PACIFIC ENSO UPDATE

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

2nd Quarter, 2016 Vol. 22, No. 2 **ISSUED: May 23rd, 2016**

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

http://www.weather.gov/peac

CURRENT CONDITIONS

The epic El Niño of 2015/16 is now in its post-Peak phase (Figure 1), with the CPC's Oceanic Niño Index now beginning its fall away from its peak value reached in December 2015 (Figure 2). Very dry conditions have developed over the past few months across much of Micronesia and into Hawaii (Figures 23 and 24). Prolonged and widespread dry conditions are typical during the post-Peak phase of a strong El Niño. The following records for low rainfall have been set (compiled from NOAA NCEI):

(1) Koror, Palau — driest Oct-Mar, driest Apr-Mar;
(2) Yap Island — driest Oct-Mar;
(3) Pohnpei Island — 3rd driest Oct-Mar, 4th driest Apr-Mar;
(4) Nukuoro (Pohnpei State) — driest Apr-Mar, 3rd driest Oct-Mar;
(5) Ulithi (Yap State) — 2nd driest Oct-Mar, driest March;
(6) Woleai (Yap State) — driest Oct-Mar, driest Apr-Mar;
(7) Alingalapalap (RMI) — 2nd driest Oct-Mar;
(8) Kwajalein (RMI) — 5th driest Oct-Mar;
(9) Majuro (RMI) — driest Oct-Mar;
(10) Jaluit (RMI) — driest Oct-Mar, driest Apr-Mar;
(11) Mili (RMI) — 2nd driest Oct-Mar, driest March;

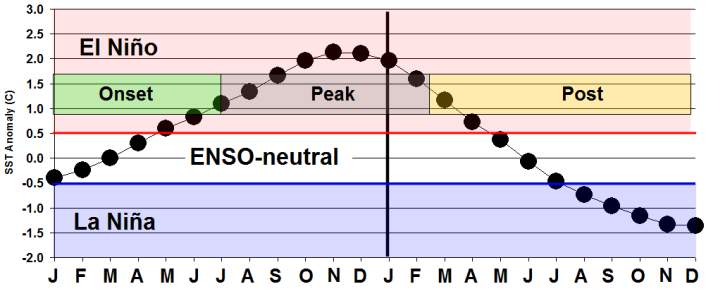

Figure 1. Typical (but smoothed) evolution of the Niño 3.4 ENSO index over the entire span of a strong El Niño event, with timing of "Onset", "Peak" and "post-Peak" phases indicated.

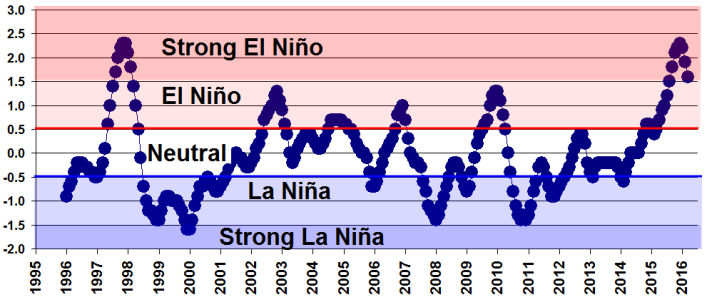

Figure 2. Three-month running mean of the CPC Oceanic Niño Index (ONI) for the period 1996 to current. Note that 2015/16 is the first occurrence of strong El Niño since 1997/98, and right on schedule, the values of the ONI have now started to decrease.

In response to the impact of drought conditions on water supply, local governments have issued proclamations concerning drought: the governments of Palau and of the FSM have declared drought emergencies for portions of their jurisdictions, and the government of the Republic of the Marshall Islands has gone even further with a declaration of drought disaster. On 27 April, President Obama issued Presidential Declaration for the Republic of the Marshalls Islands in response to earlier RMI request. With very dry conditions ongoing, the nature and extent of impacts is still being gathered and assessed. Substantial draw-down and degradation of municipal water supplies is widespread, streamflow on high islands is very low, and vegetation has suffered (yellowing, wilting, and destruction by wildfire). Reports of ecological impacts have been received, such as the loss of perhaps a few million jellyfish in Palau's world famous Jellyfish Lake (28 April 2016 Palau "Island Times"):

" 'The decline in number of adult jellyfish is due to El Nino,' says researcher Sharon Patris of Coral Reef Research Foundation (CRRF). 'They are not gone, just reduced from an average of 7 million to about 300,000 based on our weekly monitoring,' added Patris. 'The lake is so big, so with this number, some people will think it is all gone but last week we saw large adult ones at a corner of the lake.' Coral Reef Research Foundation has been monitoring Jellyfish Lake since 1989."

... " 'We are not going to close the Jellyfish Lake,' says Governor Adachi. 'The number of tourists does not contribute to the lesser number of jellyfish. It is the El Nino that is causing the decline,' emphasized Governor Adachi."

... "The important ones are polyps because they produce the jellyfish and we have ... seen lots and lots of those [on the lake floor] and so we are sure that the jellyfish population will return. Note that s similar reduction occurred in 1998, but the Jellyfish recovered in about a year.

"Jellyfish Lake, enclosed within a ring of limestone islets in the larger setting of the archipelago of the Rock Islands of Palau is truly a wonder of nature that is a must-see for any travel enthusiast. Swimming with the jellyfish is allowed!

The PEAC is actively involved in cataloging and assigning drought impacts to the drought categories (D0, D1, D2, D3 and D4) used in the U.S. National Drought Monitor (USDM) to portray the severity of drought. In an ongoing project to incorporate the USAPI into the USDM, the PEAC is working closely with Mr. Richard Heim and the Guam Weather Forecast Office and the other regional Weather Service Offices.

CURRENT CONDITIONS

We are proud to announce that for the first time, the PEAC obtained a perfect skill score for two consecutive 3-month rainfall outlooks generated for the US-API in November and December for anticipated dry conditions in the 3-month periods of DJF and JFM, respectively. During El Niño, the skill of seasonal forecasts is greatly improved, both in the computer guidance and in the PEAC final forecast products. Subsequent forecast products are now not likely to fare so well, if only for the fact that the rainfall in American Samoa during April far exceeded predictions, with an incredible 30.43 inches recorded at the Pago Pago WSO (please see the Local Variability Summary for American Samoa for more details).

After nearly a decade of very high values, the sea level has dramatically fallen across Micronesia over the past two years (Fig. 3; *also see sea level section*).

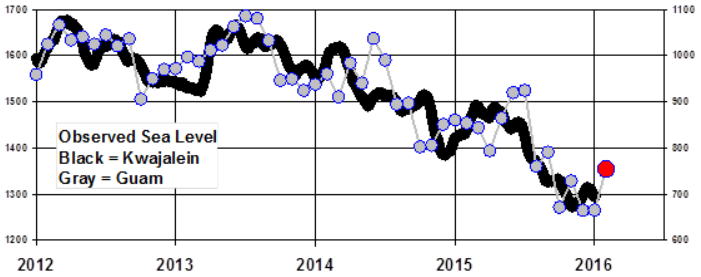

Figure 3 Time series of sea level at Guam and Kwajalein from January 2012 through February 2016. Note the steady decline through most of the period, with a sudden reversal noted at Guam during February 2016 (red dot).

Since the middle of 2013 to the end of 2015, the total drop in the sea level at both Guam and at Kwajalein was approximately 40 cm, or 1.3 feet! The magnitude of the fall was roughly the same in both 2014 and 2015. A sharp drop of mean sea level typically occurs during El Niño, with the lowest value of sea level occurring in December of the El Niño year. A sharp rise of sea level occurs in the first few months of the post-Peak year of the El Niño event. By February 2016, the sea level at some of the stations of Micronesia appeared to have hit the low point for this El Niño event, with a short-term reversal of the steep downward trend perhaps signaling the start of the anticipated steady rise of sea level for the rest of 2016. See the sea level discussion for more details and specific forecasts.

CURRENT STATE OF ENSO

Current Situation and Outlook Summary

- The 2015-16 El Niño is rapidly weakening and about to transition to neutral ENSO conditions;
- The peak strength of the 2015-16 El Niño was comparable in strength to the very strong 1982-83 and 1997-98 El Niño events;
- The majority of the models surveyed and expert opinion suggest the tropical Pacific will reach neutral ENSO conditions by June, with an increasing likelihood of La Niña development during third quarter, and virtually no chance for a resurgence of El Niño;
- Climate impacts in many regions typically continue during the declining phase of El Niño. Some impacts could endure until mid-year.

Synopsis: A transition to ENSO-neutral is likely during late Northern Hemisphere spring or early summer 2016, with an increasing chance of La Niña during the second half of the year.

During the past month, sea surface temperature (SST) anomalies decreased across the equatorial Pacific Ocean, with near-to-below average SSTs recently emerging in the eastern Pacific (see Figure 4). The latest Niño region indices also reflect this decline, with the steepest decreases occurring in the Niño-3 and Niño-1+2 regions. The surface cooling has already started; however, while oceanic anomalies are clearly trending toward ENSO-neutral, many atmospheric anomalies were still consistent with El Niño, such as the negative equatorial and traditional Southern Oscillation indices. Collectively, these anomalies reflect a weakening El Niño and a trend toward ENSO-neutral condition. Most models predict the end of El Niño and a brief period of ENSO-neutral by early Northern Hemisphere summer. The forecaster consensus favors La Niña onset during the summer, mainly weighting the dynamical models (such as NCEP CFSv2) and observed trends toward cooler-than-average conditions. Overall, La Niña is favored to develop during the Northern Hemisphere summer 2016, with about a 75% chance of La Nina during the fall and winter 2016-17 (click CPC/IRI consensus forecast for the chance of each outcome for each 3-month period).

"Sea surface temperature (SST) anomalies were between 1.0° and 1.5°C across most of the central and eastern equatorial Pacific Ocean during early April, having weakened appreciably over the last month. The latest weekly values for all of the Niño indices dropped to below 1.5°C. The subsurface temperature anomaly in the central and eastern Pacific decreased to negative values in association with a significant expansion of below-average temperatures at depth. Low-level westerly wind anomalies and upper-level easterly wind anomalies weakened compared to February. The equatorial Southern Oscillation Index (SOI) remained negative but weakened, while the traditional SOI was near zero. Enhanced convection continued over the central tropical Pacific but weakened east of the Date Line, and was suppressed over northern Indonesia and the Philippines. Collectively, these anomalies reflect a weakening El Niño."

"Nearly all models predict further weakening of El Niño, with a transition to ENSO-neutral likely during late spring or early summer 2016. Then, the chance of La Niña increases during the late summer or early fall. The official forecast is consistent with the model forecasts, also supported by a historical tendency for La Niña to follow strong El Niño events. A transition to ENSO-neutral is likely during late Northern Hemisphere spring or early summer 2016, with an increasing chance of La Niña during the second half of the year. …". Climate Prediction Center National Centers for Environmental Prediction. NOAA/National Weather Service. College Park, MD 20740

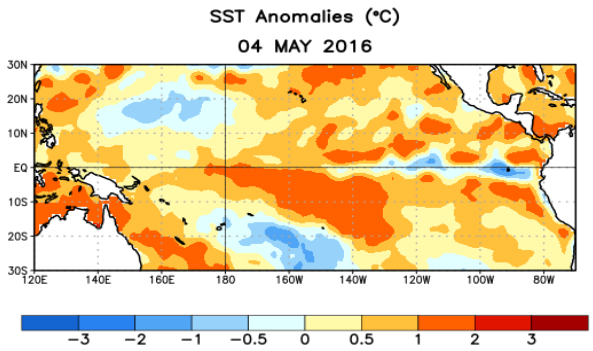

Figure 4. Average sea surface temperature (SST) anomalies (°C) for the week centered on 4 May 2016. Anomalies are computed with respect to the 1981-2010 base period weekly means.

Also see: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.pdf

TROPICAL CYCLONE ACTIVITY

The PEAC archives western North Pacific tropical cyclone 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 tropical cyclone 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 significant differences in the statistics (e.g., storm maximum intensity) for a given tropical cyclone among the agencies that are noted in this summary.

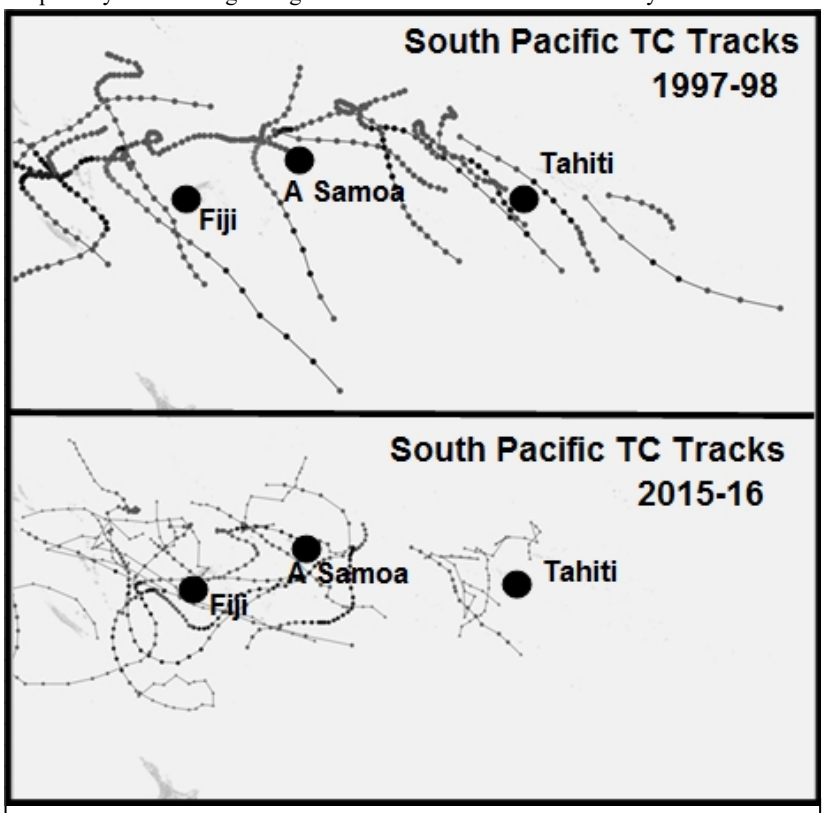

Figure 5. South Pacific Tropical Cyclone activity during the cyclone seasons of 1997-98 and 2015-16. Note the enhanced activity within the region eastward of American Samoa to French Polynesia in the 1997-98 season that is lacking in the 2015-16 season.

Tropical Cyclone Summary

The count of tropical cyclones in the Southern Hemisphere (SH) to-date has been well below normal, with the JTWC numbering only 20 systems, of which only 17 were named by any SH tropical cyclone warning center. In fact, the 2015-16 Australian region cyclone season was the least active tropical cyclone season since reliable records started during 1969, with only three named tropical cyclones developing in the region. Reasons for the low activity during the year, included a positive Indian Ocean Dipole occurring and the 2015–16 El Niño event. The Australia region was expected to fall short of TC count in the 2015-16 season, with the active region of TC formation shifted eastward toward Fiji and beyond into French Polynesia. Indeed, activity was high near Fiji, with the Fiji Islands severely impacted by cyclones during early 2016. The activity was also high near American Samoa, with several cyclones tracking nearby bringing episodes of heavy rainfall and gusty winds. American Samoa, however, was spared any major damage from the cyclones by virtue of storm weakness or distance of passing TCs from any island.

The biggest surprise of the 2015/16 SH cyclone season was the failure of the South Pacific cyclone activity to make a substantial shift as far to the east as anticipated. Only one relatively weak named cyclone (Yalo, TC 14P as per JTWC) passed near the islands of French Polynesia (see Fig. TC-1). During past strong El Niño events, such as 1982-83, and 1997-98 (also shown in Fig. 5), there was far more tropical cyclone activity within and eastward of French Polynesia than that seen during 2015-16.

PEAC Center Tropical Cyclone Assessment

Western North Pacific and American Samoa

Three organizations typically produce seasonal outlooks for tropical cyclone activity in the western North Pacific that are routinely used by the PEAC Center for guidance on the upcoming typhoon season: (1) The Guam Weather Forecast Office (WFO), (2) The City University of Hong Kong Laboratory for Atmospheric Research, and (3) The Benfield Hazard Research Centre Tropical Storm Risk (TSR) research group.

The Guam Weather Forecast Office (WFO) and the TSR group have now released outlooks for the upcoming 2016 western Pacific typhoon season. The WFO forecast, issued in early May settled on a forecast of below normal activity for the remainder of 2016, with a call for a total of 25 numbered cyclones, with a distribution of 12 typhoons, 12 tropical storms and one tropical depression. The WFO Guam forecast also calls for a total of 10 numbered tropical cyclones to track within the bounds of Micronesia, with a distribution of 4 typhoons, 3 tropical storms and 3 tropical depressions. The WFO forecast does not specify the location of the anticipated TCs within Micronesia, but the PEAC would like to add that most or all of the activity is likely to occur in the western half of Micronesia, with areas in eastern Micronesia such as Pohnpei, Kosrae and the atolls of the RMI not adversely affected by tropical cyclones during 2016. The TSR group (in its May forecast) also foresees a below average season, with the below-normal, normal, and above-normal activity tercile probabilities set at 60%, 32% and 8%, respectively. The Hong Kong group is still not issuing a basin-wide TC forecast while the factors responsible for the recent decadal decline of western North Pacific TCs are still under investigation.

The PEAC concurs that tropical cyclone activity will be below average in the western North Pacific basin in most categories of TC activity (e.g., basin annual counts of tropical storms and typhoons, and basin Accumulated Cyclone Energy (ACE) – a parameter loosely described as a running sum of the intensity of storms at all 6-hour intervals of their lives). The PEAC further believes that it will also be a relatively inactive year within the bounds of Micronesia, a result of both the low basin count and a westward shift to the activity. No tropical cyclones have occurred in the western north Pacific basin during 2016 to-date, and the risk of a damaging tropical cyclone will remain well below average at all Micronesia locations through August 2016. Late in the year (October through December), the risk of a tropical storm or typhoon increases across far western Micronesia (Yap State and the Republic of Palau), but remains low at Guam and points eastward.

TROPICAL CYCLONE ACTIVITY

The cyclone season is now nearly over for American Samoa and the risk of another significant cyclone passing near or over American Samoa is very low, although not impossible. The new South Pacific cyclone season starts on July 01, 2016. No activity is anticipated near American Samoa in the new season until November or December of 2016. Estimates of the severity of the next cyclone season (i.e., 2016-17) in American Samoa will not be made at this time, but will be considered in subsequent newsletters.

SEASONAL SEA LEVEL OUTLOOK FOR THE US-AFFILIATED PACFIC ISLANDS

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 April-May-June (AMJ), May-June-July (MJJ), and June-July-August (JJA) of 2015, (ii) AMJ return values at 20 and 100-yr period, (iii) the observed monthly mean and maximum sea-level anomalies for the previous season JFM 2015, and (iv) Seasonal sea level variability: Island Summary. *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 such as tropical cyclones, storm surges or tsunamis.*

Seasonal Sea Level Forecast (anomalies with respect to climatology) for AMJ, MJJ, and JJA of 2016

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 JFM of 2016, the resulting CCA model has been used to forecast the sea level of three consecutive seasons: AMJ, MJJ, and JJA (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 (AMJ, MJJ, and JJA)

	Seasonal Mean Deviations [1]				Seasonal Max Deviations [2]					
Tide Gauge Station	**AMJ**	**MJJ**	**JJA**	**Seasonal Outlook[3]**	**AMJ**	**MJJ**	**JJA**	**Seasonal Outlook[3]**	**AMJ: Return Period[4]**	
Lead Time [5]	**0M**	**1M**	**2M**	**Seasonal Outlook[3]**	**0**	**1M**	**2M**	**Seasonal Outlook[3]**	**20- YR**	**100-YR**
Marianas, Guam	+3	+3	+2	Marginal Above	+17	+18	+18	Above	5.6	6.7
Malakal, Palau	+2	+3	+3	Marginal Above	+38	+38	+38	Above	9.6	14.3
Yap, FSM	+1	+2	+2	Normal	+29	+30	+30	Normal	16.7	33.0
Chuuk, FSM**	+1	+2	+2	Normal	+29	+30	+30	Normal	n/a	n/a
Pohnpei, FSM	+3	+3	+4	Above	+32	+32	+33	Marginal Above	5.8	7.1
Majuro, RMI	+3	+3	+3	Marginal Above	+41	+41	+41	Above	4.1	5.1
Kwajalein, RMI	+3	+3	+4	Above	+39	+40	+41	Above	4.5	5.9
Pago Pago, Am. Samoa***	-1 (-6)	-1 (-6)	+1 (-4)	Normal	+23 (+18)	+25 (+20)	26 (+21)	Marginal Below	3.9	5.4
Honolulu, Hawaii	+1	+1	+2	Normal	+20	+21	+21	Normal	4.1	5.9
Hilo, Hawaii	+1	+1	+1	Normal	+23	+25	+25	Normal	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 Pacific stations are likely to be normal to slightly above-normal (normal and average are synonymously used throughout the sea level section) in the forthcoming AMJ, MJJ, and JJA seasons. The lone south Pacific Island Pago Pago is expected to be normal to slightly below-normal during the same time-period. In Hawaii, both Honolulu and Hilo are likely to be slightly elevated, but still close to normal. This trend is very supportive to the on-going weakening El Ninõ state; several features across the tropical Pacific are characteristic of decaying phase of El Niño. Observations revealed that some of the stations located in Micronesia and Marshalls Islands have already started rising, which is expected in the current weakening phase of El Ninõ. This is a turning point when sea level is starting to become normal (or above normal) from its year-long below normal stage.

SEASONAL SEA LEVEL OUTLOOK FOR THE US-AFFILIATED PACFIC ISLANDS

Observed Monthly Mean Sea Level Anomalies (with respect to climatology) for JFM 2015

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: The monthly mean sea level in most of the stations stayed below normal, but recorded rise in March/2016. Only Guam displayed slight fall in March. This rise indicates a turning point towards normal state within the next couple of months. Pago Pago--the lone south Pacific island--is currently normal and stable. Other than Yap, the monthly maxima also displayed fall in most of the north Pacific stations. In Hawaii, Honolulu recorded fall while Hilo recorded rise. The recent trend of sea level is very supportive to the on-going El Nino state. Normally sea level is lower than normal during any El Nino year, higher than normal in any La Nina year, and normal or close to normal (with +/- 2 inches variations) in any ENSO-neutral year.

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

Tide Gauge Station	Monthly Mean Deviations[1]				Monthly Max Deviations[2]			
	Jan	Feb	Mar	Standard Deviations	Jan	Feb	Mar	Sea level Trend
Marianas, Guam	-3.8	-1.5	-2.2	4.4	+11	+12	+14	Below-Rising
Malakal, Palau	-5.2	-5.2	-3.5	5.3	+28	+31	+30	Below-Rising
Yap, FSM	-4	-5	0	4.9	+22	+24	+31	Below-Rising
Chuuk, FSM*	**	**	**	*	**	**	**	**
Pohnpei, FSM	-3.5	-1.2	+2.2	3.6	+25	+27	+25	Below-Rising
Majuro, RMI	0	+2	+5.5	2.4	+40	+42	+36	Normal-Rising
Kwajalein, RMI	-3.4	**	0	3.1	+33	+33	+37	Below-Rising
Pago Pago, American Samoa***	+6.5 (+1.5)	+5 (0)	+4 (-1)	3.3	+28*	+30*	+26*	Normal-Falling
Honolulu, Hawaii	+3.5	+4.2	+1.2	1.6	+23	+23	+19	Above-Stable
Hilo, Hawaii	0	+1.2	+3	2.0	+24	+24	+21	Normal-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 AMJ of 2014, a comparative perspective of two years of seasonal sea level variations is given below (Fig. 2). The sea lever in the western Pacific started to fall from JFM of 2015. This falling trend continued up to JAS of 2015. Again after JAS, it started to rise from OND of 2015. Currently it is below normal, but will see a steady rise during the remainder of 2016. However, the lone South Pacific Island Pago Pago is likely to see slight fall in the next couple of months before it turns back to normal.

See page 15 for sea level observations from Jason-2 satellite picture (Fig. 22).

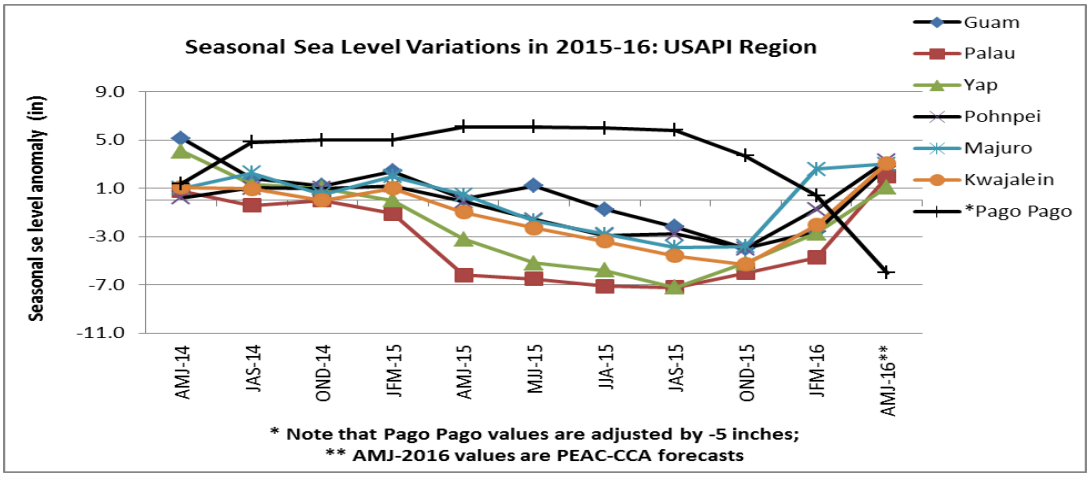

Figure 6. A comparative perspective of Island-wise seasonal sea level variations (JFM 2014 to JFM 2015) (*Note that Pago Pago data needs correction because of level shift after 2009 earthquake. ,There was a level shift (approximately 2-4 inches) at that time which has not been adjusted).

LOCAL SUMMARY AND FORECAST

American Samoa: American Samoa had some wild weather in the First Quarter of 2016, including very dry conditions in January and February, an extremely wet April, an unusual heat wave in mid-February, and an abundance of tropical cyclones passing through regional waters.

Rainfall amounts at American Samoa are not strongly correlated with any ENSO index. During the few cases of strong El Niño in the historical record, there is a tendency for dry conditions to occur at American Samoa in the post-Peak phase, although with some high month-to-month variability. Duly noting the weak relationship of El Niño with rainfall at American Samoa, the PEAC nonetheless (in the previous ENSO Newsletter) forecast dry conditions at American Samoa for the First Quarter of 2016. This did occur, with the 2016 First Quarter total of 21.74 inches at the Pago Pago WSO falling well short of average at 60%. The dry conditions were spectacularly interrupted

American Samoa Rainfall Summary: 1st Qtr 2016

Station		Jan	Feb	Mar	Apr	1st Qtr
Pago Pago WSO	Rain (in)	4.49	6.49	10.76	30.43	21.74
	% Avg.	36%	51%	96%	253%	60%
Siufaga Ridge	Rain (in)	4.88	6.08	15.41	23.89	26.37
	% Avg.	31%	41%	119%	184%	46%

when, during April, an incredible amount of rain was experienced. The 30.43 inches of rainfall at Pago Pago during April 2016 was by far the highest April rainfall in the historical record, with the 28.35 inches recorded during April 1992 the previous peak value. In fact, the April 2016 rainfall total at Pago Pago is the second highest rainfall total of any month in the historical record, exceeded only by the 32.66 inches recorded at Pago Pago during February 1968.

One of the big surprises of early 2016 was the failure of tropical cyclone activity to shift eastward. For most of the 2015/16 South Pacific cyclone season to-date, the focus of tropical cyclone formation has been continually near the Fiji Islands, with several cyclones passing near American Samoa. Cyclone Ula passed south of American Samoa in late December 2015, promoting a long period of heavy rainfall, high winds and hazardous surf. Heavy rainfall caused flooding and landslides that blocked roads and river crossings. High winds generated hazardous surf that claimed a life by drowning on the island of Manu'a. In late April, Cyclone Amos tracked near American Samoa. While on approach to American Samoa from the west, it officially became the strongest tropical cyclone to track near Samoa and American Samoa in over three years. Just prior to its closest point of approach it weakened rapidly and ended up giving only a glancing blow to American Samoa. Pago Pago International Airport, on the southern end of American Samoa's largest island, Tutuila, recorded a peak wind gust to 54 mph as the center of Amos passed to its north.

Another unusual weather event occurring during the 1st Quarter of 2016 was a prolonged heat wave that saw temperatures soar to 90°F or higher for 13 consecutive days in the first half of February. For four days at the height of the hot conditions, the temperature at the Pago Pago WSO reached 94°F with nighttime minimum temperatures remaining in the low 80s (Figure 7). Island residents were feeling miserable in the heat and dusty dryness at that time. The hot conditions led to a lively and prolonged internet dialog among Pacific weather forecasters and

LOCAL SUMMARY AND FORECAST

other interested parties, concerning the causes and the severity of the event, and even some questioning o the validity of the measurement

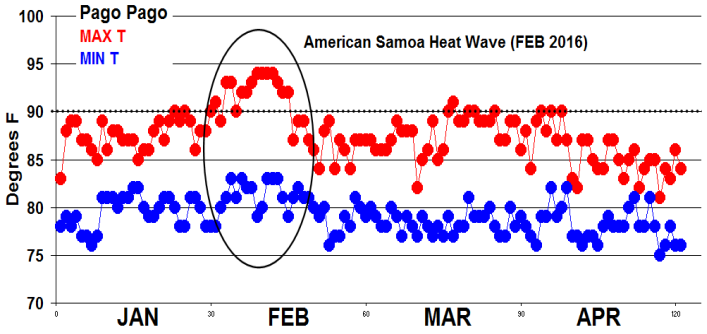

Figure 7. A time series of the Maximum and Minimum temperatures recorded at the Pago Pago WSO during JFMA 2016. A notable heat wave occurred during the first half of February with daytime highs reaching the mid 90s and nighttime lows staying in the low 80s.

Climate Outlook: During the post-Peak phase of strong El Niño, the rainfall at American Samoa has a tendency to be below average, with high month-to-month variability. American Samoa is now entering its dry season, and the huge amount of rainfall seen during April notwithstanding, the forecast will continue to call for below average rainfall over the next few months. This will be tempered with a consideration of persistence of the factors leading to a wet April, so that the final forecast will call for an overall slight to moderate reduction of rainfall over the next few months.

The South Pacific cyclone season of 2015/16 is nearing its end. Although tropical cyclones have occurred near American Samoa as late as June, the risk of yet another cyclone to pass near American Samoa close enough to cause flooding rains or damaging wind is considered unlikely, but not impossible during the next two months. The odds of such an occurrence are set at 5-10%.

Lastly, the sea level behavior at American Samoa lags that of Micronesia by 3 to 4 months. Whereas the mean sea level falls to its lowest level in Micronesia in December or January at the peak of El Niño, at American Samoa the mean sea level falls to its lowest level during March or April of the post-Peak phase of El Niño. Thereafter, the sea level rises for the rest of the post-Peak year (e.g., Jul-Dec 2016), but is still typically slightly below average at the close of such a year (see sea level section). Predicted rainfall for American Samoa from April 2016 through March 2017 is:

Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]
April - June 2016 (Onset of Next Dry Season)	80%
July - September 2016 (Heart of Next Dry Season)	80%
October - December 2016 (Onset of Next Rainy Season)	90%
January - March 2017 (Heart of Rainy Season)	100%

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

LOCAL SUMMARY AND FORECAST

Guam/CNMI: The weather throughout Guam and the CNMI during 2015 and through April of 2016 progressed almost exactly as expected during the course of a strong El Niño event. The calendar year 2015 featured some wild weather, with an early start to typhoon activity (Tropical Storm Bavi in March and Typhoon Dolphin in May), and then a continual series of additional close passages of tropical cyclones through November. The year 2015 will long be remembered as the year that "midget" Typhoon Soudelor (in August) devastated Saipan. Other wild weather incidences included some extreme (15 inches or more) 24-hour rain events, very high (25-30 foot) surf, and (later in the year) a perceptible drop of the mean sea level.

During November and December 2015, and continuing into January 2016, the weather became quiet. A trade-wind regime dominated, with typical gusty east-northeast winds. Residents perceived these conditions as comfortable and cool – a good time for having a barbeque, riding a motorcycle or just being outdoors. The reduction of rainfall during early 2016 led to an incremental manifestation of the outward signs of drought: yellowing of vegetation, complete browning of un-watered lawns, reduction of stream flows, cracks in the clay soil, and an increase of "boonie fires" (Fig. 8).

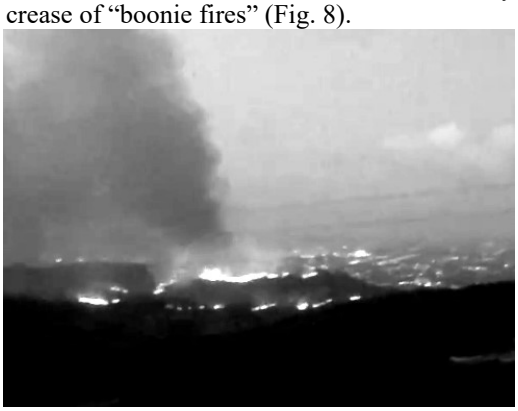

Figure 8. A "boonie fire" rages out of control on the top of Nimitz Hill, Guam on the evening of 08 May 2016. This wild fire sent skyward a plume of smoke laden with fragments of incinerated sword grass that showed on Guam's weather radar and caused air traffic to be diverted (Image courtesy of Mr. Ed Feeley).

Guam and CNMI Rainfall Summary: 2016 1st Qtr.

Station		Jan	Feb	Mar	1st Qtr
GUAM					
GIA (WFO)	Inches	2.62	3.63	1.63	7.88
	% Avg	59%	97%	55%	71%
AAFB	Inches	4.11	4.73	2.90	11.74
	% Avg	72%	91%	71%	78%
Sinajaña	Inches	2.45	3.76	2.38	8.59
	% Avg	55%	101%	80%	77%
CNMI					
Saipan Intl. Airport	Inches	2.23	2.72	3.29	8.24
	% Avg	70%	113%	165%	108%
Capitol Hill	Inches	3.65	2.94	4.68	11.27
	% Avg	91%	98%	187%	119%
Tinian Airport	Inches	2.14	1.61	3.00	6.75
	% Avg	54%	54%	120%	71%
Rota Airport	Inches	3.04	2.07	4.63	9.74
	% Avg	58%	44%	125%	71%

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Long anticipated by the PEAC, the post-Peak El Niño dry conditions on Guam and in the CNMI were not quite as bad as those seen during the post-Peak phase of the 1997-98 strong El Niño event (Fig. 9). Northern Guam's limestone aquifer is one of the world's best, and is essentially immune to an El Niño drought. The aquifers of Saipan and other islands of the CNMI are not quite as extensive as those of Guam, and growing impacts to water quantity and quality have been observed, but are not yet serious. A summary of drought impacts on Guam and in the CNMI will be featured in the next newsletter.

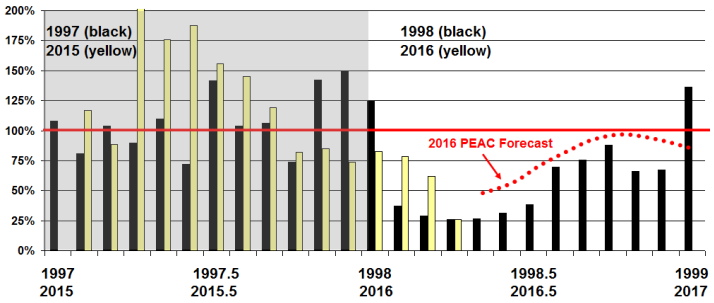

Figure 9. A time series of the percent of average of the 3-month moving sum of the rainfall at AAFB, Guam, during the course of two strong El Niño events: 1997-98 (black bars), and 2015/16 to-date (yellow bars). Although 2016 has not been as sharply dry in JFMA as it was in JFMA 1997, the total rainfall for the period October 97 through April 98 (augmented by Typhoon Pongsona in December 97) was 46.89 inches versus 36.69 inches for the same 7-month period of 2015/16. The PEAC rainfall outlook for Guam and the CNMI is shown by the dotted red line – note that it is not quite as dry as the same period in 1998.

Climate Outlook: By March 2016, the CPC's ENSO Index had fallen from its January peak value of +2.7 (well into strong El Niño territory) to +1.5 (the threshold of strong El Niño). The ENSO index should continue its decline to become ENSO-neutral by the late spring, and likely shift all the way to La Niña by the end of the year. In this scenario, well below average rainfall is anticipated on Guam and all the islands of the CNMI through June or even July. Thereafter, through the remainder of 2016, conditions should remain relatively dry, but with enough rain to put an end to wildfires and keep the grass green. Guam and the CNMI are among the few islands of the USAPI that do not quite return to average in their rainy seasons after an El Niño-related spring drought, primarily a result of post-Peak easterly surface wind anomalies and the reduction, or near elimination, of the monsoon trough and tropical cyclone activity

Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]	
	Guam/Rota	Saipan/Tinian
April – June 2016 (Second Half of Dry Season)	60%	60%
July - September 2016 (Heart of Rainy Season)	85%	85%
October - December 2016 (Transition to Rainy Season)	85%*	85%*
January – March 2017 (First Half of Dry Season)	95%	95%

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

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in the region (see Fig G2 above, and table of predicted rainfall below).

The tropical cyclone threat on Guam and in the CNMI is usually greatly reduced during the year of the post-Peak of a strong El Niño event. It is tempting to declare that no direct strikes of any tropical storm or typhoon will occur during 2016, but the odds do not fall to zero, as illustrated by the passage of tiny Tropical Storm Alex over Rota during October of 1998 (a post-peak year of a strong El Niño event). It is possible that in latter quarter of 2016, two or three of the basin's tropical cyclones could develop near enough to Guam and the CNMI to bring some much-needed rains and periods of gusty winds to the region. Predicted rainfall for the Mariana Islands from April 2016 through March 2017. Finally, the monthly mean sea level of Guam remained slightly elevated throughout the years of 2014 and part of 2015. In August 2015, it fell down abruptly (-5 in) again and stayed below since then.

Federated States of Micronesia

Yap State: For one last time, we will mention the severe beating by typhoons that Yap State suffered during 2015 (Figs 10 and 11), with the atolls of Ulithi and Fais incurring one

Fig 10. Aerial view of damage caused by supertyphoon Mayak on Ulithi Atoll, Yap. Photo: Brad Holland / FSM Office of Environment and Emergency Management

Fig 11. Damage caused by Typhoon Maysak in Ulithi, Yap, Federated States of Micronesia Photo: Brad Holland / FSM Office of Environment and Emergency

Yap State Rainfall Summary: 2016 1st Quarter					
Station		**Jan**	**Feb**	**Mar**	**1st Qtr**
Yap State					
Yap WSO	**Inches**	**2.23**	**1.77**	**0.70**	**4.70**
	% Norm	**30%**	**30%**	**12%**	**24%**
Ulithi	**Inches**	**1.29**	**2.61**	**0.62**	**4.52**
	% Norm	**21%**	**51%**	**12%**	**18%**
Woleai	**Inches**	**0.01**	**0.05**	**0.28**	**0.34**
	% Norm	**0%**	**1%**	**3%**	**1%**

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of the region's most devastating

strikes by a tropical cyclone, that of Super Typhoon Maysak, during the wild El Niño year of 2015.

Kaselehlie Press, April 2016, by Katlyn Murray:
"It has been just over a year since Typhoon Maysak struck Chuuk and Yap States affecting 29,700 people. Many are still struggling to recover from this devastating natural disaster. … In staying true with the culture and tradition of the islands in Ulithi Atoll and Fais, affected individuals have decided to pool their assistance together in order to benefit the entire community, not just those affected by the storm"

Following all the havoc dealt to Yap State by typhoons, another insidious climatic hazard — drought — slowly tightened its grip on the state at the close of 2015 into the beginning of 2016. After a wet August 2015, a continual sharp decline of monthly rainfall commenced (Fig. 12). The rainfall total of 21.70 inches at the Yap Island Weather Service Office during the six months of OND (2015) + JFM (2016) was only 39% of average, and was the driest such 6-month total in that station's post-WWII historical climate record! By March 2016, the Yap Island reservoir was nearly depleted, and several wild fires had scorched portions of the island. By July of 2015, the PEAC began to issue long-range forecasts for very dry conditions to occur during late 2015 into the first half of 2016. The following remarks were taken from PEAC ENSO newsletters published in the indicated month:

July 2015: "*In a typical moderate or strong El Niño, rainfall begins to fall substantially below normal by October, and then is drastically reduced in the period of December through May …*" PEAC 3-month rainfall forecast: Jan – Mar 2016. Yap Island, Heart of next Dry Season = 50%. Verification = 16%
November 2015: *"Drought related to El Niño becomes severe early in the year that follows El Niño (e.g., 1983, 1998 and likely now also 2016)."* PEAC 3-month rainfall forecast: Jan – Mar 2016. Yap Island, Heart of next Dry Season = 50%. Verification = 16%
February 2016: *"Regardless of the time it takes for the climate system to fade to ENSO-neutral and/or transition all the way to La Niña, the major weather threat is the same: drought!! Very dry conditions are anticipated throughout Yap State through June 2016. Thereafter, monthly rainfall amounts should recover to near average"*. PEAC 3-month rainfall forecast: Jan – Mar

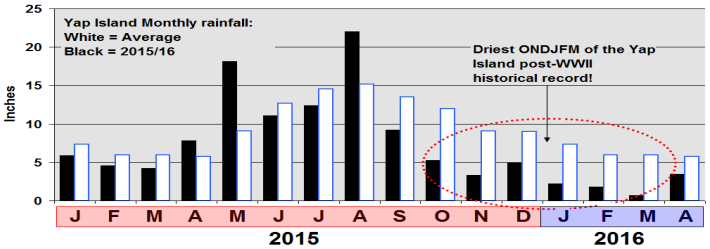

Fig. 12. Time series of monthly rainfall at the Yap Island WSO. The continuous dryness at the end of 2015 into JFM of 2016 set a new historical record.

2016. Yap Island, Heart of Dry Season = 40%. Verification = 16%.

Climate Outlook: .By March 2016, the CPC's ENSO Index had fallen from its January peak value of +2.7 (well into strong El Niño territory) to +1.5 (the threshold of strong El Niño). The ENSO index should continue its decline to become ENSO-

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neutral by the late spring, and likely shift all the way to La Niña by the end of the year. In this scenario, Yap Island and the atolls of Yap State should begin an incremental recovery of rainfall, moving ever closer over the next several months to near average values by August or September (Fig. 13). For many months following the post-Peak phase of El Niño (e.g., March through December 2016), the typhoon threat is reduced across Yap State. In the first half of the year, the general reduction of Pacific basin

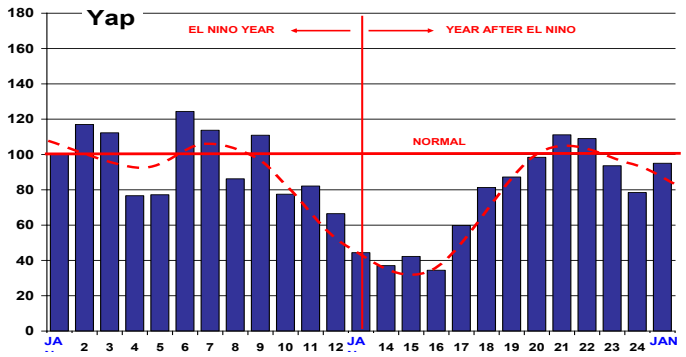

Figure 13. Rainfall at the WSO Yap for a composite of five El Nino events. Significant drying occurs in the latter 3 months of the El Niño year (2015) and is severe in the first half of the year (2016) that follows the peak of El Niño.

typhoons reduces the local risk, and in the second half of the year, the westward and northward displacement of the basin's tropical cyclones helps to reduce the local typhoon threat in Yap

Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]	
	Woleai	Yap & Ulithi
April – June 2016 (End of Dry Season)	40%	50%
July – September 2016 (Heart of Next Rainy Season)	85%	90%
October – December 2016 (End of Next Rainy Season)	85%	95%
January – March 2017 (Heart of Dry Season)	*110%	95%

1 Forecast rainfall quantities represent BEST ESTIMATES given the probabilistic forecast for each particular season and station. * Trade-wind trough becomes strong at Woleai latitude in La Nina.

State. Late in the year (OND 2016), Yap State is among the first locations in Micronesia where the risk of impacts from tropical cyclones returns to near normal (10-15%). Predicted rainfall for Yap State from April 2016 through March 2017 is given below: Lastly, Yap has been considerably below normal since February 2015. After a record 8 inches fall in October, it started to rise again. Currently it is staying about 1 inch above normal.

Chuuk State: The weather and climate at most islands of Chuuk State evolved as expected during the course of the 2015/16 strong El Niño event: very wet during the first six-to-nine months of 2015 followed by a drying trend in the final three months of 2015 that persisted into the first few months of 2016. The last El Niño event of comparable strength to 2015/16 was the strong El Niño event of 1997/98. There was a substantial

LOCAL SUMMARY AND FORECAST

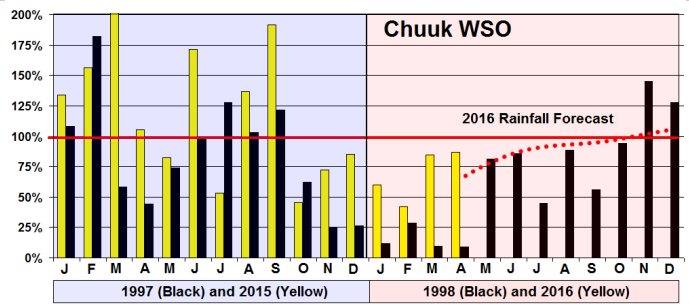

Figure 14 (above). A time series of the monthly rainfall at the WSO Chuuk during 1997/98 (black bars) compared to the rainfall during 2015 through 2016 to-date (yellow bars). Red dotted line shows the anticipated rainfall for the rest of 2016.

reduction of rainfall across Chuuk State during October 1997 through April 1998 (see Fig. 14). As with the 1997/98 event,

Chuuk State Rainfall Summary: 2016 1st Qtr					
Station		Jan	Feb	Mar	1st Qtr
Chuuk Lagoon					
Chuuk WSO	Inches	6.4	2.59	7.08	6.07
	% Avg	60%	42%	85%	64%
Southern Mortlocks					
Namoluk	Inches	9.73	5.42	5.25	20.40
	% Avg	92%	57%	44%	63%
Northern Mortlocks					
Losap	Inches	7.41	2.73	0.95	11.09
	% Avg	69%	44%	11%	44%
Northern Atolls					
Onoun	Inches	4.67	2.56	0.36	7.59
	% Avg	44%	41%	4%	30%
Western Atolls					
Polowat	Inches	3.07	4.81	1.39	9.27
	% Avg	38%	77%	22%	45%

dry conditions became established on schedule in October of 2015 and persisted through April 2016, but it was not nearly as dry as during 1997/98. Nevertheless, drinking water quantity and quality was affected by early 2016. In February 2016, the President of the FSM National Government issued an emergency declaration for drought conditions in all of the states of the FSM. Chuuk State was not as hard-hit by drought during the 2015/16 El Niño event as it was during the 1997/98 event, even while other Micronesia locations such as Yap, Palau and the northern RMI did suffer record or near record dryness on par with 1997/98. It must also be mentioned that dryness was likely more extreme in the atolls in the northern and western part of Chuuk State, where there was likely to have been serious impacts on drinking water quantity and quality, with damage to local agricultural resources (e.g., taro, breadfruit and coconuts). The PEAC hopes to have a more complete summary of drought impacts in Chuuk State in next Quarter's ENSO Newsletter.

Climate Outlook: By March 2016, the CPC's ENSO Index had fallen from its January peak value of +2.7 (well into strong

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El Niño territory) to +1.5 (the threshold of strong El Niño). The ENSO index should continue its decline to become ENSO-neutral by the late spring, and likely shift all the way to La Niña by the end of the year. In this scenario, monthly rainfall amounts at islands and atolls of Chuuk State should rise to near average by summer and remain near average for the rest of 2016. Atolls in the south of Chuuk State already have recovered to near normal, and recovery to near average rainfall should progress northward until by July, all of Chuuk State will be receiving near average summer rainfall (also see Fig. 15).

During 2015, Chuuk State experienced a great abundance of tropical cyclones that should not be repeated soon. For the remainder of 2016, the risk of a damaging tropical cyclone in Chuuk State should be lower than average, with the greatest risk during this quiet year occurring from late September through the end of the year.

Lastly, the sea level, which is still slightly lower than average throughout Chuuk State, should begin a rapid rise, with the mean sea level reaching near average by summer, and going above average by the end of the year (see the sea level section

Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]			
	Chuuk Lagoon, and Nama	Polowat	Northern Atolls	Mortlocks
Apr – Jun 2016	75%	70%	70%	80%
Jul – Sep 2016	85%	80%	85%	95%
Oct – Dec 2016	95%	85%	95%	100%
Jan – Mar 2017	90%	85%	95%	110%

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

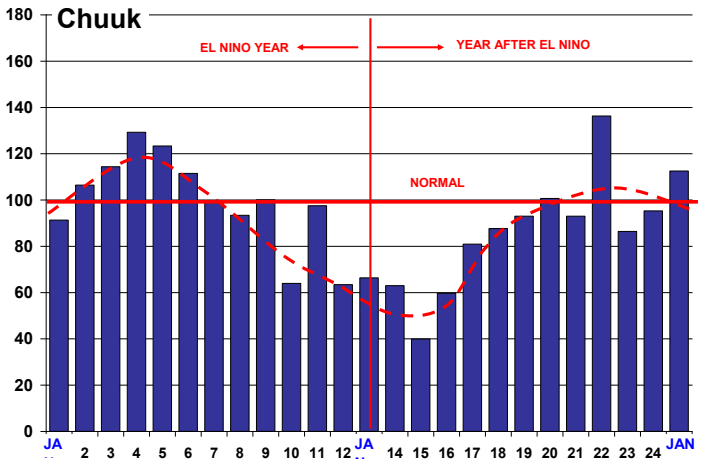

Figure 15. Rainfall at the WSO Chuuk for a composite of five El Nino events. Note the wet conditions in the first half of the El Nino year, with a gradual drying that begins by August or September. Drying is substantial in the first half of the year that follows the El Nino Peak, but recovers by July or August of that year.

for details). Predictions for Chuuk State for April 2015 through March 2017:

Pohnpei State: The calendar year 2015 was very wet at the WSO Pohnpei (see Fig. 16). 2015 ranks as the 4th wettest year in the time series after 1976, 1992 and 1929. After a wet 2015, a

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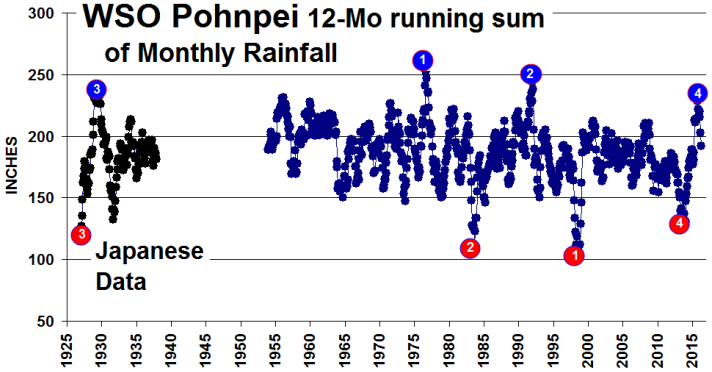

Figure 16. A time series of the 12-month running sum of the monthly rainfall at the WSO, Pohnpei Island, with the pre-WWII Japanese data included. The top 4 wettest and bottom 4 driest 12-month periods are indicated. The rainfall during 2015, ranks at #4. Three of the four wettest 12-month periods occur during El Niño. Three of the four driest 12-month sums occur during the post-Peak phase of El Niño, with #1 and #2 in 1983 and 1998, respectively. The post-Peak phase of the 2015/16 strong El Niño was forecast to be among the driest periods in the time series, but does not now look like it will place among the driest of times.

period of substantially decreased rainfall was predicted to occur on Pohnpei Island and the northern atolls of Pohnpei State through the first 4 or 5 months of 2016 as a response to the post-Peak phase of El Niño. Dryness began on Pohnpei Island in the latter half of January 2016, with a noteworthy brush fire observed on the east side of Sokehs Rock on the last day of January. February and March were also dry on Pohnpei Island, with hot dry days and dusty conditions thought to be responsible for an uptick in the number of cases of pink eye (conjunctivitis). Locations on the northern and eastern coasts of Pohnpei Island (e.g., the airport) reported the driest conditions. Streamflow on Pohnpei Island decreased and water hours were implemented by the public water utility. During April, however, an increase of rainfall brought a suspension of water restrictions on Pohnpei Island. The atolls of Pohnpei State had moderately below average rainfall during the 1st Quarter of 2016, and no reports of significant impacts were received by the PEAC. All things considered, Pohnpei Island and the atolls of Pohnpei State were spared

Pohnpei State Rainfall Summary : 2016 1st Qtr						
Station		Jan	Feb	Mar	Apr	1st Qtr
Pohnpei WSO	Rain (Inches)	13.49	4.64	5.76	11.01	23.89
	% of Average	103%	43%	43%	67%	64%
PNI Airport	Rain (Inches)	11.33	4.42	3.53	7.99	19.28
	% of Average	37%	24%	21%	101%	27%
Atolls of Phonpei State						
Station		Jan	Feb	Mar	Apr	1st Qtr
Nukuoro	Rain (Inches)	10.65	11.60	8.77	7.23	31.02
	% of Average	91%	110%	64%	48%	86%
Pingelap	Rain (Inches)	11.96	2.65	1.52	5.39	16.13
	% of Average	103%	130%	50%	67%	92%
Kapinga..	Rain (Inches)	9.40	6.04	10.02	12.78	25.46
	% of Average	85%	58%	78%	105%	74%

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the severity of dry conditions that were observed at many other locations across Micronesia, and during the 1997-98.

Climate Outlook: By March 2016, the CPC's ENSO Index had fallen from its January peak value of +2.7 (well into strong El Niño territory) to +1.5 (the lower threshold of strong El Niño). The ENSO index should continue its decline to become ENSO-neutral by the late spring, and likely shift all the way to La Niña by the end of the year. Normally in this scenario, there is a substantial reduction of rainfall on Pohnpei Island and across the northern atolls of Pohnpei State during the period January through May, with a return to average rainfall amounts by June. With observed rainfall amounts across the state rising during April, it is now thought that rainfall amounts will continue their rebound and be near average across all of Pohnpei State for the reminder of 2016 through early 2017. If the climate system moves into La Niña in 2017, the spring months of 2017 could be very wet at Pohnpei Island and Sapuawafik Atoll followed by a drying at Kapingamarangi. For the remainder of 2016, the threat of a damaging tropical cyclone anywhere within Pohnpei State is very low (less than a 1-in-10 chance). Predicted rainfall for Pohnpei State from April 2016 through March 2017 is:

Lastly, the sea level typically begins a rapid rise in the post-Peak months, and sea level could be above average by mid-summer (see the sea level section for details).

Inclusive Period	% of long-term average	
	Pohnpei Island/ atolls	Kapingamarangi
Apr – Jun 2016	80%	95%
Jul – Sep 2016	95%	95%
Oct – Dec 2016	100%	95%
Jan – Mar 2017	120%	90%*

** Located near the equator, the rainfall pattern at Kapingamarangi is much different than at islands and atolls farther to the north. It remains wet through the onset and peak of El Niño, and typically stays wet through all of the post-Peak period El Niño. Major drought at Kapingamarangi is often associated with strong La Niña events, and dryness could begin at Kapingamarangi in the second half of 2017 if the climate system makes a sharp push toward La Niña late in 2016.

Predicted rainfall for Pohnpei State from April 2015 through March 2016:

Kosrae State: Rainfall amounts on Kosrae were well below average during both October and November 2015, which, at the time, was thought to be the beginning of dry conditions associated with the start of the post-Peak phase of the strong 2015/16 El Niño. During December, however, and continuing through January and February 2016, monthly rainfall bounced back to near normal. Then it was thought that perhaps Kosrae would be spared any further substantial post-Peak El Niño related dryness. But, during March and April 2016, very dry conditions returned, so that overall, the rainfall sum across the entire period October 2015 through April 2016 was well below normal (60.41 inches versus 117.67 inches or 51%). In fact, the 7-month total rainfall at Kosrae from October 2015 through April 2016 was actually the third-driest such period in the time series of rainfall at Kosrae (See Fig. 16). To-date, there have been no reports of any serious problems related to dry conditions on Kosrae.

Climate Outlook: By March 2016, the CPC's ENSO Index had fallen from its January peak value of +2.7 (well into strong

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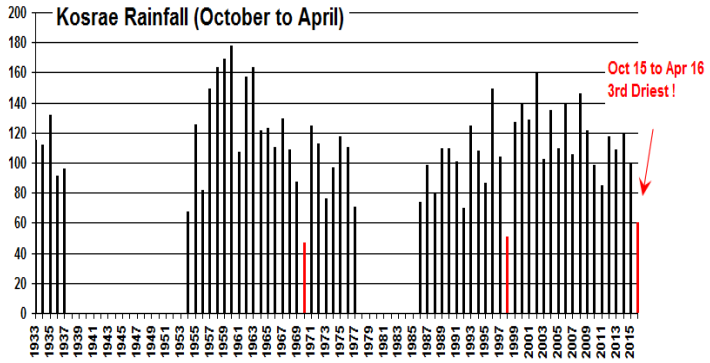

Figure KS-1. Time series of 7-month Oct-Apr rainfall total at Kosrae SAWRS (Airport) observing site, including a period of observation at Lelu on the east coast (1954-1977), and a period of Japanese observations (1933-1937). The period Oct 2015 to Apr 2016 was the 3rd driest such period in the time series behind only 1970 and 1998.

Kosrae State Rainfall Summary: 2016 1st Qtr					
Station		Jan	Feb	Mar	1st Qtr
Airport (SAWRS)	Inches	9.95	14.50	5.15	29.60
	% Avg	69%	89%	28%	60%

El Niño territory) to +1.5 (the threshold of strong El Niño). The ENSO index should continue its decline to become ENSO-neutral by the late spring, and likely shift all the way to La Niña by the end of the year. In this scenario, continued below average rainfall would normally be anticipated on Kosrae for about two more months, then by July, near-average rainfall returns and stays then near-average for the rest of the year.

Tropical cyclones occur at Kosrae almost exclusively during the months of El Niño Onset through the El Niño Peak phase. During the El Niño post-Peak months, and indeed all the way through to the end of 2016, the threat of a damaging tropical cyclone at Kosrae is very low.

Lastly, the sea level typically begins a rapid rise throughout all of Micronesia in the post-Peak months of an El Niño event. Thus, the sea level at Kosrae should return to average by mid-summer, and likely rise to above average late in the year (see the sea level section for details).

Predicted rainfall for Kosrae State from April 2016 through March 2017:

Inclusive Period (Kosrae)	% of long-term average / Forecast rainfall (inches) [1]
April – June 2016	75%
July – September 2016	90%
October – December 2016	95%
January – March 2017	110%

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

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LOCAL SUMMARY AND FORECAST

Republic of Palau: The persistent long-term dryness of 2015/16 at Palau reached historical lows in a variety of durations and monthly splits. The 2015 annual total rainfall of 97.06 inches (66%) recorded at the Weather Service Office in Koror made 2015 the driest year in that station's 63-year post-WWII climate record. With rainfall readings taken by Japanese observers on Palau during the period 1924-1937 included in the historical record, the recent dry conditions still set record lows (see Fig 17) for the entire 80 years of observation. The driest 12-month sum found in the historical record (including Japanese data) is the 86.09 inches that occurred from August 1997 to July 1998. The second lowest value is the 86.25 inches recorded during April 2015 to March 2016, which is the driest APR to MAR when compared head-to-head (Figure 18). By March of 2016, Koror had accumulated a deficit of 71 inches in the 15-month period beginning in January 2015 and ending in March 2016 (Figure 19). The driest year at Palau in the Japanese data is the 128.76 inches recorded during 1938. In contrast, the wettest 12-month sum was 208.26 inches occurred during the period September 2010 to October 2011. In a hopeful sign that the long dry spell at Palau may soon ease, April 2016 was the first month since September 2015 with above-average rainfall.

Reported impacts of dryness included brush fires, reduced stream flow, yellowing of vegetation, and the death of millions of jellyfish in Palau's world-famous Jellyfish Lake (Fig. 20) (as detailed in the Current Conditions section). A more in-depth report of impacts on Palau associated with this historical drought is anticipated in the next PEAC newsletter..

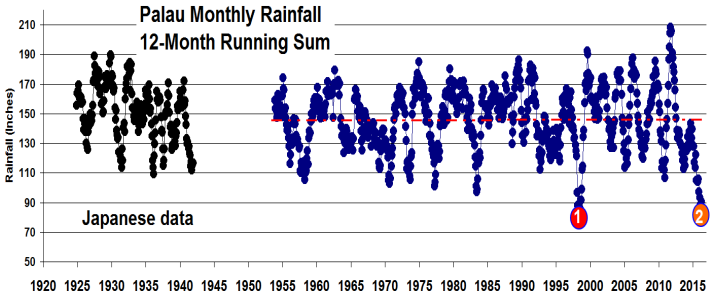

Figure 17 A time series of a 12-month running sum of rainfall at Koror, Palau including rainfall data tabulated by Japanese observers during 1924-1941. The two driest 12-month periods are indicated by the large dots.

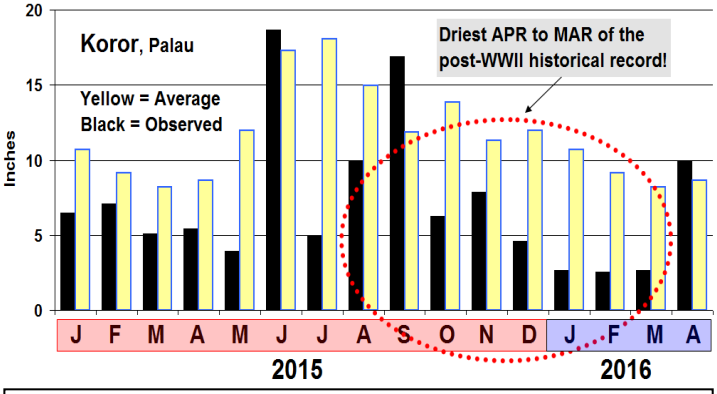

Figure 18. Observed rainfall (black bars) versus average rainfall (yellow bars) at Koror, Palau, during 2015 through 2016 to-date.

LOCAL SUMMARY AND FORECAST

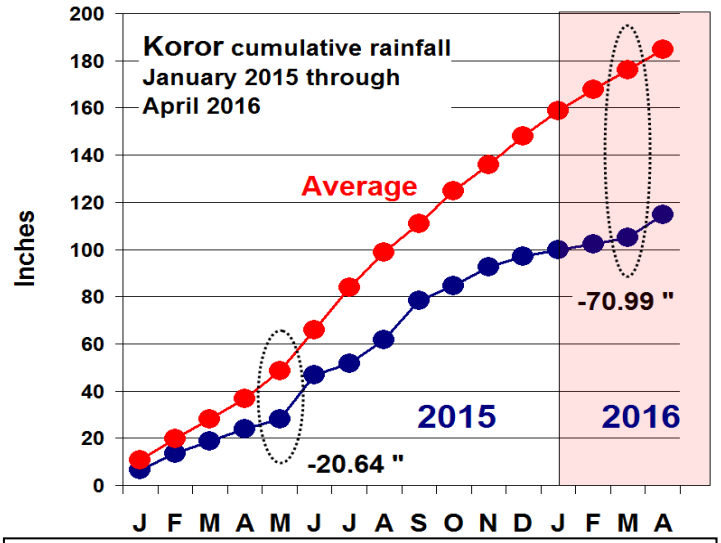

Figure 19. Cumulative rainfall at Koror. Red line shows the normal accumulated rainfall from JAN 2015 through APR 2016, and the dark blue line shows the measured accumulated rainfall. By APR 2016, the accumulated rainfall deficit was -70.99 inches.

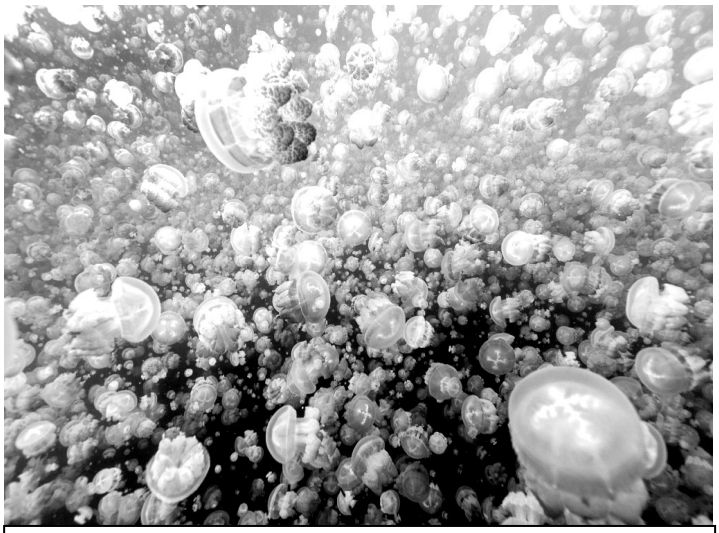

Figure 20. The jellyfish of Jellyfish Lake, Rock Islands, Palau. Normally, several million jellyfish provide a never-forgotten spectacular show for swimmers who take the boat trip and short hike over a limestone forest hill to swim in the lake. The 2015/16 drought decimated their numbers, but they should rebound as normal rains return.

Republic of Palau Rainfall summary JFMA 2016 and 1st Quarter total.

Station		Jan	Feb	Mar	Apr	1st Qtr
Koror WSO	Rain (Inches)	2.64	2.53	2.68	9.90	7.85
	% of avg.	25%	28%	33%	114%	28%
Intl. Airport	Rain (Inches)	3.92	2.13	2.28	13.68	8.33
	% of avg.	33%	21%	25%	143%	27%

Climate Outlook:

By March 2016, the CPC's ENSO Index had fallen from its January peak value of +2.7 (well into strong El Niño territory) to +1.5 (the threshold of strong El Niño). The ENSO index should continue its decline to become ENSO-neutral by the late spring, and likely shift all the way to La Niña by the end of the year. Palau is one of the first places in Micronesia to fall short of average rainfall during the course of a strong El Niño event. With the climate now in the post-Peak phase of El Niño, rainfall amounts should make a sustained and steady climb to near average by July, and perhaps go slightly above average by the close of the year.

For many months during the post-Peak phase of El Niño (e.g., March through July), the typhoon threat is reduced in the Republic of Palau. In the first half of the year, the general reduction of Pacific basin typhoons reduces the local risk, and in the second half of the year, the westward and northward displacement of the basin's tropical cyclones helps to reduce the local typhoon threat, at least until very late in the year (OND), when the Republic of Palau is among the first locations in Micronesia where the risk of impacts from tropical cyclones returns to near average.

Lastly, the sea level was very low in Palau during 2015, and should now undergo a rapid rise over the next few months to stand above average by the end of the year and into early 2017 (see the sea level section for details). Predicted rainfall for Palau from April 2016 through March 2017 is:

Palau Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]
April – June 2016	75%
July – September 2016	90%
October – December 2016	105%
January – March 2017	110%

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

Republic of the Marshall Islands (RMI)

The weather in the Republic of the Marshall Islands during 2015 and through April of 2016 progressed almost exactly as expected during the course of a strong El Niño event. The spring of 2015 was particularly wet in association with unusual monsoonal westerly winds reaching the southern RMI and with equally unusual tropical cyclone activity. Through 2015, developing tropical cyclones continually affected the region, and there were three separate instances of damaging sea inundation associated with each of tropical cyclones Bavi (March 2015), Dolphin (May 2015) and Nangka (July 2015). The RMI escaped its late season (October 2015 through January 2016) threat of a tropical cyclone when three tropical cyclones with a plausible pathway to the RMI – TD 08C (October), TD 09C (December) and Hurricane Pali (January) – remained quasi-stationary just east of the International Date Line. These tropical cyclones were trapped eastward of the International Date Line by monsoonal influences. The last of the suite of climate anomalies typically delivered to the RMI by a strong EL Niño (i.e,

LOCAL SUMMARY AND FORECAST

drought) was not held in check.

During the 4th Quarter of 2015, rainfall amounts began to decline. This is a typical response to El Niño, and was well-forecast several months in advance. By November and December, most atolls began experiencing monthly rainfall values below the critical experimental drought thresholds being considered for assigning drought categories in the U.S. Drought Monitor. Through the 1st Quarter of 2016, rainfall at most of the atolls of the RMI was far below normal, with serious impacts. The magnitude of rainfall deficits set record low marks in some places:

Ailingalapalap -- 2nd driest Oct-Mar, driest March
Kwajalein -- driest Oct-Mar, driest Apr-Mar
Majuro -- 2nd driest Oct-Mar
Jaluit -- 5th driest Oct-Mar
Mili -- driest Oct-Mar
Utirik -- driest Oct-Mar, driest Apr-Mar
Wotje -- 2nd driest Oct-Mar, driest March

The following is contained in a situation report issued on 05 May 2016 by the International Office for Migration (IOM) Marshall Islands:

Background

Below average rainfall throughout the equatorial Pacific Ocean in early 2016 has created drought conditions in many Pacific nations. According to the National Oceanic and Atmospheric Administration (NOAA), 'all locations across the Marshall Islands are in a severe or extreme drought' and that 'one of the strongest El Nino events in recorded history remains entrenched across the equatorial Pacific Ocean.'

Time Line of Drought

- February 03, 2016: RMI President H.E. Dr. Hilda Heine declares State of Emergency.
- March 08, 2016: RMI President H.E. Dr. Hilda Heine declares State of Disaster.
- April 27, 2016: U.S. President Barack Obama Declares Disaster in the Marshall Islands.
- 21,000 people in RMI are affected by severe drought conditions.
- 1,257 households are affected on the outer islands and 5,195 households are affected in urban areas.
- Government of RMI identified 8.99 million USD in emergency response needs.

U.S. President Obama Declares Disaster

On April 27, 2016, United States President Barack Obama officially declared a disaster in RMI due to the ongoing drought. President Obama's declaration will make federal funding available for "emergency relief...assistance to the Republic of the Marshall Islands", according to the White House. IOM, in close coordination with the RMI Government and the donor community [including USAID/OFDA], continues to deploy RO units and distribute hygiene materials throughout the RMI. Additional funding could help address other needs, including supplemental food assistance.

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RMI Rainfall Summary: 2016 1st Qtr						
Station		Jan	Feb	Mar	Apr	1st Qtr
RMI Central and Southern Atolls						
Majuro WSO	Inches	1.11	3.17	1.33	2.05	5.61
	% Avg	13%	52%	16%	20%	25%
Mili	Inches	2.22	5.68	1.41	2.70	9.31
	% Avg	26%	92%	17%	26%	41%
Ailing-laplap	Inches	7.69	0.33	0.55	2.54	8.57
	% Avg	118%	7%	9%	28%	49%
Jaluit	Inches	4.57	3.69	1.63	4.52	9.89
	% Avg	54%	60%	20%	44%	43%
RMI Northern Atolls						
Kwajalein	Inches	3.20	0.46	1.05	1.13	3.53
	% Avg	44%	14%	26%	30%	26%
Wotje	Inches	T	0.05	0.28	0.16	0.34
	% Avg	0%	2%	10%	4%	5%
Utirik	Inches	0.39	0.94	0.77	1.86	2.10
	% Avg	19%	48%	30%	52%	32%

Climate Outlook:

By March 2016, the CPC's ENSO Index had fallen from its January peak value of +2.7 (well into strong El Niño territory) to +1.5 (the lower threshold of strong El Niño). The ENSO index should continue its decline to become ENSO-neutral by the late spring, and likely shift all the way to La Niña by the end of the year. In this scenario, the RMI should begin an incremental recovery of rainfall, moving ever closer over the next several months to near average values by August or September (Fig. 21). Figure RMI 1 was put together by PEAC and the WFO Guam for use by the WSO Majuro Chief Meteorologist, Reggie White, in his efforts to help coordinate and inform ongoing drought relief in the RMI. It is a smoothed and relatively conservative estimate of the nature of the rainfall recovery at Majuro. Atolls further to the north (e.g., Kwajalein, Utirik and Wotje) receive less average monthly rainfall than at Majuro, and recovery from the impacts of drought in the northern atolls may take a month or two longer than at Majuro.

Predicted rainfall for the RMI from April 2016 through March 2017 is as follows:

Inclusive Period	% of long-term average / Forecast rainfall (inches) [1]		
	South of 6ºN	6ºN to 8ºN	North of 8ºN
April – June 2016 (Onset of Rains)	60%	60%	50%
July – Sept 2016 (Rainy Season)	85%	85%	80%
Oct – Dec 2016 (Start of Dry Season)	90%	90%	90%
Jan – March 2017 (Dry Season)	110%	100%	90%

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

LOCAL SUMMARY AND FORECAST

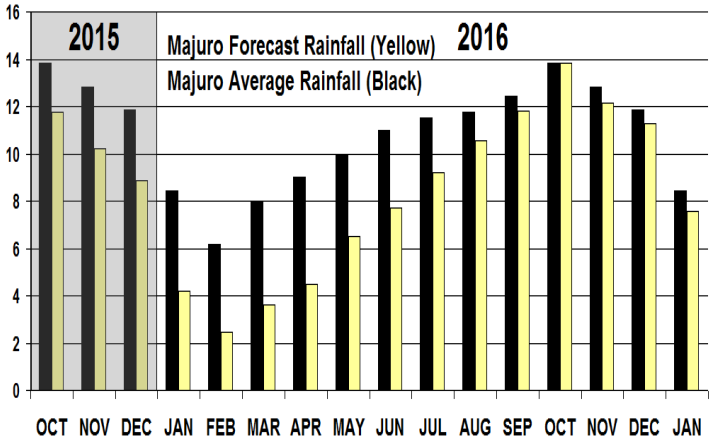
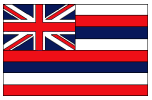


Figure 21. A plausible scenario for the slow recovery of rainfall at Majuro for the remainder of 2016. The average monthly values of rainfall at Majuro are shown in black, and the forecast values are shown in yellow. The forecast amounts are, of course, unrealistically smoothed, but are intended to show the typical time scale of the recovery of rainfall after a severe post-Peak El Niño drought.

Tropical cyclones occur within the RMI almost exclusively during the months of El Niño Onset and during El Niño Peak (e.g., 2015). In the upcoming El Niño post-peak months, and indeed all the way through to the end of 2016, the threat of a damaging tropical cyclone within the RMI is very low (less than 10%).

Lastly, the sea level typically begins a rapid rise in the post-Peak months, and sea level should be at or above average by mid-summer (see the sea level section for details). Majuro is the first station in north Pacific that became positively elevated in January 2016 (earliest than all other stations). Currently, it is about 5 inches above normal.



Hawaii

The following information was compiled from the NWS Honolulu Office Drought Information Statements for the first quarter or 2016 found at http://www.prh.noaa.gov/hnl/pages/hydrology.php.

The characteristic dry weather conditions associated with El Niño events arrived in Hawaii by late December 2015 and persisted through March of 2016 with drought conditions progressively worsening throughout the first quarter of the year. Some of the worst impacts have been observed on the Big Island of Hawaii where by the beginning of April Extreme Drought conditions, D3 category in the U.S. Drought monitor, had developed over portions of the North Kona and South Kona districts. Many of these impacts remain as of press time. This development of D3 conditions made it the first time areas of this drought category were present in the state since April 8 2014. By early April, 79% of the state was affected by some level of drought conditions, an increase of 25% since the same time in March.

During April, persistent trade winds helped ease drought conditions along the windward slopes across the state. Unfortunately most of the leeward areas did not receive much of this enhanced trade wind rainfall and showed little improvement in drought conditions. Currently, some level of drought conditions covers just about 70% of the state. On the Big Island, Extreme Drought, the D3 category, conditions are still present along the Kona Slopes and Severe Drought, the D2 category, covers most of the

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western part of the island. Severe Drought conditions also continue to affect Lanai, Niihau, the southern coast of Kauai and the southwest slopes of Haleakala on Maui. On Oahu, Moderate Drought, or the D1 category, persists over the western half of the island.

Finally, note that, as compared to the above north and south Pacific stations, the sea level of Hawaiian stations are less sensitive to ENSO. Therefore, in addition to ENSO, other local oceanic and atmospheric factors are equally important. However, current observations revealed that, since January 2015, the monthly mean sea level in Honolulu remained slightly elevated. It recorded an abrupt 7 inches rise in September 2015 and then started to fall again. Currently, it is staying close to normal (+1 in). On the other hand, Hilo's sea level remained slightly elevated since January 2015. It went down to below normal in December 2015.

Hawaii Rainfall Summary: JFMA 2016 and 1st Quarter 2016 total						
Station		Jan	Feb	Mar	Apr	1st Qtr
Lihue Airport	Inches	0.32	0.85	2.62	0.84	3.79
	%Norm	14%	46%	101%	43%	57%
Honolulu Airport	Inches	0.03	0.40	0.22	0.22	0.65
	%Norm	3%	40%	28%	42%	22%
Kahului Airport	Inches	1.29	1.00	1.95	1.20	4.24
	%Norm	56%	93%	104%	135%	81%
Hilo Airport	Inches	0.55	3.28	4.89	9.57	8.72
	%Norm	6%	39%	45%	107%	31%

Climate outlook:

The current El Niño event has progressively decayed over the past few months. This trend is expected to continue with ENSO conditions continuing to decline and become ENSO-neutral by the late spring, and likely shift all the way to La Niña conditions by the end of the year. According to the CPC long range seasonal forecast for Hawaii (found here http://www.cpc.ncep.noaa.gov/products/predictions/90day/fxhw40.html) Above median precipitation is favored across the state from July to October by Multi Model Ensemble predictions. In spite of this they note that this forecast is quite uncertain due to the drying trend over portions of the Hawaiian Islands during recent La Niña events.

Predicted rainfall for Hawaii State from July 2016 through March 2017 is:

	Station			
Inclusive Period	Hilo	Honolulu	Kahului	Lihue
Jul – Sep 2016	40% chance of Above Median rainfall	40% chance of Above Median rainfall	40% chance of Above Median rainfall	40% chance of Above Median rainfall
Oct – Dec 2016	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 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

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The CPC U.S. Seasonal Drought Outlook (found here http://www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_summary.php) predicts drought conditions likely to persist over the western half of all the Hawaiian Islands during the May through August period. This is attributed to the fact that the state of Hawaii should be transitioning soon into its dry season.

Current sea level forecasts indicate that both the stations will stay marginally above normal during the next season.

Sea Level Observation from the Global Satellite Picture:

SEASONAL SEA LEVEL OUTLOOK Cont.

Observations from the recent global satellite picture (Fig. 22, below) revealed that the sea levels have been low over the western part of the Pacific Basin and high over the central and eastern Pacific. ***The tropical Pacific atmosphere and ocean are currently at decaying phase of El Niño.*** *Any further sea level fall in the north Pacific islands is most unlikely as the on-going El Ninõ has already started to be weakening and turning to be in neutral phase by early summer of 2016. This satellite data are supportive to tide-gauge observations, and revealed that some of the stations located in Micronesia and Marshalls Islands have already started rising, This is a turning point when sea level transitions to normal (or above normal) stage from its year-long below normal stage.*

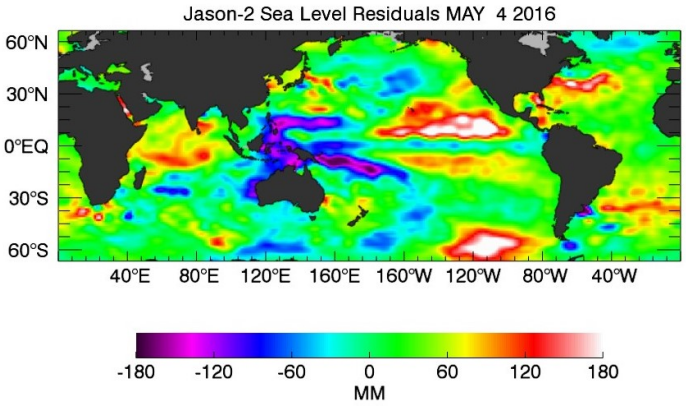

Figure 22. Jason-2 sea level residuals (May 4 2016). (Source: https://sealevel.jpl.nasa.gov/images/latestdata/jason/2016/20160504G.jpg)

SEASONAL RAINFALL OUTLOOK FOR THE US-AFFILIATED PACFIC ISLANDS

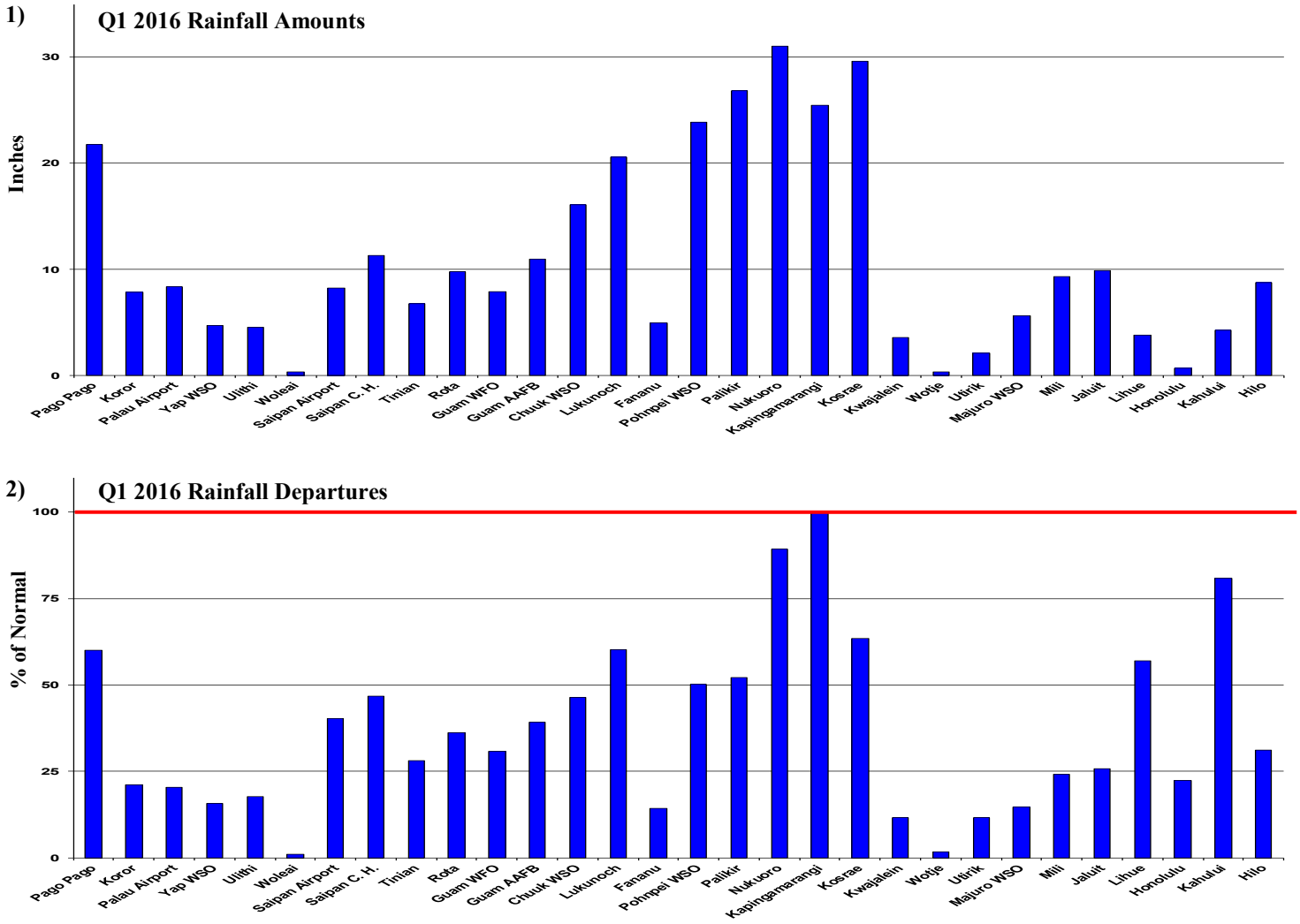

Figure 23 and 24, 2016 First Quarter Percent of Average rainfall amounts in inches at the indicated locations and rainfall departure from average (in percent) at the indicated locations.

ACKNOWLEDGEMENTS AND FURTHER INFORMATION

Pacific ENSO Applications Climate (PEAC) Center:
HIG #340, 2525 Correa Road, Honolulu, Hawai'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, ***Editor—Pacific ENSO Update***
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, Hawai'i 96822
Dr. Mark Merrifield, PEAC Principal Investigator at 808-956-6161: for more information on sea level and climate in Hawai'i.

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

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

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