the monsoon during October and its associated outbreak of TCs, brought abundant rainfall to Yap in that month. In the final months of 2017, the monsoon trough and its associated TC activity were focused near the Philippine Archipelago and in the South China Sea. Nevertheless, areas of disturbed weather that were the precursors to the late-season TCs farther to the west, brought abundant rainfall across Yap State to finish-off 2017 on the wet side.

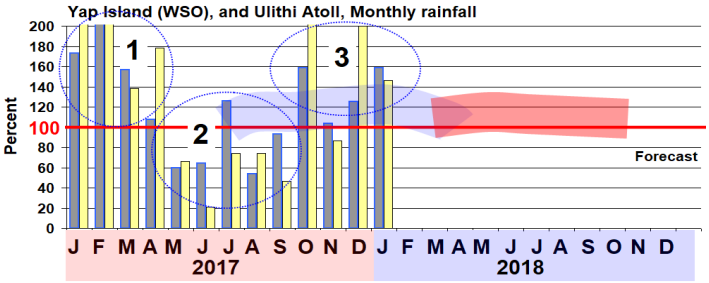

Figure Y1. Time series of monthly rainfall at the Yap Island WSO (gray bars) and Ulithi Atoll (yellow bars) for 2017. Three prominent and prolonged rainfall extremes appear within the dotted blue circles: (1) a very wet period extending across the first four months of the year; (2) a prolonged dry period from May through September; and, (3) another period of wet weather to finish off the final 4 months of the year. The magnitude and length of the 5-month dry spell that commenced in May 2017 was not well forecasted (blue-shaded bar), but the wetness of the final four months of the year was well-captured. The current forecast (red-shaded bar) anticipates average to above-average rainfall through the summer months.

Yap State Rainfall Summary: OND 2017, 4th Qtr. & 2017 Annual						
Station		Oct	Nov	Dec	4thQ	Annual
Yap State						
Yap WSO	Inches	18.99	9.40	11.27	39.66	139.64
	% Norm	159%	104%	125%	132%	116%
Ulithi	Inches	27.12	6.66	15.28	49.06	124.87
	% Norm	267%	86%	200%	192%	122%
Woleai	Inches	11.10	9.55	7.47	28.12	105.26*
	% Norm	82%	88%	65%	78%	76%

* Some months of the year had several missing days with unknown impact on totals.

Climate Outlook: Computer model forecasts continually indicated wet conditions for Yap State for all of the monthly forecast cycles for 2017. This is one of the reasons that the mid-year dry spell was not foreseen, as the computer model forecasts made in April (and again in July) over-estimated the AMJ and JAS monthly rainfall totals, respectively. With La Niña now in-place, computer model forecasts are still aggressively indicating above average rainfall across Yap State over the next three months. During the February PEAC conference among all the US-API stakeholders, the PEAC decided to let stand the very aggressive forecasts for wet conditions across Yap State over the next three months. The rationale for now accepting the computer forecasts of wet weather is the following: given that the mid-year dryness was likely a result of altered rainy season weather patterns (e.g., a delayed and weak western North Pacific monsoon, and reduced TC activity), rainfall through the 2017-18 dry season should not be similarly impacted, and rainfall is anticipated to be at least near average, if not above average as indicated by the models.

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Through May of 2018, the PEAC assesses the risk of some damaging effects from the near passage of a TC, such as high waves, gales or very heavy rainfall at 10-15% (a 1-in-10 to 1-in-7 chance) for each of the islands of Yap State, particularly from Yap Island northeastward through Fais and Ulithi (this risk is about average for this time period). With the long-range evolution of ENSO somewhat uncertain at this time, and with the absence of other agency typhoon outlooks (at least until March 1st), the TC outlook through the summer and fall of 2018 will be discussed in more detail in the next newsletter (May 2018).

Predicted rainfall for Yap State from January 2018 through December 2018 is:

Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]	
	Woleai	Yap & Ulithi
January-March 2018 (Onset of next Dry Season)	95%	110%
April-June 2018 (End of Dry Season)	90%	115%
July-September 2018 (Onset of next Dry Season)	95%	110%
October-December 2018 (End of next Dry Season)	90%	110%

Chuuk State: The 2017 annual rainfall across most of Chuuk State was near average; although some of the northern atolls (e.g., Fananu and Onoun) were very dry in the first half of the year. There was high seasonal variability of rainfall throughout Chuuk State during 2017 that included three major anomalies (Figure CH-1):

(1) A period of high rainfall during the 6-month period OND (2016) – JFM (2017);

(2) Another period of persistent dryness during the 5-month period AMJJA (2017); and,

(3) A wet finish to the year (SOND) 2017 (particularly in the Chuuk lagoon and some of the atolls of the southern Mortlocks).

During the first half of 2017, dryness in the northern atolls was of sufficient severity to impact the availability of potable water. The northern atolls of Chuuk State were mentioned in a series of Drought Information Statements (DGTs) issued by the WFO Guam during the 1st Half of 2017. However, due to a small (but sufficient) increase of rainfall in June and early July, mention of the northern atolls of Chuuk State was dropped from the DGT issued on 20 July. The dryness at Polowat is thought to be, in part, an artifact of poor exposure of the rain gauge. No reports of impacts of low rainfall were received from this or nearby atolls. The PEAC rainfall forecasts for the 3rd and 4th quarters were spot-on (Figure CH-1).

The sea level across Micronesia exhibits large fluctuations related to ENSO. During the 2015 El Niño, the sea level dramatically fell. During 2016, with the demise of El Niño, the sea level began a dramatic climb to become above average by the end of the year across all of Chuuk State and elsewhere in Micronesia. The sea level remained well above average during all of 2017, as La Niña became established in the 2nd half of the year. Variations of sea level in Chuuk State (and across Micronesia) are almost entirely forced by the Pacific trade wind system. Fortunately, because of a general lack of large waves and swell, the high sea level in 2017 resulted in mostly nuisance splash-over and higher-than-average shoreline run-up at times of unusually high astronomical tides. In addition, the elevated mean sea level coupled with high astronomical tides and gusty winds yielded some notable rough sea conditions just offshore of the International Airport runway.

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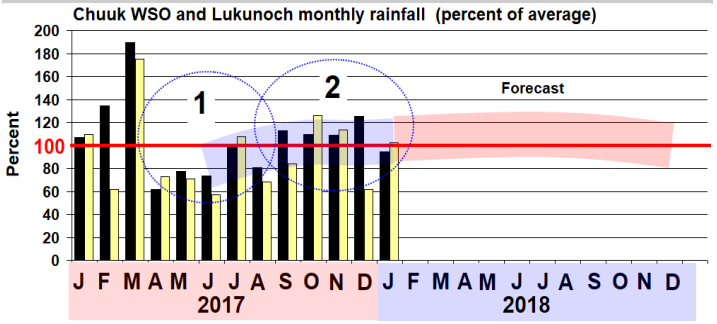

Figure CH-1. A time series of the monthly rainfall at the WSO Chuuk (black bars) and at Lukunoch (yellow bars) during 2017. The transition from an extended dry period (the blue circle "1") to a period of wet weather (blue circle "2") was well-captured by the long-range forecast made in June (light-blue band). The light red band is the latest long-range rainfall prediction for the next several months.

Sidebar: Waterspout danger

Late in December 2016, and again in October 2017, a landfalling waterspout caused damage on an atoll of Micronesia. In the former case, a large and intense waterspout swept across Falalop (one of the islets of the Ulithi Atoll). Eyewitnesses described a surge of high wind that blasted across the islet filling the air with lofted debris that appeared to be rotating. The Ulithi waterspout/tornado occurred in association with deep convection in a near-core rainband of Tropical Storm Nock-ten.

The next incident of a landfalling waterspout occurred on Saturday, October 14, when waterspouts were observed at Nomwin Atoll in the Hall Islands of Chuuk State. One of the waterspouts went ashore on Nomwin where "it was strong enough to topple banana trees, and weak houses were blown down and damaged" as reported to the WSO Chuuk. A boat was found capsized in Nomwin waters on Sunday, 15 October. It is thought by islanders that the boat was capsized by a waterspout. The Nomwin incident of waterspout formation occurred in association with the large area of heavy convective showers comprising the monsoon depression that would, 2 days later, become Tropical Storm Lan.

Chuuk State Rainfall Summary: OND 2017, 4th Qtr. & 2017 Annual						
Station		Oct	Nov	Dec	4thQ	Annual
Chuuk Lagoon						
Chuuk WSO	Inches	14.64	11.15	13.52	39.31	136.53
	% Avg	109%	108%	125%	114%	102%
Southern Mortlocks						
Lukunoch	Inches	13.10	12.38	7.90	33.38	131.74
	% Avg	126%	113%	61%	98%	92%
Northern Mortlocks						
Nama	Inches	10.81	13.33	19.93	44.07	108.19
	% Avg	81%	129%	184%	127%	81%
Northern Atolls						
Fananu	Inches	4.05	7.11	8.35	19.51	85.09
	% Avg	30%	69%	77%	56%	63%
Onoun	Inches	10.70	8.40	4.89	23.99	N/A*
	% Avg	80%	81%	45%	69%	%
Western Atolls						
Polowat	Inches	1.96**	N/A	N/A	N/A	N/A
	% Avg	28%	%	%	%	%

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Climate Outlook: With La Niña now in-place, computer model forecasts are still aggressively indicating above average rainfall across Chuuk State over the next three months. During the February PEAC conference among all the US-API stakeholders, the PEAC decided to let stand the very aggressive forecasts for wet conditions. During the spring of 2018, the ITCZ could be enhanced across the central and southern islands of Chuuk State, bringing abundant rains there in April, May and June.

Through May of 2018, the PEAC assesses the risk of some damaging effects from the near passage of a TC, such as large waves, gales or very heavy rainfall at 10-15% (a 1-in-10 to 1-in-7 chance) for islands and atolls of Chuuk State, particularly from Chuuk Lagoon and northward. With the long-range evolution of ENSO somewhat uncertain at this time, and with the absence of other agency typhoon outlooks (at least until early March), the TC outlook through the summer and fall of 2018 will be discussed in more detail in the next newsletter (May 2018).

Lastly, because of the strengthening of the Pacific trade wind system during La Niña, the sea level in Chuuk State now is at a higher-than-average stand of approximately 6 inches above the long-term average, and is forecast to remain at-or-above the magnitude of this elevated stand for the next three months, likely trending lower thereafter as La Niña transitions to ENSO-neutral. (see the sea level section for details).

Predicted rainfall for Chuuk State from January 2018 through December 2018 is:

Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]			
	Chuuk Lagoon, Losap, & Nama	Polowat	Northern Atolls	Mortlocks
Jan – Mar 2018	110%	85%	95%	110%
Apr-Jun 2018	115%	90%	100%	115%
Jul - Sep 2018	110%	90%	100%	110%
Oct - Dec 2018	110%	90%	100%	110%

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

Pohnpei State: For most of 2017, Pohnpei Island and the atolls of Pohnpei State had a long period of uneventful tranquil weather. The 2017 annual rainfall total at the WSO Pohnpei was above average, but with high month-to-month variability (Figure PN-1, top). The low-latitude atolls (Nukuoro and Kapingamarangi) were particularly wet during the first half of 2017, and then mostly dry during the 2nd half of the year, with the exception of an incredibly wet December at Kapingamarangi!

The 41.30 inches of rainfall during the month of December at Kapingmarangi was over 400% of average. Not only was it the all-time wettest month at that location, it also set a record as the all-time wettest month for any 1st-order Micronesia recording station in their respective modern historical records. At first, it was thought to be an error, but the WSO Pohnpei investigated and found the tally to be an accurate summation of the reported daily amounts recorded on-site. A look at the satellite imagery during December revealed a large area of continual deep convection along the equator, with many days of showers and thunderstorms over-and-around Kapingamarangi. The level of satellite cloudiness was not, by itself, indicative of such an extraordinary amount of rainfall, but it does not rule it out! In any case,

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lying along the equator, where ENSO-related fluctuations of SST have a big influence on convection, Kapingamarangi Atoll is typically subject to large variations in rainfall (particularly at the inter-annual time scale of ENSO). When Kapingamarangi residents were asked by WSO Pohnpei staff how they dealt with so much rain, there were no complaints – it was welcome! The Pacific atolls are nearly immune to impacts of extremely heavy rainfall but can very quickly develop serious (and even life-threatening) problems when the rainfall is deficient.

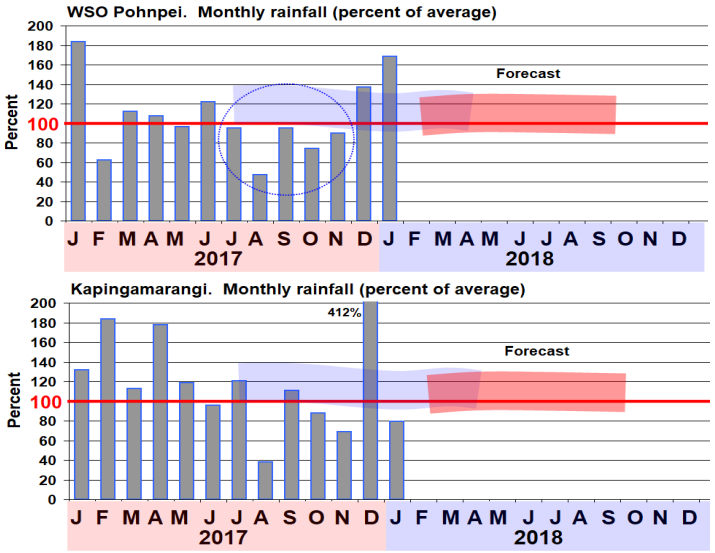

Figure PN-1. A bar chart of the monthly rainfall at WSO Pohnpei Island (top) and at Kapingamarangi (bottom) during the calendar-year 2017 through January 2018. The extended forecast for rainfall made by the PEAC in June of 2017 (light blue band in each chart) was too wet for the months of ASON. The heavy December rainfall at Kapingamarangi is in a class by itself and would seem impossible to anticipate. The latest forecast (light red band) now indicates an expectation for above-average rainfall throughout Pohnpei State.

The elevated sea level played a part in one climatic event of note: very high astronomical tides combined with La-Niña forced elevated sea level resulted in sea inundation of coastal homes in parts of Sohkes (Pohnpei Island) and also allowed waves to splash-over the causeway that leads from Kolonia to the Pohnpei International Airport. Three factors contribute to high water in the Sohkes location and the airport causeway: (1) very high astronomical tides, (2) La Niña associated elevated sea level; and (3) brisk easterly winds that develop a heavy chop across the extensive shallow-water reef flat zone (particularly to the east of the causeway). (see the sea level discussion). .

Climate Outlook: Computer Recent computer model forecasts are nearly unanimous in a forecast for above-average rainfall for at least the next three months for Pohnpei State, and indeed, for almost all of Micronesia. During the February PEAC conference call among all the US-API stakeholders, the PEAC decided to let stand the very aggressive forecasts for wet conditions. During the spring of 2018, the ITCZ could be enhanced across islands and atolls between 4°N to 8°N contributing to above-average rainfall to locations in this latitude band during April, May and June.

Rainfall for Kapingamarangi is not explicitly forecast by the suite of computer models used by the PEAC, so it was decided that the same forecast of above average would be used there as was for the rest of Pohnpei State, even though Kapingamarangi is located in a somewhat different climatic regime. A stronger La Niña could lead to drier conditions there, but that is not anticipated at this time.

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Pohnpei State Rainfall Summary: OND 2017, 4th Qtr. & 2017 Annual						
Station		Oct	Nov	Dec	4thQ	Annual
Pohnpei WSO	Rain (Inches)	12.31	14.13	20.86	47.30	190.74
	% of Average	74%	90%	137%	99%	101%
PNI Airport	Rain (Inches)	16.52	12.00 *	17.70*	46.26	186.48
	% of Average	120 %	93%	142%	118 %	120%
Atolls of Phonpei State						
Station		Oct	Nov	Dec	4thQ	Annual
Nukuoro	Rain (Inches)	27.07	20.77	12.56	60.40	225.24
	% of Average	252 %	173%	105%	174 %	151%
Pingelap	Rain (Inches)	5.53	16.82	15.69	38.04	150.96
	% of Average	40%	130%	126%	97%	97%
Kapinga	Rain (Inches)	5.93	5.95	41.30 **	53.18	174.89
	% of Average	88%	69%	412%	209 %	141%

** This huge amount of rain was investigated by the WSO Pohnpei, and found to be an accurate sum of the locally reported daily rainfall totals, it is an accepted new record high rainfall insofar as there are not any un-discovered problems with the rain gauge or exposure.

For the first half of 2018, the threat of a damaging TC anywhere within Pohnpei State is anticipated to be low (less than a 10% chance); although the precursors to 1 or 2 named storms could track through Pohnpei State waters, with the main effect being an enhancement of rainfall. With the long-range evolution of ENSO somewhat uncertain at this time, and with the absence of other agency typhoon outlooks (at least until early March), the TC outlook for the 2nd half of 2018 will be discussed in more detail in the next newsletter (May 2018).

Lastly, because of the strengthening of the Pacific trade wind system during La Niña, the sea level in Pohnpei State now is at a higher-than-average stand of approximately 6 inches above the long-term average and is forecast to remain at this elevated stand for at least the next three months, and then decline as La Niña slowly transitions to ENSO-neutral (see the sea level section for details).

Predicted rainfall for Pohnpei State from January 2018 through December 2018 is:

Inclusive Period	% of long-term average	
	Pohnpei Island/ atolls	Kapingamarangi
Jan – Mar 2018	120%	110%
Apr – Jun 2018	120%	105%
Jul – Sep 2018	100%	100%
Oct – Sep 2018	110%	105%

Kosrae State: The weather on Kosrae during 2017 was wet at the beginning, dry in the middle, and wet at the end (Figure KS-1). The seven wetter months of the year outweighed the five dry months to yield an annual total that was above average. The annual rainfall of 230.10 inches at the Kosrae Supplemental Aviation Weather Reporting Station (SAWRS) was 112% of average. At the Nautilus Hotel, somewhat less rainfall was observed

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(as compared to SAWRS), and the annual total of 205.08 inches was 99% or average. The temporal pattern of rainfall during 2017 (high … low … high) occurred at both locations. The PEAC long-term rainfall forecast made in June 2017 actually captured this behavior (as shown in Figure KS-1).

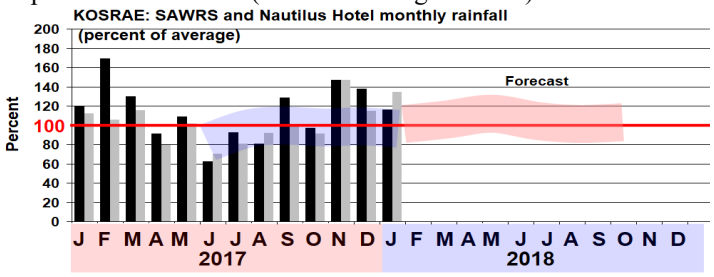

Figure KS-1. A time series of the monthly rainfall at Kosrae Supplemental Aviation Weather Reporting Station (SAWRS) (black bars) and the Nautilus Hotel (gray bars) for the period January 2017 through January 2018. The PEAC rainfall forecast made in June (light blue band) for the remainder of 2017 was accurate. The light red band shows the latest PEAC forecast for the next several months. Note the forecast bump in the spring. The SAWRS is located on the northwest side of the island, while the Nautilus Hotel is located on the east-northeast.

The wet conditions of 2017 were an abrupt turn-around from dry conditions a year earlier (Figure KS-2). Centered on June of 2016, the 12-month moving average of the SAWRS monthly rainfall fell to its 3rd lowest value in the entire Kosrae historical record, inclusive of the pre-WWII Japanese rainfall observations recorded at Lelu (near the Nautilus Hotel on the east side of the island). A year later, centered on June 2017, the rainfall had increased to a value that was the 3rd wettest in the record since 1986.

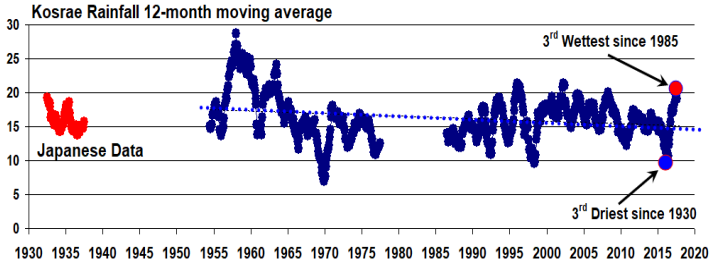

Figure KS-2. A plot of the 12-month moving average of rainfall at the Kosrae Supplemental Aviation Weather Reporting Station (SAWRS). The period of Japanese observation of rainfall is shown in red. Note the large swing from very dry to very wet going from 2016 into 2017. Dashed blue line shows the linear trend (not including the Japanese data). It appears to be downward, but may not be truly representative as the station has been at different locations during the historical period of record and there is a near 10-year gap from the mid-1970s to the mid-1980s.

Kosrae is one of the wettest locations in Micronesia. At 206 inches per year, the annual rainfall at Kosrae SAWRS is roughly equivalent to that on Palikir, Pohnpei Island (204 inches per year). Only at some unusual locations, such as the summit of Pohnpei's highest mountain (Nahna Laud), are found higher values; as in the case of Nahna Laud with its incredible 330 inches per year! At Aasufou (a USGS rain gauge that was located at an elevation of 1,340 feet in the mountains of American Samoa), an annual average of 203.31 inches was observed. Alas, Hawaii holds the US-API record, where the annual rainfall at Waialeale (a rain gauge located in the mountains of Kauai) averages 452 inches per year in a record that goes back to 1912. To illustrate just how much rain occurs on Kosrae, Figure KS-3 is

LOCAL SUMMARY AND FORECAST

provided to show a comparison (by month) of the rainfall at SAWRS versus the rainfall at Boston and at Miami, Florida.

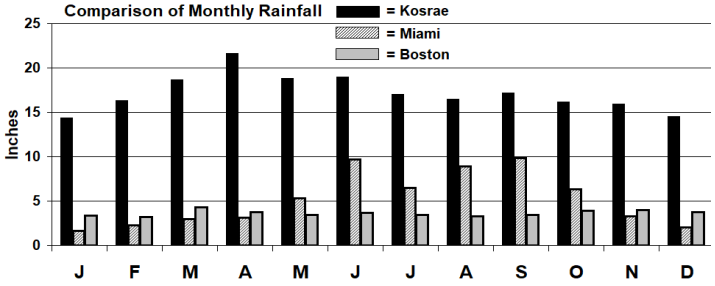

Figure KS-3. A comparison of the average monthly rainfall at Kosrae SAWRS versus the rainfall at Miami and at Boston. Miami is one of the wettest major cities in the U.S. mainland, but is dwarfed by the high amounts at Kosrae. The rainfall at Boston is typical of most cities east of the Mississippi River, and away from the Gulf Coast. It is hard to imagine that Kosrae would ever have any problems with its supply of fresh water, but it does happen during major El Niño events when four or five consecutive months of sub-5 inch rainfall causes streams to run low and vegetation to be stressed (e.g., during 1983 and during 1998).

Kosrae State Rainfall Summary: OND 2017, 4th Qtr. & 2017 Annual

Station		Oct	Nov	Dec	4thQ	Annual
Airport (SAWRS)	Rain (Inches)	15.65	23.21	19.85	58.71	230.10
	% of Average	97%	146 %	137%	126 %	112%
Nautilus Hotel	Rain (Inches)	14.75	23.31	16.66	54.72	205.08
	% of Average	91%	147 %	115%	117 %	99%

Climate Outlook: Recent computer model forecasts heavily favor above-average rainfall for at least the next three months at Kosrae, and indeed, across almost all of Micronesia. In consultation with island partners, the PEAC decided to let-stand a forecast for above-average rainfall at Kosrae over the next few months. During the spring of 2018, the ITCZ should be enhanced across Kosrae bringing above-average rains there, particularly in April, May and June. During La Niña, colder water along the equator usually reduces cloudiness and rainfall there and helps to concentrate cloudiness and rainfall over the warmer water to the north under the ITCZ cloud band. If La Niña remains in-place or transitions to ENSO-neutral by the late spring or summer, the rainfall forecast would be the same for the first three months, then fall back a small amount to at least average rainfall beyond the 3-month window.

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 first half of 2018 considered to be typically low (less than 1-in-10 chance). Depending on the evolution of ENSO beyond the summer months, the risk of a late-season tropical storm tracking near Kosrae could be enhanced, but this is very uncertain at this time.

Lastly, because of the enhanced Pacific trade wind system during La Niña, the sea level at Kosrae, has been, and is now, approximately 6 inches above the long term average. It is forecast to remain at the magnitude of this elevated stand for at least the next three months, and then slowly decline as La Niña transitions to ENSO-neutral (see the sea level section for details).

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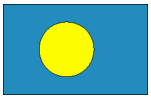
Predicted rainfall for Kosrae State from January 2018 through December 2018 is:

Inclusive Period (Kosrae)	% of long-term average / Forecast rainfall (inches) [1]
Jan – Mar 2018	105%
Apr – Jun 2018	110%
Jul – Sep 2018	100%
Oct – Dec 2018	105%

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



Republic of Palau

During 2017, the Republic of Palau continued its slow recovery from the record dry conditions that persisted continually over the course of the 2015-16 El Niño event. On balance, wet months outweighed dry months to yield an annual total that was above average (Fig. PL-1). By the end of December 2017, a full 36.49 inches had been shaved from the -85.73 inch low-point of the long-term accumulated rainfall deficit reached in August 2016 (Fig. PL-2). There is still a long way to go to erase the nearly 50 inches that remains of the long-term deficit of rainfall accrued during the record-breaking 2015-16 El Niño.

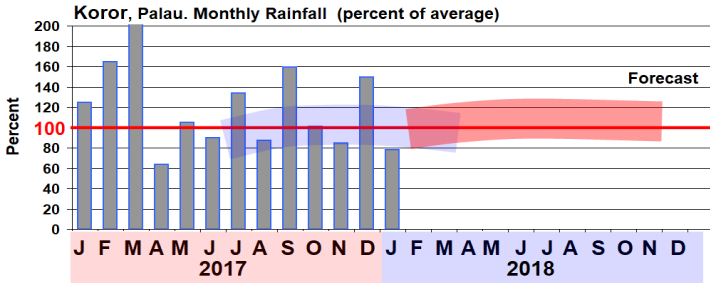


Figure PL-1. A bar chart of observed monthly rainfall (percent of average) at the Koror WSO during 2017. The forecast presented in the June Newsletter for the rest of 2017 is shown by the light-blue band. The current long-range rainfall forecast is shown by the light red band.

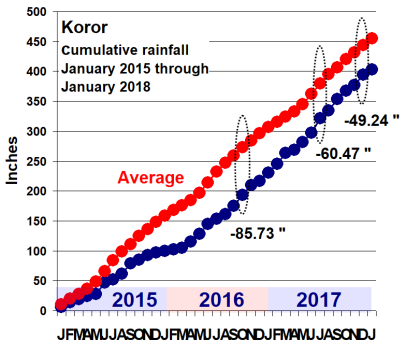


Figure PL-2. Three years of cumulative rainfall at Koror. Red line shows the normal accumulated rainfall from JAN 2015 through JAN 2018, and the dark blue line shows the observed accumulated rainfall over the same time period. The accumulated deficit reached its extreme low of -85.73 inches in August 2016. Abundant rainfall in late 2016 and through 2017 has allowed for a recovery of 36.49 inches against the long-term deficit.

An ecological impact of the 2015-16 El Niño was a severe die-off of jellyfish in Palau's famous Jellyfish Lake. The lake remains closed to tourists as per official statement of the Palau Ministry Natural Resources Environment and Tourism (Ongeim'l Tketau, Jellyfish Lake, 18 May 2017). The following commentary on Jellyfish Lake appeared in the January 2018 online version of scubadiverlife.com newsletter[1]:

"In normal years, the golden jellyfish number around 5 million.

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In 1999, following a strong El Niño, the jellies disappeared from the lake. They returned until El Niño and a strong drought simultaneously occurred in 2015 and 2016, which caused the medusa (i.e., mature jellyfish) to begin disappearing again. While healthy jellyfish polyps continue to live in the lake, the last medusa appeared in May 2016. Scientists do not yet know the exact cause of the disappearing medusas. The production of mature jellyfish, however, might depend on just the right environmental conditions."

"It's also possible that the jellies are starving before they reach the medusa stage, but multiple factors acting sequentially are likely the overall cause of the disappearance. The Coral Reef Research Foundation of Palau continues to monitor the situation, hoping to determine not only the factors behind this disappearance, but all the various health indicators for the lake as well."

[1] https://scubadiverlife.com/whats-the-real-deal-with-jellyfish-lake/ What's the Real Deal with Jellyfish Lake? Jan 7, 2018

Breaking news

During the night of 11 February 2018, Tropical Storm Sanba passed just to the south of Koror. Over a 24-hour period bracketing Sanba's closest point of approach, the WSO Koror reported 5.45 inches of rainfall. Peak winds at the WSO Koror were 25 kt gusting to 32 kt. The PEAC received no reports of any serious damage caused by the storm in the Republic of Palau.

Republic of Palau Rainfall summary
OND 2017, 4th Qtr. & 2017 Annual

Station		Oct	Nov	Dec	4thQ	Annual
Koror WSO	Rain (Inches)	14.03	9.55	17.89	41.47	177.73
	% of avg.	101%	84%	149%	112%	120%
Intl. Airport	Rain (Inches)	16.52	8.92	16.19	41.63	179.64
	% of avg.	108%	72%	123%	102%	110%
Mele-keok*	Rain (Inches)	17.69	8.20	16.63	39.03	171.64
	% of avg.	121% *	69% *	132% *	109% *	110% *
Nekken	Rain (Inches)	20.34	8.03	16.50	44.87	171.22
	% of avg.	147%	71%	138%	121%	116%
Peleliu	Rain (Inches)	7.95	5.11	15.00 **	28.06	120.66
	% of avg.	57%	45%	125%	75%	82%

* This is a new station; % of average uses one half of (AVG Koror + AVG Intl. Airport).
** Estimated amount.

Climate Outlook: Recent computer model forecasts are nearly unanimous in a forecast for above-average rainfall across the Republic of Palau for at least the next three months. The PEAC concurs with this and will go with the computer forecasts for the next three months. Beyond the next three months, we anticipate continued above-average rainfall, or at least near-average rainfall.

The PEAC assesses the risk of potentially damaging effects from a passing TC, such as large waves, gales or very heavy rainfall at 10% (a 1-in-10 chance), through June 2018. This level of risk is near average. With the long-range evolution of ENSO somewhat uncertain at this time, and with the absence of other

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agency typhoon outlooks (at least until early March), the TC outlook through the summer and fall of 2018 will be discussed in more detail in the next newsletter (May 2018).

Lastly, with the recent onset of La Niña the regional sea level now stands substantially above average across nearly all of Micronesia (see the sea level section for details).

Predicted rainfall for Palau from January 2018 through December 2018 is:

Palau Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]
Jan-Mar 2018	115%
Apr-Jun 2018	115%
Jul-Sep 2018	110%
Oct-Nov 2018	120%

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

Republic of the Marshall Islands (RMI)

Over the past two years (2016, 2017 and to-date in early 2018) the RMI has undergone substantial variations of rainfall (Figure RMI-1 and RMI-2). The pattern of rainfall variation was very similar during both 2016 and 2017; with both years beginning very dry and then ending very wet (Figure RMI-1). For two years in a row, drought conditions were experienced in the northern atolls (e.g., at or north of 9ºN latitude). During early 2016, drought conditions were part of widespread dryness associated with El Niño. Then, in early 2017, there was another period of dryness that was most pronounced in the northern atolls. The dry conditions in both early 2016 and early 2017 severely impacted potable water supplies in the northernmost atolls of the RMI, with household rain catchment tanks and shallow dug wells depleted. Emergency short-term assistance was provided by the RMI government to the drought-impacted northern islands. Food plants and other island vegetation were stressed, and are still recovering.

During the final months of 2017 and continuing into January 2018, there was very heavy rainfall at some of the atolls of the RMI. The January 2018 total rainfall at Kwajalein of 14.46 inches was the 2nd wettest January in their post WWII historical record; the January rainfall of 15.76 inches at Majuro was the 7th wettest January in its 64-year historical record. However, north of 10ºN, drought conditions are again prevailing, and the WFO Guam is issuing Drought Information Statements for the northern RMI atolls.

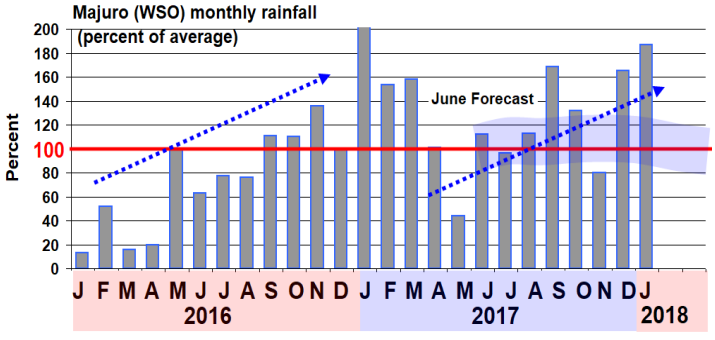

Figure RMI-1. A time series of rainfall at the WSO Majuro (gray bars) during 2016 through January 2018. Note two repeated dramatic rises from dry conditions early in the year to the return of abundant rainfall in both the fall of 2016 and the fall of 2017. The PEAC long-term forecast of rainfall made in June (light blue band) was reasonable.

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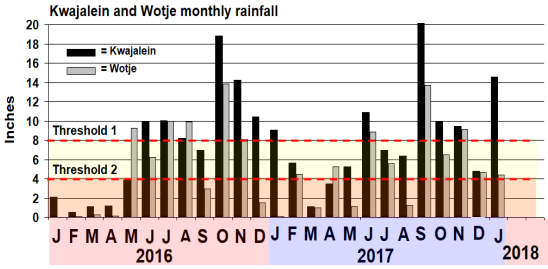

Figure RMI-2. A time series of rainfall at Kwajalein Atoll (black bars) and at Wotje (gray bars) during 2016 through January 2018. Note the evolution from extremely dry conditions during the first half of 2016 to wet at the end of 2016, and a similar occurrence of dryness at the beginning of 2017 trending to wet at the end of 2017. There was a return to dry conditions in early 2017 that were more pronounced at Wotje (and other northern atolls). Amounts of rainfall at Wotje were well below critical water-needs thresholds in both the 2016 and 2017 dry spells. The two thresholds: Threshold 1 = 8 inches; Threshold 2 = 4 inches, are the monthly amounts needed to adequately replenish municipal water supplies, and the amount needed to avoid desiccation and death of island vegetation, respectively. These two thresholds are now used to inform the drought categories (D0, D1-4) assigned to the island sites in the U.S. National Drought Monitor[1] (USDM).

Back-to-back Drought (reprinted from the last newsletter):
Severe drought in the RMI typically occurs in the first-half of the year that directly follows the peak of El Niño (e.g., 1983, 1998 and 2016). Dryness in early 2016 was anticipated well in advance as part of the evolution of the strong El Niño event of 2015-16. The severity of dry conditions in the northern RMI in early 2017 was not anticipated. The dryness of early 2017 was more localized than the dry conditions typically caused by El Niño. In fact, many locations in the RMI, and throughout Micronesia, had abundant rainfall in early 2017 (apart from a dry month or two). Localized areas of persistent and severe dryness have occurred with apparently random timing throughout Micronesia in the past. The very dry conditions on Guam in the first half of 1993 [and again in late 2017 into early 2018] are a good example of what was then labeled a "personal" drought -- only on Guam, but not anywhere else. New research by a PEAC-sponsored doctoral student, Alex Ludert, suggests that whereas *widespread* severe drought across the RMI typically accompanies El Niño, *localized* severe drought in the northern RMI might also have a consistent link with the status of the large-scale Pacific climate. His dissertation reports that in addition to severe dryness over the latter stages of a strong El Niño event, drought conditions reliably occur in the northern RMI at another non-El Niño stage of the ENSO cycle. If such is the case, then it should be possible to forecast these dry conditions. The current dry conditions in the northern RMI could result in a back-to-back-to-back drought. We will see.

Recent sea inundations

(1) On the last few days of October 2017 into the first few days of November, a slow moving tropical disturbance passed through the RMI, bringing heavy showers, thunderstorms and a gusty southwesterly wind. Southwest winds gusting to near 30 mph caused lagoon-side inundation in Majuro on Wednesday, November 1st. Reports were received of roadside splash-over and flooding of low-lying shorefront areas. Astronomical tides at the time were not extreme. Astronomical spring or King tides (the highest spring tides of the year) are not a necessary or even sufficient condition for sea inundation in the RMI. Wind and waves (local or remotely generated) are the primary cause of damaging inundation – both on lagoon-side shores and on the seaward side.

(2) On February 4, 2018, there was some reported minor sea inundation at both Kwajalein and Majuro. At Roi Namur Islet

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of the northern tip of Kwajalein Atoll, nuisance flooding occurred at the time of high tide, with large waves washing rubble onto the boundary road by the sea wall. At the Kwajalein Regan Test Site, large waves were observed, but they did not top the sea wall. At Majuro, on the same day, there was some minor inundation at high tide at the bridge area and stretching farther along the coast of the Long Island area. This inundation occurred with a combination of an unusually high astronomical high tide and a large northerly swell. The astronomical higher-than-average high tides of early February 2018 were flagged in-advance by Pac-IOOS for risk of inundation. Very high tides by themselves often result in nuisance inundation; damaging inundation, however, requires large waves, and may occur outside of the spring or King tide condition. With atolls, rising tides fill the lagoon from all directions with the only drainage, if needed, occurring over the land.

RMI Rainfall Summary: OND 2017, 4th Qtr. & 2017 Annual

Station		Oct	Nov	Dec	4thQ	Annual
RMI Central and Southern Atolls						
Majuro WSO	Inches	18.21	10.27	19.59	48.07	162.99
	% Avg	132%	80%	165%	125%	124%
Ailing	Inches	7.89	9.08	12.24	29.18	105.59
	% Avg	61%	77%	123%	84%	90%
Jaluit	Inches	5.40	10.46	9.30	25.16	98.32
	% Avg	39%	82%	78%	65%	75%
Arno	Inches	13.34	13.39	21.11	47.84	N/A*
	% Avg	96%	105%	178%	124%	%

Climate Outlook: Recent computer model forecasts are aggressively projecting above-average rainfall for at least the next three months at Kwajalein, but have backed-off somewhat at Majuro, where 2-of-9 models are now projecting below average rainfall, another 2-of-9 models are now projecting average-above rainfall, and the remaining 5 models are still indicating above average rainfall there during JFM. In consultation with island partners, the PEAC settled on a less aggressive forecast favoring average-above rainfall at Majuro, Kwajalein and throughout the south and central RMI over the next few months. During the spring of 2018, the ITCZ could be accentuated across the central RMI bringing above-average rains to these atolls in April, May and June. During La Niña, colder water along the equator reduces cloudiness and rainfall there and helps to concentrate cloudiness and rainfall over the warmer water to the north under the ITCZ cloud band.

The extreme dryness in the northern atolls of the RMI during the first half 2016 and again during the first half of 2017 is considered to be an unusual combination of a major El Niño-related drought coupled with a follow-on localized drought. Dryness is again plaguing the northern and northwestern atolls of the RMI and it could last until spring.

Damaging TCs are rare in the RMI, and those rare storms that do occasionally pass through the RMI do so primarily during strong El Niño events. Thus, the risk of a damaging TC anywhere in the RMI during the first half of 2018 is considered to be typically low (less than 1-in-10 chance). The risk of a damaging TC in late 2018 depends on the evolution of ENSO, which should be better known at the time of the next newsletter.

Lastly, because of an enhanced Pacific trade wind system, the sea level in the RMI is approximately 6 inches above the long-term average and is forecast to remain elevated to this degree for the next three months, with a possible decline in sea level there-

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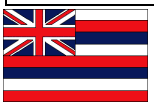
after as La Niña begins a slow transition to ENSO-neutral (see the sea level section for details).

Predicted rainfall for the atolls of the RMI from January 2018 through December 2018:

Inclusive Period	% of long-term average		
	South of 6ºN	6ºN to 8ºN	North of 8ºN*
Jan—Mar 2018	110%	115%	50%
Apr –Jun 2018	110%	115%	80%
Jul –Sep 2018	100%	105%	100%
Oct—Dec 2018	100%	110%	105%



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. A shift of the large scale atmospheric wave pattern in the North Pacific during late January placed the main Hawaiian Islands within a wet pattern that continued into February. This pattern remained generally stuck through the month, producing several low pressure systems that passed over or near the state. This, in turn, resulted in one of the wettest Februarys across the island chain in over 10 years.

The Island of Kauai was affected by wet conditions and all of the gages reported above average monthly rainfall totals. The Island of Oahu had monthly totals in the above average range for the month of February, and the Maui County received above average rainfall. The Island of Hawaii (Big Island) also logged above average monthly totals for February.

Climate Outlook: From CPC Long-Lead Hawaii Outlooks. Dynamical tools favor 40% chance of above median precipitation for all Hawaiian Islands during MAM of 2018. During JAS and SON of 2018, equal probabilities of below, average or above average rainfall is projected for all Hawaiian Islands.

Predicted rainfall for Hawaii State from March 2018 through November 2018 is:

	Station			
Inclusive Period	Hilo	Honolulu	Kahului	Lihue
Mar – May 2018	40% chance of Above Median rainfall	40% chance of Above Median rainfall	40% chance of Above Median rainfall	40% chance of Above Median rainfall
Jun – Aug 2018	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
Sep – Nov 2018	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

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

A recent assessment indicated that severe drought, or the D2 category on the U.S. Drought Monitor map, is no longer present over the lower slopes of the South Kohala District on the Big Island. The area is now considered to be under moderate drought conditions, or the D1 category. Moderate drought also exists over the upper slopes of the South Kohala District, the southern portion of the Kau District, and the lower leeward slopes of Kauai. There are no other areas considered to be in drought across the main Hawaiian Islands.

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 slightly elevated over the western part of the Pacific Basin. ***The tropical Pacific atmosphere and ocean are currently at weak or decaying phase of La Niña.*** *This satellite data are supportive to tide-gauge observations, and revealed that some of the stations located in Micronesia and Marshalls Islands are elevated, This is a turning point when sea level transitions to normal stage from its year-long above-normal stage.*

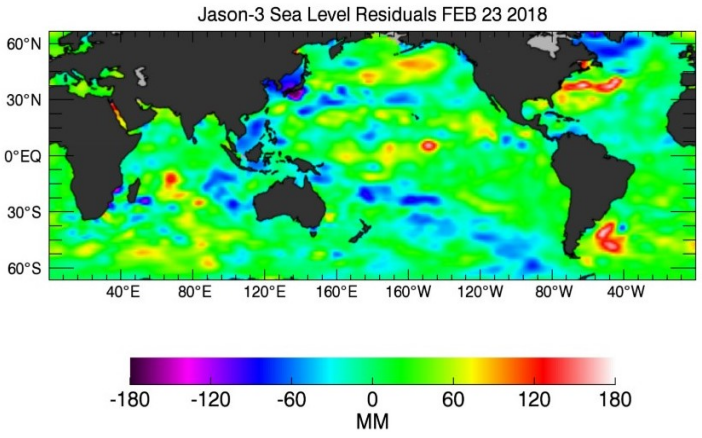

Figure 8. Jason-2 sea level residuals (November 9, 2016). (Source: https://sealevel.jpl.nasa.gov/images/latestdata/jason/2016/20160721G.jpg)

***Pacific ENSO Update* is Now Available Online:**
To receive notification when the newsletter is available online visit:
http://www.weather..gov/peac/update.php
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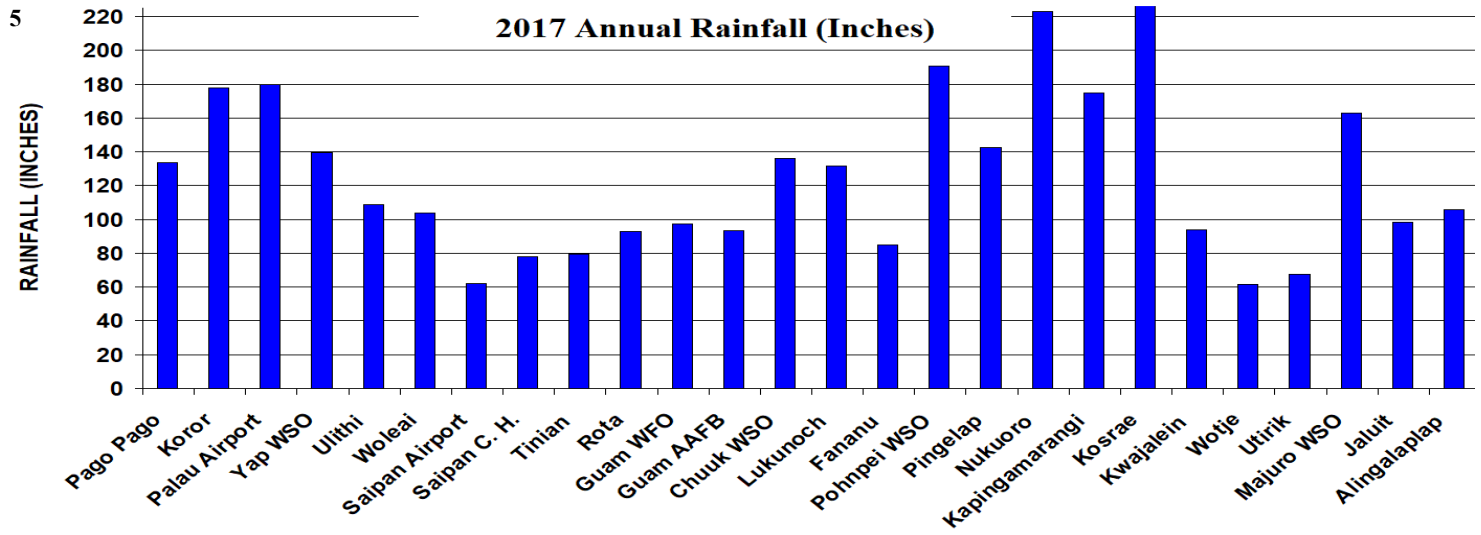
SEASONAL RAINFALL OUTLOOK FOR THE US-AFFILIATED PACFIC ISLANDS



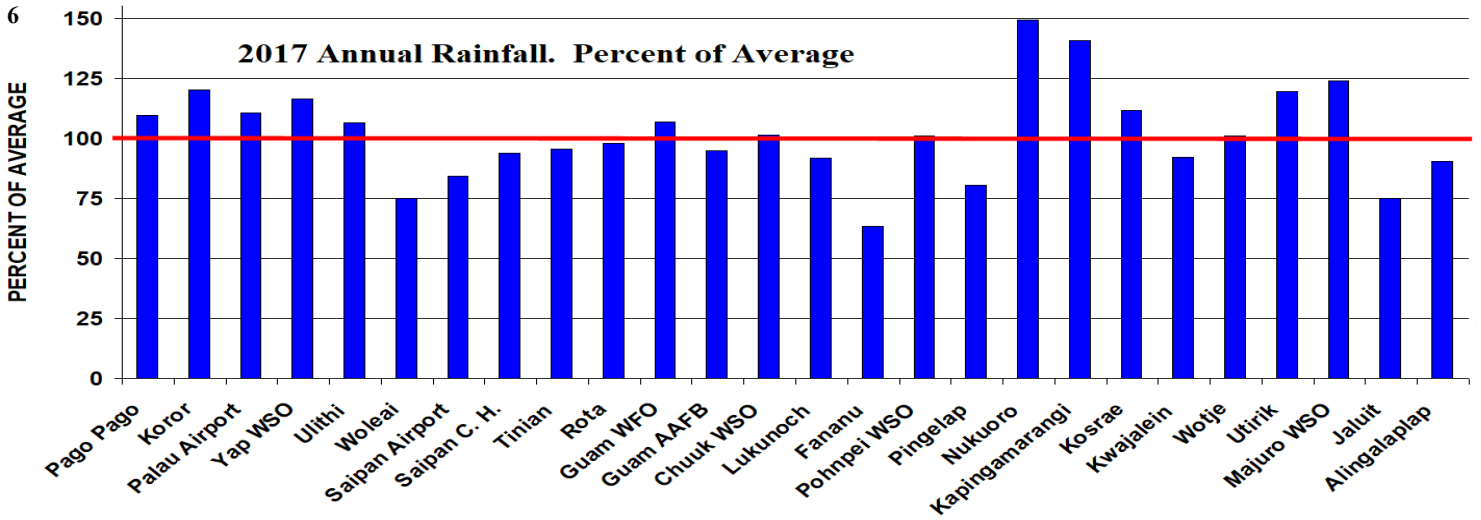


Figure 5. 2017 Annual rainfall amounts in inches at the indicated locations.
Figure 6. 2017 annual rainfall as a percent-of-average at the indicated locations. Note that there was about an even split of above- and below-average rainfall at locations across Micronesia. The northern RMI atolls of Utirik and Wotje recovered nicely from dry conditions earlier in the year.

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