pacific ENSO update

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Pacific ENSO Update

*The **Pacific ENSO Update** is a bulletin of the **Pacific El Niño-Southern Oscillation (ENSO) Applications Center (PEAC).** 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, with additional special reports on important changes in ENSO conditions as may be required from time to time.*

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CURRENT CONDITIONS

According to the U.S. Climate Prediction Center (CPC), the climate of the tropical Pacific entered El Niño in the second half of 2004. The CPC's definition of El Niño requires three consecutive months with SSTs at least 0.5 degrees Celsius warmer than normal in a region of the central equatorial Pacific designated as "Niño 3.4." This threshold was reached in September 2004, and has continued since then. The atmospheric response to El Niño (persistent negative values of the Southern Oscillation Index, for example) has been weak. Widespread dryness associated with El Niño, which typically begins at many locations in Micronesia late in the year, was not extreme.

For the 2004 calendar year, most of the islands of Micronesia and American Samoa had near normal to above normal rainfall (**Fig. 1a, 1b**). Due in part to the near passage of several tropical cyclones, the island of Guam had its second wettest year in its rainfall time series, which extends back to the 1950's. At 21 selected locations throughout the region, 13 had above normal annual rainfall (**Fig 1a**). Annual rainfall totals exceeded 120% of normal at Ulithi, Guam, Saipan, Tinian, Rota, and Kapingamarangi. Annual rainfall totals were below 80% of normal at American Samoa, Peleliu, and Pingelap. During the final months of 2004, a wide expanse of drier than normal weather spread across the tropical western Pacific in a "horseshoe"- or "boomerang"-shaped area extending from Fiji westward to the Solomon Islands and Indonesia, and across most of Micronesia in the North Pacific. **Drier than normal weather is anticipated throughout much of Micronesia for the next 3 to 6 months; however, a major El Niño-related Micronesia-wide drought is not expected**.

The general consensus among international computer climate forecasts is for the **weak El Niño conditions to weaken for the next three months, and gradually subside back toward ENSO neutral conditions during mid-2005**. Historically, climate forecasts made during this time of the year show little skill, so it is difficult to predict conditions beyond three months with any reliability; most models to show a return to ENSO Neutral conditions. The following comments from the EL NIÑO/ SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION were posted on the U.S. Climate Prediction Center web site on

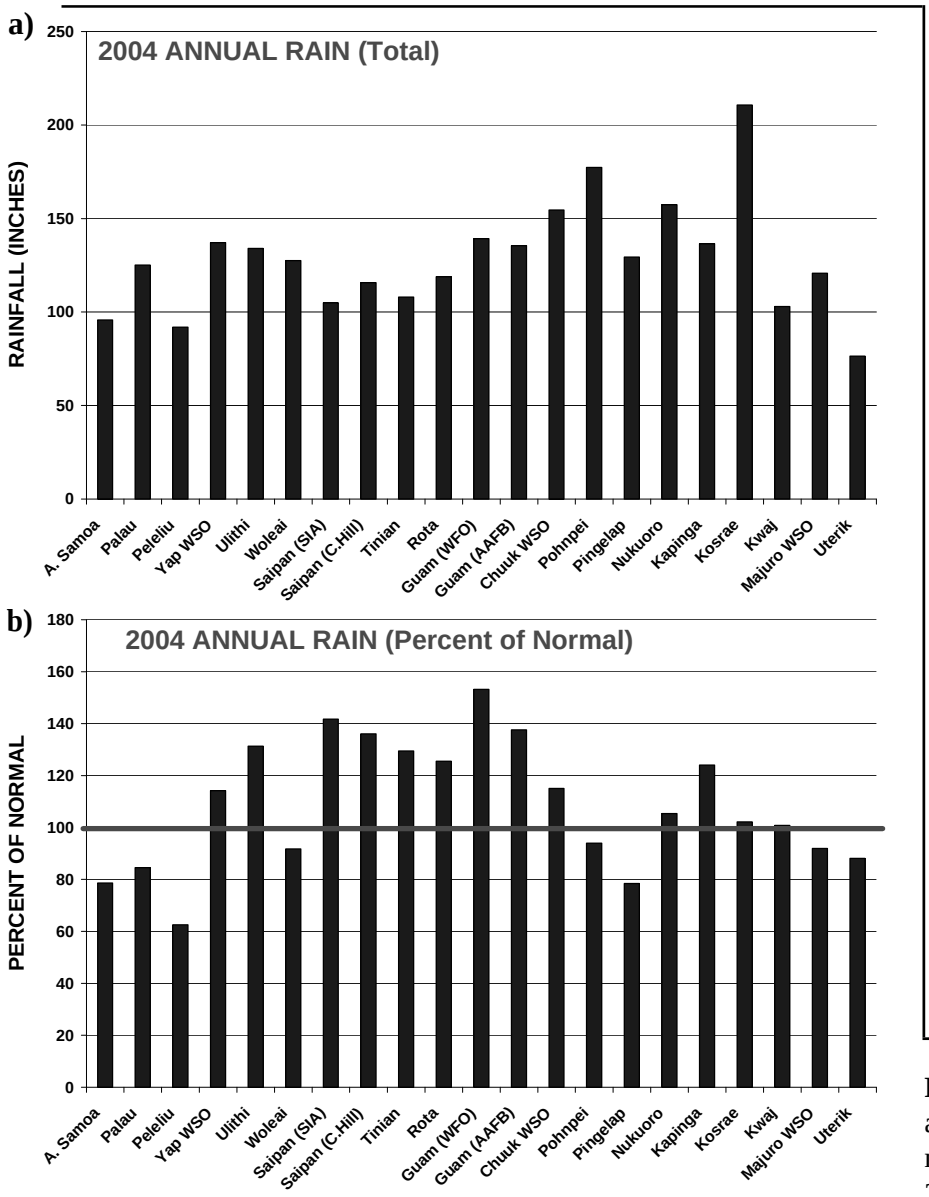
cont'd on page 2

CURRENT CONDITIONS

" Synopsis: A transition from weak warm-episode (El Niño) conditions to ENSO-neutral conditions is expected during the next three months.

Sea surface temperature (SST) anomalies decreased in the equatorial Pacific everywhere east of the date line during January 2005, resulting in decreases in all of the Niño indices with the exception of Niño 4. However, positive sea surface temperature (SST) anomalies greater than +1°C (~1.8°F) persisted in portions of the central and western equatorial Pacific. By early February 2005, positive equatorial SST anomalies greater than +0.5°C (~0.9°F) were found from 140°E eastward to 155°W. The pattern of anomalous warmth in the equatorial Pacific in recent months and the most recent 5-month running mean value of the Southern Oscillation Index (-0.5) indicate that a weak warm (mid-Pacific El Niño) episode is in progress. However, through December there was a lack of persistent enhanced convection over the anomalously warm waters of the central equatorial Pacific, which limited El Niño-related impacts….

Based on the recent evolution of oceanic and atmospheric conditions and on a majority of the statistical and coupled model forecasts, it seems most likely that weak warm episode (El Niño) conditions will gradually weaken during the next three months and that ENSO-neutral conditions will prevail during the last half of 2005."



CURRENT CONDITIONS

SEA SURFACE TEMPERATURE (SST)

By the end of 2004, western Pacific SSTs were near than normal throughout much of Micronesia. Warmer than normal SSTs were found near and along the equator from 160° E (the approximate longitude of Kapingamarangi) eastward across most of the central Pacific. SST anomalies exceeding +1° C (~ +2° F) were located near and along the equator in the region of the International Date Line. By early February 2005, cooler water appeared along the South American coast and the equatorial eastern Pacific, while the warm pool continues to persist near the International Date Line. The resurgence of cool water along the eastern Pacific is consistent with a gradual weakening of the El Niño conditions. The current weak El Niño conditions are expected to continue to weaken during the next few months bringing cooler SSTs.

SOUTHERN OSCILLATION INDEX (SOI)

During the fourth quarter of 2004, the SOI was moderately negative. Individual monthly index values were -0.3, -0.9, -1.1 and .3 during October, November, December, and January, respectively. The most recent 5-month running mean value of the SOI was -0.5. This weakly negative 5-month running mean is consistent with weak El Niño conditions. Nearly all El Niño events are associated with a persistently negative SOI near -1.0 or lower. During La Niña, the SOI is persistently positive, near +1.0 or higher. With a gradual weakening of El Niño conditions in the Pacific basin, the SOI should be near zero for the next three to six months.

Figure 1. (a) Annual rainfall totals (in inches) and **(b)** anomaly (expressed as percent of normal) at the indicated islands for calendar year 2004.

CURRENT CONDITIONS

SEA LEVEL

Sea level data used in this discussion was provided by the UH Sea Level Center <http://uhslc.soest.hawaii.edu>. "Normal" sea level at each station is defined as the average sea level for that location from 1985 – 2004.

The average sea level anomalies in most of the tide gauge stations in USAPI continued to be close to normal in the fourth quarter 2005 with monthly anomalies of less than 11 cm (< 5 inches) **(Table 1).** Since June 2004, the sea level was below normal in a large region from Guam extending westward to Yap State and Palau. During July, August, and September these negative anomalies decreased and remained slightly below normal (~ 2 inches) from Palau eastward to Guam and the CNMI. By October, November and December, these negative anomalies were confined to the area around Saipan and Guam. The sea level was slightly higher than normal from Kapingamarangi eastward through the southern Marshalls at Majuro. In the South Pacific, Pago Pago was slightly above normal (3 – 4 inches) in the third quarter and continues to be slightly above normal throughout the fourth quarter

The deviations of sea level are relatively small at the present, but are consistent with a weak El Niño pattern. With weak El Niño conditions, the sea level distribution in Guam, CNMI, Palau, and FSM for the first few months of 2005 is likely to be a few inches (one to three) below normal. The sea level is likely to start displaying negative anomalies in American Samoa beginning in 2005. However, as the El Niño condition is gradually weakening, the sea level variation may remain close to normal in this quarter too.

These forecasts are seasonal averages. Storm surges, typhoon strikes and hazardous surf can occur and cause large daily deviations in sea level. For more information on sea level read SPECIAL SECTION: ENSO and Sea-Level Variability on p. 10-11 of this newsletter.

Tide Gauge Station	Observed anomaly October (cm)	Observed anomaly i November (cm)	Observed anomaly December (cm)
Saipan, CNMI	- 5	-2	-5
Guam	-7	-7	-11
Malakal, Palau	0	+ 2	+ 7
Yap, FSM	+ 6	+ 1	- 6
Pohnpei, FSM	+ 4	+ 5	+ 3
Kapingamarangi, FSM	+ 10	+ 4	+ 5
Kwajalein, Marshalls	+ 1	+ 5	+ 4
Pago-Pago, A Samoa	+ 10	+ 8	+ 3

Table 1. Sea level anomalies (cm) at indicated islands for the fourth quarter (October, November, December) of 2004. - indicates negative anomaly (fall of sea level), + indicates positive anomaly (rise of sea level)

TROPICAL CYCLONE ACTIVITY

The tropical cyclone activity over the entire western North Pacific was above normal during 2004 with 32 numbered tropical cyclones (the average is 31) according to the Joint Typhoon Warning Center (JTWC). Twenty-one of these became typhoons (the average is 18), and seven became super typhoons (the average is 4). The number of typhoons in 2004 is the highest since 1997.

Several tropical cyclones affected the islands of Micronesia during 2004. Substantial property damage, injuries, or fatalities occurred in association with three of these: Sudal, Tingting, and Chaba. On April 9, 2004 Typhoon Sudal hit Yap Island directly, causing much damage. During the last week of June, Typhoon Tingting was responsible for an extreme rain event on Guam. Flooding was extensive, and caused much property damage. High surf generated by this tropical cyclone caused 7 deaths by drowning (all in the few days after the typhoon had moved away from Guam). On the night of August 22, 2004 the center of Typhoon Chaba passed close to the island of Rota in the CNMI. Major damage to vegetation, property and infrastructure occurred on that island. Yap Island was almost run over by Typhoon Nanmadol on the 30th of November. This typhoon passed just to the north of Yap Island, and the island was spared another round of destruction. On the night of the 10th of December, Tropical Storm Talas passed just south of Kwajalein Atoll. Coconut fronds were strewn about, and some broadleaf trees were uprooted by winds that gusted to 65 mph. In American Samoa, Hurricane Heta passed close during the first week of January 2004 causing power outages, damage to trees and flooding rains.

One of the biggest weather stories of 2004 was the record number of tropical cyclones that made landfall in the main islands of Japan. A total of ten tropical cyclones of tropical storm intensity (39 mph maximum wind speed) or greater made landfall there, some causing many deaths and injuries. The previous record of six tropical cyclones making landfall in one year occurred during 1990 and 1993 (recording period began in 1951). Though not officially recognized as a typhoon when it hit the Japan, the post-tropical remnants of Typhoon Nanmadol passed across Japan in early December bringing wind gusts of 100 mph to some locations; In Tokyo the temperature rose to 77° F in warm down-slope wind conditions in the wake of the passing storm system — this is the highest temperature ever recorded in Tokyo during December.

Condolences go out from PEAC to the residents of Japan and Micronesia who have suffered during this very active typhoon season.

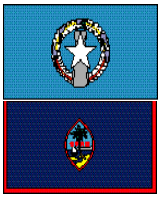
LOCAL SUMMARY AND FORECAST

American Samoa: The total rainfall of 95.76 inches in American Samoa during the calendar year of 2004 was below normal (79%). In both total annual rainfall and percent of normal annual rainfall, American Samoa was one of the driest locations covered in this summary (**Fig. 1a, 1b**). Only four of twelve months (February, March, July and October) during 2004 had above normal rainfall. Rainfall at Pago Pago Airport for October, November, and December was 11.52 inches (107%), 4.00 inches (37%), and 9.68 inches (67%), respectively, amounting to 70% of normal for the 3-month period. With warmer than normal sea surface temperatures persisting in the central equatorial Pacific, the threat of a tropical cyclone in American Samoa may be slightly higher than normal through April 2005 (at print time Tropical Cyclone Nancy and Olaf are passing through the region. Information on the effects of these typhoons will be included in the next *Pacific ENSO Update*).

Computer forecasts and a consensus of outlooks from several regional meteorological centers indicate that rainfall in American Samoa is likely to be below normal through the rest of the current rainy season and through the next dry season. Long-range computer rainfall forecasts, however, have only limited skill in the tropical Pacific islands. Predicted rainfall for American Samoa from February 2005 through January 2006 is:

Inclusive Period	% of long-term average
Feb-Apr 2005 (Heart of Rainy Season)	80%
May-Oct 2005 (Next Dry Season)	90%
Nov 2005-Jan 2006 (Onset of Next Rainy Season)	95%

- source: UOG-WERI



Guam: Rainfall on Guam during 2004 was excessive. The total rainfall of 139.32 inches at the Guam International Airport (GIA) was well above normal (153%). This was the 2nd wettest year in a time series of rainfall on Guam that extends back to 1950. 2004's total just surpasses the annual total of 139.10 inches recorded there in 2002, and is exceeded only by the 141.12 inches recorded there in 1976. Guam's summer rainy season (June through October) was very wet, with enormous month-to-month variation. Beginning in September, however, and continuing into January 2005, Guam has become increasingly dry. The rainfall for October, November, and December at the GIA was 9.86 inches (82%), 6.46 inches (79%), and 9.89 inches (82%) respectively. The total of 19.59 inches was 76% of normal for the 3-month period. At Andersen Air Force Base (AAFB), the rainfall for October, November, and December was 9.57 inches (74%), 9.94 inches (110%), and 4.48 inches (75%) respectively, amounting to 86% of normal for the 3-month period. During the latter half of January 2005, wildfires in Guam's grasslands have been

LOCAL SUMMARY AND FORECAST

occurring almost daily. Based on the gradual demise of weak El Niño conditions during 2005, conditions are anticipated to be drier than normal for Guam through the upcoming dry season and into the onset of the summer rainy season.

Two typhoons adversely affected Guam during 2004: Tingting and Chaba. During June 27-28, Typhoon Tingting produced extraordinary amounts of rainfall. 24-hour rainfall totals exceeded 20 inches at many locations. Flooding was extensive, and combined with mudslides caused much property damage. There were 7 deaths attributable to the high surf produced by Tingting. On the night of August 21, Typhoon Chaba passed between Rota and Tinian. Damage to property and vegetation was extensive on these islands. On Guam, Chaba produced heavy rains with a peak 24-hour total of 9.05 inches at the GIA. Westerly winds exceeded typhoon force in gusts on much of the northern half of the island. Fortunately, Guam narrowly escaped the brunt of Typhoon Chaba, and only minor property damage was reported there.

The distribution of rainfall in the CNMI during 2004 was similar to that on Guam: an extraordinarily wet June, a dry July, an extraordinarily wet August, followed by drier than normal conditions in September and October. Rainfall on Saipan during November and December exceeded that on Guam based on heavy rains from passing tropical disturbances that by chance produced more rain on Saipan than on Guam. Typhoon Tingting contributed to the excessive rainfall total during June, and Typhoon Chaba contributed to the excessive rainfall total during August. Typhoon Chaba was a major disaster for the island of Rota, and to a lesser extent for Tinian and Saipan.

The rainfall for October, November, and December at the Saipan International Airport (SIA) was 5.76 inches (53%), 13.10 inches (226%), and 7.58 inches (197%) respectively, amounting to 129% of normal for the 3-month period. The 2004 annual total of 104.88 inches at SIA was well above normal (142%). The 2004 annual total of 115.65 inches at Capitol Hill was also well above its normal (136%). The rainfall at Capitol Hill during October, November, and December was 5.73 inches (48%), 12.02 inches (165%), and 6.56 inches (137%), respectively.

Rainfall amounts for June, July, August, September, and October at the Tinian Airport were 18.80 inches (324%), 1.71 inches (19%), 37.85 inches (303%), 9.16 inches (68%), and 9.16 inches respectively, amounting to 145% of normal for the 5-month period. The 37.85 inches of rainfall at the Tinian Airport during August is an all-time record. On the night of 22 August, Typhoon Chaba passed to the south of Tinian. Rainfall during the two-day period of August 22 through August 23 was 9.88 inches. The peak wind gust recorded at the Tinian Aiport during Chaba was 81 mph.

The 2004 annual rainfall total of 118.84 inches at the Rota

LOCAL SUMMARY AND FORECAST

Airport was well above normal (125%). Rainfall amounts for October, November, and December at the Rota Airport were 8.53 inches (67%), 9.65 inches (112%), and 3.89 inches (68%) respectively, amounting to 82% of normal for the 3-month period. On the night of August 22, the center of Typhoon Chaba passed just to the north of Rota, placing that island in its eye wall and highest wind speeds. Data recently retrieved from the TRMM-sponsored rain gage network at the Rota Resort and Country Club indicates that rainfall during Typhoon Chaba was far greater there than at the Rota Airport. A two-day total of 16.89 inches occurred at the resort (with a maximum one-hour total of 4.25 inches), whereas only 9.60 inches was recorded at the Rota Airport during the same time period.

With the demise of weak El Niño conditions in 2005, the threat of a typhoon for Guam and the CNMI during the upcoming year is expected to be near normal. During an average year, three or four tropical storms and one or two typhoons pass within 200 miles of any location. The odds of typhoon force winds (or greater) at any given location on Guam or in the CNMI during any given year are approximately 1 in 7. Dangerous surf from a typhoon does not require that the typhoon pass close to any location, so it is certain that at least one episode of dangerous typhoon-generated waves will occur. Every year several lives are lost due to hazardous surf.

Based on the gradual demise of weak El Niño conditions during 2005, conditions are anticipated to be drier than normal for Guam and the CNMI through the upcoming dry season and into the onset of the summer rainy season.

Predicted rainfall for the Mariana Islands from Feb 2005 through Jan 2006 is as follows:

Inclusive Period	% of long-term average	
	Guam/Rota	Saipan/Tinian
Feb-May 2005 (Dry Season)	75%	75%
Jun-Jul 2005 (Onset of Next Rainy Season)	90%	85%
Aug-Oct 2005 (Heart of Next Rainy Season)	100%	95%
Nov 2005-Jan 2006 (Next Dry Season Onset)	90%	85%

- source: UOG-WERI

Federated States of Micronesia

Yap State: The 2004 annual rainfall at most recording locations in Yap State was above normal. The Weather Service Office (WSO) near the Airport on Yap Island had a total of 137.07 inches during 2004, which was 114% of normal. The distribution of rainfall in most of Yap State during 2004 was similar to that on Guam: a wet June, a dry July, a wet August, followed by drier than normal conditions in September, October and December. With Typhoon Nanmadol passing through Yap State in November, the rainfall for that month was much above normal and also much higher than on Guam. At the Yap WSO the rainfall for October, November, and December was 8.27 inches (69%), 17.77 inches (196%), and 4.06 inches (44%) respectively, amounting to 100% of normal for the 3-month period.

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At Ulithi, the 2004 annual rainfall total of 133.97 inches was 102% of normal. The rainfall totals at Ulithi for October, November, and December were 10.15 inches (100%), 12.06 inches (156%), and 5.61 inches (73%) respectively, amounting to 109% of normal for the 3-month period. Farther south at Woleai Atoll the 2004 annual rainfall total of 127.44 inches (92%) was lower than at Yap Island and at Ulithi. This rainfall distribution is accounted for by substantial rainfall during the months of April and November when typhoon passages contributed most to heavy rainfall at the northern islands. The rainfall totals at Woleia for October, November, and December were 11.17 inches (82%), 6.85 inches (63%), and 4.51 inches (39%) respectively, amounting to 63% of normal for the 3-month period. The increasing dryness at Woleai during the last three months of 2004 is similar to what has happened on Guam and Palau, and may signal the beginning of a period of moderate reduction in rainfall for the first few months of 2005.

The tropical cyclone threat at Yap during 2005 should be near normal. During most years approximately 2 or 3 tropical cyclones pass close enough to Yap (and/or its outer islands) to cause gales, but there are usually no direct strikes by a typhoon at any Yap location. The threat of a direct strike by a typhoon at Yap Island and at Ulithi is roughly one-half to two-thirds that of Guam and the CNMI. The threat is even less further south at Woleai. Yap has recently undergone a period of unusually high typhoon activity. Three typhoons affected Yap State in a span of one year (Lupit in November 2003, Sudal in April 2004, and Nanmadol in November 2004). While we expect no direct strikes by a typhoon of any island or atoll of Yap State during 2005, residents should always be prepared for the possibility.

Predicted rainfall for Yap State from Feb 2005 through Jan 2006 is as follows:

Inclusive Period	% of long-term average
Feb-May 2005 (Dry Season at Yap and Ulithi)	70%
Jun-Oct 2005 (Rainy Season)	95%
Nov 2005-Jan 2006 (Next Dry Season Onset)	90%

- source: UOG-WERI

Chuuk State: Rainfall was abundant throughout most of Chuuk State during 2004. The 2004 annual rainfall of 154.57 inches at the Chuuk Weather Service Office (WSO) at the airport on Weno Island was well above normal (134%) (**Fig. 1**). The month-to-month variability of rainfall throughout most of Chuuk State during 2004 was substantial: April and June were very wet; July was very dry; August was very wet; and the period September through December was relatively dry. A similar pattern of high month-to-month variability was seen at Guam, and at other islands in Micronesia. The fourth quarter of 2004 was drier than

LOCAL SUMMARY AND FORECAST

normal. This may be a signal of the weak El Niño that began in September 2004. Drier than normal conditions are expected for the first half of 2005 as weak El Niño conditions gradually fade. During January 2005, rains associated with the new year's first tropical cyclone (Tropical Storm Kulap) were helpful to break the recent spell of moderately dry weather.

The total rainfall for the 3-month period October, November and December was drier than normal at most of Chuuk's islands and atolls. During October, November, and December, the WSO at Weno Island measured 10.83 inches (81%), 7.32 inches (71%), and 6.96 inches (64%) respectively. This amounted to a total of 25.11 inches (73%) for the 3-month period. In the Mortlocks at Lukunoch, the rainfall was only 5.64 inches (42%) in December, 7.48 inches (72%) in November, and 7.47 inches (69%) in October. This amounted to a total of 20.59 inches (60%) for the 3-month period. At Polowat, in the western atolls, rainfall was less than half of normal during the 4th quarter of 2004. The rainfall there for October, November and December was 5.92 inches (49%), 2.46 inches (27%), and 6.57 inches (71%), respectively. This amounted to a total of only 14.95 inches (49%) for the 3-month period.

The threat from a tropical cyclone for Chuuk State during 2005 is expected to be near normal. Normal indicates that one or two tropical storms and one typhoon should pass through some parts of Chuuk State, accompanied by gales and high surf. A direct hit by a typhoon at any of the islands and atolls of Chuuk State is not expected.

Based on the gradual demise of weak El Niño conditions during 2005, conditions are anticipated to be drier than normal for Chuuk State for the next 3 to 6 months.

Predictions for Chuuk State from Feb 2005 through Jan 2006 are as follows:

Inclusive Period	% of long-term average
Feb - May 2005	80%
Jun - Aug 2005	95%
Sep 2005-Jan 2006	90%

- source: UOG-WERI

Pohnpei State: Rainfall was near normal on Pohnpei Island and at Nukuoro during 2004, somewhat drier than normal at Pingelap and Mwoakilloa, and wetter than normal at Kapingamarangi. The 2004 annual rainfall total of 177.30 inches at the Pohnpei Weather Service Office (WSO) in Kolonia on Pohnpei Island was slightly drier than normal (94%), the 2004 annual total of 157.42 inches at Nukuoro was 105% of normal, the 2004 annual total of 129.38 inches at Pingelap was 78% of normal, and the 2004 annual total of 136.47 inches at Kapingamarangi was 124% of normal. The rainfall in the fourth quarter of 2004 (October, November and December) was a bit below normal on Pohnpei Island and Mwokilloa, well below normal at Nukuoro and at Pingelap, and above normal at Kapingamarangi. The pattern of rainfall in Pohnpei State during the fourth quarter of 2004 was consistent with the pattern typically associated with El Niño (drier than normal on Pohnpei Island and atolls to the west and east, and wet at Kapingamarangi which is near the equator). Slightly drier than normal conditions are expected for the first half of 2005 as weak El Niño conditions gradually fade.

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The rainfall at the Pohnpei WSO (on the north side of Pohnpei Island) was 11.26 inches (67%) in October, 13.67 inches (87%) in November, and 17.99 inches (118%) in December, for a 3-month total of 42.92 inches (90%). At Pingelap, observed rainfall in October, November and December was 7.02 inches (47%), 7.59 inches (53%), and 5.31 inches (40%), respectively, for a 3-month total of only 19.92 inches (47%). At Nukuoro, observed rainfall in October, November, and December was 4.89 inches (45%), 10.10 inches (84%), and 10.32 inches (86%) respectively, for a 3-month total of 25.31 inches (73%). The rainfall at Kapingamarangi during October, November, and December was 3.42 inches (71%), 14.20 inches (173%), and 5.96 inches (68%) respectively, for a 3-month total of 23.58 inches (108%). For most of 2004 persistent convection was anchored along the equator in association with warmer than normal SST there. This convection has been producing substantial amounts of rain at Kanpingamarangi, which is located near the equator.

The frequency of named tropical cyclones passing Pohnpei is less than once every three years within 75 nm, with a sharp gradient that features almost no tropical storms south of 5° N to over 1 tropical storm or typhoon passing within 75 nm of locations several hundred miles to the north and west of Pohnpei. During 2005, one or two tropical storms may pass to the north of Pohnpei Island bringing heavy rain showers, gusty southwest winds, and high surf. A direct strike by a strong tropical storm or a typhoon is unlikely at any island in Pohnpei State. However, Pohnpei is not immune to a direct hit from a typhoon. This year marks the one-hundred year anniversary of an intense and devasting typhoon that made a direct hit at Pohnpei Island.

Based on the gradual demise of weak El Niño conditions during 2005, conditions are anticipated to be drier than normal at Pohnpei Island and atolls, and near normal at Kapingamarangi for the next 3 to 6 months.

Predicted rainfall for Pohnpei State from Feb 2005 through Jan 2006 is as follows:

Inclusive Period	% of long-term average	
	Pohnpei Islands/ Atolls	Kapingamarangi
Feb - May 2005	85%	105%
Jun - Sep 2005	100%	100%
Oct 2005 - Jan 2006	95%	95%

- source: UOG-WERI

LOCAL SUMMARY AND FORECAST

Kosrae State: Rainfall was abundant on Kosrae during most of 2004, with amounts falling off to somewhat drier than normal during the final 3 months of the year. At the Kosrae Supplemental Aviation Weather Reporting Station (SAWRS) located at the airport on the northwest side of the island, the 2004 annual total rainfall of 210.71 inches was 102% of normal. This was the highest recorded annual rainfall total in Micronesia for 2004 (except for the over 300 inches recorded by the experimental University of Guam/Conservation Society of Pohnpei rain gage on the top of Nahna Laud on Pohnpei Island). During the 4th quarter of 2004 (October, November, and December) the monthly rainfall at Kosrae SAWRS was 12.04 inches (74%), 19.50 inches (123%) and 10.44 inches (72%) respectively, for a 3-month total of 41.98 inches (90%). The rainfall at Utwa (south side of the island) was drier than at the airport. For all of 2004 the total rainfall was 173.52 inches. During October, November, and December the rainfall at Utwa was 12.14 inches (about the same as at the airport), 12.99 inches (67% of the airport total), and 8.40 inches (80% of the airport total), respectively, for a 3-month total of 33.53 inches (80% of the airport total). Long-term means at Utwa (and at other Kosrae recording locations) have not been established, so the rainfall at these stations is compared to the rainfall at Kosrae SAWRS.

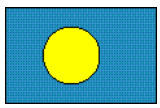
During 2005, one or two tropical storms may pass to the north of Kosrae bringing heavy rain showers, gusty southwest winds, and high surf. Kosrae, fortunately, is located close enough to the equator so that a direct strike by a strong tropical storm or a typhoon is very unlikely, although it did occur 100 years ago!

Based on the gradual demise of weak El Niño conditions during 2005, conditions are anticipated to be slightly drier than normal at Kosrae during the next 3 months, and then return to near normal

Predicted rainfall for Kosrae State from Feb 2005 through Jan 2006 is as follows:

Inclusive Period	% of long-term average
Feb - May 2005	85%
Jun - Sep 2005	100%
Oct 2005 -Jan 2006	95%

- source: UOG-WERI



Republic of Palau: Conditions at Palau were wetter than normal during the first half of 2004 and drier than normal during the second half of 2004. The 2004 annual totals were 125.05 inches (85%) at the Weather Service Office (WSO) in Koror, 121.60 inches at the Mariculture Center, 115.14 inches at a new rain gage placed at the Palau International Airport, and 91.92 inches at Peleliu (63%). The second half of 2004 was very dry at all Palau locations. The rainfall total for August through December 2004 at the WSO Koror was 34.60 inches, or only 54% of the normal 63.98 inches that typically falls in this 5-month period. During August, September, October, November and December, the rainfall recorded at WSO Koror was 3.94 inches (26%), 7.68 inches (65%), 7.92 inches (57%), 8.59 inches (76%), and 6.47 inches (54%), respectively. At Peleliu (about a 20-mile boat ride through the Rock Islands to the south of Koror) the rainfall during August, September, October, November, and December was 4.94 inches (33%), 6.59 inches (56%), 5.48 inches (42%), 5.56 inches (49%), and 3.25 inches (27%), respectively. The 5-month total of 25.82 inches was nearly 9 inches less than the 5-month total at WSO Koror.

LOCAL SUMMARY AND FORECAST

The recent dry conditions at Palau are consistent with the onset of weak El Niño conditions during the second half of 2004. This dryness is expected to continue for the next three to six months. The reduction of rainfall is not expected to become a serious problem.

A direct strike by a typhoon is not likely to occur in Palau during 2005, but westerly gales may occur two or three times in response to typhoons passing to the north of Palau during the period August through November.

Predicted rainfall for Palau from Feb 2005 through Jan 2006 is as follows:

Inclusive Period	% of long-term average
Feb - May 2005	70%
Jun - Oct 2005	95%
Nov - Jan 2006	100%

- source: UOG-WERI

Republic of the Marshall Islands (RMI): Rainfall at most locations in the RMI was near normal during 2004. The 2004 annual totals were 120.72 inches (92%) at the Weather Service Office (WSO) in Majuro and 102.96 inches at Kwajalein (102%). During October, November, and December, the WSO at Majuro measured 7.26 inches (52%), 6.00 inches (47%), and 11.05 inches (93%) respectively. This amounted to a total of 24.31 inches (63%) for the 3-month period. At Kwajalein and nearby Ebeye in the northern atolls of the RMI, the rainfall for October, November, and December was 9.74 inches (82%), 12.84 inches (120%), and 11.54 inches (142%), respectively. This amounted to a total of 34.12 inches (111%) for the 3-month period. At Alinglaplap, the October, November, and December rainfall was 15.02 inches (117%), 8.52 inches (73%), and 10.25 inches (103%), respectively. This amounted to a total of 33.79 inches (98%) for the 3-month period.

El Niño conditions bring an enhanced threat of a tropical cyclone to the central and northern Marshall Islands, especially in the months of November and December of an El Niño year, and in the January of the year after. In the last Newsletter, the possibility was highlighted for a tropical storm to form within the RMI, or to move westward across the International Date Line into the RMI. This did indeed happen when Tropical Storm Talas formed east of the International Date Line in

LOCAL SUMMARY AND FORECAST

early December and passed just to the south of Kwajalein on the night of the 10th. Tropical Storm Talas passed about 20 miles to the south of Kwajalein where a peak wind gust of 65 mph was recorded, the sustained wind reached 46 mph, and the sea level pressure fell to 1002.9 mb. According to sources at the Kwajalein missile test range, there was some light damage to the facilities there, including many palm fronds torn from the coconut trees and strewn on the lawns and roads, several broadleaf tropical trees uprooted, a metal door torn off the high school, and minor architectural failures such as tin roofing torn off. Two barges broke loose from their moorings and had to be corralled, but not before they bumped into and damaged a sailboat.

Based on the gradual demise of weak El Niño conditions during 2005, conditions are anticipated to be slightly drier than normal in the northern atolls of the RMI during the next 3 to 6 months, and then return to near normal. The central and southern atolls should continue to have near normal rainfall.

Predicted rainfall for the RMI from Feb 2005 through Jan 2006 is as follows:

Inclusive Period	% of long-term average		
	S. of 6°N	6°N to 8°N	N. of 8°N
Feb - May 2005	110%	85%	70%
Jun - Oct 2005	100%	95%	95%
Nov 2005 - Jan 2006	100%	95%	90%

- source: UOG-WERI

FOURTH QUARTER 2004
MONTHLY PRECIPITATION
STATE OF HAWAI'I SUMMARY

October: Several significant heavy rain events across the state marked the first month of the 2004-2005 Hawaiian wet season.

The worst heavy rain event of the month occurred during the evening of October 30 over Manoa Valley in east Oahu. Intense rain falling at a peak rate of more than 5 inches per hour during one 15-minute period produced a surge of water that caused Manoa Stream to overflow its banks. The resultant flooding damaged many Manoa Valley homes and caused extensive damage to several buildings on the campus of the University of Hawaii at Manoa. Although no official damage estimates are available, the total is expected to be several millions of dollars. Fortunately, the flooding did not cause any deaths or significant injuries. For additional details, please refer to our [NWS-HFO] online Manoa Flood summary.

On October 26, another significant heavy rain event produced flash flooding over the windward slopes of the Koolau Mountains on Oahu....East Kauai experienced very heavy rains during the late morning through early afternoon hours of October 15 associated with a low pressure system northwest of the island chain....Finally, a flash flood occurred during the early morning hours of October 27 when thunderstorms over the north-facing slopes of Kauai caused

LOCAL SUMMARY AND FORECAST

Hanalei River to overflow its banks.

In addition to the flash flood events, heavy rains also produced minor flooding problems on October 12 (Big Island, central and east Oahu), October 13 (Oahu, Big Island, and east Maui), October 19 (east Big Island), October 24 (east Kauai), October 25 (Oahu), and October 31 (central Oahu).

November: November saw a continuation of wet conditions experienced in October across most of the main Hawaiian Islands. Although not as intense or damaging as the October heavy rain events, the wet weather pattern required the issuance of flood advisories or flash flood warnings on 10 days during the month, keeping forecasters and emergency managers busy monitoring conditions.

The most significant heavy rain event in terms of duration and overall impacts across the state occurred during the period from November 22 through November 28 due to a persistent upper level low pressure system near the island chain.... On November 5 and 6, a slow moving, poorly defined cold front dropped over the western half of the state, bringing moderate to heavy rains to Kauai, Oahu, and Molokai...Finally, a strong shear line pushed across the island chain from November 13 through 15. As is usually the case with shear lines, frequent showers occurred mainly over the north through east facing slopes of the islands...

December: After a very wet November, the more familiar trade winds started off the month of December and persisted through December 11. Trade winds became rather strong on December 3 and 4, causing some damage on the Big Island. A ridge of high pressure settled over the island chain, bringing dry conditions from December 12 through 22. And then the rains started.

A pre-frontal convergence band brought moderate to heavy showers over portions of Oahu, Molokai, and Lanai on December 22.. The associated cold front stalled just west of Kauai. A slightly stronger cold front followed several days later with its pre-frontal convergence band producing heavy showers and thunderstorms over Kauai and Oahu on December 26 and 27.

The year closed out with the island chain under threat of a strong cold front that was expected to push across the main Hawaiian Islands accompanied by strong winds, heavy rains, and strong thunderstorms. However, the low pressure system developed and strengthened farther south and west than anticipated, resulting in a delayed onset of heavy rains and a weakened weather system by the time the cold front reached Kauai on New Year's Day.

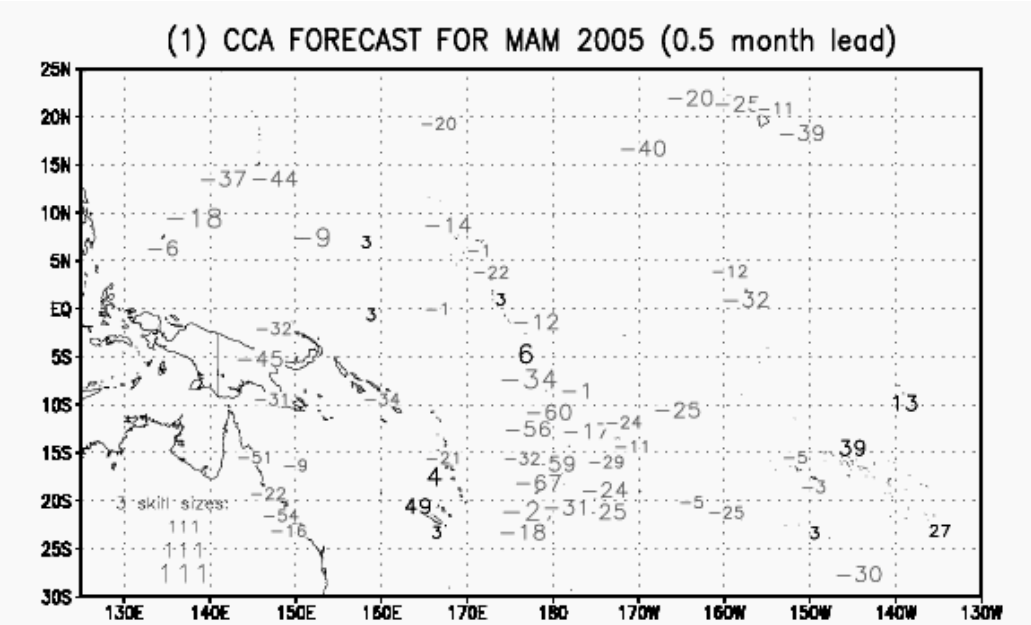
Kevin R. Kodama, Senior Service Hydrologist
National Weather Service Forecast Office, Honolulu, Hawaii

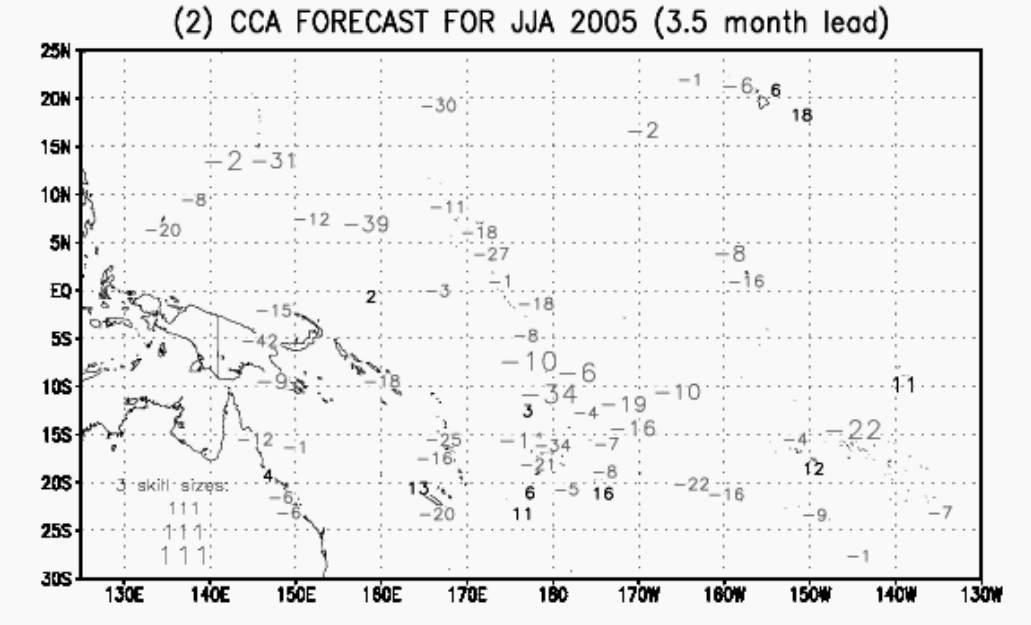
Editor's Note: The Monthly Precipitation Summaries for Hawaii are issued monthly as a public service. Individual rainfall station information and specific island information for Hawaii can be found in the Monthly Precipitation Summaries which are located online at <http://www.prh.noaa.gov/hnl/pages/hydrology.php>.

Experimental Forecasts for Pacific Island Rainfall

The latest results from the CPC statistical model for all predicted locations are shown below. This map-like presentation applies only to two particular seasons (Mar - May 2005 and Jul - Aug 2005) of the 13 three month periods out to a year in advance that are available from the model. The full time series in graphs and tables are updated monthly on the internet at: <http://www.cpc.ncep.noaa.gov/pacdir/CCA11.html>.

Negative numbers are forecasts for less than normal rainfall while positive numbers are forecasts for greater than normal rainfall. The *size* of the number (*not* the value of the number) indicates how accurate the forecast is expected to be, on the average, for the station at the given time of year and the forecast lead time. There are three sizes: the smallest size indicates low skill, the medium size indicates moderate skill, and the largest size indicates a relatively high skill. The value of the numbers tell how large a deviation from normal is expected. These values are in standardized units that indicate how typical (or atypical) the rainfall conditions are expected to be relative to the station's normal climatology. For example, numbers from 0 to 25 (or 0 to -25) are small deviations, indicating conditions that would be considered typical of the climate for the station and the time of year. Deviations from 25 to 60 (or -25 to -60) are moderate deviations, indicating somewhat wetter (or drier) conditions than would be expected for the station and the time of year. Deviations of over 60 (or less than -60) are large deviations, indicating much wetter (or drier) conditions than normal for that location and time of year.





Sites Covered
(list not complete, selected sites only)
1. Hilo, Hawaii
2. Kahului, Hawaii
3. Honolulu, Hawaii
4. Lihue, Hawaii
5. Anderson AFB Guam
6. Guam WSMO
7. Johnston Island
8. Koror WSO, Palau
9. Kwajalein Atoll
10. Majuro WSO, RMI
11. Pohnpei WSO, FSM
12. Wake Island
13. Yap WSO, FSM
14. Chuuk WSO, FSM

SPECIAL SECTION: ENSO and Sea Level Variability (3): Climatology of Annual Cycle
(Guam, CNMI, Marshalls, Palau, FSM and American Samoa)

This is the third article of a series by Dr. Rashed Chowdhury on predicting sea level variations for the US Affiliated Pacific Islands. The first article focused on the historical differences in sea level and the ENSO cycle, the second issue focused on the physical mechanics behind these differences. This issue focuses on the annual sea level cycle.

The climatology and sea level of a region are intimately related. The following section presents a brief examination of this relationship in the U.S-affiliated Pacific Islands. Fifty years of sea level data have been taken from the 'University of Hawaii Sea Level Center' (UHSLC) for this analysis. In this analysis, six stations were observed: Guam, Saipan (CNMI), Malakal (Palau), Kwajalein (Marshalls), Yap (FSM), and Pago Pago (ASamoa).

The observed value of long-term monthly sea level variability (**Fig. 2** – solid lines) of most of the northern Pacific Islands, by and large, displayed a strong annual cycle (**Fig. 2a, 2b, 2c**). The sea level of these islands varies slightly from one island to another and are significantly correlated to each other, which mean that variation (rise/fall) of sea level in one island is closely related to the variation of sea level (rise/fall) of the other island (**Table 2**). In Guam, a gradual increase of sea level from January to July has been observed (**Fig. 2a**). Soon after the peak in July, a gradual recession starts, which extends up to December. Saipan and Malakal, Palau also experienced similar peak and recession. Yap, on the other hand, experienced higher sea level in boreal summer (June-August) because of its closer proximity to the central Pacific. This is how Yap is different from the other three north Pacific Islands. Kwajalein, on the other hand, displayed a peak in April, and then followed by intermittent fluctuations afterward (**Fig. 2e**). After October, the sea level recorded a sharp drop in the following few months. Pago Pago, the lone south Pacific station, tended to show several peaks (two of which are major) in the annual cycle (**Fig. 2f**). The first major cycle indicated a gradual rise of sea level from January and a peak is observed in March. A second major cycle indicated an abrupt rise from June with a peak in July. Slow and intermittent recessions followed in the later part of the year.

Table 2: Correlation coefficient of sea level variation for five USAPI stations

	Guam	Palau	Saipan	Kwajalein	Yap	Pago Pago
Guam	1.00					
Palau	0.642**	1.00				
Saipan	0.743**	0.680**	1.00			
Kwajalein	0.763**	0.777**	0.661**	1.00		
Yap	0.771**	0.952**	0.808**	0.681**	1.00	
Pago Pago	0.348	0.001	0.217	0.140	0.086	1.00

** Correlation is significant at 0.01 level, * Correlation is significant at 0.05 level

Note: *Correlation* is a statistical technique which can show whether and how strongly pairs of variables (here sea level of each of the stations) are related. A correlation coefficient of 1.00 or -1.00 is a perfect relationship between two variables. The closer the correlation coefficient is to zero, the less relationship there is between the two variables. In this example sea level variations in Palau and Yap are very closely related (correlation coefficient = .952) where as the sea level variations between Palau and Saipan are less closely related (correlation coefficient = .680)

Significance levels show how likely a result is due to chance. The most common level, used to mean something is good enough to be believed, is "0.01" or "0.05" meaning that the finding has a one percent (0.01) or five percent (0.05) chance of not being true. In our data, all north Pacific stations were significant at the .01 level.

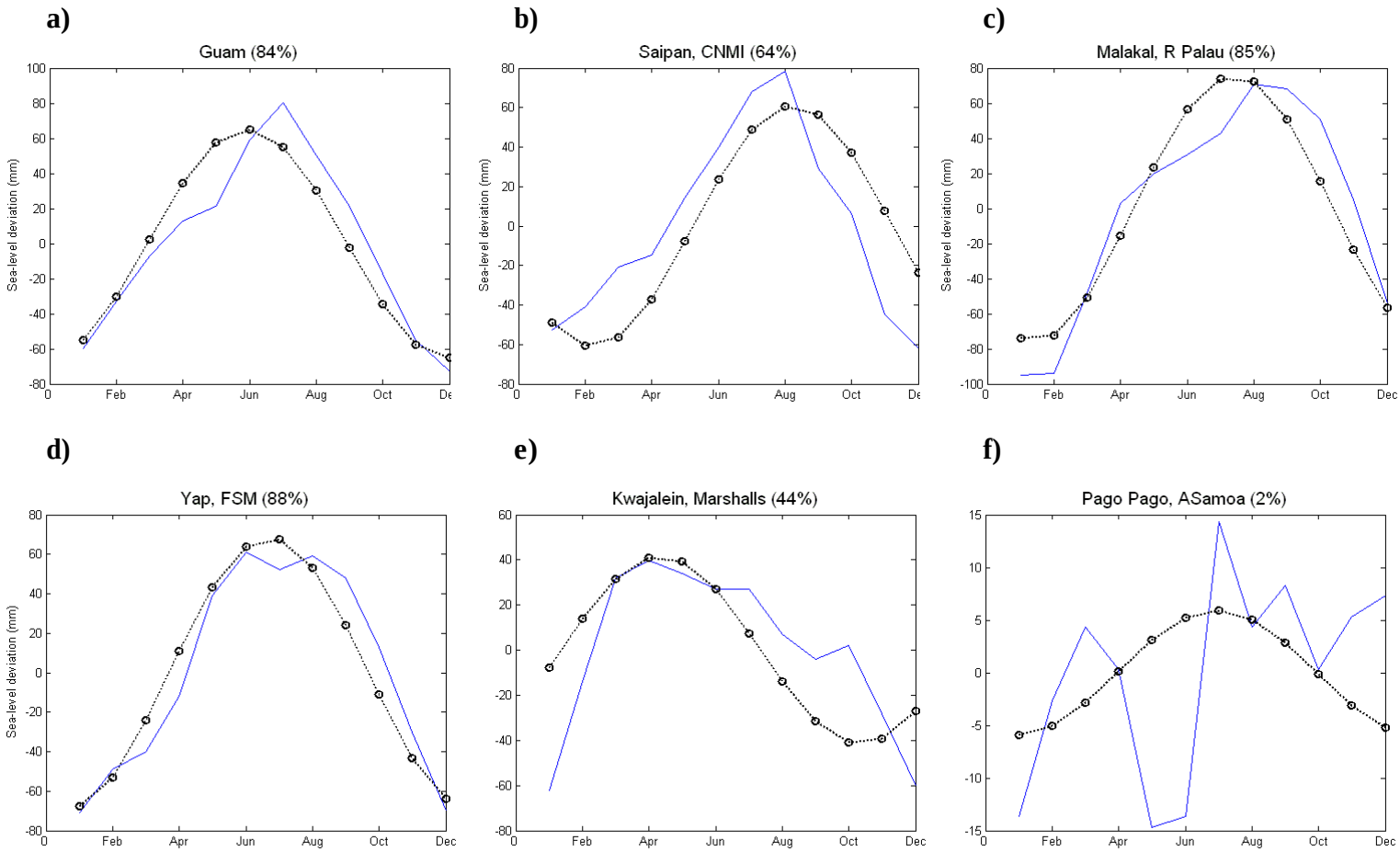


Figure 2. Average annual cycle of sea level for five stations. Solid line denotes monthly anomalies in mm from long term mean (1948-2003) for each individual station; dashed line denotes first harmonic and corresponding locations. Values in parentheses (%) are variances explained by the first harmonics of sea level.

While a qualitative variation of the climatology of annual cycle is identifiable from the monthly average sea level data records (as discussed before) (**Figure 2** – solid line), it is the *harmonic* analysis that can give a picture of quantitative variation in these data (**Figure 2** – dashed line). Therefore, to quantitatively evaluate the importance of the annual cycle from these data, *harmonic* analysis has been performed. Harmonic analysis consists of representing the fluctuations or variation in a time series as having arisen from the adding together of a series of *sine* and *cosine* functions. These trigonometric functions are "harmonic" in the sense that they are chosen to have frequencies exhibiting integer multiples of the "fundamental" frequency determined by the sample size of the data series. For example, a common physical analogy is the musical sound produced by a vibrating string, where the pitch is determined by the fundamental frequency, but the aesthetic quality of the sound depends on also on the relative contributions of the higher (1st and 2nd) harmonics. The 1st harmonics represents the annual cycle and explains the maximum variances.

The first harmonic, here in this case, explained about a considerable percentage of variance of the sea level variability in the north Pacific Islands (**Fig. 2a-2e**). The first harmonic for all islands explained variances of 64-88%. For the western most islands in the north Pacific (Guam, Saipan, Palau and Yap), maximum rise of sea level occurs in summer months (June to August). The annual cycle is relatively weak (though still explaining over 40% of the variance for sea level) in Kwajalein (**Fig. 2e**), and the annual cycle is extremely weak in Pago Pago (only 2% variance) (**Fig. 2f**). However, a second harmonic, which represents the semiannual cycle, explains 3-17% of variances (not reported here). This component adds considerably to the variance of Kwajalein (17%) and Pago Pago (11%).

Pacific ENSO Update

ENSO FORECAST

PROGNOSTIC DISCUSSION FOR LONG-LEAD OUTLOOKS
NOAA NWS - Climate Prediction Center - Camp Springs MD- 8:30 am EST Thursday Jan 20, 2004
Summary of the Outlook For Non-Technical Users

Current observations indicate that weak warm episode conditions (El Niño) continue over the equatorial Pacific. A majority of sea surface temperature (SST) prediction tools indicate that these conditions are likely to persist through the remainder of the winter and into spring. SSTs near the equator in the central Pacific Ocean are just over 1 degree C above normal while those in the eastern Pacific Ocean currently average about .5 degrees C above normal. While these SST anomalies are high enough to classify this as a weak El Niño event, there has been very little atmospheric response to the SSTs so far this season with significantly positive SST anomalies confined mainly to the central equatorial Pacific. This El Niño should have only a very limited influence on the U.S. climate for the remainder of the cool season. Central Pacific El Niños in the past such as in 1963-64, 1968-69 and 2002-03 have a much less reliable signal than basin-wide El Niños where warm SSTs extend to the South American coast.

EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION
issued by NOAA NWS Climate Prediction Center-February 10, 2004

***Synopsis**: A transition from weak warm-episode (El Niño) conditions to ENSO-neutral conditions is expected during the next three months.*

Sea surface temperature (SST) anomalies decreased in the equatorial Pacific everywhere east of the date line during January 2005, resulting in decreases in all of the Niño indices with the exception of Niño 4. However, positive sea surface temperature (SST) anomalies greater than +1°C (~1.8°F) persisted in portions of the central and western equatorial Pacific. By early February 2005, positive equatorial SST anomalies greater than +0.5°C (~0.9°F) were found from 140°E eastward to 155°W. The pattern of anomalous warmth in the equatorial Pacific in recent months and the most recent 5-month running mean value of the Southern Oscillation Index (-0.5) indicate that a weak warm (mid-Pacific El Niño) episode is in progress. However, through December there was a lack of persistent enhanced convection over the anomalously warm waters of the central equatorial Pacific, which limited El Niño-related impacts.

Since late 2003 MJO activity has resulted in week-to-week and month-to-month variability in many atmospheric and oceanic indices. The MJO activity weakened considerably during early November 2004 and remained weak through mid-December. During the last half of December the MJO strengthened, as enhanced convection and precipitation over the Indian Ocean shifted eastward across Indonesia into the western tropical Pacific. Since early January enhanced convection has persisted in the western equatorial Pacific and expanded eastward into the central equatorial Pacific, accompanied by a weakening of the low-level easterly winds over the region. At this time it is not clear whether the recent enhanced convection and weakening of the easterly winds in the central equatorial Pacific are transient features (related to the MJO) or perhaps evidence of a coupling between the anomalously warm waters and the overlying atmospheric circulation.

Based on the recent evolution of oceanic and atmospheric conditions and on a majority of the statistical and coupled model forecasts, it seems most likely that weak warm episode (El Niño) conditions will gradually weaken during the next three months and that ENSO-neutral conditions will prevail during the last half of 2005.

ACKNOWLEDGEMENTS and FURTHER INFORMATION:

PACIFIC ENSO APPLICATIONS CENTER:
HIG #350, 2525 Correa Road, Honolulu, Hawaii 96822
Contact Nicole Colasacco at 808-956-2324 for more information on the *Pacific ENSO Update* and ENSO-related climate data for the Pacific Islands.
Contact Dr. R. Chowdhury at 808-956-2324 for more information on ENSO and sea level variability in the USAPI.

University of Guam (UOG)
WATER AND ENERGY RESEARCH INSTITUTE (WERI):
UOG Station, Mangilao, Guam 96923
Contact Dr. M. Lander at 671-735-2685 for information on tropical cyclones and climate in the Pacific Islands.

NOAA National Weather Service-Pacific Region
WEATHER SERVICE FORECAST OFFICE (WSFO)
3232 Hueneme Road, Barrigada, Guam, 96913
Contact C. Guard at 671-472-0900 for further information on tropical cyclones and climate in the Pacific Islands.

University of Hawaii (UH) School of Ocean and Earth Science and Technology (SOEST)
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Contact Dr. T. Schroeder at 808-956-7476 for more information on hurricanes and climate in Hawaii.