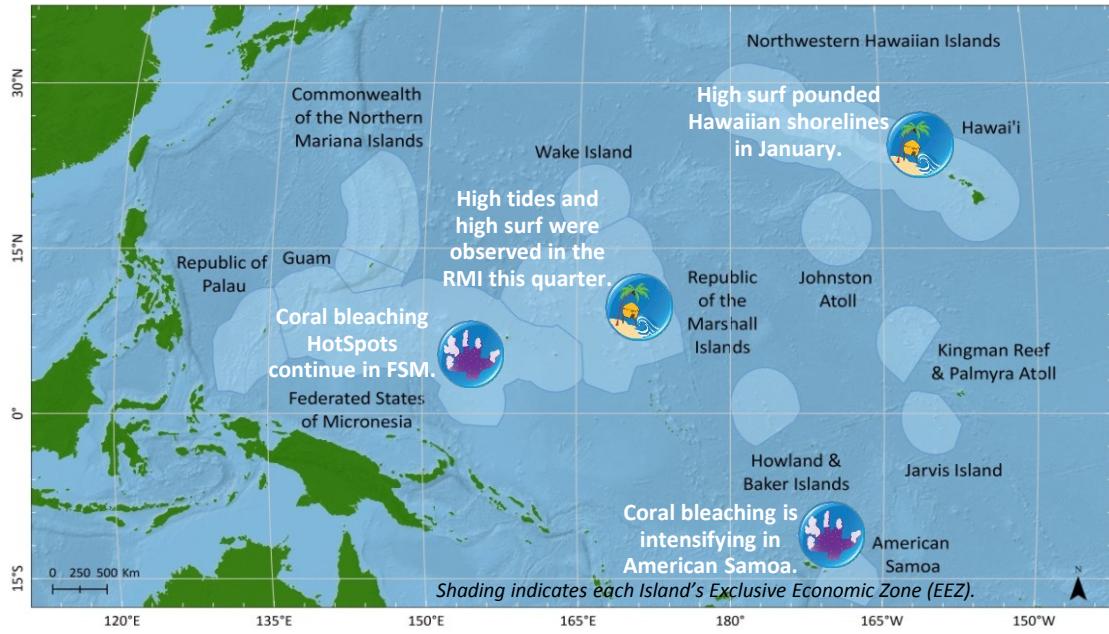


Climate Impacts and Outlook

Hawaii and U.S. Pacific Islands Region 1st Quarter 2017

Significant Events and Impacts for 4th Quarter 2016

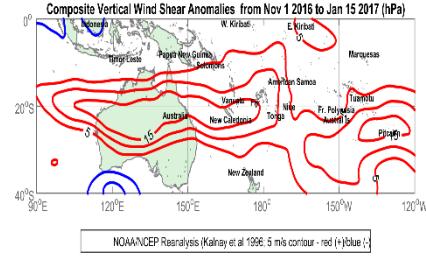
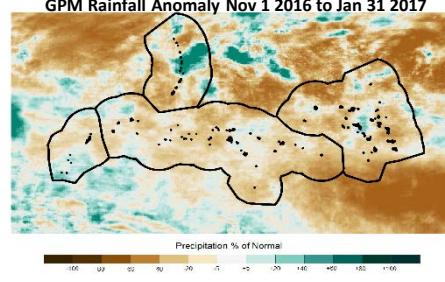
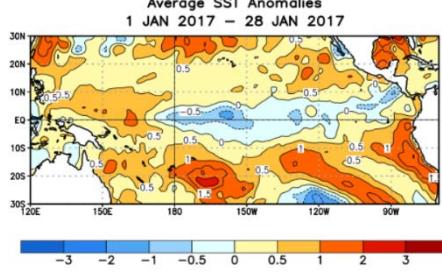


Near-normal rainfall was recorded in parts of the Commonwealth of the Northern Mariana Islands, while above-normal rainfall was reported in Guam.

Much below normal rainfall was reported in Hawaii, while most of the Federated States of Micronesia, the Republic of Palau, and the Marshall Islands were above normal. Near normal rains were observed in American Samoa.

There were a total of 31 tropical cyclones in the western North Pacific during 2016.

Regional Climate Overview for 4th Quarter 2016



Vertical Wind Shear Anomaly Map valid 15 January 2017. Source: <https://www.esrl.noaa.gov/>

There are no active ENSO advisories in effect. As of February 1st, the Niño 3.4 region anomaly was -0.4° C, supporting a neutral state.

Sea-surface temperatures are above normal across much of the western Pacific, with a small localized region of cold anomalies along the equatorial eastern Pacific. The warmest anomalies exceeding 0.5° C remain across the RMI, FSM, and CNMI, with 1.0° C anomalies near Kapingamarangi. Meanwhile, cold anomalies near -0.5° C continue near the Howland and Baker Islands. However, **sub-surface water temperature anomalies have warmed substantially** and are now very close to normal. This represents a significant retreat of the colder deeper waters in the eastern Equatorial Pacific compared to last quarter.

The monthly mean sea level in most of the stations recorded rises in the past quarter and currently all are above normal. After significant rise in September-October, the sea level recorded marginal fall in November and December of 2016. Only Pago Pago recorded further rise in December. As of December 2016, all stations are steady but stay well above normal.

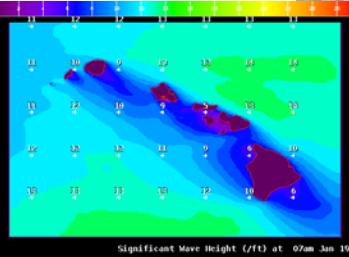
In Hawaii, rainfall was below normal for the quarter at Honolulu (23%) and Lihue (13%), but near normal at Kahului (91%), and above normal at Hilo (118%). From Nov-Jan, Saipan was slightly below normal at 87% and Guam was above normal with 133% of average rainfall. In Kwajalein and Majuro in the RMI, rainfall was much above normal with 146% and 135% of average rainfall respectively. In the FSM, quarterly rainfall was generally above normal: Chuuk (124%), Kosrae (92%), and Pohnpei (145%) of normal. Further west, welcome rains returned to the islands of Yap (135%) and Palau (113%). In American Samoa, rainfall was near normal for the quarter (95%). On 31 December, an active wave within the South Pacific Convergence Zone produced 1.80" of rain in just 2 hours measured at the Weather Station Office in Tafuna.

Tropical Cyclone (TC) activity in the western North Pacific basin was above normal with 4 named storms and 2 tropical depressions, all of which were west of the USAPI. From Nov-Jan, there was only minimal tropical cyclone activity in the SW Pacific, which is now a record slow start to the season. Enhanced vertical wind shear on the order of $10-15 \text{ ms}^{-1}$ and pronounced high-pressure centered across the region are potential causes for the reduced activity.

Sectoral Impacts for 4th Quarter 2016

Facilities and Infrastructure – A series of large NW swell events in early-to-mid November led to sharp erosion at Sunset Beach, north shore, Oahu. The high swell and morning high tide of 2016-11-14 allowed wave run-up to cross the highway in Waianae, west shore, Oahu and select sections of the coastal highway on the north shore of Oahu. Coastal wave run-up was also high enough to cross select sections of the highway on the north shore 2017-01-13, -25, and -30. Meanwhile, gale-force trade winds 2017-01-21 and -22 had seas to 17 feet as measured by a wave buoy off Kailua, Oahu. It caused minor coastal wave run-up.

High surf on Sunset Beach, Oahu.
Photo courtesy of Jodi Wilmott.



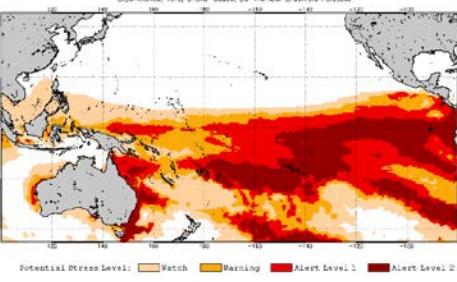
Significant Wave Height in Hawaii for January 19. Image from NOAA National Weather Service.

Water Resources – Despite high surf, high tides, and higher than normal sea levels, long-period swell did not affect the capital of the RMI during the quarter. Water reservoir levels in the Majuro, FSM, and Koror remain adequate with regularly-occurring rains, however the northern Marshall Islands are very dry.

Natural Resources – Eddy kinetic energy near Hawaii has been unusually high over the last quarter. Eddies (gyres) have important biological implications in that they can drive upwelling of cooler, nutrient rich water that influences ocean temperatures and fuels a localized increase in phytoplankton production, an essential source of energy for higher trophic groups. In American Samoa, coral bleaching patterns are evident on the reef slope areas around 30-50ft along a large portion of the main island of Tutuila. Meanwhile, HotSpots in the Northern Hemisphere remain concentrated around the Federated States of Micronesia (FSM) and the western Pacific, where a Bleaching Watch is in effect. In Fiji, water temperatures in the shallow back reefs have spiked to 34° C and bleaching is intensifying there.

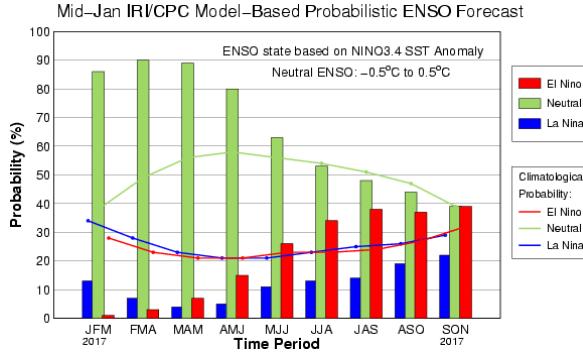
National Weather Service - Honolulu

2017 Feb 7 NOAA Coral Reef Watch 80% Probability Coral Bleaching Thermal Stress for Feb-May 2017 Experimental, v3.0, CPC-based, 28-member Ensemble Forecast



Coral Bleaching Thermal Stress Outlook for Feb-May 2017. Map courtesy of NOAA Coral Reef Watch.

Regional Outlook for 1st Quarter 2017 (Feb-Apr)



ENSO Probabilities, Valid April 2016. Source: <http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/>

Following the latest ENSO prediction models, there is a 90% chance of ENSO neutral conditions lasting into the northern hemisphere spring season.

The SST anomaly outlook for the 1st quarter indicates 0.25-1° C above-normal values in Hawaii, RMI, FSM, Guam, and CNMI. Above-normal SST anomalies near 0.5° C are projected around American Samoa. NOAA's Coral Reef Watch most recent four-month Bleaching Outlook projects heat stress to be highest from Fiji eastward to the Samoas and the Southern Cook Islands. These areas are expected to reach Alert Level 2 (widespread bleaching and significant mortality) in the next 1-4 weeks.

The forecast values for sea level in the 1st quarter indicate that all western Pacific stations are likely to be above normal and will last through the boreal spring season. These sea-level values are consistent with the lingering oceanic influence from La Niña.

Above-normal rainfall is projected for FSM, Guam, CNMI, most of the RMI and average to above normal rainfall is projected for American Samoa. However the northern RMI will be dry for the next several months. In the FSM, Kapingamarangi will have near normal rainfall even as La Niña fades. Meanwhile, near to slightly above normal rains are expected across the Hawaiian Islands.

Tropical cyclone (TC) activity in the western north Pacific is expected to be below-average in the 1st quarter, as atmospheric conditions remain unconducive for TC formation and any activity that does develop should remain west of Micronesia. In the southwest Pacific TC activity for American Samoa is expected to be normal for the late season portion of the 2016/17 TC season; the 30-year expected average for existing ENSO conditions is 1.6 TCs per late season.

Regional Partners

Pacific ENSO Applications Climate Center:
<http://www.prh.noaa.gov/peac/>

NOAA NWS Weather Forecast Office Honolulu:
<http://www.prh.noaa.gov/pr/hnl/>

NOAA NWS Weather Forecast Office Guam:
<http://www.prh.noaa.gov/pr/guam/>

NOAA National Centers for Environmental Information:
<http://www.ncei.noaa.gov/>

NOAA NMFS Pacific Island Fisheries Science Center:
<http://www.pifsc.noaa.gov/>

NOAA OceanWatch - Central Pacific:
<http://oceancatch.pifsc.noaa.gov/>

NOAA Coral Reef Watch:
<http://coralreefwatch.noaa.gov/>

USGS Pacific Islands Water Science Center:
<http://hi.water.usgs.gov/>

USGS Science Center – Pacific Coastal and Marine Science Center: <http://walrus.wr.usgs.gov/>

University of Hawaii - Joint Institute of Marine and Atmospheric Research:
<http://www.soest.hawaii.edu/jimar/>

University of Guam - Water and Environmental Research Institute: <http://www.weriguam.org/>