

**Western Regional Climate Center
Final Report & Recommendations for the
Pacific Island Climate Monitoring Network
National Park Service
2012-15**



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Photo: September 29, 2016. Siufaga Ridge climate observing station, National Park of American Samoa.
Photo credit: David Simeral

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Project Abstract

In collaboration with the National Park Service (NPS) Pacific Island Network (PACN) Inventory and Monitoring Program (I&M), the Western Regional Climate Center (WRCC) installed a network of long-term weather/climate monitoring stations across the PACN I&M network. In addition to deployment of the monitoring network, the WRCC carried out the following in accordance with the task agreement: data telemetry and data management procedures; providing near real-time data access to the public via the Internet; training NPS staff on maintenance and operational procedures; field maintenance; technical consultations; and summarization of station data for annual reporting. The network will provide critical baseline weather and climate data to meet PACN monitoring objectives to characterize climatic change/variability and to better understand patterns associated with climatic extremes, such as, drought, extreme precipitation events, and tropical cyclone activity. In application, the network will enable PACN management to characterize a critical physical component of the park ecosystems and provide valuable information on weather conditions in support of management decisions and public safety.

Project Highlights

- **February 2012** - Installation of five monitoring stations in the following park units: Hawaii Volcanoes National Park (HAVO), Kalaupapa National Historical Park (KALA), Pu'ukoholā Heiau (PUHE), and Pu'uhoanua o Hōnaunau (PUHO).
- **March 2012** – Installation of two stations in the National Park of American Samoa (NPSA).
- **February 2014** – Station installation at the American Memorial Park (AMME) in Saipan.
- **September 2014** – Visitation to HAVO, PUHE, and PUHO for field maintenance, repairs, sensor replacement, a site survey (PUHE), and training activities.
- **January 2015** – Installation of a replacement station at PUHE (Figure 1). The original station was damaged beyond repair in an act of vandalism.
- **September 2015** – Visitation to the NPSA for field maintenance including: sensor replacements, replacement of a damaged datalogger and satellite transmitter, and training.
- **January 2016** – Visitation to HAVO for field maintenance and sensor replacement.
- **April 2016** – Climate station data summarization for annual reporting for 2012-15.

Project Participants

Development, installation, and operations/maintenance of the PACN network was a collaborative effort between the NPS PACN staff and the WRCC. NPS PACN staff included: Ryan Monello (Program Manager, HAVO); Scott Kichman (Climate Monitoring Program Lead/GIS Specialist, HAVO); Eric Brown (Marine Ecologist,

KALA); Visa Vaivai (Biological Science Technician, NPSA); and Justin Mills (Biological Science Technician, WAPA). From the WRCC the following personnel were involved: David Simeral (Associate Research Scientist, Climatology & Principal Investigator) Greg McCurdy (Associate Research Scientist, Climatology), and Elizabeth Sisson (Field Technician).



Figure 1 – Replacement climate station installed at Pu'ukoholā Heiau NHP in January 2015.

Recommendations & Discussion

New Stations

- The proposed station in War of the Pacific National Historical Park was not installed as a result of park-level decisions related to siting and vandalism concerns. In recent months, there has been renewed interest in establishing the station in Guam and preliminary discussions are underway to identify an acceptable site location that meets the site selection criteria.
- It may be interest to expand the monitoring network and install several new monitoring stations with the goal of having better representation of climatic conditions across the large elevational gradients present in HAVO, KALA, and

NPSA. Since large climatic gradients exist across both elevation and slope aspect on these islands, it may be desirable to deploy several new stations that would serve to fill gaps and could possibly be co-located with, for example, established vegetation plots or hydrological measurements.

Potential Station Relocation

- The existing station at Toa Ridge (NPSA) has been identified as a candidate station for potential relocation. The station is currently located in a remote part of the park where ease-of-access for unscheduled emergency maintenance has been a limiting factor in keeping the station fully operational. From a long-term monitoring aspect, relocation of a long-term site is generally not recommended; however, practical considerations related to basic operations and maintenance (O&M) should be addressed to avoid extended “down-time” periods and related associated data gaps. If the observing station was to be relocated to improve access, a recommended target location would be situated in the vicinity of the summit of Mt. Alava.

Sensors

- **Sensor Issues** - After four years of network operations, valuable insights have been gained in relation to the functionality, limitations, and longevity of sensors in a corrosive, tropical marine environment. Corrosion has been an issue primarily at sites in HAVO and NPSA. In HAVO, the presence of vog has compounded sensor and station infrastructure corrosion issues. Several air temperature/relative humidity (AT/RH) sensors at both HAVO and NPSA have malfunctioned within a 1-2 year time-frame. Sensor failures have been the result of a combination of corrosion, and design weaknesses. Issues with the specific sensor have been conveyed to the manufacturer, Campbell Scientific Incorporated (CSI) and steps are being taken to address the design issues. In response, CSI supplied PACN with a prototype AT/RH sensor to test its versatility and performance in HAVO.
- **Sensor Recommendations** -
 - o Overall, a small “cache” of spare sensors should be acquired and kept on-site at each of the three main geographic locations within PACN: American Samoa, Hawaii, and the Northern Mariana Islands. This would allow for a more rapid response time if any emergency maintenance issues arise and would serve to reduce station down-time and associated data gaps. **(High priority)**

- o Installation of redundant AT/RH sensors is recommended for all monitoring stations in the network to reduce the likelihood of data gaps if a sensor malfunctions as well as serving as a means to track sensor performance over time. **(High priority)**
- o Addition of alter-shielding to the precipitation gauge at PUHE is recommended. Some possible site-specific issues have been identified in relation to the effect of turbulence and the ability of the gauge to catch precipitation. Alter-shielding would reduce turbulence around the gauge and improve its ability to capture precipitation during windy conditions. **(Medium priority)**
- o Addition of storage modules/flash memory cards to station dataloggers would significantly enhance data storage capacity. This could be of value if additional sensors are added to a given station. Increased memory would also be of valuable if higher time-resolution measurements are needed for a particular sensor. **(Low to medium priority)**
- o Over the next several years, several sensors (sonic anemometers, pyranometers) should be replaced and sent to the manufacturer for refurbishment and factory calibration. **(Low to medium priority)**
- o Addition of soil moisture sensors would complement soil temperature measurements. **(Low priority)**

Maintenance

The importance of establishing a structured annual maintenance plan cannot be over-emphasized. Long-term planning should address what funding levels are necessary to keep the network operational in terms of costs associated with data management, instrumentation, personnel, station infrastructure, training, and travel expenses. Looking ahead, a primary area of opportunity would be to allow for increased flexibility in staff scheduling in order to improve response time of personnel in terms of emergency maintenance repairs. Improvements in this area would help to avoid prolonged periods of station down-time and associated potential data loss.

- **Maintenance Recommendations –**

Moving forward, specific maintenance recommendations include the following:

- o Addressing station infrastructure corrosion issues at Siufaga Ridge and Toa Ridge stations (NPSA). Both stations are in need of partial replacement of specific elements of their grounding systems (Figure 2) as

well as replacement of some basic hardware on the tripod. **(High to medium priority)**



Figure 2 - Corrosion on the grounding system - Toa Ridge.

- Enclosure seals need to be reinforced at Siufaga Ridge and Toa Ridge. Looking at recent data from the enclosure relative humidity sensors, high humidity levels have been observed within the enclosures which leads to condensation build-up and corrosion on the datalogger and satellite transmitters. **(High priority)**
- Upgrading power supply systems may of interest. The current system includes a 7 amp hour (ah) battery. Enhancing power systems would help to accommodate power requirements if additional sensors were to be added to the station. Upgrading to a 24 ah battery would be recommended as well as purchase of a new power charging/regulating system. Upgrading the power system would be beneficial during extended cloud-covered periods when batteries could be drawn down to critical levels. **(Medium to low priority)**

- O The stations at AMME and KALA are both due for scheduled annual maintenance and sensor auditing after several years of operations. **(Medium priority)**
- O To reduce visual impacts and concern related to vandalism, painting (camouflaging) of the tripod at PUHE is recommended. **(Medium priority)**

NPS PACN & Select RAWS Climate Station Data by Park Unit

American Memorial Park – Saipan (NPS PACN)

Latitude: 15.2177

Longitude: -145.7178

Elevation: 25 feet

Period of Record: 2/25/14 – present



General Description: Located on the leeward side of the island of Saipan, the AMME site is located ~500 feet from the western coastline at an elevation of 25 feet. The climate of Saipan is characterized as a tropical marine climate influenced by seasonal trade winds out of the northeast from November to March and easterly winds from May to October. Winds are generally light and out of the east and northeast. On 8/2/15, Typhoon Soudelor passed directly over Saipan and the station recorded a max wind gust of 86.8 mph. The period of record mean air temperature was 81.5°F and average relative humidity at 76%. The highest temperature recorded was 91.1°F and the lowest 71.6°F. Annual precipitation ranged from 61 to



2014 – 2015 Summarized Data

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Average Relative Humidity			Precipitation
Date	ly	mph	Deg	mph	Deg F			%			in
mm/yyyy	Total	Ave.	Vector Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Feb-14	1263	7.70	78.68	29.59	79.09	83.9	75.23	76.02	89.5	56.37	0.2
Mar-14	15366	5.74	71.45	27.92	79.85	87.8	72.8	73.6	94	54.39	4.38
Apr-14	15136	4.49	79.78	25.59	81.87	88.2	74.93	75.09	92.9	53.17	2.18
May-14	16765	3.95	84.68	25.43	82.8	90.8	74.3	74.4	92.9	51.43	2.5
Jun-14	15527	3.27	81.19	21.41	84	90.1	76.33	75.86	93.1	49.36	3.04
Jul-14	13429	4.10	89.27	27.89	83.08	89.5	75.16	78.32	93.4	57.28	8.09
Aug-14	13471	2.84	84.46	24.83	82.9	91.1	74.42	78.12	92.7	56	4.94
Sep-14	10843	3.32	97.29	29.93	82.24	90.9	72.79	80.45	93.8	56.42	18.74
Oct-14	11027	3.50	96.44	41.07	81.72	88.8	74.86	80.38	93.6	56.52	8.57
Nov-14	10991	4.16	83.73	25.37	81.62	88.4	74.81	80.02	93.8	62.32	7.73
Dec-14	12003	5.34	81.81	28.39	81.64	87	74.71	75.12	93	58.84	1.25
Annual	135821	4.40	84.43	27.95	81.89	88.77	74.58	77.03	92.97	55.65	61.62

Station deployed 2/25/14.

Jan-15	10236	4.89	83.23	29.3	79.89	87.4	74.26	76.36	93.6	55.61	4.17
Feb-15	12340	4.60	79.54	24.76	78.11	84.4	71.62	64.78	87.2	46.13	0.11
Mar-15	14582	5.55	74.67	44.63	79.55	86.2	72.51	74.49	94.5	54.07	5.41
Apr-15	15358	6.12	78.11	30.47	80.87	86.1	73.29	75.01	92.4	57.37	2.37
May-15	15704	4.26	85.68	48.63	82.17	88.9	74.1	75.4	91.9	52.08	4.7
Jun-15	15819	5.11	81.42	26.82	82.2	87.6	72	76.23	93.1	59.5	2.87
Jul-15	14647	3.87	88.11	36.4	82.52	90	73.95	77.75	93.5	53.05	21.79
Aug-15	13394	5.38	138.4	86.8	82.76	90.2	75.92	78.85	96.6	59.58	9.77
Sep-15	13358	3.98	99.85	40.73	83.23	90.4	74.86	77.96	93	55.53	5
Oct-15	12191	5.35	108.8	46.44	82.22	89.2	73.75	78.27	95.5	58.37	21.07
Nov-15	12237	7.81	72.08	33.53	81.6	86.5	75.42	76.61	91.3	56.01	3.19
Dec-15	11597	8.15	70.57	32.82	80.28	85.3	73.34	75.98	93.2	50.04	4.26
Annual	161463	5.42	88.37	40.11	81.28	87.68	73.75	75.64	92.98	54.78	84.71

Typhoon Soudelor makes landfall in August 2015.

Wind Rose Climatology

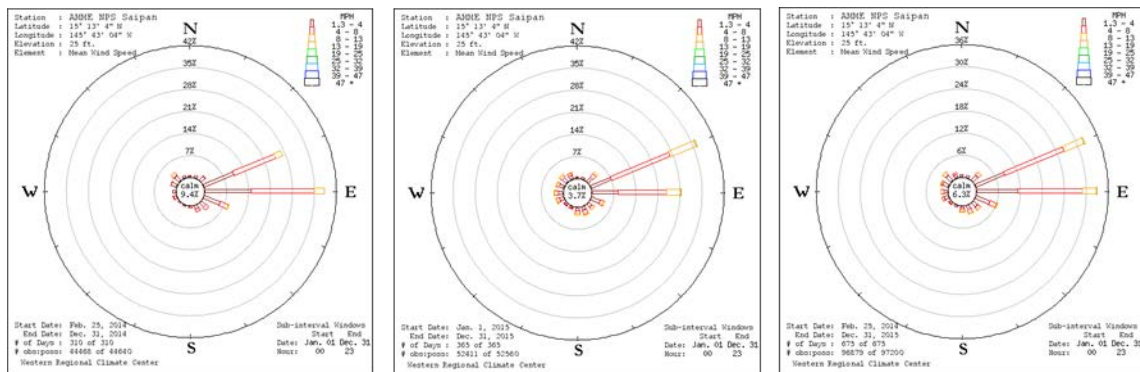
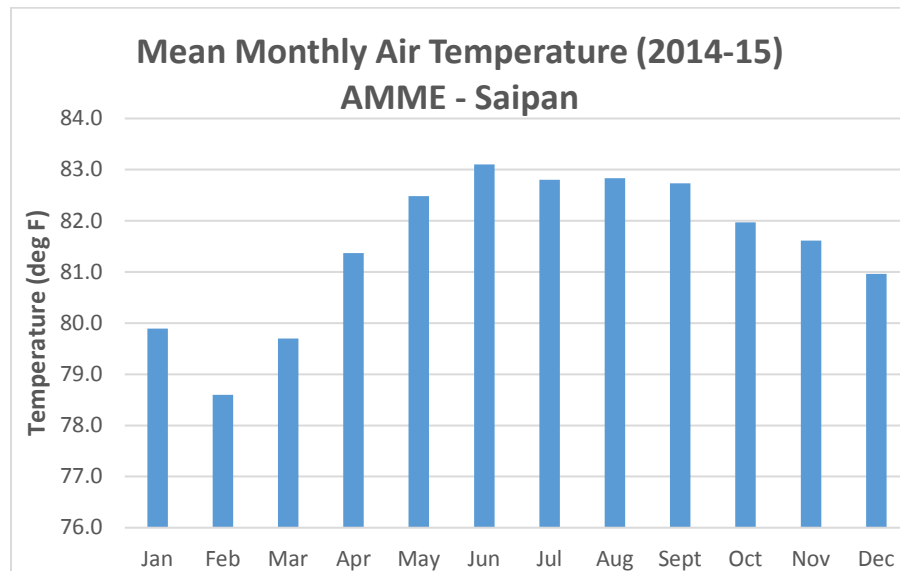
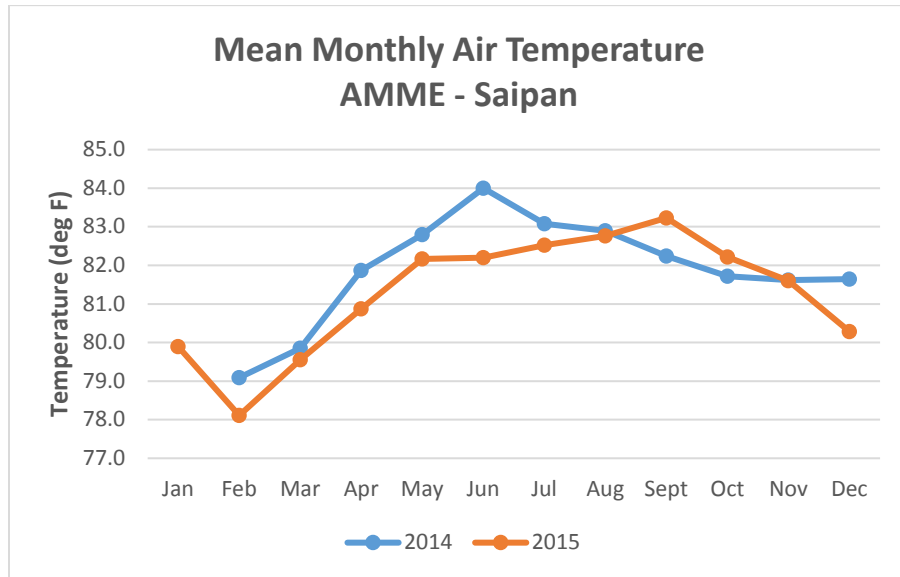
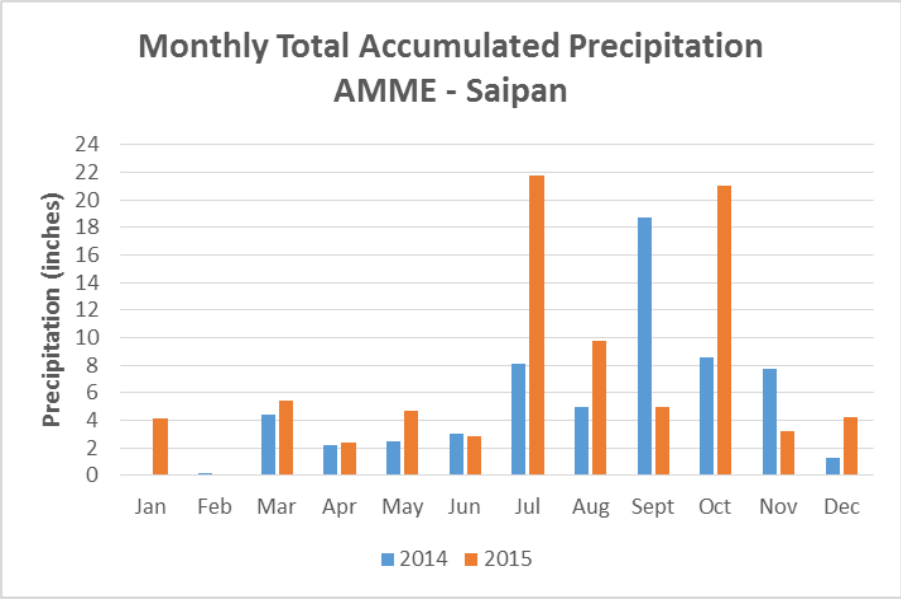


Figure 3 - AMME wind rose climatology for 2014, 2015, and 2014-15.

Mean Monthly Air Temperature and Annual Precipitation





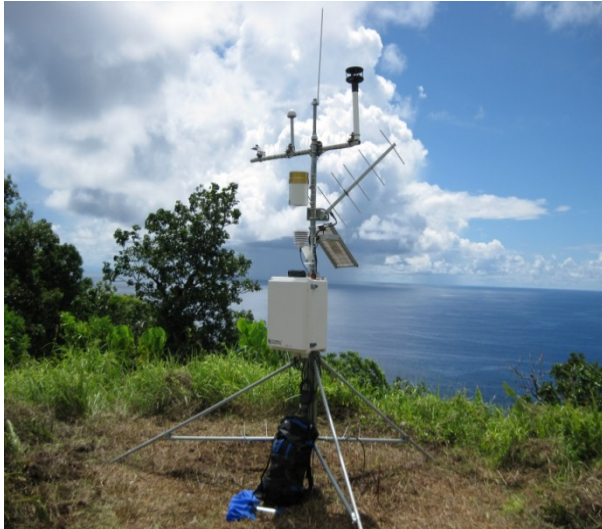
National Park of American Samoa – Siufaga Ridge (NPS PACN)

Latitude: -14.2762

Longitude: -170.722

Elevation: 480 feet

Period of Record: 3/15/12 – present



General Description: The Siufaga Ridge site is located on the north-central part of the island of Tutuila on the west end of the National Park of American Samoa at 480 feet in elevation. Wet season on the island group generally extends from October through May and the dry season from June through September. Due to its latitudinal position between the Equator and Tropic of Capricorn, solar radiation is intense and variability in temperature is limited. Mean wind direction is generally out of east. The maximum wind gust recorded was 60 mph in February 2014. The mean air temperature from 2012-2015 was 79.4°F and average relative humidity at 80%. The maximum temperature recorded was 100°F and the lowest was 68°F. Period of record maximum annual precipitation was 175" in 2015 and the maximum monthly total of 24.56" in October 2015.



2012 – 2015 Summarized Data

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Average Relative Humidity			Precipitation
Date	ly	mph	Deg	mph	Deg F			%			in
mm/yyyy	Total	Ave.	Vector Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Mar-12	5121	3.68	48.94	31.05	79.31	92	73.47	82.81	94.7	64	6.74
Apr-12	12106	2.87	88.61	22.35	81.29	94.8	73.91	78.38	94.7	55.4	5.93
May-12	11030	2.91	127.8	28.9	80.29	94.6	71.03	79.41	94.6	53.88	22.67
Jun-12	9278	3.91	138	24.85	78.4	87.7	71.81	79.01	93.3	53.7	11.59
Jul-12	10205	3.87	148.7	30.11	77.49	90.3	70.41	80.49	93.9	58.27	9.46
Aug-12	11670	3.71	138.1	30.8	78.08	88.5	72	76.79	93.3	48.17	6.47
Sep-12	12065	3.68	43.63	26.35	79.16	90.9	71.34	80.29	94.5	53.5	11.48
Oct-12	13284	3.40	34.99	31.88	80.21	91.5	73.02	78.4	93.4	55.62	8.79
Nov-12	12409	3.39	53.95	27.92	80.83	92.5	73.78	80.38	94.1	54.9	13.91
Dec-12	12570	3.85	79.37	36.06	80.42	95.7	73.18	80.18	93.8	54.29	12.56
Annual	109738	3.53	90.21	29.03	79.55	91.85	72.40	79.61	94.03	55.17	109.60

Station deployed on 3/13/12.

Jan-13	10262	4.35	38.02	45	79.64	99	73.38	83.15	94.9	50	9.41
Feb-13	11917	2.66	36.43	45	80.42	94	72	80.21	94	59	0
Mar-13	5381	4.73	47.3	46	80.08	96	72	78.61	94	52	0
Apr-13											
May-13	8527	3.10	17.64	39.68	81.14	91.5	75.46	79.77	92.5	52.36	3.17
Jun-13	9582	3.35	92.1	36.84	80.07	89.4	71.91	80.34	94.4	56.99	11.42
Jul-13	9769	3.54	82.66	37.25	78.58	90.7	71.12	81.16	94.1	54.08	13.16
Aug-13	11099	3.32	68.7	40.06	78.67	89.6	70.97	80.6	94.6	55.86	16.2
Sep-13	11842	3.50	20.06	31.45	79.13	91.6	72.26	79.11	93.7	55.04	10.11
Oct-13	13064	3.79	78.47	29.24	79.15	96.3	72.15	79.07	94.9	49.54	14.16
Nov-13	12469	2.86	89.83	29.62	80.12	94.6	70.62	78.75	94.3	54.21	9.83
Dec-13	13391	3.57	51.51	32.57	80.43	94.2	72.71	80.77	95.3	55.04	7.42
Annual	117303	3.52	56.61	37.52	79.77	93.35	72.23	80.14	94.25	54.01	94.88

Missing precipitation data for Feb-Apr 2013 and all parameters for April 2013.

Jan-14	11066	4.86	34.67	44.54	79.54	97.3	73	83.42	95.7	54.66	12.87
Feb-14	12269	3.11	52.69	60	81.42	98	74	79.04	95	48	8.36
Mar-14	13626	2.55	79.31	27	81.47	94	72	77.96	95	51	8.05
Apr-14	11491	2.43	93.67	64	79.96	94	72	79.66	95	50	18.77
May-14	10446	2.77	83.23	29	79.16	92	73	80.05	94	45	9.14
Jun-14	10253	2.91	151.4	24	78.17	87	71	79.59	96	55	8.65
Jul-14	9985	2.92	106.8	29	77.1	91	69	79.05	96	43	19.6
Aug-14	10802	3.28	137.5	30	76.75	88	69	80.6	94	58	11.59
Sep-14	11722	2.81	134.8	25	78.43	89	73	79.54	95	57	5.18
Oct-14	13948	2.49	81.44	27	79.52	91	71	77.41	95	53	6.91
Nov-14	11452	2.58	75.73	29	78.71	94	72	82.07	96	55	15.64
Dec-14	11343	2.84	146.8	30	79.12	95	72	82.63	96	54	17.67
Annual	138403	2.96	98.17	34.88	79.11	92.53	71.75	80.09	95.23	51.97	142.43

Jan-15	12248	2.40	61.13	32	80.82	94	73	81.66	97	50	16.59
Feb-15	12130	2.81	45.46	34	80.93	92	73	81.34	97	57	6.79
Mar-15	12830	1.98	69.68	31	81.35	97	73	81.16	96	55	8.29
Apr-15	12091	1.97	104.6	21	80.93	100	73	79.05	96	54	10.74
May-15	8512	2.65	135.3	26	79.21	92	72	84.99	97	62	17.96
Jun-15	9209	3.19	151.1	35	78.93	90	72	82.26	100	59	19.4
Jul-15	10325	3.41	148.8	28	77.79	91	72	81	97	54	18.13
Aug-15	11555	3.38	134.8	31	76.9	91	71	79.06	98	51	13.8
Sep-15	12187	2.98	138.2	26	78.38	91	68	79.82	98	41	3.44
Oct-15	10846	3.38	146.3	32	77.18	88	72	85.65	100	57	24.56
Nov-15	11253	2.74	41.93	53	79.63	91	73	86.55	100	59	20.63
Dec-15	11722	2.61	126.4	37	79.38	90	72	84.62	99	57	15.38
Annual	134908	2.79	108.64	32.17	79.29	92.25	72.00	82.26	97.92	54.67	175.71

Wind Rose Climatology

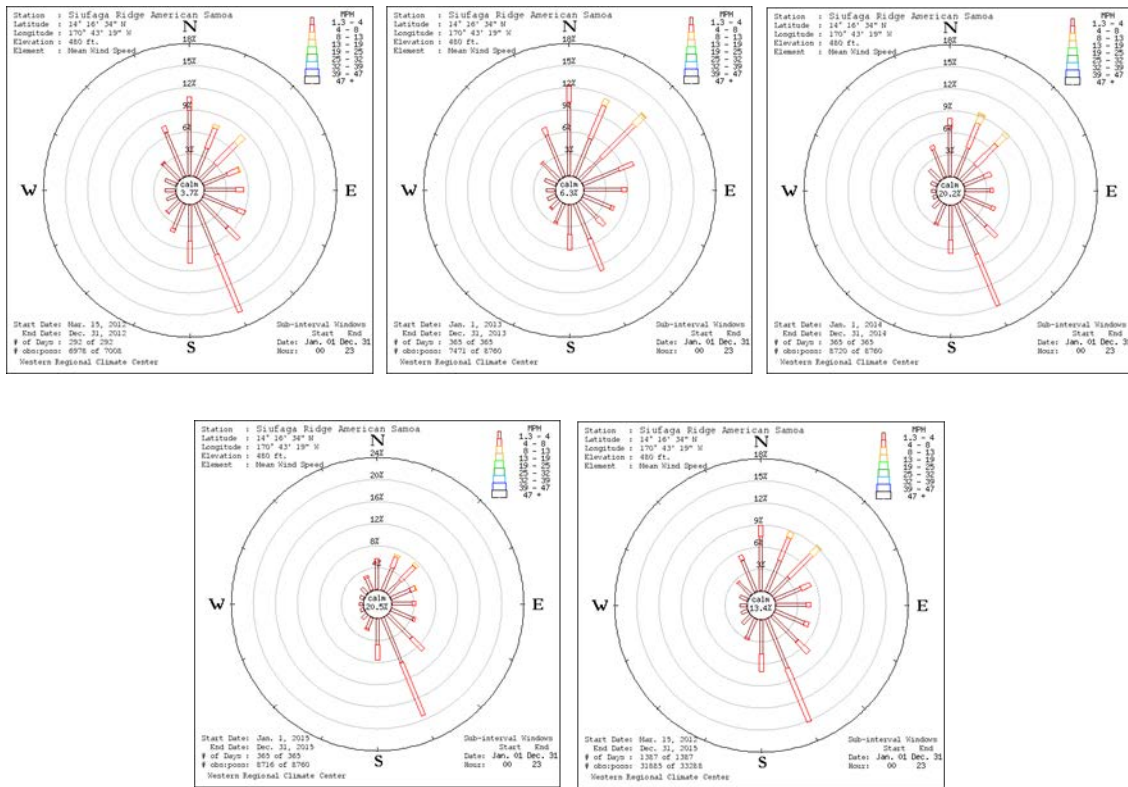
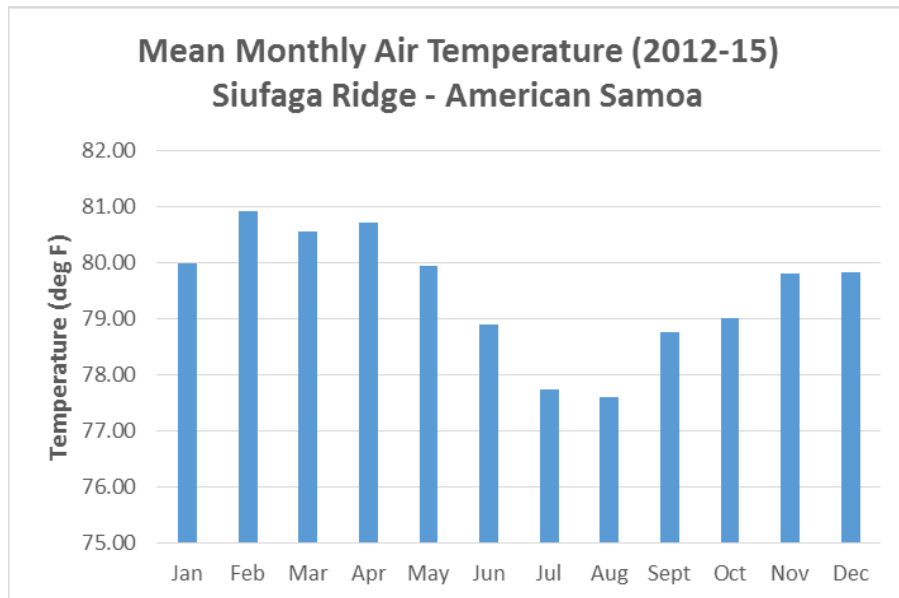
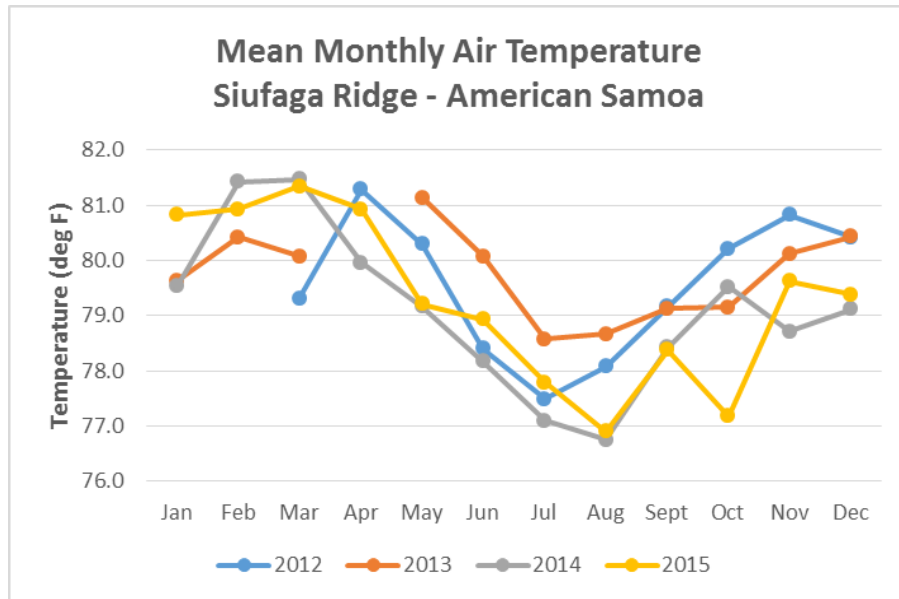
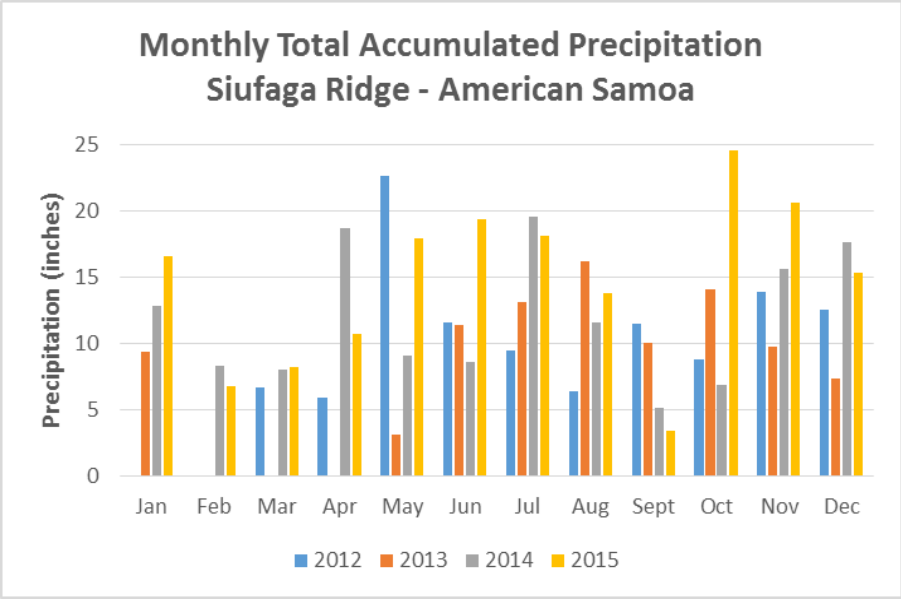


Figure 4 - Siufaga Ridge wind rose climatology for 2012, 2013, 2014, 2015, and 2012-15.

Mean Monthly Air Temperature and Annual Precipitation





National Park of American Samoa – Toa Ridge (NPS PACN)

Latitude: -14.2612

Longitude: -170.687

Elevation: 1285 feet

Period of Record: 3/13/12 – present



General Description: The Toa Ridge site is located on the north-central part of the island of Tutuila on the east end of the National Park of American Samoa at 1285 feet in elevation. Wet season on the island group generally extends from October through May and the dry season from June through September. Winds at the site are generally out of west-southwest with the maximum recorded gust of 59.9 mph. From 2012-2015, the mean air temperature was 73.9°F and average relative humidity at 90%. The highest temperature recorded was 90.5°F in February 2014 and the lowest was 59.7°F in January 2014. The maximum annual precipitation observed during the period of record was 113" in 2014 and the maximum monthly total of 16.21" in October 2015.



2012 – 2015 Summarized Data

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature					Average Relative Humidity			Precipitati on
Date	ly	mph	Deg	mph	Deg F					%			in
mm/yyyy	Total	Ave.	Vector Ave.	Max.	Ave.	Ave. Daily Max.	Max.	Ave. Daily Min.	Min.	Ave.	Max.	Min.	Total
Mar-12	4720	3.32	214.2	29	75.65	81.72	89	72.5	70	89.7	97	64	6.29
Apr-12	11363	2.49	217.1	21	77.44	85.4	89	73.13	70	85.68	98	61	5.12
May-12	10348	3.13	212.1	29	76.17	83.58	89	72.45	68	86.55	100	57	11.69
Jun-12	8497	3.58	218	32	74.49	80.37	86	71.53	68	87.22	100	55	7.38
Jul-12	8523	3.22	211.7	31	73.61	79.39	87	70.52	67	88.09	100	59	6.31
Aug-12	11159	3.82	227.6	36	74.04	81.13	87	70.32	68	84.41	98	47	4.91
Sep-12	10808	4.10	231.1	33	75.29	81.73	87	71.63	69	87.72	99	60	6.65
Oct-12	10653	3.84	226.4	33	75.91	82.03	86	72.32	70	86.4	99	61	5.5
Nov-12	10247	3.48	228.5	30	76.84	83.07	87	73.4	71	88.52	99	64	10.24
Dec-12	10695	3.23	225.2	35	75.22	81.67	87	71.26	68	87.85	100	63	10.51
Annual	97013	3.42	221.19	30.90	75.47	82.01	87.40	71.91	68.90	87.21	99.00	59.10	74.60

Station deployed on 3/13/12.

Jan-13	539.4	3.92	237.6	23	73.12	76.33	80	70.67	69	91.68	99	79	2.31
Feb-13													
Mar-13													
Apr-13													
May-13	7955	4.63	237.9	41.09	75.97	81.8	87.5	72.78	71.39	87.01	97.8	62.72	2.63
Jun-13	9587	3.94	229.6	35.19	74.23	80.72	85.5	70.63	64.78	87.78	98.4	59.8	6.95
Jul-13	8907	4.16	229	36.01	71.66	77.18	86.8	68.48	64.09	90.08	100	62.11	6.87
Aug-13	10859	3.72	227.7	34.29	71.84	78.59	85.2	67.96	61.17	89.37	100	61.95	11.75
Sep-13	10723	4.45	227.7	36.57	72.27	78.01	85.3	68.86	66.34	88.37	100	56.85	5.1
Oct-13	10950	3.99	225.8	38.68	72.27	78.44	84.8	68.91	65.27	89.2	100	57.46	9.35
Nov-13	9965	3.45	225.5	32.79	73.02	78.97	85.4	69.23	64.46	89.18	100	59.99	5.58
Dec-13	11017	3.48	219.5	32.17	73.65	79.89	86.8	70.04	66.36	90.58	100	63.73	7.03
Annual	80502	3.97	228.92	34.42	73.11	78.88	85.26	69.73	65.87	89.25	99.47	62.62	57.57

Missing data from Jan-April 2013 – datalogger malfunction.

Jan-14	8484	3.99	202.2	33.58	70.47	75.49	86.8	67.26	59.76	93.88	100	60.98	15.35
Feb-14	10958	3.25	197.5	30.51	75.56	82.88	90.5	71.26	67.65	89.43	100	53.49	10.68
Mar-14	12298	2.82	167.5	25.97	75.45	82.61	88.8	71.28	69.44	88.95	100	61.28	9.5
Apr-14	10741	3.39	225.3	35.68	74.6	81.57	88.6	70.51	68.05	90.17	100	59.02	15.74
May-14	9806	3.92	224.1	33.73	73.68	79.74	84.4	70.51	68.21	90.14	100	53.66	5.12
Jun-14	9461	3.45	217.3	30.38	73.25	79.58	84.2	69.84	67.42	89.93	100	57.61	5.8
Jul-14	9458	3.56	217.1	27.22	72.46	78.66	87.5	69.05	63.89	88.73	100	45.06	15.84
Aug-14	10237	3.39	215.8	27.34	72.1	78.57	85.9	68.72	63.93	90.74	100	62.43	5.46
Sep-14	10267	3.53	219.9	34.54	73.05	79.18	87.4	69.77	68.1	90.86	100	61.51	3.56
Oct-14	12244	3.36	225.3	42.43	74.13	81.46	86.1	70.06	65.29	87.35	100	60.97	4.42
Nov-14	9394	3.28	208.3	59.93	69.78	71.62	71.62	68.69	68.69	92.51	100	62.39	8.35
Dec-14	9152	3.11	198.6	38.07						93.07	100	66.24	13.56
Annual	122500	3.42	209.91	34.95	73.14	79.21	85.62	69.72	66.40	90.48	100.00	58.72	113.38

Missing air temperature/relative humidity data in Dec 2014 – sensor and GOES satellite transmitter malfunction.

Jan-15	10827	2.82	182.1	62.5						91.5	100	59.49	15.98
Feb-15	11342	3.29	217.2	26.93						92.26	100	66.31	7.62
Mar-15	12002	2.69	201.1	25.19						91.84	100	60.98	7.61
Apr-15	11053	2.88	227	24.38						89.63	100	61.52	7.03
May-15	7979	3.41	229.5	31.43						94.53	100	65.07	14.52
Jun-15	8812	3.30	210.8	36.08						92.19	100	61.86	12.24
Jul-15	8625	3.03	202.4	31.65						91.35	100	57.88	9.73
Aug-15	10196	3.34	208.5	36.1						87.81	100	56.06	7.65
Sep-15	10225	3.16	218.1	29.77	72.17	78	78	69	69	90.34	100	47.12	2.11
Oct-15	8421	2.78	207.5	35	73.62	78.71	86	70.9	67	93.45	100	57	16.21
Nov-15	7444	3.29	233.2	33	76.04	82	88	67.25	1	92.92	100	64	8.29
Dec-15													
Annual	106926	3.09	212.49	33.82	73.94	79.57	84.00	69.05	45.67	91.62	100.00	59.75	108.99

Missing air temperature/relative humidity data in Jan-Aug 2014 – sensor and GOES satellite transmitter malfunction.

Wind Rose Climatology

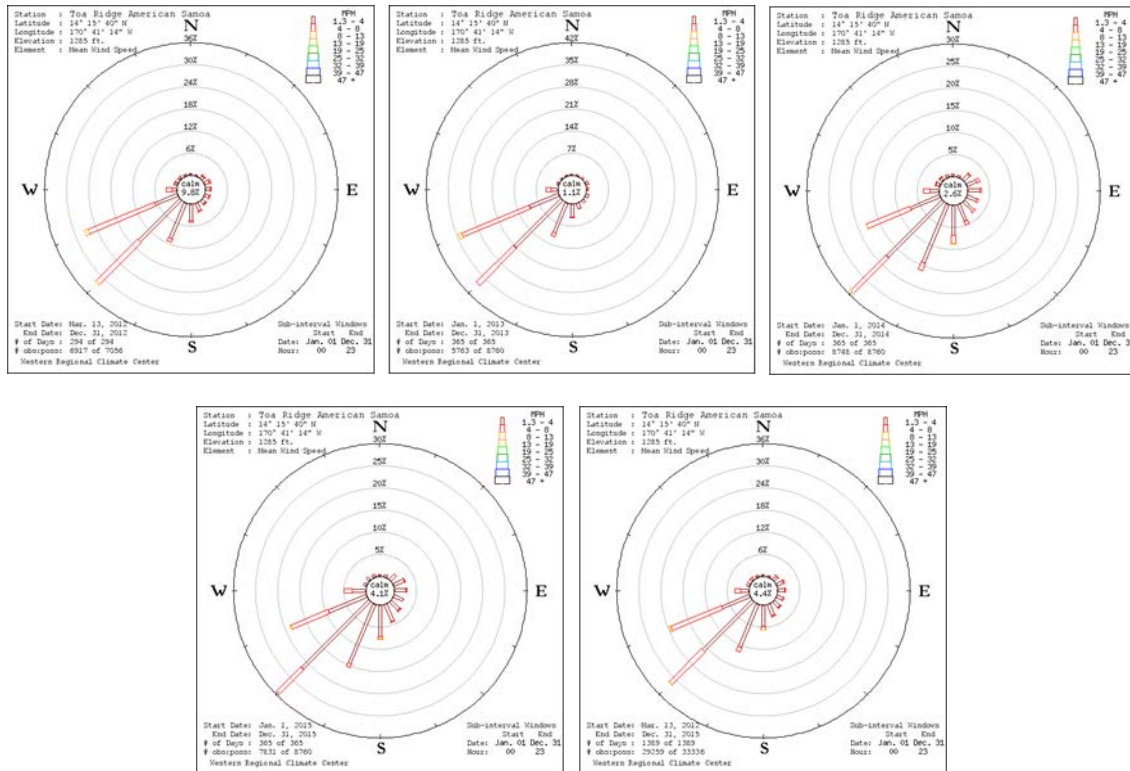
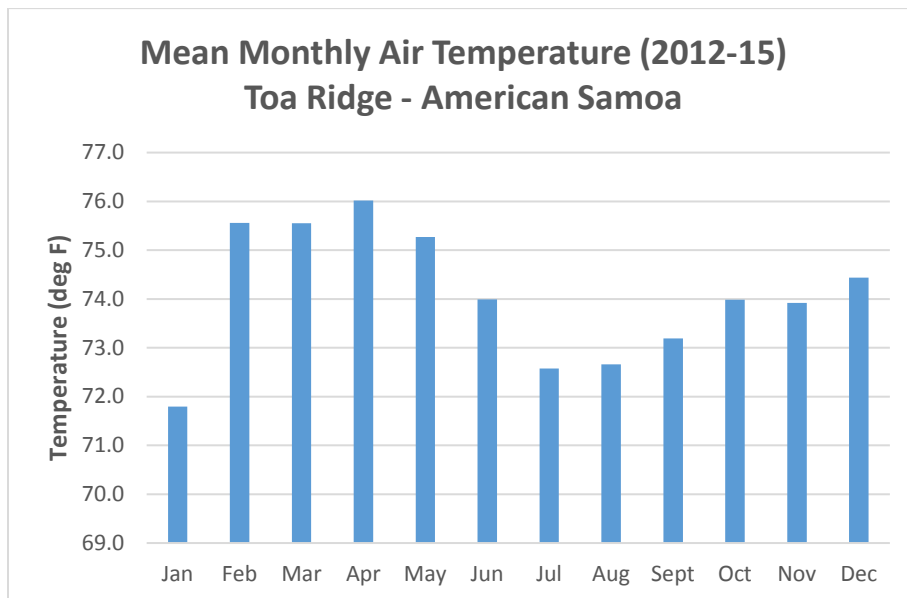
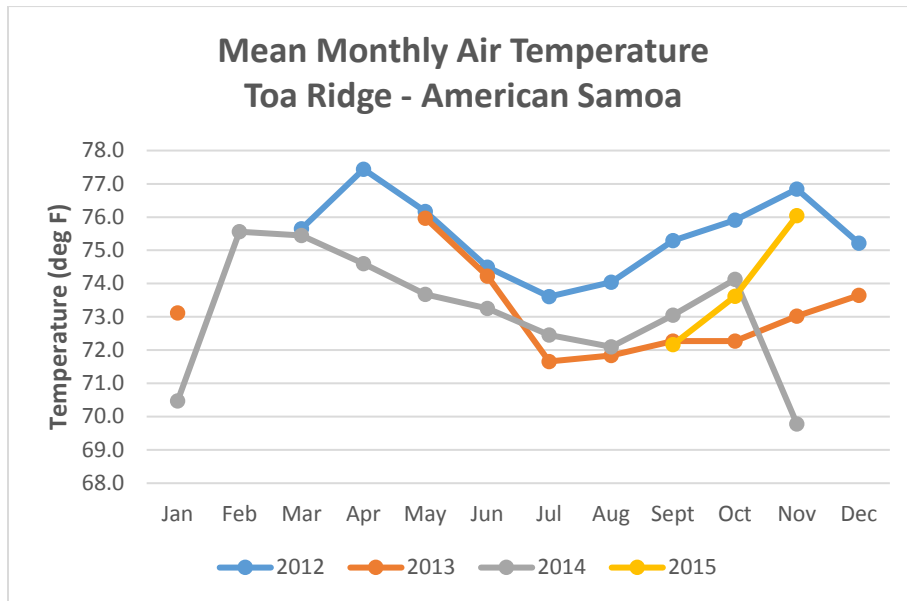
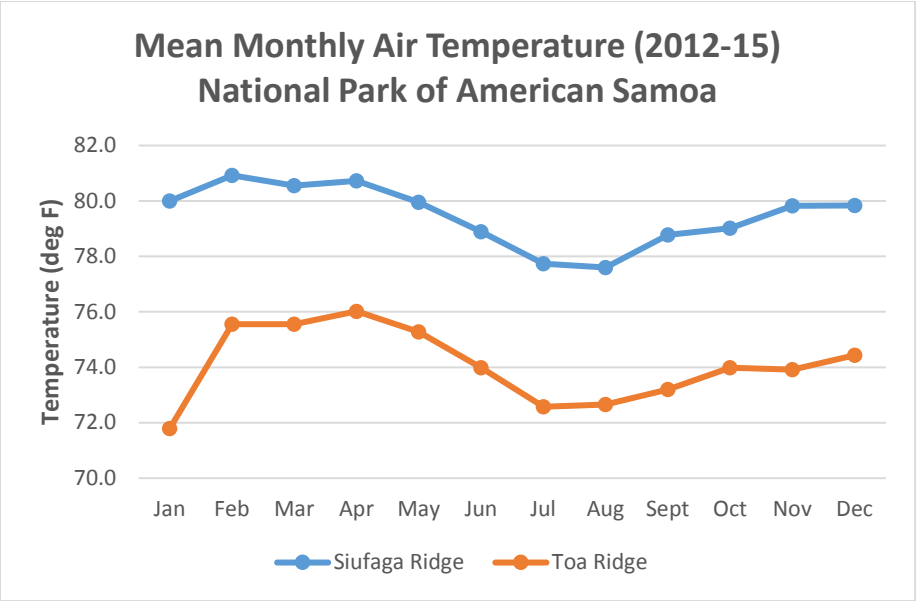
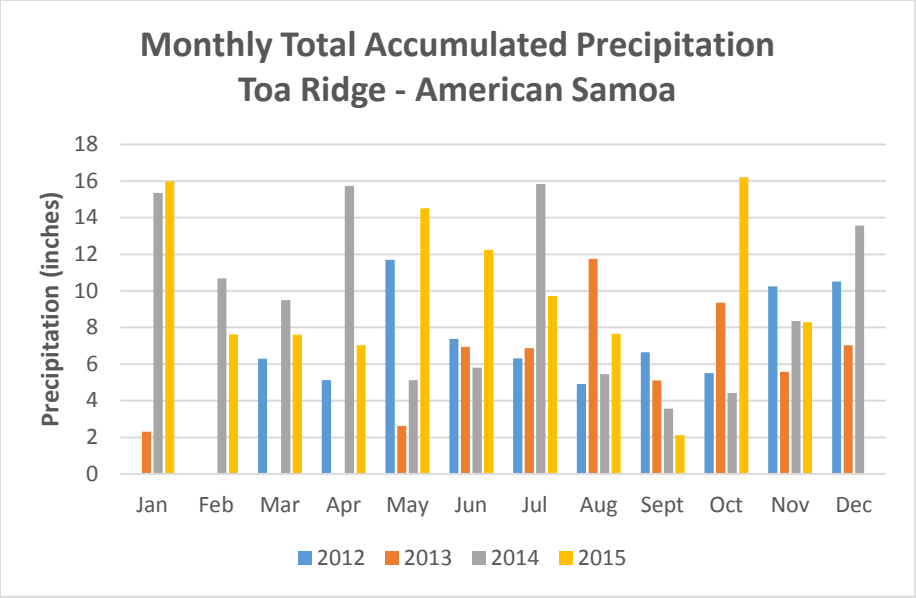
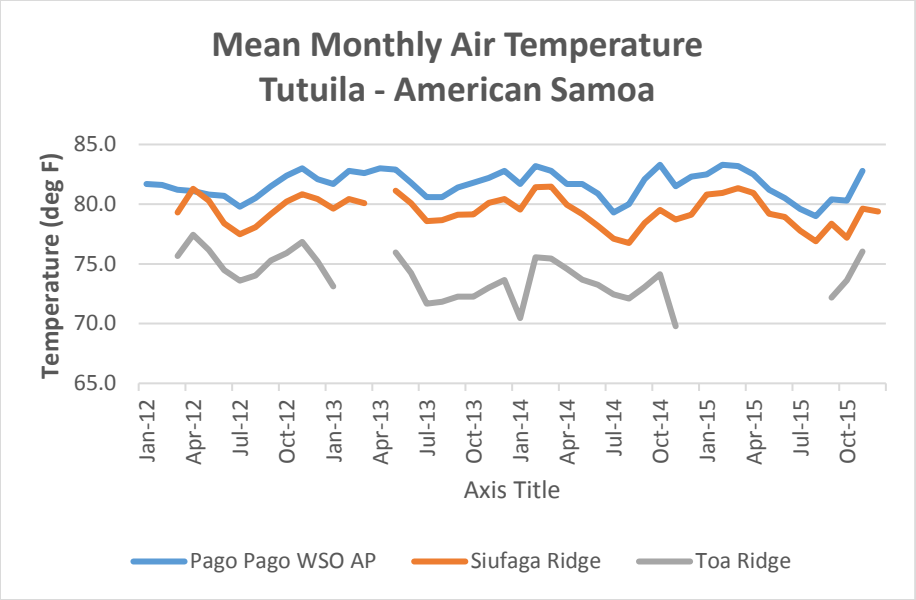


Figure 5 -- Toa Ridge wind rose climatology for 2012, 2013, 2014, 2015, and 2012-15.

Mean Monthly Air Temperature and Annual Precipitation







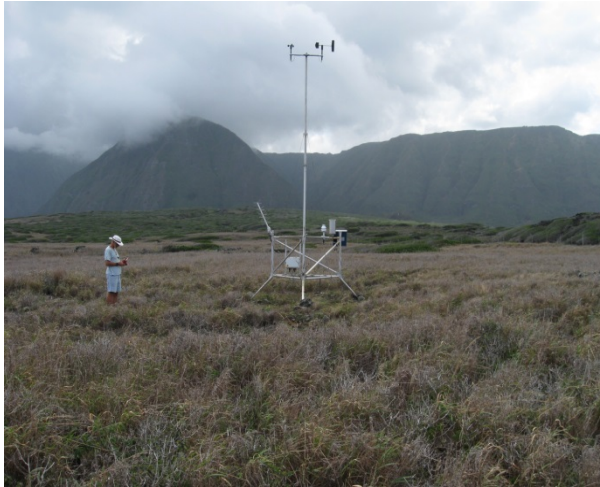
Kalaupapa NHP – Makapulapai (NPS RAWS)

Latitude: -21.203

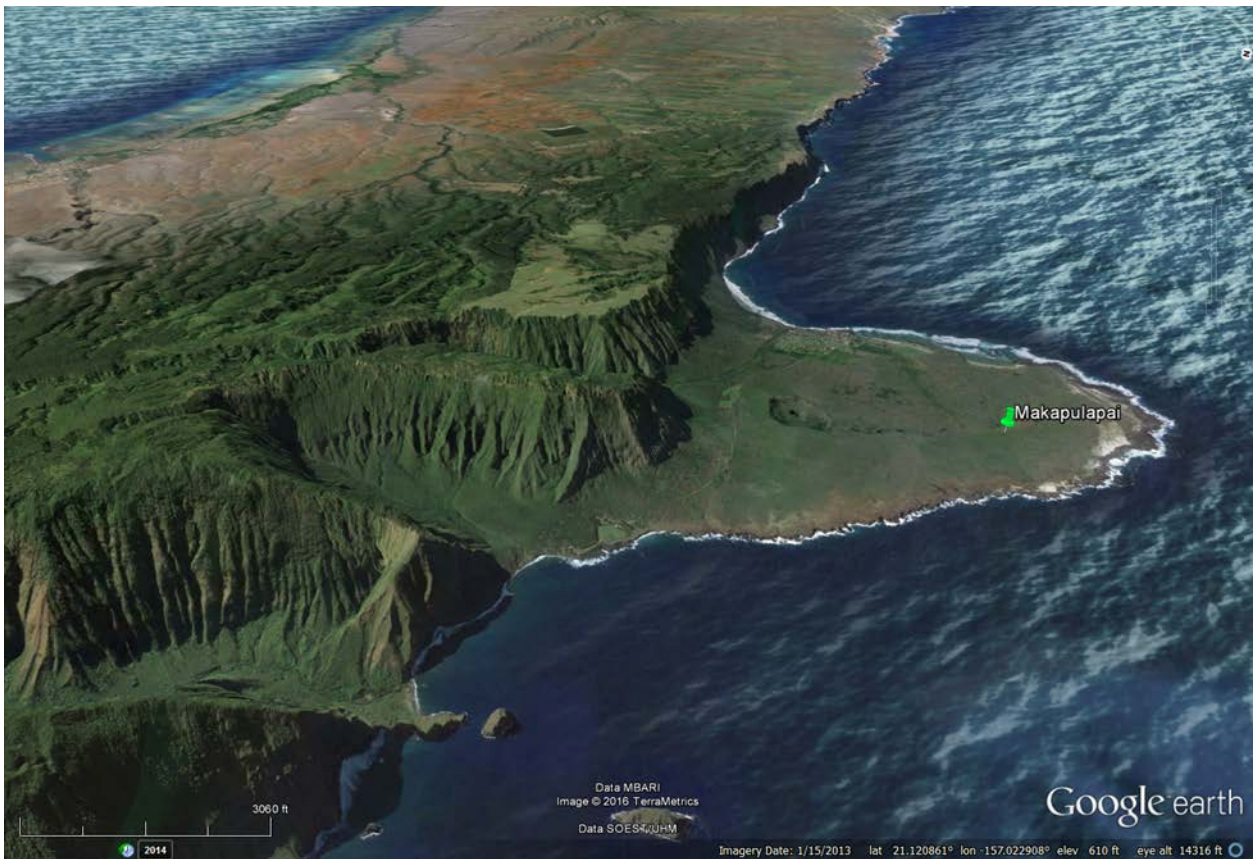
Longitude: -156.966

Elevation: 75 feet

Period of Record: 3/30/93 – present



General Description: The Makapulapai site is located on the north-central part of the island of Molokai at 75 feet in elevation. The station is not part of the PACN climate network, but is part of the RAWS fire-weather network. Winds at the site are moderate and predominantly out of east with a maximum wind gust recorded during 2012-15 of 56 mph. Mean air temperature for the period was 75.9°F with average relative humidity hovering around 75%. The maximum temperature recorded for the period was 90°F in September 2014 and the lowest was 50°F in August 2014. Annual precipitation has ranged from 32-41". The maximum monthly precipitation total of 7.52" was observed in December 2013 and the lowest of 0.01" in December 2012.



2012 – 2015 Summarized Data

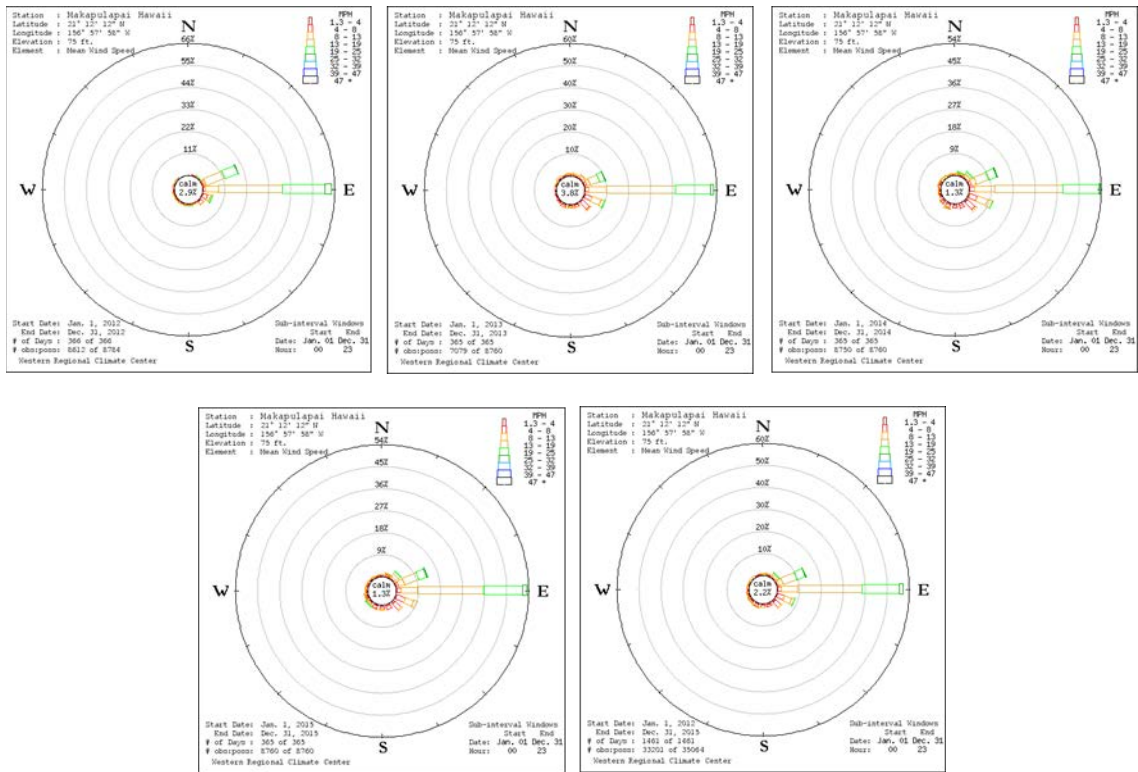
	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Average Relative Humidity			Precipitati on
Date	ly	mph	Deg	mph	Deg F			%			in
mm/yyyy	Total	Ave.	Vector Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Jan-12	13499	10.62	103.9	52	74.22	85	64	72.5	93	47	0.19
Feb-12	15219	15.47	92.02	47	73.32	85	62	72.82	92	36	1.19
Mar-12	16108	17.78	85.24	50	72.72	82	63	74.66	98	42	6.18
Apr-12	19726	16.48	86.51	40	73.53	81	66	74.9	96	56	0.95
May-12	23453	17.38	83.96	44	75.01	83	64	72.23	94	49	0.95
Jun-12	21492	17.36	82.13	42	75.8	83	69	75.52	96	54	1.75
Jul-12	23631	17.6	82.97	38	76.74	84	67	75.1	94	54	1.15
Aug-12	23479	16.23	82.71	36	78.01	85	69	72.59	93	51	0.69
Sep-12	19715	15.28	88.17	36	77.08	84	69	73.43	96	55	1.2
Oct-12	15435	12.52	93.54	32	77.31	85	68	73.08	93	51	0.51
Nov-12	13563	12.92	93.98	37	75.21	84	64	69.65	89	45	0.43
Dec-12	11578	15.4	97.02	45	73.95	87	63	74.12	93	45	0.01
Annual	216898	15.42	89.35	41.58	75.24	84.00	65.67	73.38	93.92	48.75	33.59

Jan-13	10942	12.31	90.89	51	71.32	83	62	78.25	96	33	6.76
Feb-13	4101	18.1	83.89	38	71.83	78	67	72.92	91	56	0.53
Mar-13	13041	6.856	105.2	38	70.7	83	58	76.75	95	44	4.99
Apr-13	17319	10.66	91.97	36	74.08	85	60	75.43	95	45	1.18
May-13	3050	18.22	80.91	33	76.36	81	70	75.82	89	62	0.14
Jun-13	8418	17.1	87.55	37	76.49	83	70	68.76	98	12.9	1
Jul-13	18870	15.7	90.3	41	78.29	85	67	74.79	97	56	1.84
Aug-13	19164	16.59	89.02	36	78.92	85	70	73.47	98	52	2.28
Sep-13	16592	15.2	91.15	36	79.41	86	69	72.81	95	51	1.61
Oct-13	14431	11.52	101.9	33	78.77	86	69	72.28	90	50	0.22
Nov-13	10014	10.98	100.3	36	76.12	84	65	74.36	96	48	3.93
Dec-13	10325	11.2	101	34	74.35	84	65	78.4	96	57	7.52
Annual	146267	13.70	92.84	37.42	75.55	83.58	66.00	74.50	94.67	47.24	32.00

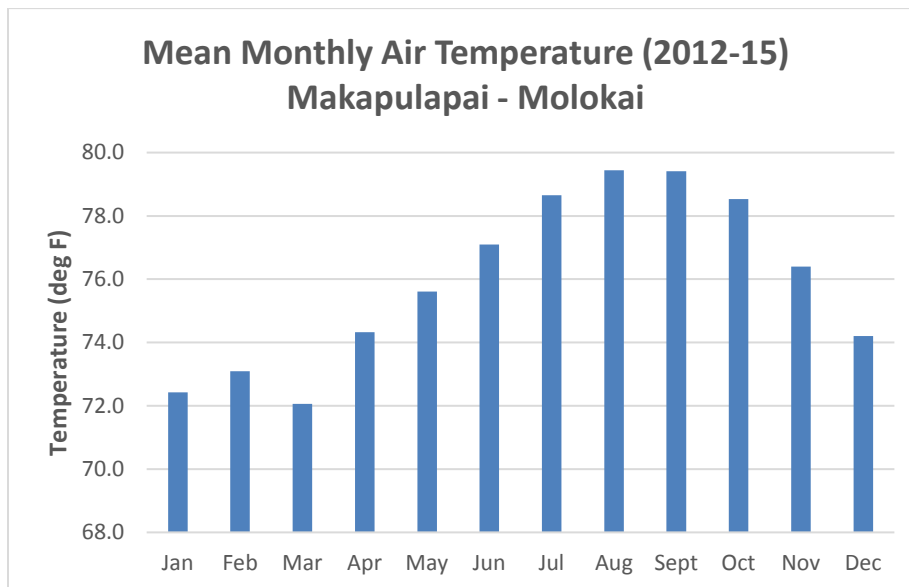
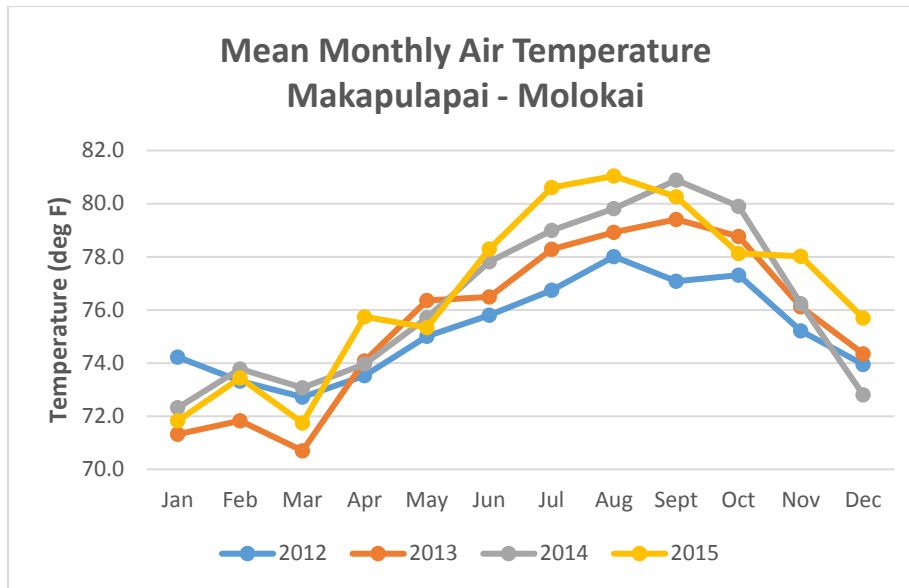
Jan-14	10157	8.539	123.7	45	72.32	84	60	74.33	96	45	4.78
Feb-14	9545	7.878	99.73	35	73.78	83	64	79.37	97	48	3.24
Mar-14	13156	12.73	91.74	37	73.07	84	62	76.05	94	44	5.35
Apr-14	14425	17.95	85.39	40	73.96	82	65	74.94	93	52	3.91
May-14	14974	10.88	100.7	34	75.71	84	67	77.69	96	56	3.48
Jun-14	18465	15.7	90.73	36	77.81	85	69	70.49	93	51	1.46
Jul-14	18012	16.71	90.16	40	78.99	86	70	72.92	95	48	2.74
Aug-14	17662	14.93	92.49	50	79.81	88	70	69.98	92	48	1.18
Sep-14	16286	11.55	94.84	33	80.89	90	71	72.42	97	16	1.34
Oct-14	13366	13.94	94.28	39	79.9	88	70	75.89	97	55	3.27
Nov-14	10177	12.91	99.3	37	76.24	85	66	74.22	96	48	2.14
Dec-14	8981	11.91	90.88	45	72.8	83	63	74.63	96	46	8.38
Annual	165206	12.97	96.16	39.25	76.27	85.17	66.42	74.41	95.17	46.42	41.27

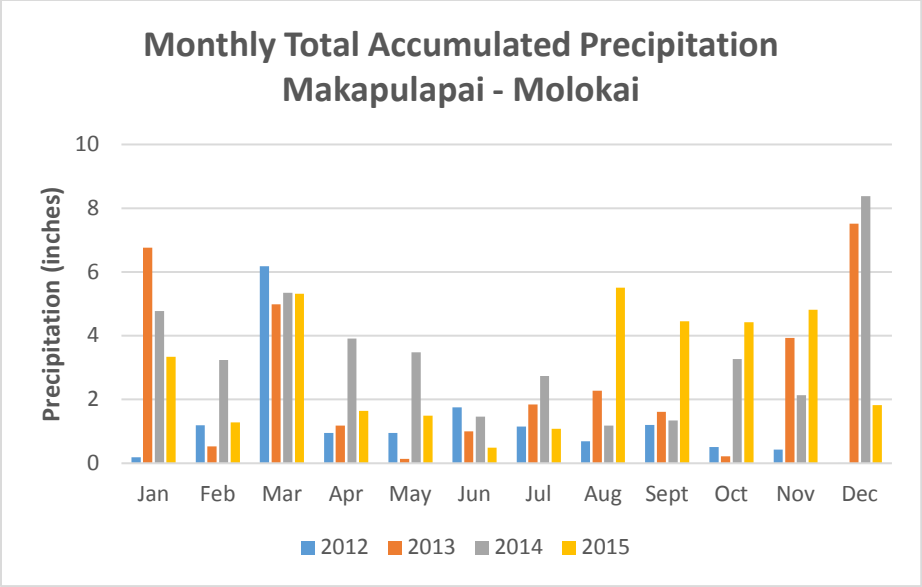
Jan-15	10895	7.293	129.7	50	71.83	84	61	72.58	95	45	3.34
Feb-15	10275	9.966	158.1	56	73.44	83	60	73.31	93	45	1.28
Mar-15	12487	11.76	82.94	34	71.75	84	61	74.11	93	47	5.32
Apr-15	16765	17.77	87.36	43	75.74	85	68	72.6	93	52	1.64
May-15	17312	15.06	87.2	37	75.34	85	65	70.64	91	46	1.49
Jun-15	18430	13.97	88.45	31	78.3	87	68	72.35	93	55	0.49
Jul-15	18785	13.9	88.39	34	80.61	88	72	72.99	93	54	1.08
Aug-15	15451	11.98	95.12	36	81.04	88	74	76.39	92	53	5.51
Sep-15	15402	13.3	94.92	40	80.26	89	72	80.3	97	62	4.45
Oct-15	12311	11.28	86.43	32	78.13	87	68	81.36	97	52	4.42
Nov-15	10627	16.83	91.76	41	78.02	88	71	77.11	97	55	4.82
Dec-15	10540	16.64	90.87	51	75.7	84	67	76.08	93	54	1.82
Annual	169280	13.31	98.44	40.42	76.68	86.00	67.25	74.99	93.92	51.67	35.66

Wind Rose Climatology



Mean Monthly Air Temperature and Annual Precipitation





Kalaupapa NHP – Puu Alii (NPS PACN)

Latitude: -21.140

Longitude: -156.902

Elevation: 3805 feet

Period of Record: 2/28/12– present



General Description: The Puu Alii site is located on the eastern part of the island of Molokai at 3805 feet in elevation. Winds at the site are light because of its forested location and predominantly out of the east. The maximum gust recorded at the site was 37 mph in December 2015. From 2012-2015, the mean air temperature was 59.5°F and average relative humidity at 93%. The highest temperature recorded was 79°F and the lowest 43°F in March 2013. During 2012-15, the highest precipitation accumulations generally occurred during the month of March. A maximum monthly precipitation total of 48.31" was observed in March 2012. Annual precipitation has ranged from 92-209" during 2012-15.



2012 – 2015 Summarized Data

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Average Relative Humidity			Precipitati on
Date	ly	mph	Deg	mph	Deg F			%			in
mm/yyyy	Total	Ave.	Vector Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Feb-12	580.2	3.31	127.7	18.81	56.67	63.95	54.03	93.45	97.1	71.98	1.2
Mar-12	8862	3.12	107.5	27.65	56.38	68.58	49.75	91.87	97.9	49.9	32.17
Apr-12	8346	2.75	103.1	27.83	56.96	70.34	51.61	92.21	97.6	63.12	8.36
May-12	11428	2.96	95.17	25.23	58.1	73.63	47.8	89.51	97.5	43.68	5.91
Jun-12	9149	3.23	101.3	27.31	59.22	71.78	53.74	92.38	97.5	48.69	8.11
Jul-12	9844	3.09	98.47	24.74	60.05	71.6	52.34	92.65	98.8	56.56	9.05
Aug-12	11107	3.01	103.8	22.12	60.97	71.78	56.18	91.4	97.6	62.64	5.07
Sep-12	9844	2.80	100.5	22.48	60.61	70.42	56.14	91.57	97.3	60.42	7.86
Oct-12	10202	2.23	117.8	21.12	62.26	77.59	54.64	87.96	97.3	50.82	2.17
Nov-12	6521	2.49	108.1	24.11	58.34	69.6	48.9	90.29	97.9	53.69	3.62
Dec-12	5064	2.95	118.2	33.58	58.05	72.77	48.42	91.39	97.8	40.85	9.55
Annual	90947	2.90	107.42	25.00	58.87	71.09	52.14	91.33	97.66	54.76	93.07

Station deployed 2/28/12.

Jan-13	5647	2.71	123.5	29.42	56.63	68.41	48.72	93.94	99.1	55.92	24.22
Feb-13	6582	3.32	94.13	25.32	54.64	67.73	49.53	92.51	100	15.01	15.06
Mar-13	9224	1.67	147.6	21	55.4	71	43	90.15	98	48	12.54
Apr-13	10927	1.58	139.3	20	59.08	74	46	87.9	97	49	1.7
May-13	10051	1.65	125.1	18	60.29	75	51	90.91	99	59	10.26
Jun-13	9350	3.00	96.27	26	60.05	70.52	54.56	94.42	98.5	67.03	8.4
Jul-13	11106	2.69	106.5	25.46	61.92	72.33	54.27	91.41	98.4	61.71	6.71
Aug-13	12894	2.74	100.9	22.01	62.68	77.03	54.95	88.87	98.3	58.08	4.91
Sep-13	10906	2.71	97.57	19.98	62.17	74.27	54.02	89.98	98.3	62.25	4.81
Oct-13	8351	1.91	119.7	19.17	61.92	75.65	53.66	90.91	98.2	58.49	1.87
Nov-13	6314	2.08	111.3	19.44	59.85	73.68	48.67	91.73	99.2	42.89	13.81
Dec-13	5909	2.16	118	20.92	58.81	74.09	51.56	92.87	99.2	55.61	12.95
Annual	107261	2.35	114.99	22.23	59.45	72.81	50.83	91.30	98.60	52.75	117.24

Jan-14	5436	2.23	167.5	25.7	56.08	68.88	45.67	93.37	99.2	65.69	24.15
Feb-14	6819	1.80	147.6	21.9	59.19	73.18	47.27	92.27	99.2	48.74	19.96
Mar-14	8594	2.43	120.2	20.89	56.82	70.7	47.51	94.05	99.5	50.45	40.5
Apr-14	6962	3.13	95.05	27.42	56.28	70	48.97	96.07	99.7	64.67	31.36
May-14	9161	1.86	114.2	18.12	60.6	73.6	54.24	93.17	99.8	59.9	12.3
Jun-14	10081	2.73	100.2	20.8	60.67	71.26	55.02	93.66	99.8	63.46	5.05
Jul-14	12123	2.70	103.1	20.76	62.85	75	56.8	92.74	100	62	9.7
Aug-14	11092	2.21	100.6	31	62.69	76	55	92.12	100	44	6.24
Sep-14	10506	1.51	102.3	19	64.25	79	56	90.56	100	50	4.39
Oct-14	8581	1.91	107.5	21	63.05	74	56	93.31	100	66	8.85
Nov-14	5692	2.00	119.7	22	59.2	72	52	95.64	100	59	15.63
Dec-14	4791	1.98	113.3	22	56.17	69	46	96.14	100	64	31.09
Annual	99838	2.21	115.94	22.55	59.82	72.72	51.71	93.59	99.77	58.16	209.22

Jan-15	6446	1.46	156.3	29	56.16	71	46	91.25	100	47	7.87
Feb-15	6884	2.32	183.6	31	57.89	73	47	87.05	100	13	7.93
Mar-15	7833	1.68	49	19	55.44	71	44	95.47	100	55	48.31
Apr-15	9655	2.50	81.48	21	58.59	72	52	94.44	100	61	19.12
May-15	9043	1.94	2.478	18	57.59	70	49	96.08	100	66	17.7
Jun-15	9721	1.73	52.04	15	61.23	74	55	94.68	100	62	6.4
Jul-15	10232	1.34	11.78	16	64.03	77	56	94.34	100	64	6.67
Aug-15	7095	1.10	46.82	19	64.82	78	58	97.39	100	67	12.59
Sep-15	7718	1.74	22.09	23	64.49	79	56	96.55	100	68	12.67
Oct-15	6299	1.59	91.23	24	62.56	75	52	97.31	100	61	26.31
Nov-15	4712	3.22	3.308	24	61.14	75	55	97.35	100	69	18.44
Dec-15	6758	2.88	31.23	37	58.27	68	53	97.11	100	67	10.58
Annual	92396	1.96	60.95	23.00	60.18	73.58	51.92	94.92	100.00	58.33	194.59

Wind Rose Climatology

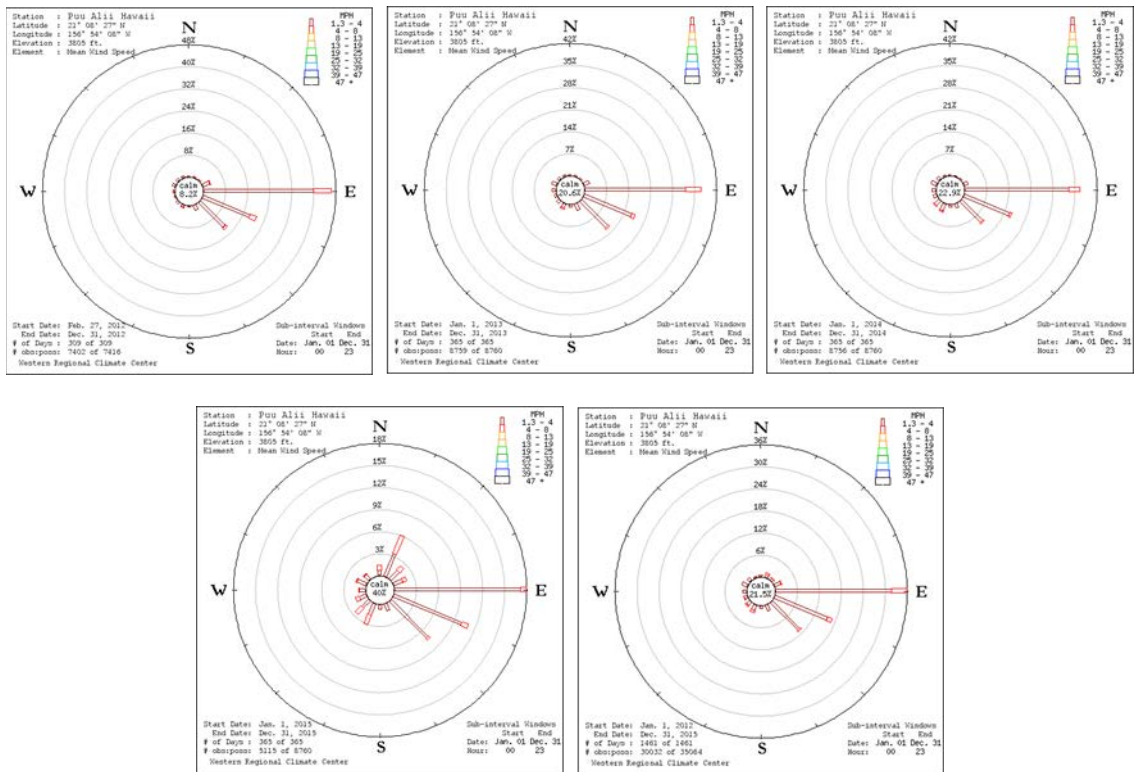
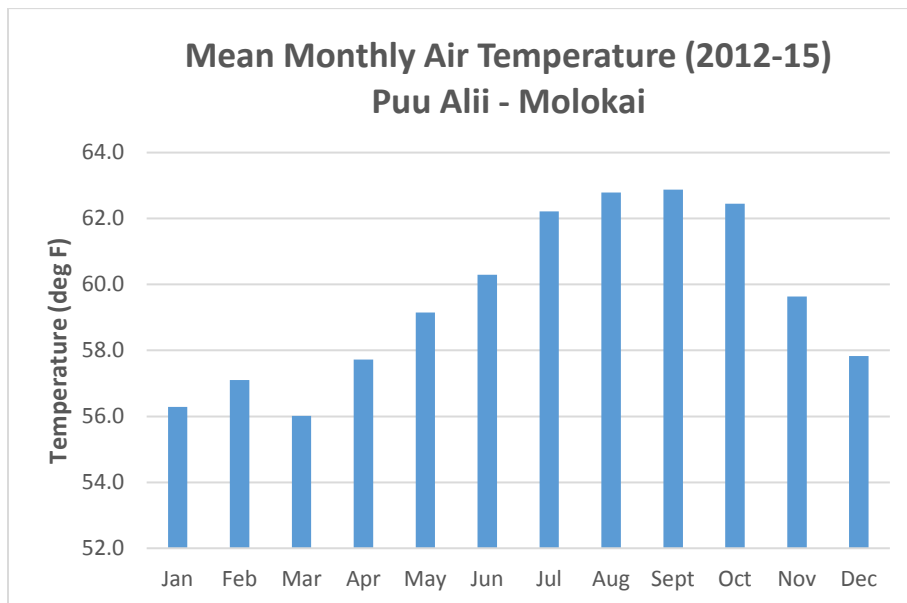
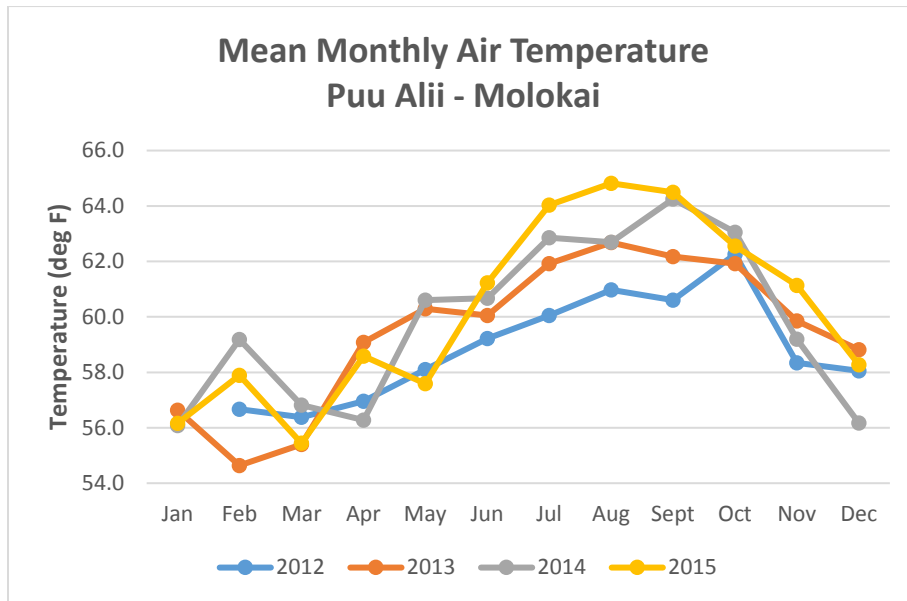
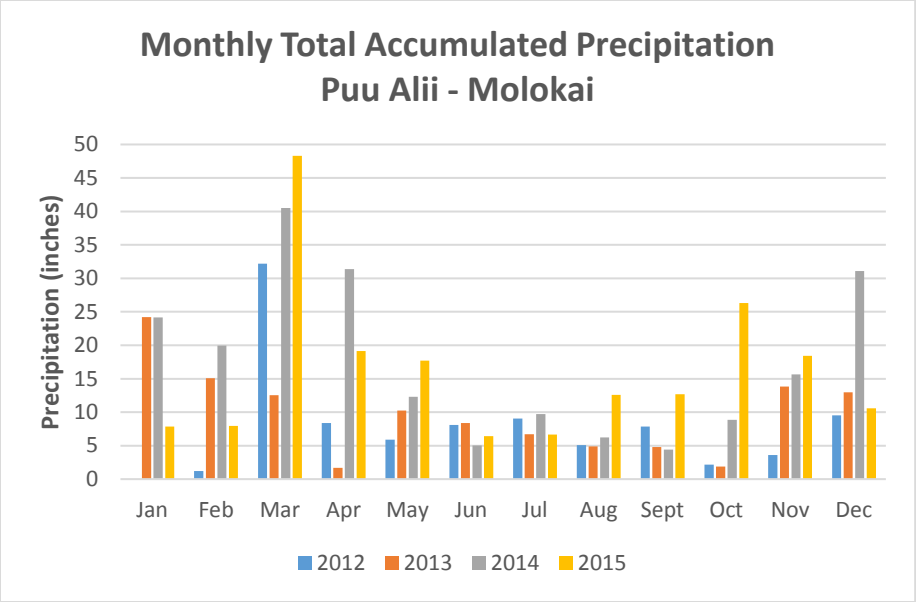


Figure 7 – Puu Alii wind rose climatology for 2012, 2013, 2014, 2015, and 2012-15.

Mean Monthly Air Temperature and Annual Precipitation





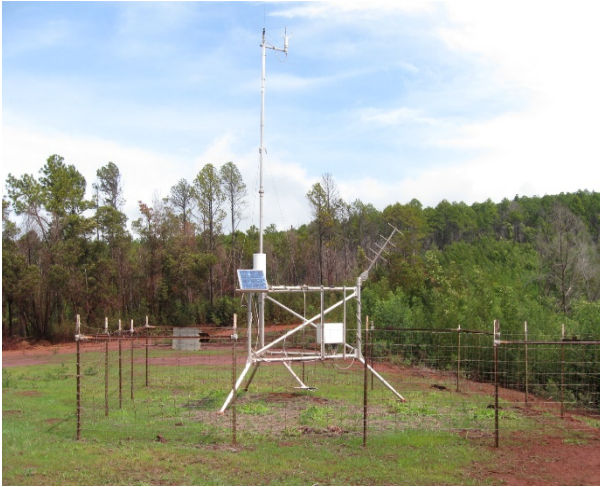
Outside Kalaupapa NHP – Molokai 1 (Hawaii State & Private Forestry RAWS)

Latitude: -21.115

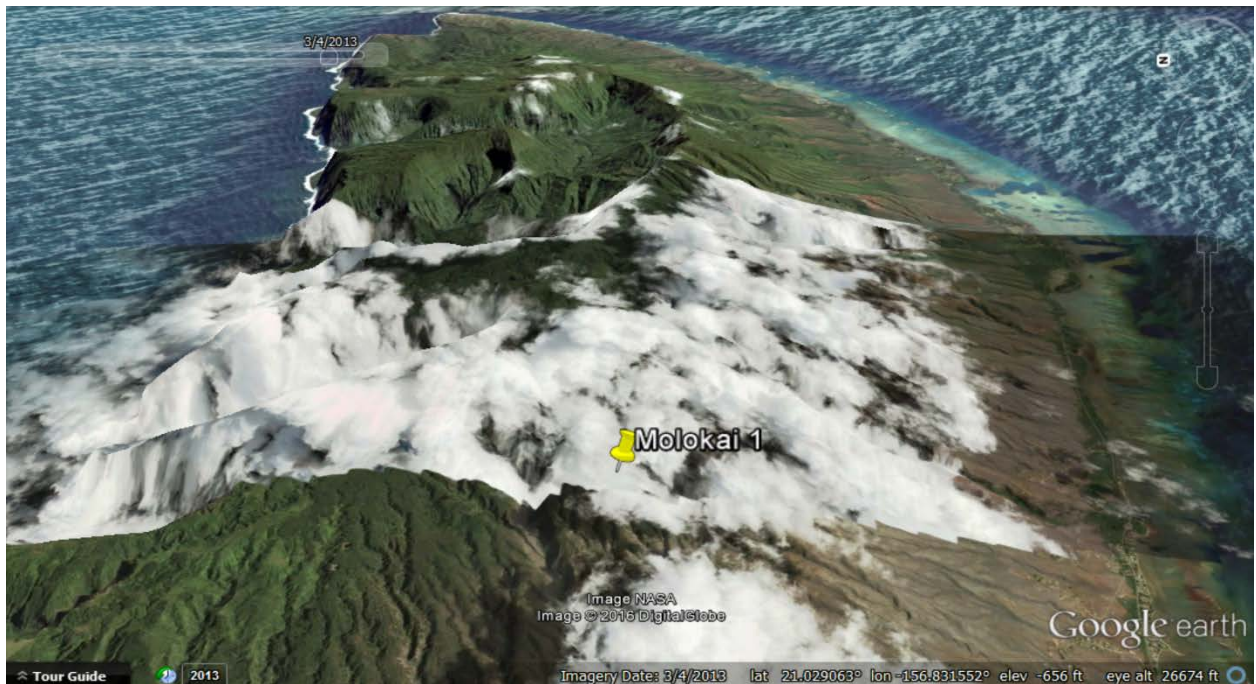
Longitude: -156.947

Elevation: 2733 feet

Period of Record: 4/16/03– present



General Description: The Molokai 1 site is located on the eastern part of the island of Molokai at 2733 feet in elevation in close proximity to Kalaupapa National Historical Park. The station is part of the RAWS fire weather network and has a record dating back to 2003. Winds at the site are generally light and predominantly out of the northeast. The maximum wind gust recorded during 2012-15 was 62 mph in March 2012. The mean air temperature for the period was 66.7°F and average relative humidity at 80%. The maximum temperature recorded during 2012-15 was 89°F in September 2014 and the lowest was 50°F in March 2015. The highest monthly precipitation totals were observed during the month of March. Annual precipitation during 2012-15 ranged from 36-47".



2012 – 2015 Summarized Data

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Average Relative Humidity		
Date	ly	mph	Deg	mph	Deg F			%		
mm/yyyy	Total	Ave.	Vector Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.
Jan-12	14007	3.42	72.68	35	64.61	80	54	76.79	100	36
Feb-12	16442	5.25	46.81	47	63.45	78	53	77.46	100	27
Mar-12	19062	5.50	47.42	62	63.24	80	54	77.74	100	35
Apr-12	20357	4.80	45.09	40	63.95	80	57	77.24	100	45
May-12	24729	5.63	52.5	44	65.61	80	54	71.05	98	35
Jun-12	21651	5.17	54.3	41	66.76	80	58	75.83	100	26
Jul-12	23201	5.24	51.65	36	67.64	81	58	76.49	100	49
Aug-12	23439	5.26	64.25	30	68.69	81	59	74.01	100	47
Sep-12	21108	5.50	61.46	48	67.89	84	60	76.49	100	45
Oct-12	17654	3.53	56.19	41	68.85	87	60	79.57	100	29
Nov-12	14622	4.65	55.34	43	65.74	82	57	76.07	100	48
Dec-12	12409	4.65	51.27	46	64.72	80	56	77.81	100	12
Annual	228681	4.88	54.91	42.75	65.93	81.08	56.67	76.38	99.83	36.17

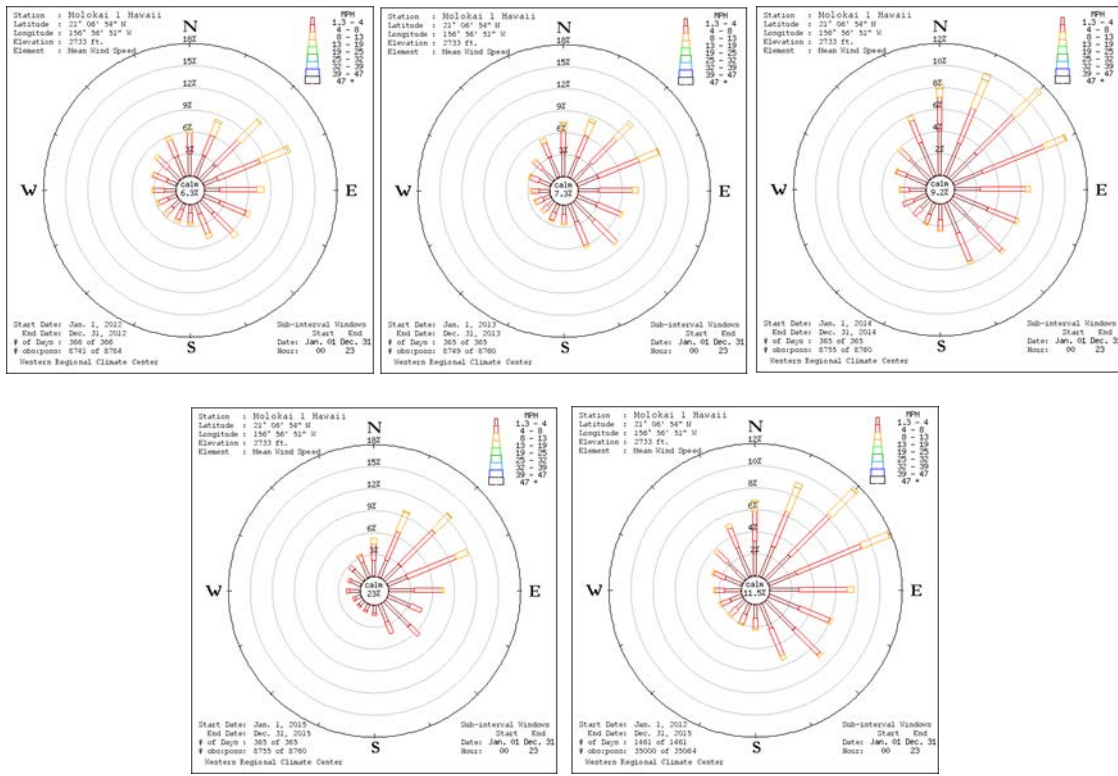
Precipitation gauge malfunctioned during 2012.

Jan-13	13518	5.07	57	55	63.09	78	54	78.68	100	41	6.53
Feb-13	17427	6.63	49.12	60	62.03	76	55	72.2	97	16	1.69
Mar-13	17056	4.11	64.61	34	62.32	80	51	79.46	100	41	7.55
Apr-13	18489	3.53	75.14	30	65.93	81	53	79.19	100	43	0.67
May-13	19536	4.03	75.82	35	67.56	79	57	81	100	50	2.49
Jun-13	23092	5.03	67.36	39	68.23	81	60	76.54	100	45	0.64
Jul-13	21460	4.43	61.44	43	69.58	82	60	75.89	100	46	3.95
Aug-13	23574	4.39	62.85	36	70.1	84	61	73.75	100	48	0.6
Sep-13	20157	4.69	58.03	38	69.78	83	61	72.51	100	40	0.32
Oct-13	16483	3.57	52.93	35	69.61	85	60	76.28	100	45	0.78
Nov-13	13872	4.35	55.42	42	67.11	83	56	80.02	100	40	3.38
Dec-13	13668	4.06	58.07	37	65.77	82	57	83.12	100	46	5.4
Annual	218332	4.49	61.48	40.33	66.76	81.17	57.08	77.39	99.75	41.75	34.00

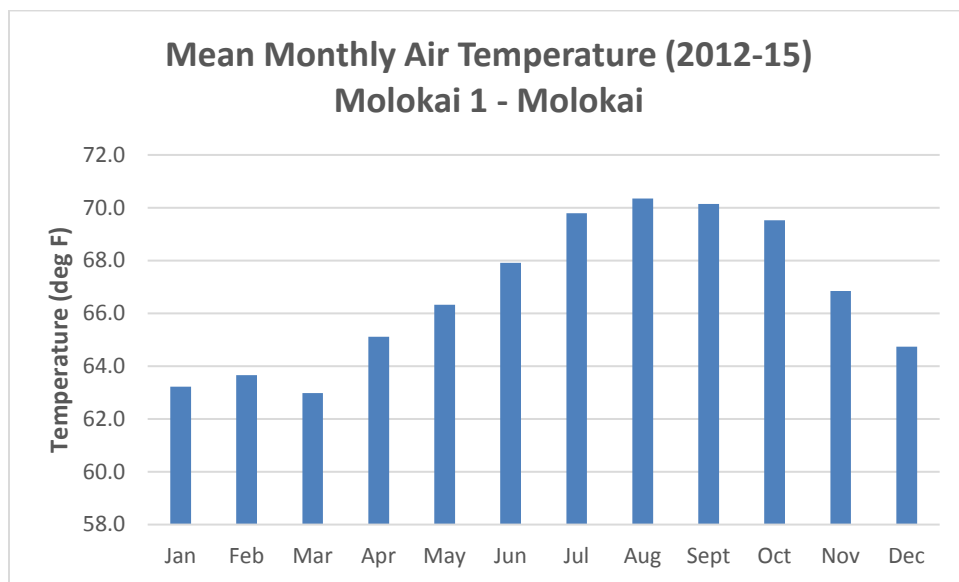
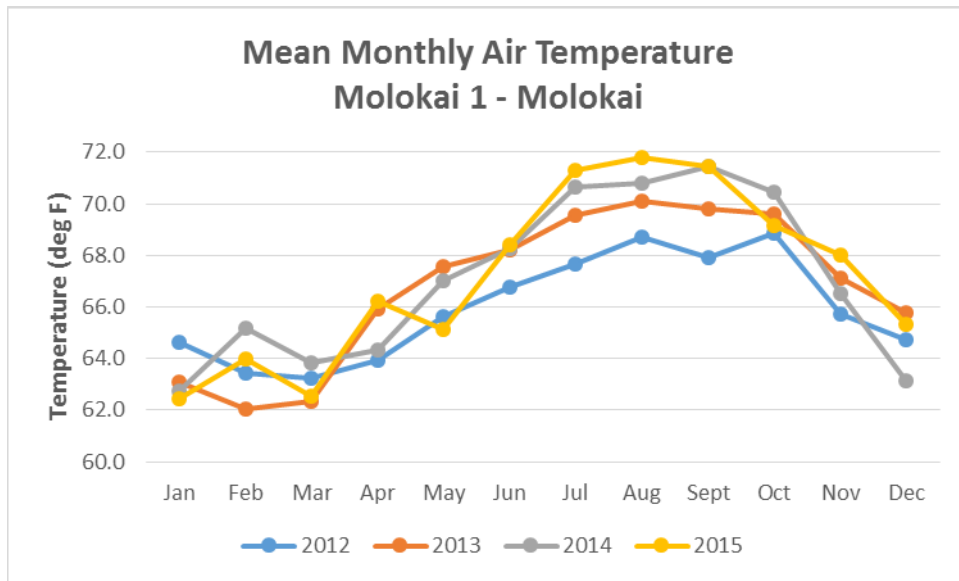
Jan-14	12913	4.54	50.89	43	62.75	81	51	88.56	100	58	14.35
Feb-14	11663	3.41	63.24	34	65.19	80	54	90.34	100	47	7.33
Mar-14	18142	4.86	46.47	45	63.81	79	52	87.97	100	41	9.98
Apr-14	20388	6.13	41.84	45	64.34	76	55	84.11	100	50	4.34
May-14	17125	3.15	41.36	30	67.01	81	59	88.1	100	48	4.85
Jun-14	22222	4.34	56	33	68.28	81	59	79.82	100	48	0.86
Jul-14	24067	4.60	70.6	57	70.64	84	61	78.95	100	48	1.24
Aug-14	23162	4.59	58.02	57	70.81	85	61	77.99	100	46	0.65
Sep-14	17395	3.09	59.18	36	71.47	89	61	80.83	100	36	1.77
Oct-14	16525	4.16	66.86	46	70.45	86	62	82.85	100	49	4
Nov-14	14950	4.42	48.02	39	66.54	82	57	85.92	100	50	2.94
Dec-14	13544	4.31	33.23	47	63.12	78	52	88.41	100	51	11.31
Annual	212096	4.30	52.98	42.67	67.03	81.83	57.00	84.49	100.00	47.67	63.62

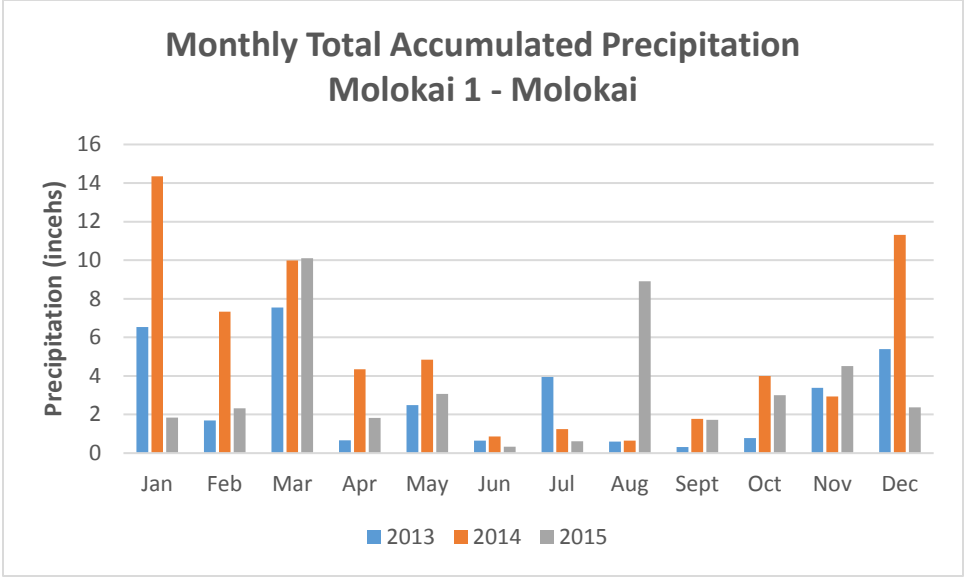
Jan-15	14617	3.24	50.27	36	62.43	80	51	89.01	100	25	1.84
Feb-15	12972	3.36	67.55	34	63.99	80	52	89.37	100	27	2.32
Mar-15	19162	5.05	39.37	35	62.55	79	50	87.06	100	57	10.1
Apr-15	19629	4.80	52.39	38	66.24	81	59	78.4	100	47	1.82
May-15	17110	4.63	52.05	31	65.14	78	56	77.92	98	48	3.07
Jun-15	15913	2.93	62.24	24	68.39	84	61	77.59	98	47	0.34
Jul-15	16030	2.63	65.44	24	71.3	83	62	76.92	98	38	0.62
Aug-15	13214	2.70	84.46	30	71.81	85	65	82.24	99	56	8.91
Sep-15	13671	3.40	66.85	39	71.45	82	64	81.05	98	57	1.72
Oct-15	11632	3.14	50.96	29	69.17	84	61	81.8	97	43	3.01
Nov-15	9115	3.91	76.27	36	68	83	62	79.78	98	47	4.52
Dec-15	9718	3.51	60.44	41	65.35	77	60	78.77	97	50	2.37
Annual	172783	3.61	60.69	33.08	67.15	81.33	58.58	81.66	98.58	45.17	40.64

Wind Rose Climatology



Mean Monthly Air Temperature and Annual Precipitation





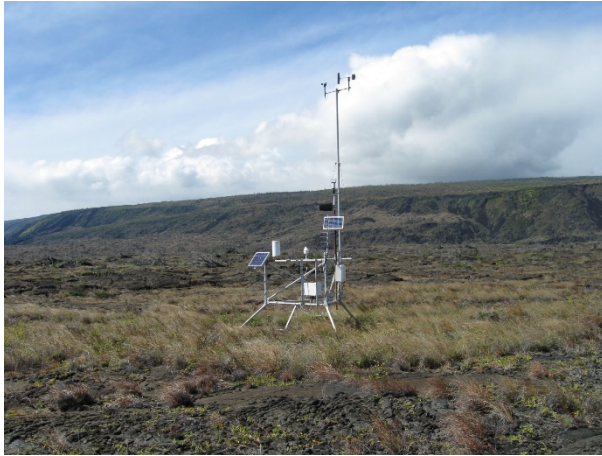
Hawaii Volcanoes NP – Kealakomo (NPS RAWS)

Latitude: 19.292

Longitude: - 155.107

Elevation: 97 feet

Period of Record: 2/14/08 – present



General Description: The Kealakomo site is located approximately 0.25 miles from the Puna coastline at 97 feet in elevation in Hawaii Volcanoes NP. The station is part of the RAWS fire weather network and has a record dating back to 2008. Winds at the site are generally light to moderate and predominantly out of the northeast. The maximum wind gust recorded during 2012-15 was 67 mph in April 2012. The mean air temperature for the period was 77.2°F and average relative humidity at 64%. The maximum temperature recorded during 2012-15 was 89°F in September 2014 and the lowest was 64°F in February 2012 and in January 2014/15. Annual precipitation during 2012-15 ranged from 37-58”.



2012 – 2015 Summarized Data

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Average Relative Humidity			Precipitation
Date	ly	mph	Deg	mph	Deg F			%			in
mm/yyyy	Total	Ave.	Vector Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Jan-12	11622	9.397	53.22	39	74.65	84	66	71.12	98	37	8.86
Feb-12	11809	11.2	49.8	39	73.71	83	64	70.99	96	36	6.34
Mar-12	11913	12.85	47.54	43	73.58	83	66	70.1	98	37	7.24
Apr-12	12470	12.89	50.23	67	74.06	84	67	69.42	94	32	2.41
May-12	14051	16.28	43.93	40	75.86	88	67	61.99	92	35	0.77
Jun-12	15937	14.86	47.72	56	76.75	92	69	59.88	88	13	1.03
Jul-12	16178	14.71	42.53	36	77.71	89	69	58.43	86	35	0.66
Aug-12	17285	13.75	42.44	41	78.42	90	69	58.56	85	32	1.86
Sep-12	15856	12.44	38.63	43	77.82	89	69	58.34	83	37	0.6
Oct-12	13972	10.17	47.8	40	77.68	88	68	62.25	85	34	0.88
Nov-12	12611	11.95	37.33	47	76.4	88	68	58.58	85	32	2.55
Dec-12	11108	10.89	45.76	35	74.56	85	67	65.11	83	40	3.96
Annual	164812	12.62	45.58	43.83	75.93	86.92	67.42	63.73	89.42	33.33	37.16

Jan-13	13451	10.57	34.7	50	74.16	85	65	61.49	81	36	3.56
Feb-13	13795	16.41	34.16	47	73.13	84	65	57.78	81	33	4.24
Mar-13	15140	8.945	42.51	42	73.87	84	65	62.34	80	31	5.5
Apr-13	16813	8.434	59.15	32	75.71	85	65	62.81	80	39	3.46
May-13	16831	8.824	56.84	33	77.14	86	68	63.52	80	33	3.37
Jun-13	16936	14.52	45.84	38	78.01	89	70	57.77	81	36	0.6
Jul-13	16519	12.76	45.36	41	79.1	96	71	59.16	81	30	1.28
Aug-13	19016	13.22	49.65	36	79.97	95	72	58.39	82	35	0.71
Sep-13	17524	12.74	38.69	37	80.19	92	69	55.27	81	30	1.38
Oct-13	12697	8.906	44.88	32	78.63	88	69	62.83	81	42	5
Nov-13	10592	9.496	36.68	39	77.48	89	68	60.79	81	32	1.92
Dec-13	11061	8.511	39.43	48	75.47	86	66	63.94	82	38	6.99
Annual	180375	11.11	43.99	39.58	76.91	88.25	67.75	60.51	80.92	34.58	38.01

Jan-14	12492	8.906	12.65	59	74.55	87	64	61.43	81	29	6.62
Feb-14	11844	5.563	51.52	40	75.88	86	67	66.55	80	42	4.82
Mar-14	15889	11.55	24.19	64	76.1	89	66	60.2	80	32	5.61
Apr-14	16161	14.31	37.43	52	76.38	87	68	58.4	81	33	2.67
May-14	17165	8.059	54.69	34	77.52	87	68	62.15	81	34	3.19
Jun-14	17886	12.58	43.62	35	78.23	88	69	61.42	94	34	2.89
Jul-14	17514	12.73	48.69	38	79.75	92	71	70.27	100	40	4.19
Aug-14	16801	13.4	44.65	64	80.28	94	69	68.75	100	32	8.52
Sep-14	10232	10.33	52.93	36	81.39	95	72	67.27	97	30	1.64
Oct-14	714.8	12.54	40.17	40	80.48	91	73	67.95	98	36	9.01
Nov-14	10575	12.66	31.03	48	77.49	87	69	71.23	97	40	7.28
Dec-14	10992	12.18	39.42	44	75.66	88	67	66.07	94	36	1.2
Annual	158266	11.23	40.08	46.17	77.81	89.25	68.58	65.14	90.25	34.83	57.64

Jan-15	12268	8.624	48.69	46	75.34	84	64	65.34	94	38	1.19
Feb-15	12548	9.552	44.43	47	76.57	86	68	68.15	96	36	1.68
Mar-15	12718	13.38	34.75	53	75.23	89	67	63.57	94	32	1.61
Apr-15	14008	13.92	49.23	38	76.23	86	68	66.86	92	35	2.34
May-15	12909	12.9	42.7	39	76.32	86	69	64.58	91	36	1.56
Jun-15	14642	13.88	50.14	44	79.72	90	72	61.64	92	37	0.66
Jul-15	15492	13.43	49.33	42	81.73	95	73	63.43	93	34	4.43
Aug-15	12764	11.94	45.62	41	82.02	94	72	68.01	92	35	10.98
Sep-15	6995	11.93	41.78	36	81.43	92	44	66.4	91	43	11.68
Oct-15	7877	12.58	39.4	46	81.67	92	72	65.29	95	39	6.19
Nov-15	4416	13.02	39.67	37	78.38	88	71	73.28	97	41	11.87
Dec-15	9097	13.89	41.19	38	76.68	88	69	68.65	95	38	4.72
Annual	135734	12.42	43.91	42.25	78.44	89.17	67.42	66.27	93.50	37.00	58.91

Wind Rose Climatology

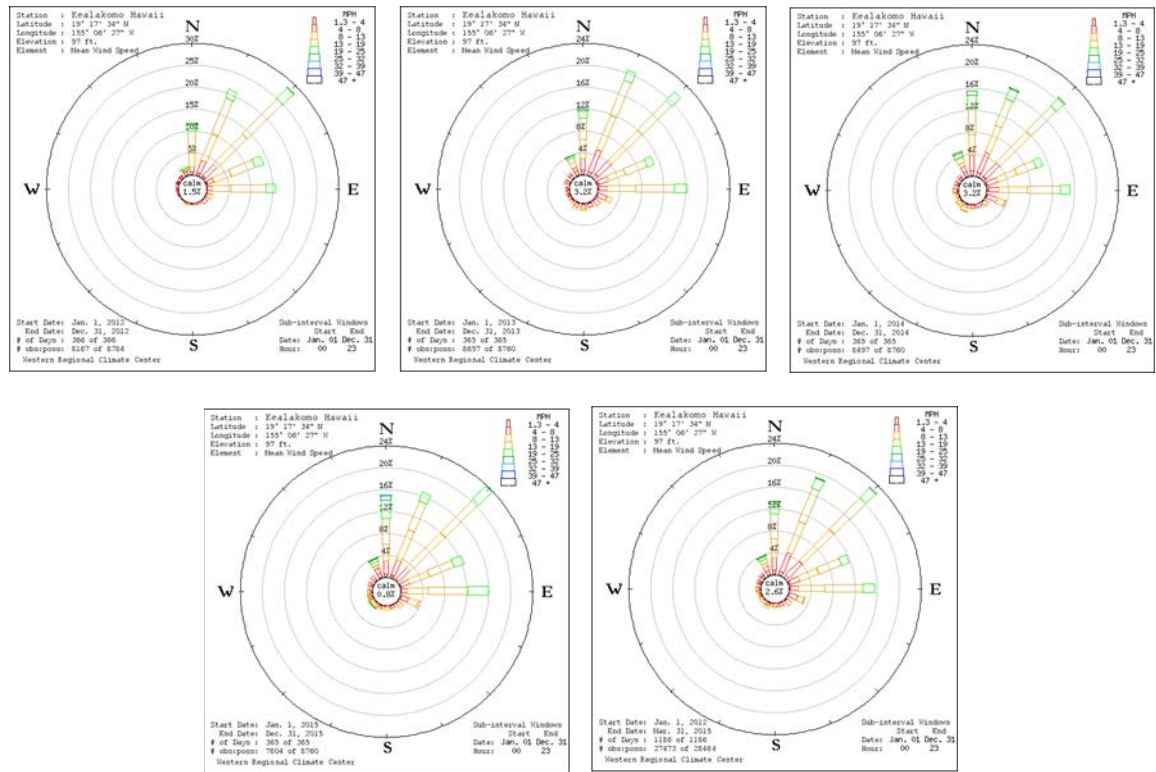
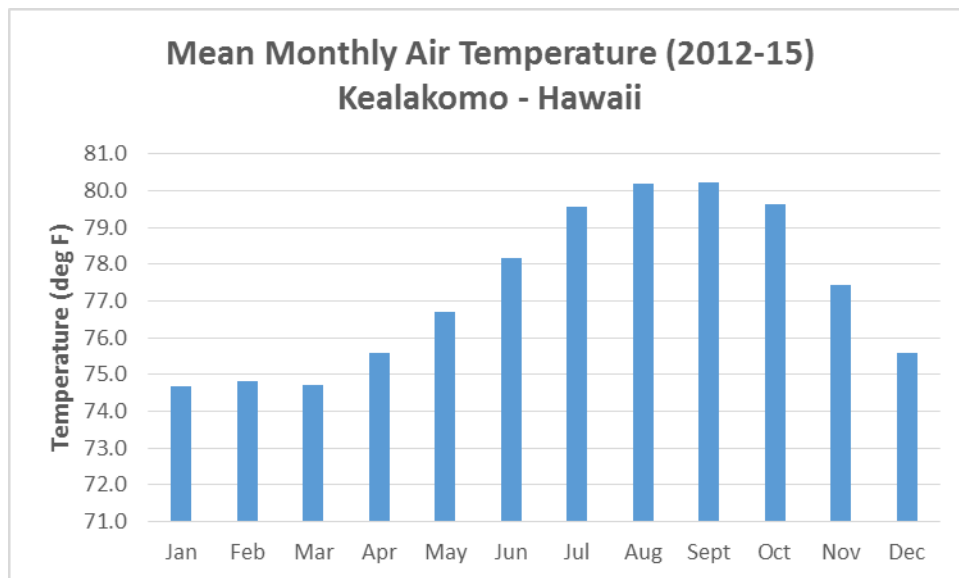
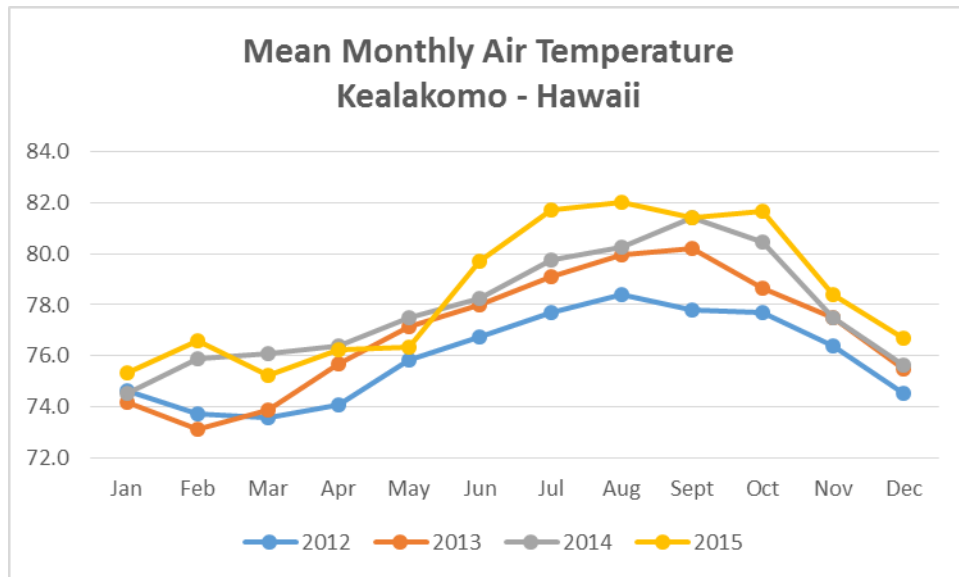
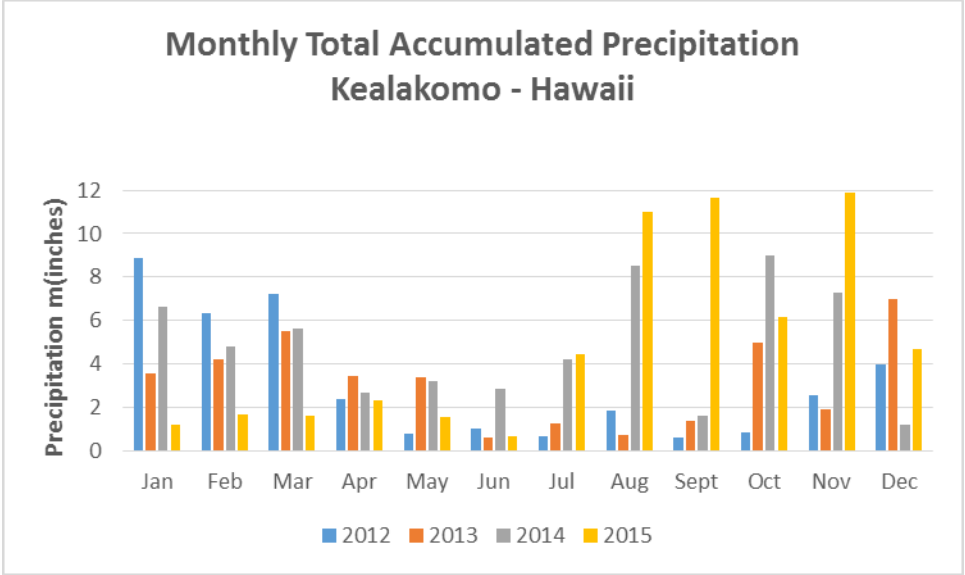


Figure 9 - Kealakomo wind rose climatology for 2012, 2013, 2014, 2015, and 2012-15.

Mean Monthly Air Temperature and Annual Precipitation





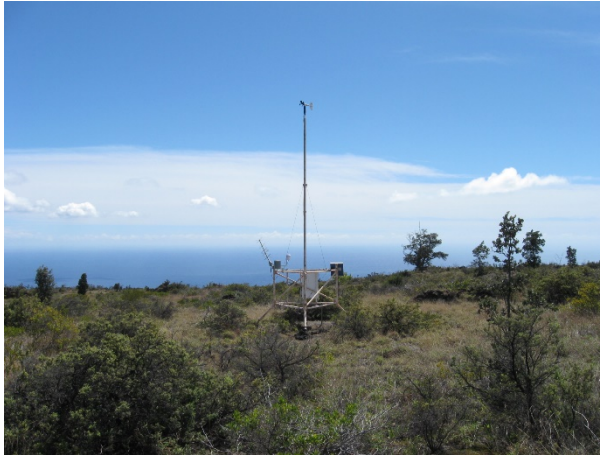
Hawaii Volcanoes NP – Pali 2 (NPS RAWS)

Latitude: 19.317

Longitude: - 155.292

Elevation: 2780 feet

Period of Record: 6/15/99 – present



General Description: The Pali 2 site is located in the Kau Desert region of Hawaii Volcanoes NP at 2780 feet. The station is part of the RAWS fire weather network and has a record dating back to 1999. Winds at the site are generally light to moderate and predominantly out of the northeast. The maximum wind gust recorded during 2012-15 was 66 mph in August 2014. The mean air temperature for the period was 66.2°F and average relative humidity at 76%. The maximum temperature recorded during 2012-15 was 87°F in July/August of 2014 and the lowest was 49°F in August 2012. The highest monthly precipitation total observed was 15.05" during August 2014 and the lowest 0.09" in July 2012. Annual precipitation during 2012-15



2012 – 2015 Summarized Data

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Average Relative Humidity			Precipitati on
Date	ly	mph	Deg	mph	Deg F			%			in
mm/yyyy	Total	Ave.	Vector Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Jan-12	8475	8.076	38.22	39	63.09	77	53	82.92	100	36	7.8
Feb-12	10898	9.862	35.9	36	61.93	76	53	81.5	100	39	5.85
Mar-12	13019	12.57	31.73	47	62.66	76	53	77.92	100	31	5.55
Apr-12	15130	12.66	34.88	44	63.39	77	56	76.73	100	37	0.37
May-12	17252	14.33	25.54	42	65.28	81	53	70.14	99	31	0.16
Jun-12	17466	14.22	27.32	45	67.07	84	58	71.45	100	5	0.58
Jul-12	17478	14.38	26.65	41	67.73	83	58	69.7	99	34	0.09
Aug-12	16458	13.1	25.48	49	68.01	82	59	71.39	96	33	0.55
Sep-12	14121	12.36	28.38	36	66.79	82	59	72.55	100	40	0.97
Oct-12	11616	9.719	41.87	37	66.98	85	58	77.56	100	15	0.5
Nov-12	10521	11.55	25.7	44	64.92	81	54	72.54	100	36	0.65
Dec-12	9853	11.11	36.01	41	63.61	75	55	79.6	100	40	3.96
Annual	162287	11.99	31.47	41.75	65.12	79.92	55.75	75.33	99.50	31.42	27.03

Jan-13	9975	9.838	28.6	44	62.5	77	51	79.44	100	20	8.86
Feb-13	13504	16.17	16.75	43	62.35	80	53	70.03	96	10	2.13
Mar-13	10221	8.419	48.06	52	62.11	79	53	83.61	100	30	2.32
Apr-13	11546	7.712	58.5	32	63.79	77	53	84.38	100	45	2.34
May-13	12072	8.059	49.31	39	65.65	82	57	84.66	100	46	3.51
Jun-13	16888	14.09	23.26	40	67.61	82	56	71.66	96	36	0.13
Jul-13	13649	11.03	26.98	51	68.01	83	60	76.77	100	37	1.79
Aug-13	16127	11.9	27.88	35	69	82	60	72.62	98	33	1.92
Sep-13	14260	12.41	28.14	36	68.96	84	58	68.61	98	24	0.37
Oct-13	9646	8.038	42.17	32	67.39	80	61	80.4	98	36	4.26
Nov-13	8288	8.708	38.99	39	65.75	80	59	79.94	98	33	3.1
Dec-13	8249	8.797	31.47	41	64.36	77	55	80.43	96	43	3.87
Annual	144425	10.43	35.01	40.33	65.62	80.25	56.33	77.71	98.33	32.75	34.60

Jan-14	8056	7.571	34.15	41	62.35	75	52	81.75	97	31	3.98
Feb-14	7393	5.494	62.8	25	63.97	74	56	87.03	98	53	3.96
Mar-14	12107	9.672	30.31	40	64.94	79	55	76.88	97	31	4.79
Apr-14	14832	14.6	22.59	49	65.43	79	56	71.7	94	40	2.07
May-14	11521	8.588	54.98	33	65.59	79	58	78.79	95	39	1.77
Jun-14	14367	12.6	30.23	44	67.26	81	58	72.47	100	33	1.08
Jul-14	15636	12.44	35.21	39	70.18	86	60	75.19	100	31	6.88
Aug-14	14665	11.8	33.58	66	71.67	139	62	73.13	100	30	15.05
Sep-14	10463	8.98	52.03	33	69.97	85	61	64.41	100	32	1.99
Oct-14	11332	11.09	38.59	45	70.05	84	62	21.01	96	31	10.58
Nov-14	9173	11.04	38.13	41	66.78	78	58	83.19	100	44	5.25
Dec-14	10118	10.48	35.05	45	64.29	79	53	78.96	100	43	3.35
Annual	139663	10.36	38.97	41.75	66.87	84.83	57.58	72.04	98.08	36.50	60.75

Jan-15	10140	7.112	56.46	54	63.15	77	53	81.59	100	44	0.94
Feb-15	9427	7.684	77.25	44	64.62	78	52	82.84	100	17	2.79
Mar-15	11254	10.38	36.66	35	63.84	82	51	76.54	97	41	1.91
Apr-15	14073	12.96	38.13	42	65.58	78	58	74.53	97	40	1.11
May-15	13346	11.1	36.42	38	65.38	79	57	77.9	100	35	2.77
Jun-15	12620	11.1	38.27	36	68.64	83	59	76.07	100	45	1.01
Jul-15	14238	11	40.61	37	71.06	87	62	76.84	100	37	1.48
Aug-15	11171	9.008	47.13	42	71.42	87	64	83.49	100	41	12.47
Sep-15	11677	10	38.75	39	70.73	84	63	83.32	100	48	9.66
Oct-15	11545	9.571	36.65	40	70.65	85	61	78.38	99	41	5.18
Nov-15	10513	12.34	35.58	44	67.61	82	61	81.11	100	27	6.56
Dec-15	11157	13.38	31.29	44	65.64	79	57	77.43	100	33	3.47
Annual	141161	10.47	42.77	41.25	67.36	81.75	58.17	79.17	99.42	37.42	49.35

Wind Rose Climatology

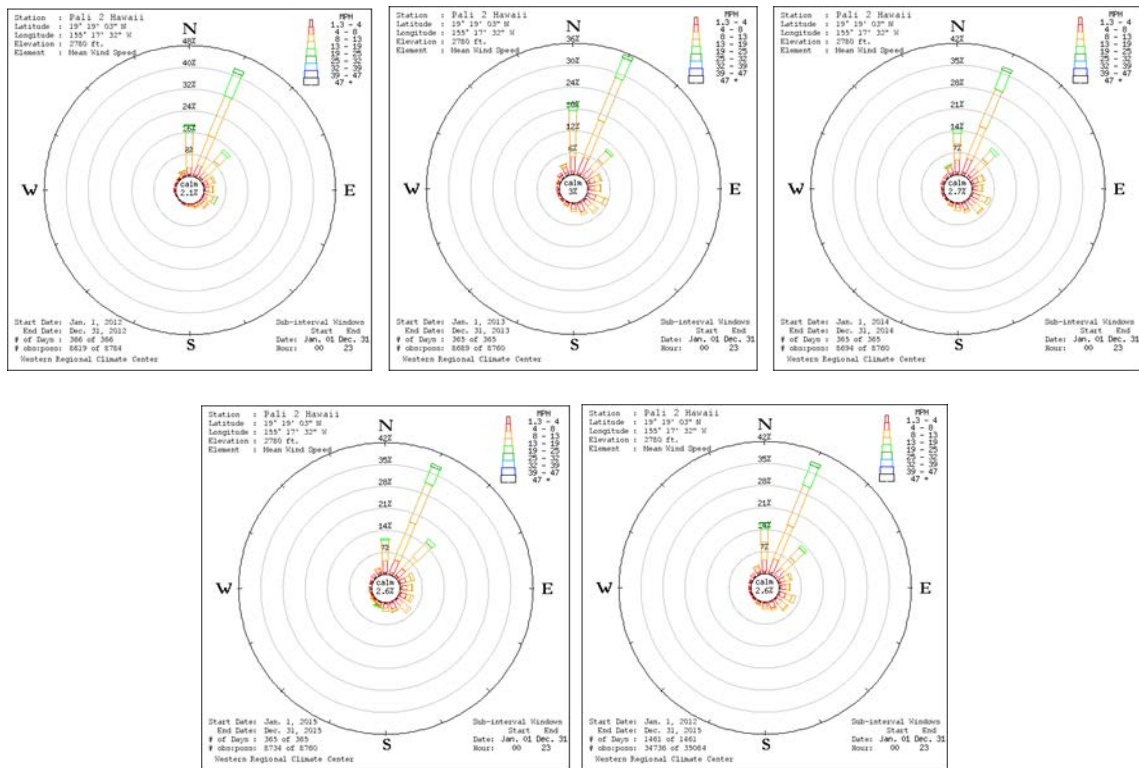
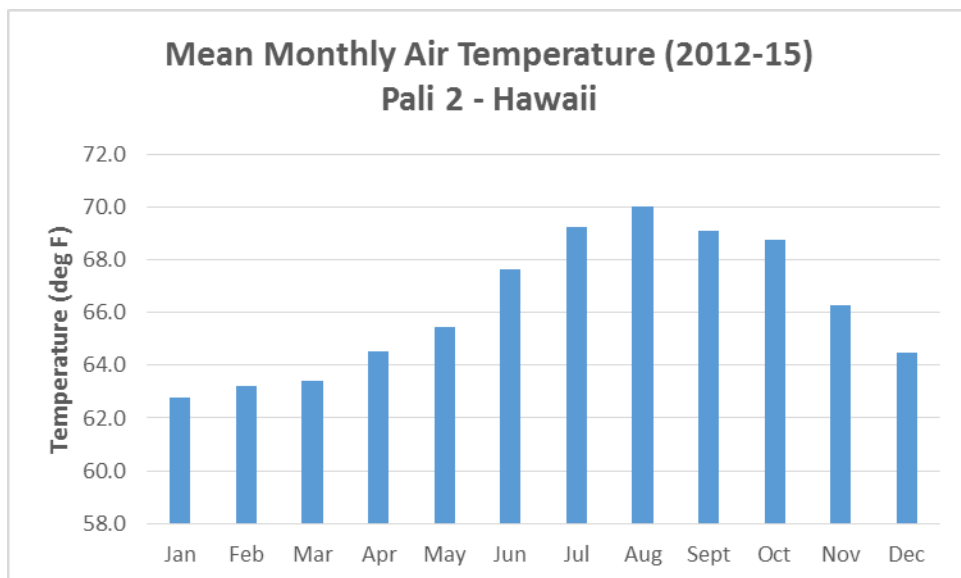
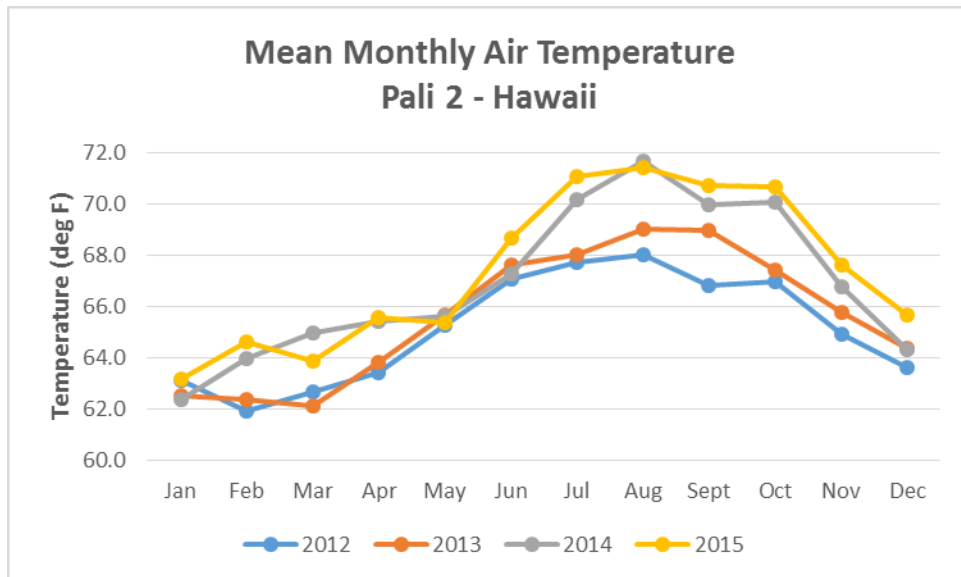
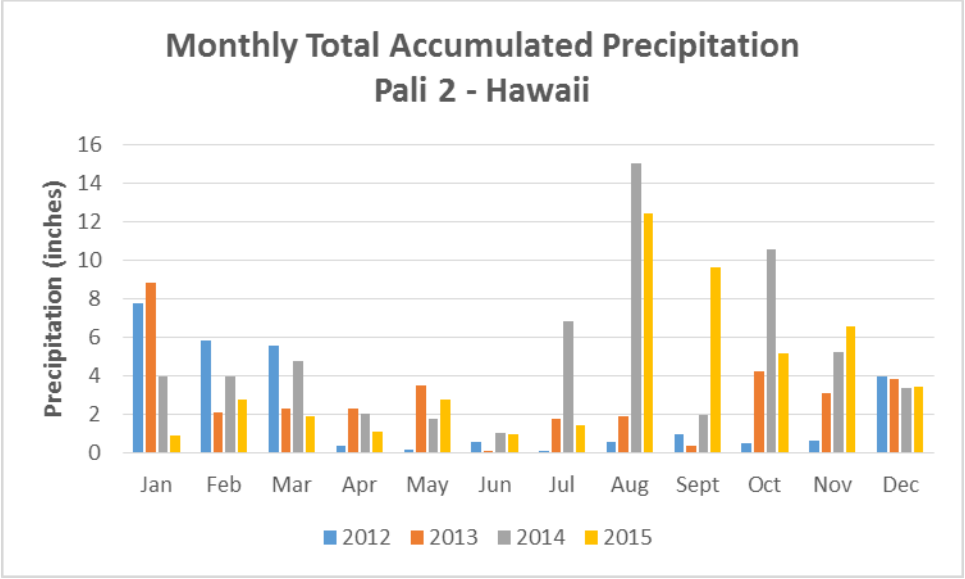


Figure 10 - Pali 2 wind rose climatology for 2012, 2013, 2014, 2015, and 2012-15.

Mean Monthly Air Temperature and Annual Precipitation





Pu'uhonua o Hōnaunau NHP – PUHO CS (NPS PACN)

Latitude: 19.421

Longitude: - 155.907

Elevation: 97 feet

Period of Record: 2/18/12 – present



General Description: The PUHO CS site is located on the west-central coast of the island of Hawaii at 97 feet in elevation. The site is situated at a maintenance facility ~0.25 miles from the coast. Winds at the site are predominantly out of the northeast. During 2012-15, the maximum wind gust recorded was 38 mph in May 2014. Mean air temperature for the period was 76.4°F and relative humidity at 66%. The maximum temperature recorded was 93°F in September 2015 and the lowest was 62°F in January 2015. The maximum monthly precipitation was 15.53" in September 2015 and the minimum 0.07" in December 2012. Annual precipitation ranged from 16-35" during 2012-15.



2012 – 2015 Summarized Data

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Average Relative Humidity			Precipitati on
Date	ly	mph	Deg	mph	Deg F			%			in
mm/yyyy	Total	Ave.	Vector Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Feb-12	5516	3.54	48.19	22.55	73.96	81.5	65.86	64.6	87.8	40.94	0.13
Mar-12	13244	3.50	74.11	20.74	73.82	82.3	65.54	64.3	90.5	43.51	0.24
Apr-12	12232	3.48	37.67	16.6	74.04	82	65.72	69.11	93.6	44.98	2.11
May-12	13221	3.39	70.77	15.32	74.85	83.5	65.13	68.77	94.1	48.75	1.77
Jun-12	12692	3.39	70.78	14.72	76.24	83.7	68.37	69.43	93.5	49.32	0.6
Jul-12	12958	3.46	66.31	15.48	77.19	85.3	69.53	67.28	92.7	46.06	0.47
Aug-12	12343	3.59	67.27	16.98	77.34	85	69.56	69.44	95	46.76	1.84
Sep-12	11222	3.32	73.24	13.38	76.58	84.7	69.08	68.77	97	46.99	1.17
Oct-12	12513	3.46	58.69	16.13	77.63	84.7	69.66	67.87	99.9	45.38	0.61
Nov-12	9616	3.40	79.07	14.94	75.41	83.1	65.64	64.71	92.3	40.54	0.34
Dec-12	10936	3.45	68.45	18.52	74.61	81.9	65.95	62.2	92.4	33.03	0.07
Annual	126493	3.45	64.96	16.85	75.61	83.43	67.28	66.95	93.53	44.21	9.35

Station deployed 2/18/12.

Jan-13	11804	3.54	60.07	24.11	73.59	82.1	63.85	63.1	98.9	36.44	0.58
Feb-13	11481	3.50	95.91	14.81	73.5	80.9	65.45	61.49	92.1	43.43	0.23
Mar-13	12909	3.71	66.98	25.75	73.42	81.8	64.15	63.82	95	31.08	1.23
Apr-13	15156	3.54	6.9	24	75.43	86	63.09	62.15	86	38.55	0.1
May-13	14081	3.06	60.94	14	76.22	84	68	69.21	96	43	2.84
Jun-13	12268	2.91	53.93	17	76.56	84	69	68.94	95	48	1.52
Jul-13	12922	2.88	46.74	19	77.61	86	70	69.13	94	50	0.51
Aug-13	14053	3.49	22.46	20.36	79	86.4	69.65	65.58	93.1	45.04	1
Sep-13	12962	3.59	92.02	13.8	78.32	86.5	70.11	65.47	96.1	45.01	2.73
Oct-13	13003	3.35	74.29	17.56	77.82	86.1	69.56	69.58	100	48.71	3.93
Nov-13	10178	3.36	77.22	20.29	76.49	84.4	68.29	67.27	100	40.84	0.74
Dec-13	10890	3.54	76.55	19.28	75.27	83.4	66.05	65.56	98.6	40.74	0.98
Annual	151707	3.37	61.17	19.16	76.10	84.30	67.27	65.94	95.40	42.57	16.39

Jan-14	11491	3.72	88.62	24.81	73.01	82.6	63.24	63.26	100	28.07	2.23
Feb-14	11253	3.56	47.4	24.32	75.31	83.6	65.87	67.14	100	40.99	0.11
Mar-14	14025	3.59	111.4	25.55	75.31	83.7	63.75	64.97	100	32.37	2.69
Apr-14	14093	3.58	118	15.23	76.44	84	67.62	62.42	91.3	40.41	0.08
May-14	11718	3.29	43.67	38.14	75.91	84.9	68.16	74	100	48.85	4.28
Jun-14	13231	3.50	79.14	18.5	76.85	85.7	68.16	70.64	100	48.68	1.68
Jul-14	14674	3.41	71.14	16.49	78.84	87.6	69.37	70.64	100	47.8	1.82
Aug-14	14142	3.40	92.52	16.87	78.8	87.7	70.4	72	100	47.47	2.01
Sep-14	12821	3.39	61.77	17.02	79.56	88.1	70.23	69.83	100	47.2	2.17
Oct-14	12575	3.12	72.79	15	78.81	88	70.48	68.73	100	42	1.87
Nov-14	11271	3.47	84.47	16.89	77.73	87.7	68.91	64.63	100	35.03	0.18
Dec-14	10831	3.64	60.85	19.91	74.58	83.7	63.93	61.75	100	40.22	0.98
Annual	152125	3.47	77.65	20.73	76.76	85.61	67.51	67.50	99.28	41.59	20.10

Jan-15	11545	3.50	68.85	23.22	73.7	83.6	62.02	60.26	100	34.36	0.56
Feb-15	12516	3.18	48.73	19	74.87	85	64	61.44	100	33	0.98
Mar-15	11077	2.74	81.75	16	73.84	84	64	64.37	100	35	1.11
Apr-15	13405	2.95	82.57	17	75.72	85	67	66.75	100	37	4.25
May-15	13776	2.83	90.21	15	75.33	84	64	66.34	98	45	2.66
Jun-15	12772	2.87	79.84	14	77.56	86	68	69.38	100	49	3.85
Jul-15	13714	2.60	86.61	13	79.66	88	71	70.07	100	48	1.75
Aug-15	13564	2.64	89.46	14	80.55	90	72	72.12	100	51	4.5
Sep-15	14358	2.83	92.2	15	80.35	93	71	71.15	100	47	13.53
Oct-15	13815	2.73	96.67	16	80.22	92	68	68.59	100	44	0.98
Nov-15	10953	2.71	72.19	13	78.07	89	69	66.43	100	39	1.32
Dec-15	11363	2.92	68.41	16	75.93	86	67	60.47	100	33	0.14
Annual	152858	2.88	79.79	15.94	77.15	87.13	67.25	66.45	99.83	41.28	35.63

Wind Rose Climatology

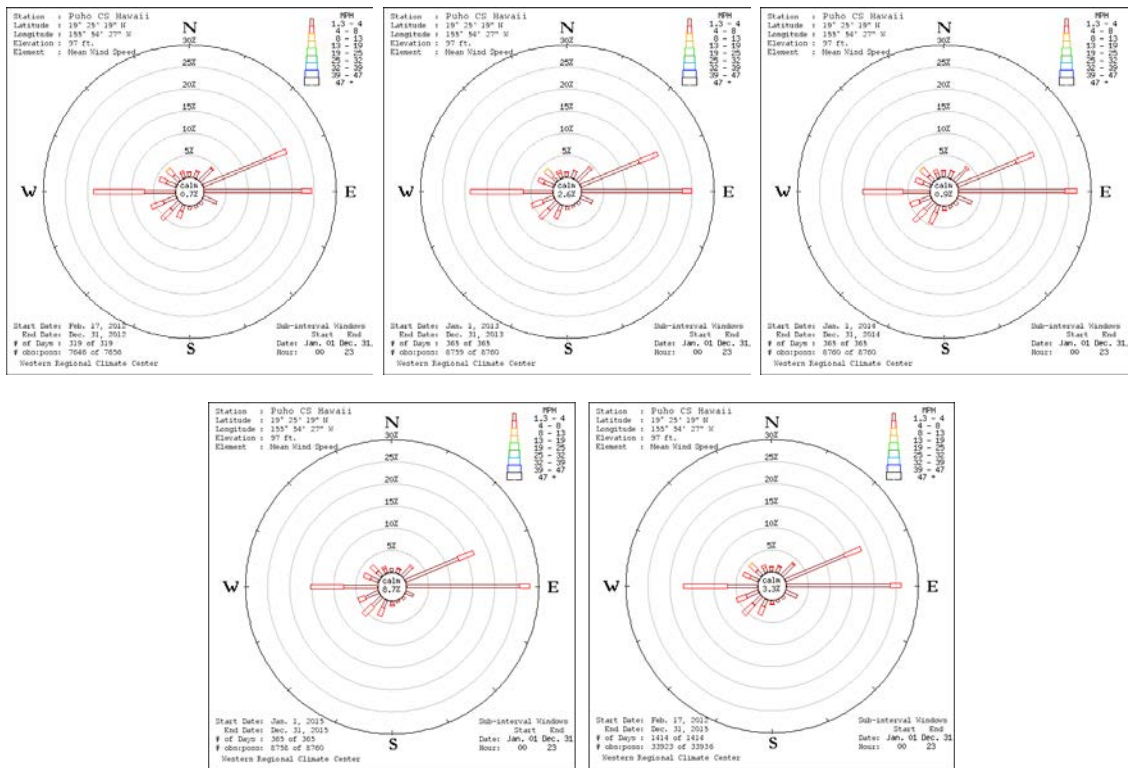
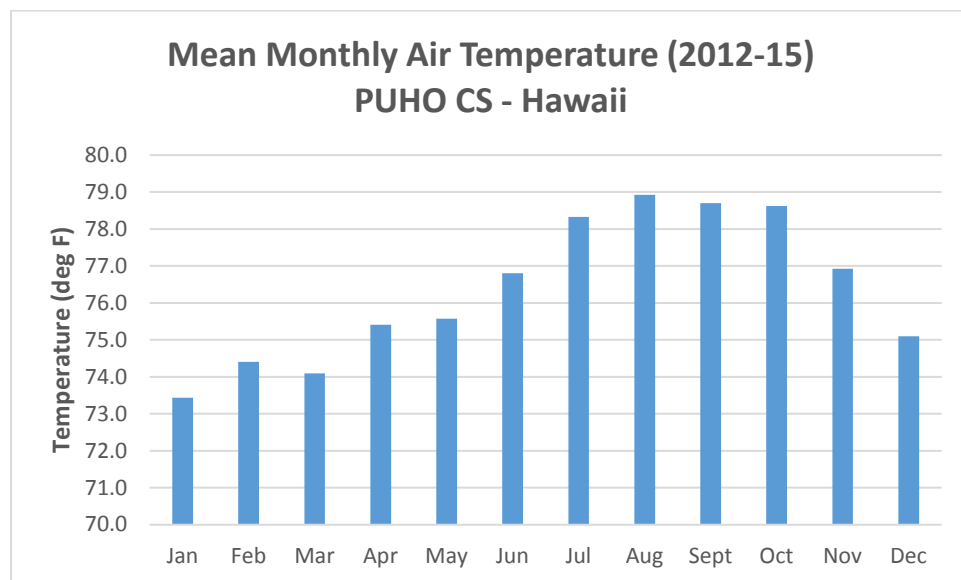
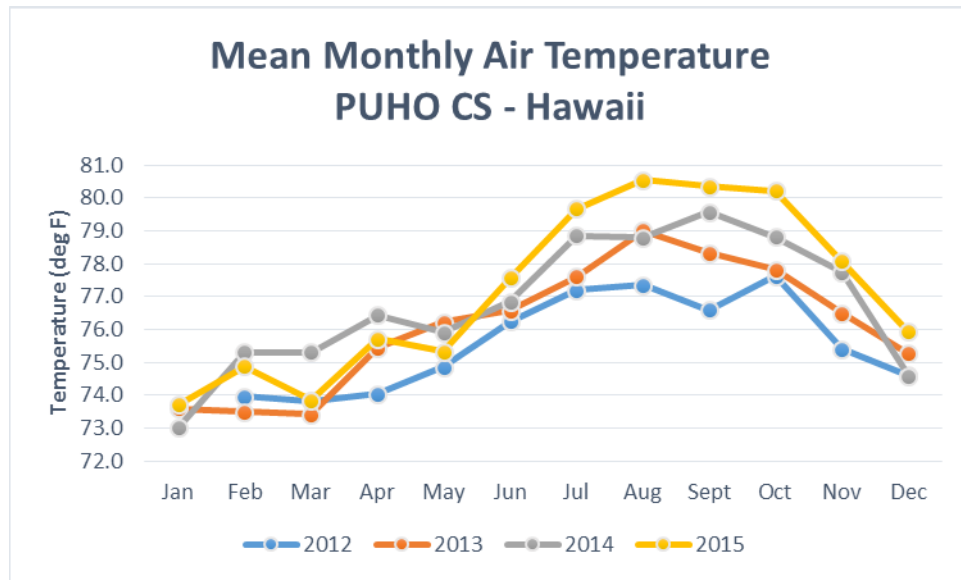
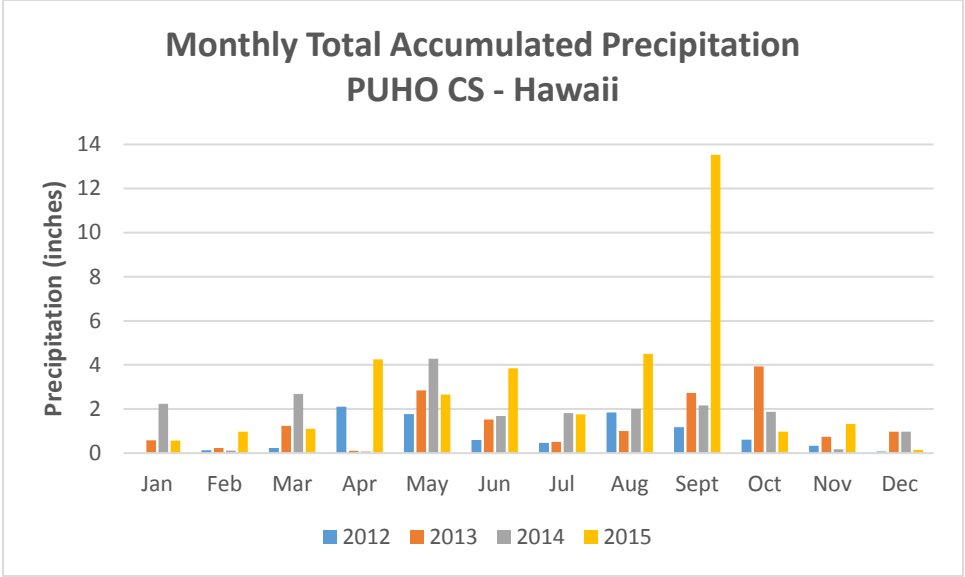


Figure 11 - PUHO wind rose climatology for 2012, 2013, 2014, 2015, and 2012-15.

Mean Monthly Air Temperature and Annual Precipitation





Pu'ukoholā Heiau NHP – PUHE CS (NPS PACN)

Latitude: - 20.023

Longitude: - 155.821

Elevation: 47 feet

Period of Record: 2/18/12 – present



General Description: The PUHE CS site is located on the northwestern coast of the island of Hawaii at 47 feet in elevation ~0.10 miles from the coast. The predominant wind direction fluctuates between day and night where on-shore/off-shore flow patterns dominate. The maximum wind gust recorded was 56 mph in December 2012. For the period of record, the mean annual air temperature was 78.1°F. The maximum temperature observed was 94°F and the minimum was 60°F and average relative humidity at 60%. The site is situated in a desert environment and annual precipitation is light. The precipitation record from the station is incomplete, however, records from the Pu'ukoholā Heiau 98.1 NWS COOP site show that area averages ~10" of precipitation annually.



2012 – 2015 Summarized Data

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Average Relative Humidity			Precipitati on
Date	ly	mph	Deg	mph	Deg F			%			in
mm/yyyy	Total	Ave.	Vector Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Feb-12	6004	5.75	163	41	74.77	83	67	58.62	77	31	0
Mar-12	15814	5.50	286.4	32	74.52	82	66	59.09	85	31	0.16
Apr-12	17882	6.50	211.8	42	75.29	84	67	58.75	84	29	0.23
May-12	19472	7.68	126	44	76.46	88	67	56.29	80	26	0.43
Jun-12	18301	6.50	276.5	45	77.65	86	71	59.23	84	20	0.03
Jul-12	19224	6.41	271.7	41	78.5	87	71	58.61	82	25	0
Aug-12	18832	5.99	294	42	78.95	90	70	59.75	87	20	0.69
Sep-12	16857	5.92	310	42	78.3	88	72	58.88	84	25	0.01
Oct-12	15300	5.12	243.7	39	78.36	86	70	60.93	84	28	0.03
Nov-12	12617	5.79	80.8	40	76.72	85	66	56.46	83	24	0
Dec-12	11521	6.99	101.3	56	75.31	86	66	58.42	88	23	0.39
Annual	171824	6.19	215.02	42.18	76.80	85.91	68.45	58.64	83.45	25.64	1.97

Station deployed 2/18/12.

Jan-13	13050	5.36	350.5	46	73.9	84	64	59.75	95	17	0.19
Feb-13	14415	9.29	79.4	53	74.64	85	65	52.89	75	23	0
Mar-13	15283	5.20	308.7	39	73.81	83	66	60.37	89	26	0.66
Apr-13	9949	4.56	259.8	31	75.12	81	65	61.61	87	40	0.05
May-13											
Jun-13											
Jul-13											
Aug-13											
Sep-13											
Oct-13											
Nov-13											
Dec-13											
Annual											

Station vandalized in April 2013. Out of commission until the new station was deployed in January 2015.

Jan-14											
Feb-14											
Mar-14											
Apr-14											
May-14											
Jun-14											
Jul-14											
Aug-14											
Sep-14											
Oct-14											
Nov-14											
Dec-14											
Annual											

Jan-15	2019	3.32	131.4	14	75.82	83	68	66.14	83	46	0
Feb-15	13480	4.18	244.3	32	75.56	87	65	67.05	97	35	0.32
Mar-15	14753	3.92	58.43	32	75.09	88	60	63.26	95	32	0.02
Apr-15	17731	5.31	262.7	47	78.71	89	70	59.38	82	32	0
May-15	18050	4.95	218.3	42	78.79	89	69	57.48	87	32	0
Jun-15	17777	3.61	265.3	32	80.24	89	71	64.14	90	38	0
Jul-15	18416	3.57	270.3	34	82.05	90	74	66.42	91	44	0
Aug-15	17196	3.76	278.6	37	83.27	94	74	68.78	95	31	0.03
Sep-15	16670	3.94	263.1	37	83.75	92	76	64.39	91	28	0
Oct-15	15219	3.58	55.18	37	82.14	92	71	61.85	92	31	0
Nov-15	11965	6.31	91.45	48	80.77	91	72	58.81	90	28	0
Dec-15	12215	7.01	94.11	47	77.94	88	70	54.79	73	27	0
Annual	175491	4.45	186.10	36.58	79.51	89.33	70.00	62.71	88.83	33.67	0.37

Precipitation data from the station has been flagged and was not utilized in graphical representations of annual data.

Wind Rose Climatology

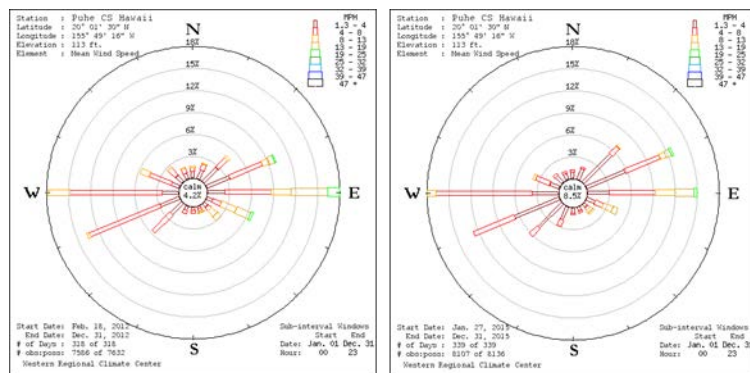
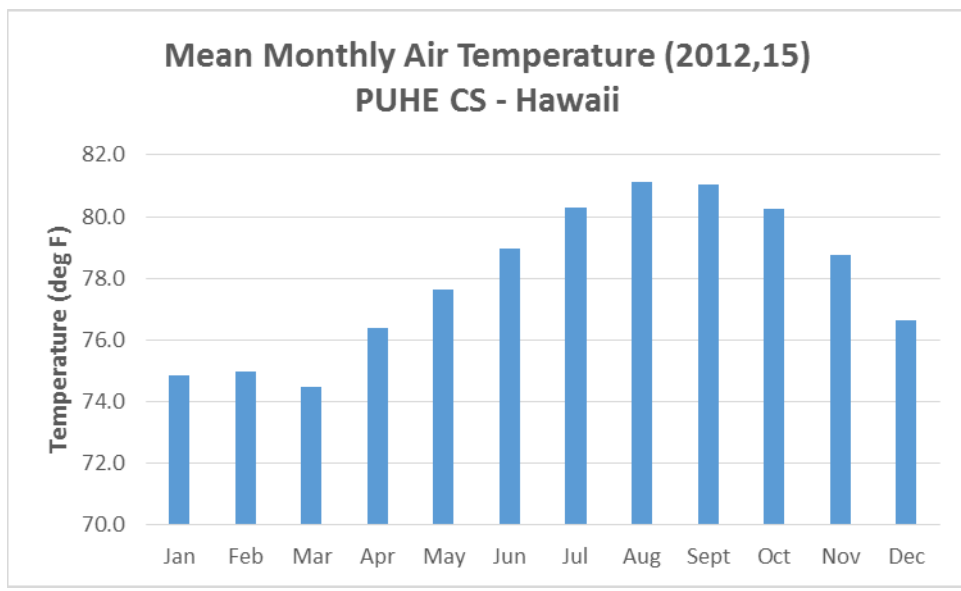
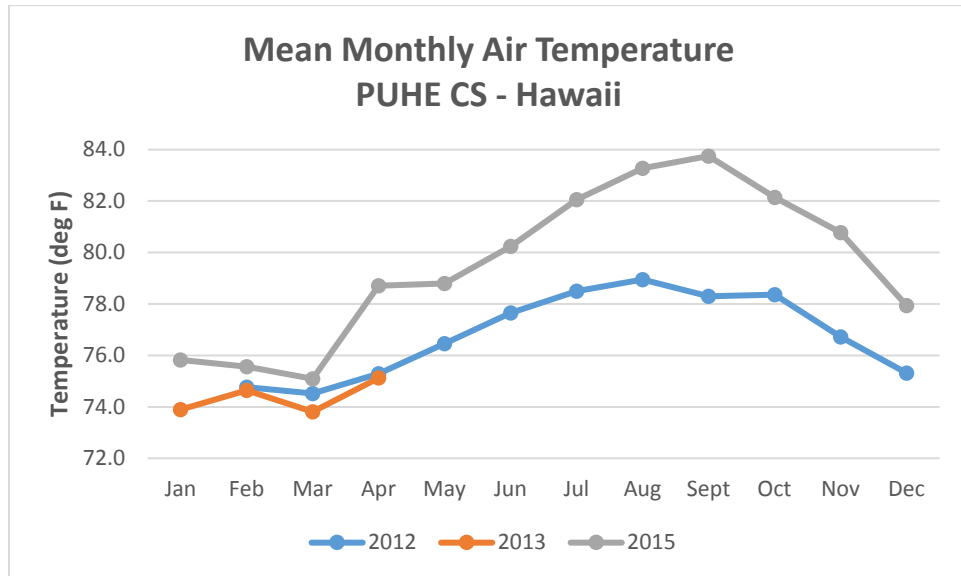


Figure 12 - PUHE CS wind rose climatology for 2012 and 2015.

Mean Monthly Air Temperature



Hawaii Volcanoes NP – Lower Kahuku (NPS PACN)

Latitude: - 19.100

Longitude: - 155.669

Elevation: 3129 feet

Period of Record: 2/23/12 – present



General Description: The Lower Kahuku site is located in the Kahuku District on the southwestern flank of Mauna Loa at an elevation of 3129 feet. Wind speeds at the site are generally low because of its protected, forested location. Winds are predominantly downslope and out of the north. The maximum recorded wind gust was 68 mph in August 2012. Mean annual air temperature for the period of record was 62.1°F and average relative humidity hovered around 80%. The maximum temperature observed was 82°F and the minimum was 40°F. The maximum monthly precipitation total for the period was 7.98" in September 2015 and the lowest 1.12" in November 2012. Annual precipitation at the site ranged from 34-47" during 2012-15.



2012 – 2015 Summarized Data

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Average Relative Humidity			Precipitati on
Date	ly	mph	Deg	mph	Deg F			%			in
mm/yyyy	Total	Ave.	Vector Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Feb-12	1870	4.36	24.8	28.57	58.66	67.03	42.18	89.48	97	66.69	2.76
Mar-12	9751	4.05	25.7	28.92	58.55	70.56	44.47	88.2	100	47.26	3.78
Apr-12	9051	3.72	27.68	29.48	58.96	69.7	49.87	88.77	100	55.79	3.29
May-12	9643	3.74	31.4	26.24	60.24	70.75	50.01	85.29	100	52.49	3.19
Jun-12	8810	3.34	28.63	22.46	61.3	72.15	51.24	88.05	100	34.11	4.47
Jul-12	8560	3.17	26.89	23	61.48	73	52	86.88	100	50	2.23
Aug-12	10524	2.88	27.74	68	62.27	74	53	79.98	100	49	4.07
Sep-12	8765	2.87	24.47	23	61.77	73	53	81.28	100	58	2.93
Oct-12	9868	2.74	32.66	20	62.84	76	50	79.34	100	54	2.75
Nov-12	8632	2.85	26.25	21	60.72	75	48	78.17	100	39	1.12
Dec-12	8421	3.60	23.37	29	60.36	74	52	80.19	100	48	4.19
Annual	93895	3.39	27.24	29.06	60.65	72.29	49.62	84.15	99.73	50.39	34.78

Station deployed 2/23/12.

Jan-13	10372	3.22	18.43	33	59.09	73	45	78.38	100	45	3.24
Feb-13	10096	3.53	25.28	27	57.82	71	40	76.64	100	33	1.07
Mar-13	11128	2.71	26.79	22	58.78	70	42	78.59	100	33	2.19
Apr-13	12562	2.99	33.8	24	60.66	73	41	79.69	100	49	2.24
May-13	10499	2.77	29.42	24	62.05	75	51	82.16	100	49	4.79
Jun-13	9452	2.97	29.58	22	62.13	74	51	90.37	100	50	3.44
Jul-13	10224	2.73	27.8	23	63.7	77	55	90.27	99	52	3.54
Aug-13	11098	2.89	26.64	22	64.45	79	53	87.35	100	34	2.71
Sep-13	10651	3.00	26.22	30	64.12	75	55	84.41	98	46	1.93
Oct-13	10565	2.70	23.79	21	64.49	76	55	87.41	98	60	5.4
Nov-13	8099	2.69	25.95	24	63.17	74	53	86.15	98	51	2.02
Dec-13	8017	2.97	18.47	20	61.31	72	49	86.85	98	48	4.94
Annual	122763	2.93	26.01	24.33	61.81	74.08	49.17	84.02	99.25	45.83	37.51

Jan-14	5532	3.00	4.793	150	60.27	73	47	83.78	97	34	3.96
Feb-14											
Mar-14											
Apr-14											
May-14											
Jun-14											
Jul-14											
Aug-14											
Sep-14											
Oct-14	769.2	3.21	31.75	24	66.42	73	61	81.47	97	57	0.05
Nov-14	8018	2.61	18.88	22	63.76	77	51	88.4	100	47	5.25
Dec-14	9337	2.65	22.18	24	61.08	76	46	84.71	99	24	1.59
Annual											

Satellite transmitter damaged by corrosion. Missing data from February – September 2014.

Jan-15	10078	2.70	18.05	36	59.94	74	46	83.86	99	26	1.42
Feb-15	10870	3.06	356.3	32	62.62	79	46	81.78	100	14	1.8
Mar-15	9243	2.57	23.12	22	60.91	74	48	85.04	99	43	1.9
Apr-15	9599	3.17	30.4	24	61.66	72	53	88.37	99	47	3.3
May-15	8246	2.58	34.69	20	61.45	73	52	90.74	100	54	4.79
Jun-15	9986	2.20	28.44	17	64.22	76	54	89.82	100	54	4.03
Jul-15	9681	2.18	30.76	23	66.54	81	56	92.05	100	52	4.19
Aug-15	9946	1.94	30.03	19	68.51	81	57	94.32	100	34	6.52
Sep-15	9328	2.18	24.7	21	67.7	82	57	99.75	100	86	7.98
Oct-15	9499	2.06	22.76	17	67.38	80	56				4.59
Nov-15	6944	3.07	20.65	24	64.43	74	54				4.67
Dec-15	8449	2.97	23.13	25	62.57	73	51				2.63
Annual	111869	2.56	53.59	23.33	63.99	76.58	52.50	89.53	99.67	45.56	47.82

Wind Rose Climatology

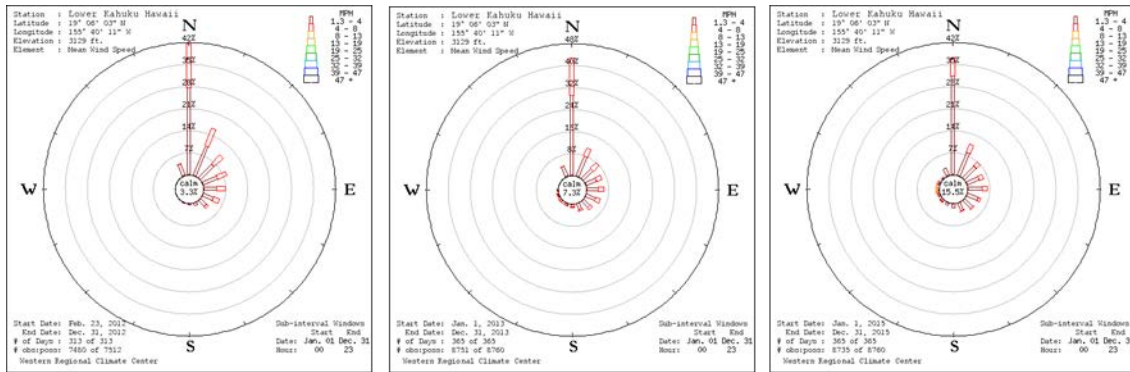
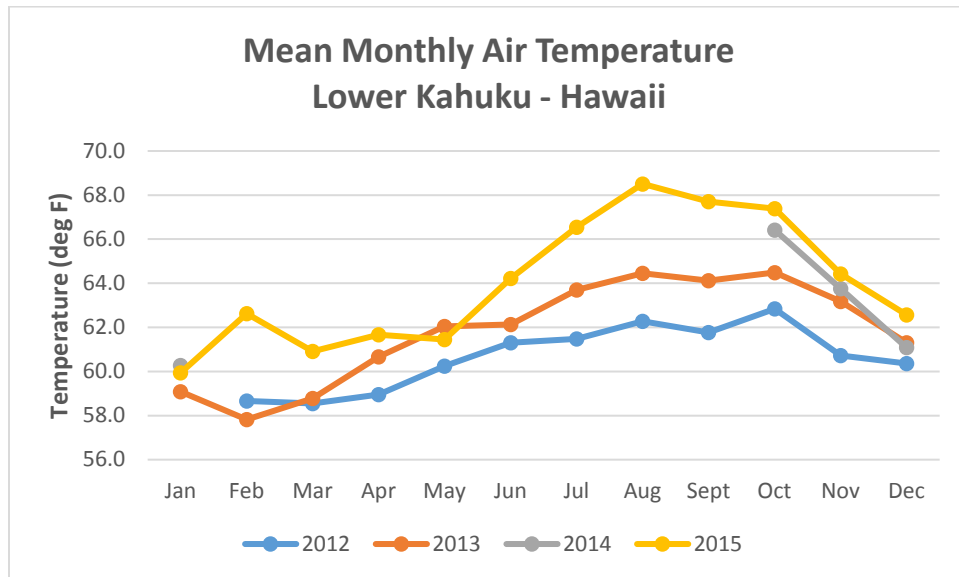
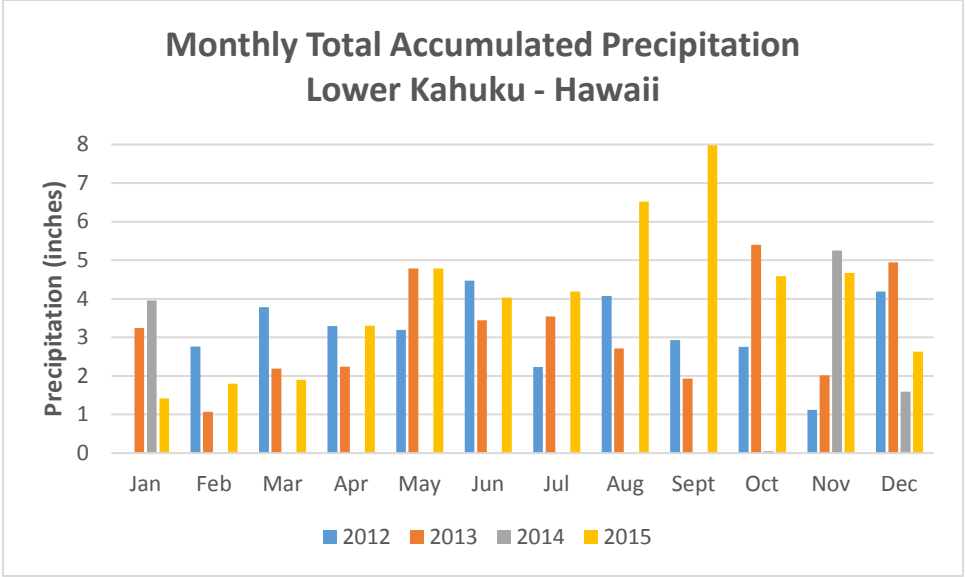


Figure 13 - Lower Kahuku wind rose climatology for 2012, 2013, and 2015.

Mean Monthly Air Temperature and Annual Precipitation





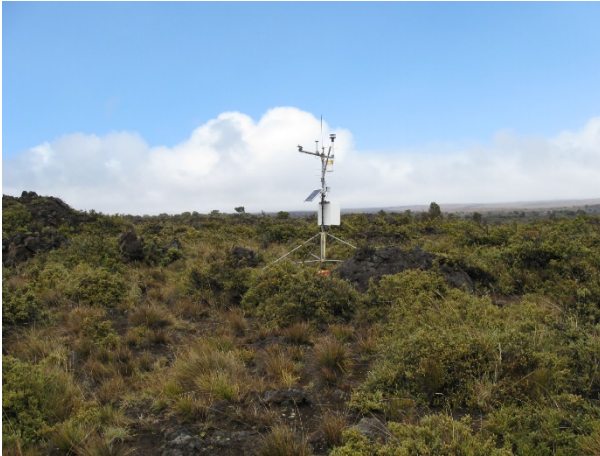
Hawaii Volcanoes NP – Nene Cabin (NPS PACN)

Latitude: - 19.256

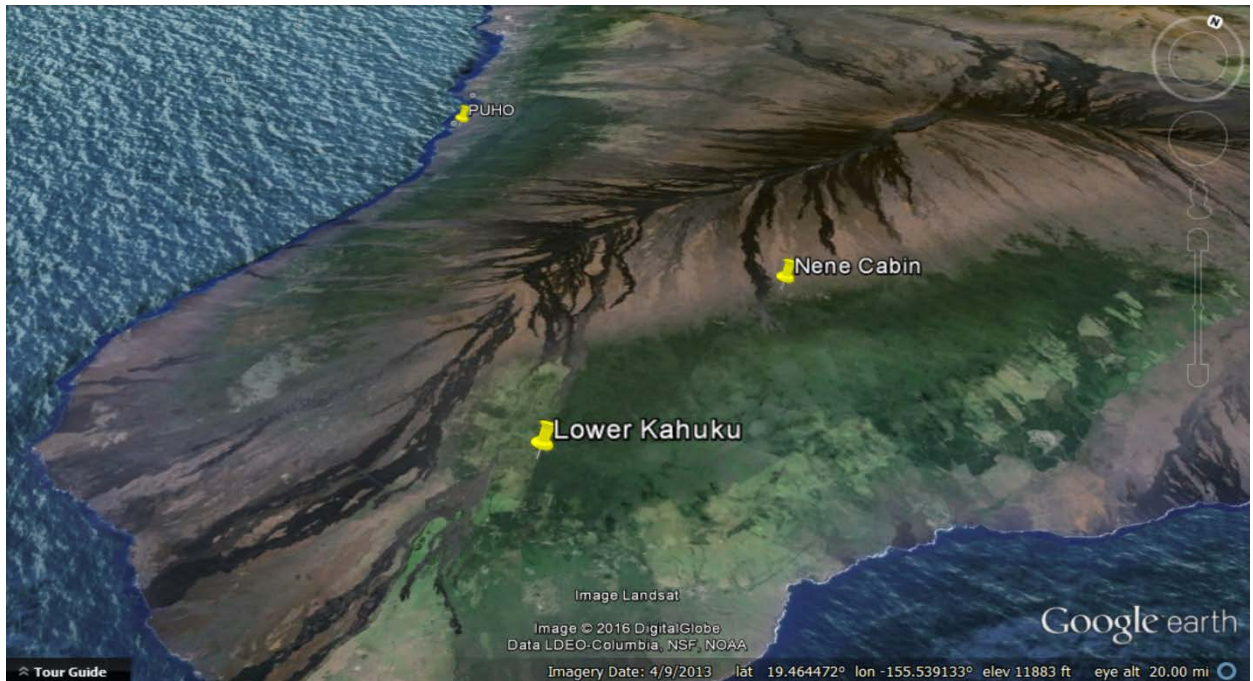
Longitude: - 155.614

Elevation: 6581 feet

Period of Record: 2/23/12 – present



General Description: The Nene Cabin site is located on the southwestern flank of Mauna Loa at 6581 feet in Hawaii Volcanoes NP. Winds at the site are predominantly light and out of the east. The maximum wind gust recorded at the site was 58 mph in January 2015. During the period of record, the mean air temperature was 67°F and average relative humidity around 70%. The highest temperature observed was 72°F in October 2015 and the lowest was 31°F in March 2015. The site has dropped below freezing on 7 calendar days since its deployment in 2012. The maximum monthly precipitation total was 4.53" in October 2015 and a minimum of 0.33" in October 2012. The maximum annual precipitation was 35.4" in 2015.



2012 – 2015 Summarized Data

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Average Relative Humidity			Precipitati on
Date	ly	mph	Deg	mph	Deg F			%			in
mm/yyyy	Total	Ave.	Vector Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Feb-12	2079	8.01	77.03	24.23	47.24	55.35	38.72	93.7	99.6	68.67	2.25
Mar-12	11150	6.99	71.93	31.59	48.37	63.34	33.75	78.88	100	11.33	2.56
Apr-12	12129	6.64	75.56	27.27	48.81	61.05	33.1	81.32	100	11.43	1.81
May-12	7568	7.31	80.03	35.57	49.85	64.51	35.73	80.45	100	15.49	1.63
Jun-12	1560	7.36	77.43	50.69	52.94	70.61	39.67	70.05	100	8.34	1.18
Jul-12	473.8	6.42	76.08	27	51.88	66	36	77.1	100	19	0.96
Aug-12	1863	5.71	76.6	23	52.77	70	37	76.09	100	13	1.23
Sep-12	1594	5.56	73.62	23	50.76	69	36	84.11	100	19	1.05
Oct-12	4788	5.91	71.3	33	54.93	71	42	62.88	100	10	0.33
Nov-12	2493	4.83	59.75	23	50.12	67	35	72.81	100	11	0.55
Dec-12	2637	7.02	70.12	33	50.76	69	34	65.77	100	7	2.21
Annual	48335	6.52	73.59	30.12	50.77	66.08	36.45	76.65	99.96	17.66	15.76

Station deployed 2/23/12.

Jan-13	737	5.94	66.41	36	49.37	65	36	70.73	100	10	1.2
Feb-13	1108	6.71	70.66	35	47.31	66	34	68.37	100	7	1.97
Mar-13	2981	5.44	50.4	28	49.35	66	33	68.12	100	7	0.95
Apr-13	3135	5.57	70.99	26	50.97	71	35	68.49	100	6	0.52
May-13	1960	5.04	80	23	52.1	65	35	81.32	100	25	1.47
Jun-13											
Jul-13											
Aug-13											
Sep-13											
Oct-13											
Nov-13											
Dec-13											
Annual											

Datalogger malfunctioned June 2013 – September 2014.

Jan-14											
Feb-14											
Mar-14											
Apr-14											
May-14											
Jun-14											
Jul-14											
Aug-14											
Sep-14											
Oct-14	131.3	6.49	76.69	26	54.5	67	46	93.08	100	35	0.93
Nov-14	855.1	5.62	57.67	27	58.08	71	46	90.48	100	6	2
Dec-14	7571	5.95	51.59	36				93.65	100	48	0.86
Annual											

Jan-15	10590	6.01	32.04	58	52.93	64	39	57.21	100	13	0.98
Feb-15	7549	8.12	359	54	54.71	75	36	46.31	100	2	0.83
Mar-15	8657	5.70	61.05	42	49.45	63	31	66.28	100	9	1.88
Apr-15	8269	6.18	76.49	24	49.76	62	39	73.85	100	21	3.12
May-15	6552	5.84	81.43	29	50.19	65	34	73.79	100	24	3.84
Jun-15	1851	4.89	74.84	20	53.2	69	40	68.73	100	18	1.06
Jul-15	3193	5.36	75.56	22	56.34	71	43	65.43	100	17	1.02
Aug-15	1015	4.93	72.98	23	58.4	70	48	73.89	100	20	7.3
Sep-15	1694	5.05	75.39	27	56.91	69	45	80.74	100	30	7.1
Oct-15	326.1	5.07	71.39	29	56.56	72	42	75.07	100	24	4.53
Nov-15	1672	7.15	72.36	28	53.17	66	43	73.95	100	17	3.43
Dec-15	2216	7.45	72.41	33	51.15	66	36	60.9	100	8	1.3
Annual	42994	5.98	99.35	30.09	53.62	68.00	39.73	68.99	100.00	17.27	35.41

Wind Rose Climatology

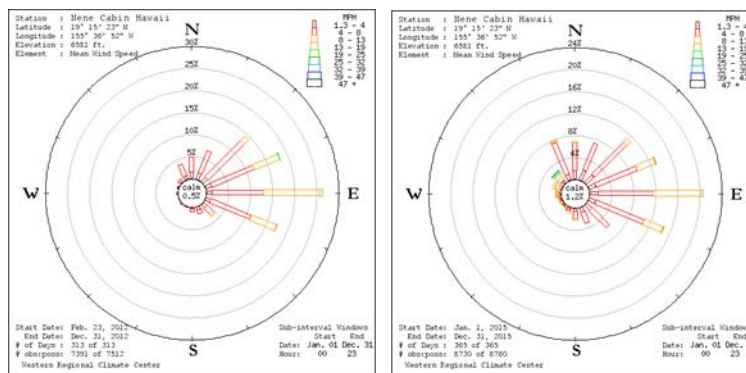
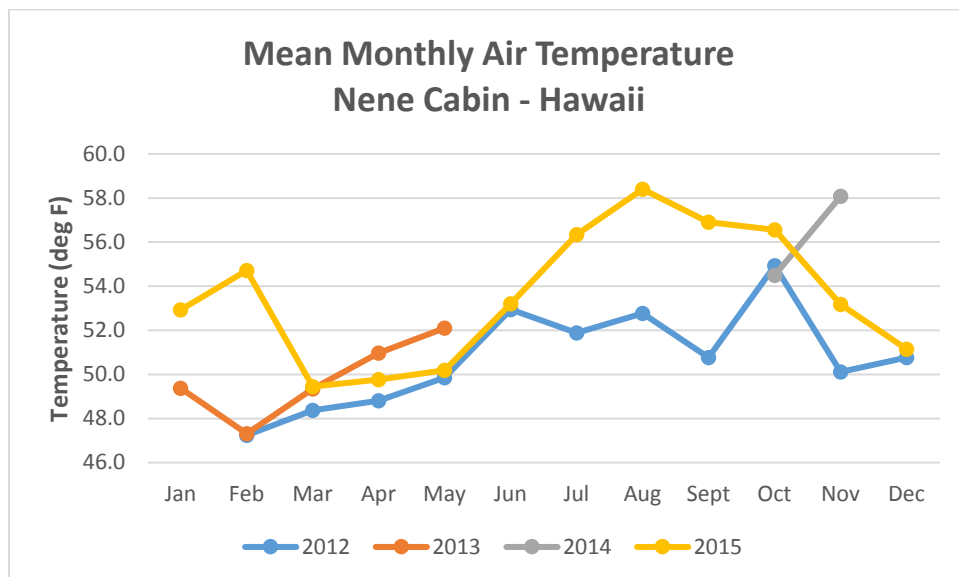
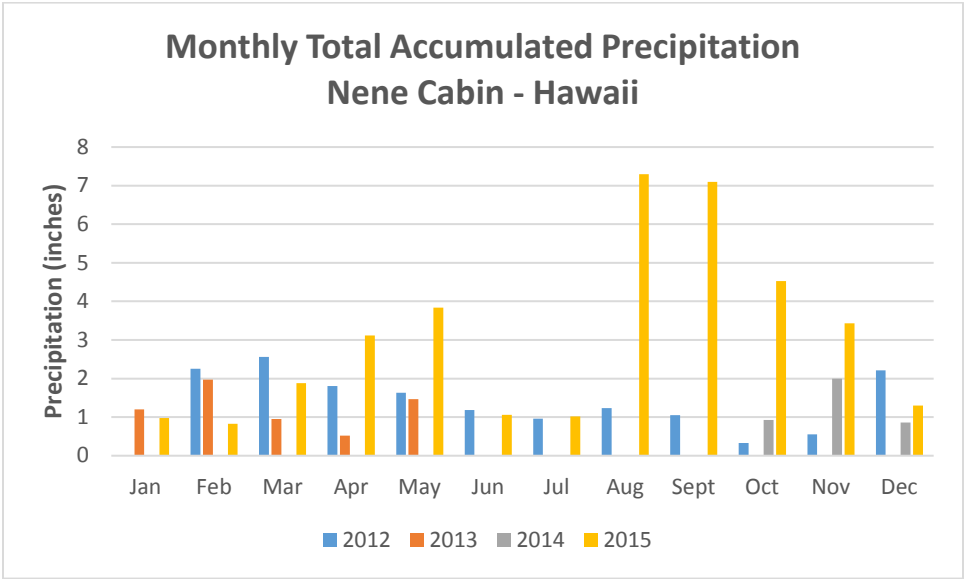


Figure 14 - Nene Cabin wind rose climatology for 2012 and 2015.

Mean Monthly Air Temperature and Annual Precipitation





Kaloko Honokohau NHP (NPS RAWS)

Latitude: - 19.672

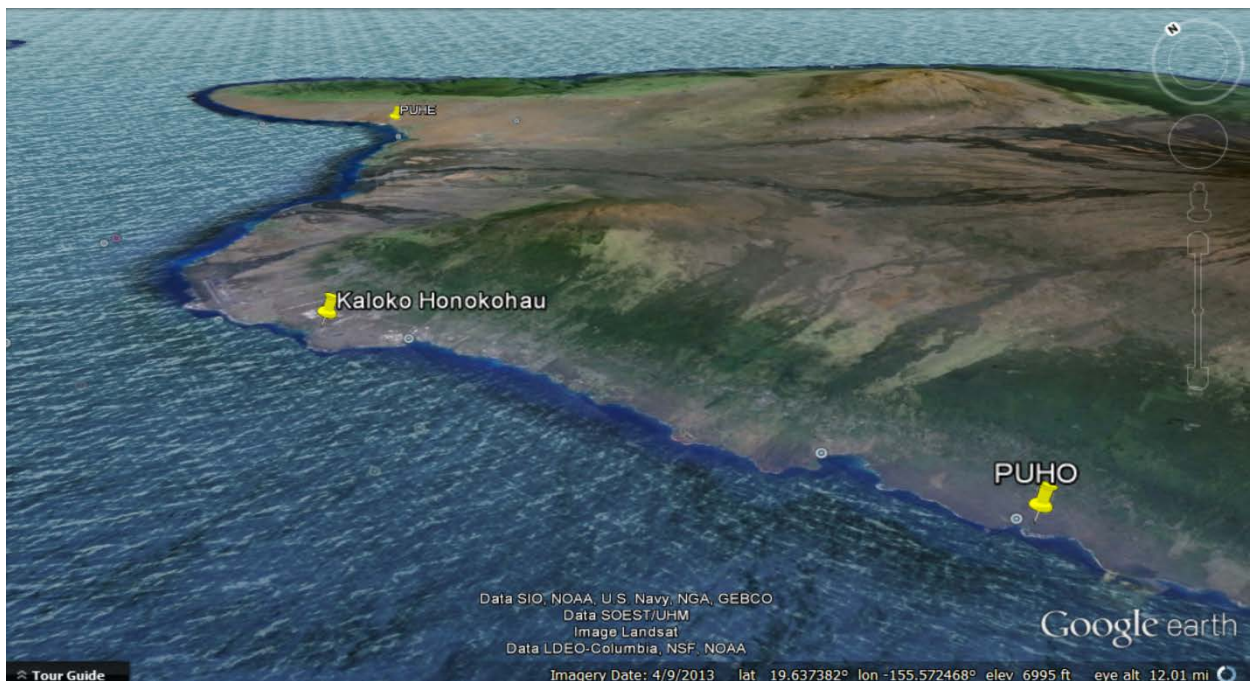
Longitude: - 156.020

Elevation: 25 feet

Period of Record: 3/11/05 – present



General Description: The Kaloko Honokohau site is located on the Kona coast of the island of Hawaii at 25 feet in elevation and is part of the NPS RAWS network. The site is situated approximately 0.4 miles inland from the coast. Winds at the site generally light and blow on-shore during the daytime and off-shore at night. The maximum wind gust recorded during 2012-15 was 34 mph in January 2015. The mean air temperature was 78.1°F and average relative humidity at 67%. The maximum temperature observed was 92° and the minimum was 60°F. The maximum monthly precipitation total for the period was 6.32" in August 2015 and the lowest of 0" in September, October, and December 2012. From 2012-15, annual precipitation



2012 – 2015 Summarized Data

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Average Relative Humidity			Precipitati on
Date	ly	mph	Deg	mph	Deg F			%			in
mm/yyyy	Total	Ave.	Vector Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Jan-12	12999	4.90	75.36	21	74.09	84	63	67.77	97	43	0.31
Feb-12	14051	5.20	150.2	24	74.32	83	61	64.97	99	39	0.37
Mar-12	13472	4.69	156.4	17	75.2	83	65	64.41	95	41	0.09
Apr-12	13857	6.09	216.8	18	76.67	84	66	66.98	93	44	0.08
May-12	12660	6.65	206.7	18	77.97	85	67	67	94	46	2.37
Jun-12	10635	7.04	216	18	81.08	86	75	63.43	90	44	0.15
Jul-12	13717	6.60	217.2	17	81.42	87	74	63.11	80	48	0.01
Aug-12	14863	6.59	214.1	18	81.12	87	73	64.6	91	45	1.63
Sep-12	13331	7.38	221.4	17	82.61	87	77	59.79	72	50	0
Oct-12	12937	8.14	239.9	20	83.91	87	80	59.23	70	43	0
Nov-12	8974	7.35	227.7	23	82.09	87	78	56.3	74	44	0.01
Dec-12	8777	7.21	235.1	24	81	87	77	55.73	73	39	0
Annual	150273	6.48	198.07	19.58	79.29	85.58	71.33	62.78	85.67	43.83	5.02

Jan-13	10941	5.56	296.7	31	74.6	84	61	67.08	97	34	1.87
Feb-13	13636	5.29	127.7	19	73.66	82	61	66.46	87	44	0.31
Mar-13	16212	5.76	96.78	24	74.1	84	61	67.67	94	43	1.15
Apr-13	17866	5.87	285.5	22	76.55	86	64	66.65	92	41	0.6
May-13	17222	5.66	173	18	77.94	86	68	71.58	93	47	2.77
Jun-13	15214	5.41	165.5	17	78.64	87	68	66.63	91	36	0.85
Jul-13	16669	5.62	174.1	29	79.43	87	68	69.04	93	48	0.94
Aug-13	17270	5.78	178.2	21	80.07	88	70	65.16	82	46	0.02
Sep-13	16329	5.60	131.9	19	79.55	88	70	65.39	92	43	2.27
Oct-13	15954	5.12	126.6	18	78.87	90	68	68.79	90	40	0.93
Nov-13	12588	5.33	62.7	32	77.54	87	67	66.72	90	38	1.23
Dec-13	13454	5.47	56.96	27	76.35	88	65	65.64	87	38	0.14
Annual	183355	5.54	156.30	23.08	77.28	86.42	65.92	67.23	90.67	41.50	13.08

Jan-14	13654	5.02	65.77	26	73.55	85	60	67.83	95	29	4.93
Feb-14	13711	5.75	9.23	26	75.84	86	62	72.37	95	44	1.16
Mar-14	16643	5.40	109.7	30	75.74	86	61	70.14	94	42	3.61
Apr-14	16174	5.48	133.3	20	77.05	86	66	65.31	88	41	0.11
May-14	15548	5.69	309.8	20	77.66	87	67	74.28	94	48	3.45
Jun-14	17171	5.59	144.8	19	78.3	87	68	69.54	92	48	2.06
Jul-14	17124	5.49	165.9	19	80.38	90	70	70.11	91	44	0.38
Aug-14	17940	5.76	153.8	32	80.44	90	69	69.8	92	44	1.52
Sep-14	16322	5.66	125.1	19	80.84	89	70	70.14	91	46	1
Oct-14	15119	5.25	92.64	21	80.19	89	71	70.2	92	46	1.48
Nov-14	13481	4.99	89.41	24	77.44	88	67	71.01	93	48	2.31
Dec-14	13071	5.41	43.74	25	74.85	87	60	64.8	92	36	0.98
Annual	185958	5.46	120.27	23.42	77.69	87.50	65.92	69.63	92.42	43.00	22.99

Jan-15	14035	5.39	34.04	34	73.8	85	61	64.91	90	40	0.61
Feb-15	14769	6.20	113.1	25	75.42	86	63	66.85	92	37	1.19
Mar-15	14826	5.13	80.45	29	74.66	86	60	67.5	93	36	1.07
Apr-15	16674	5.72	140	21	77.58	86	67	65.33	89	43	0.39
May-15	16946	5.70	128.2	22	77.49	88	67	63.6	87	37	0.32
Jun-15	17116	5.43	167.9	17	79.37	88	70	69.14	89	46	2.13
Jul-15	17909	5.49	173	20	81.84	90	72	67.81	87	50	0.19
Aug-15	17487	5.30	142.1	27	82.41	92	73	72.79	93	46	6.32
Sep-15	16950	5.40	113.4	20	82.09	92	72	71.82	90	50	2.72
Oct-15	16013	1.63	102.8	29	81.65	92	71	68.17	95	37	1.27
Nov-15	11943	2.32	119.7	16	79.21	89	68	69.13	91	45	1.53
Dec-15	13180	1.69	107.4	15	76.45	87	66	65.54	88	40	0.5
Annual	187848	4.62	118.51	22.92	78.50	88.42	67.50	67.72	90.33	42.25	18.24

Wind Rose Climatology

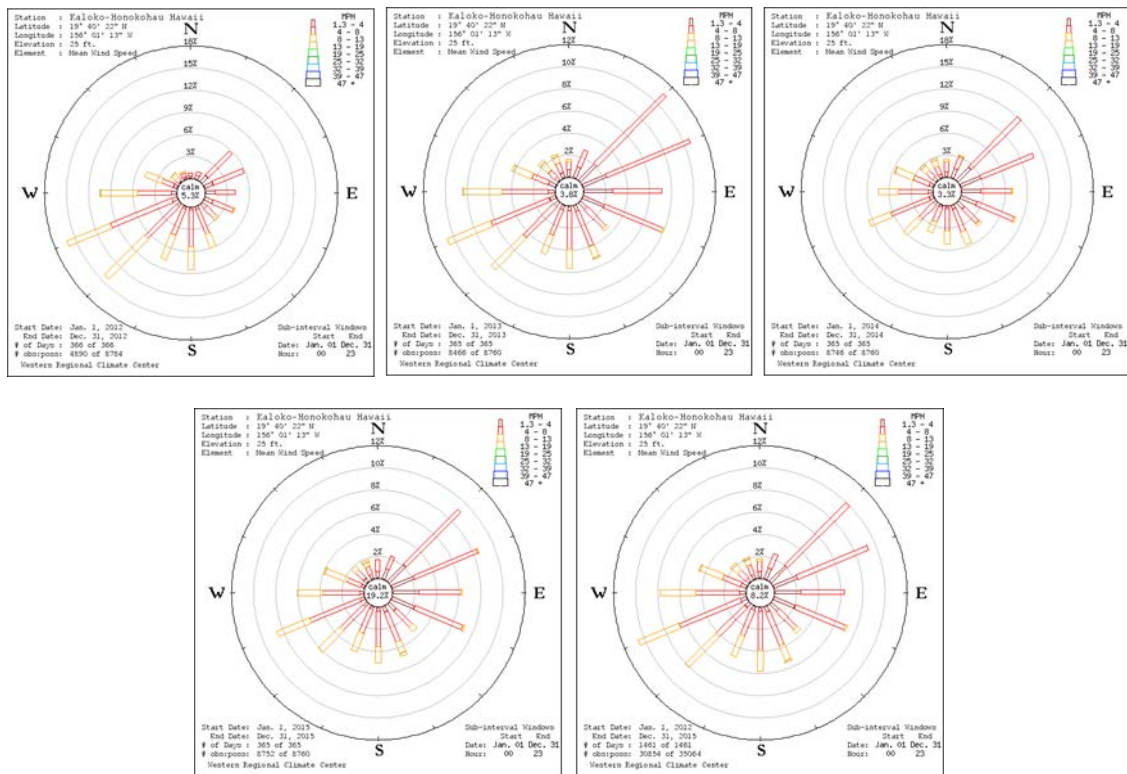
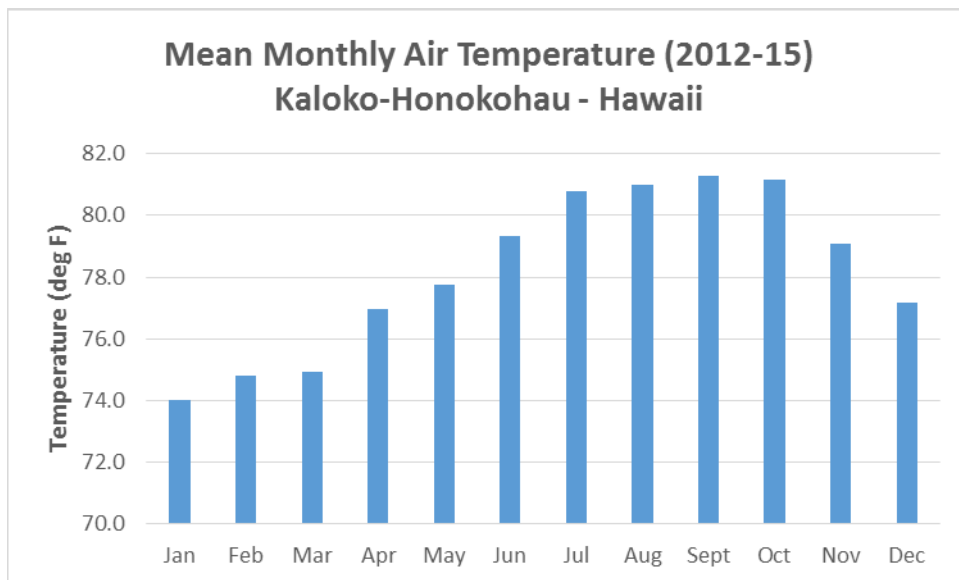
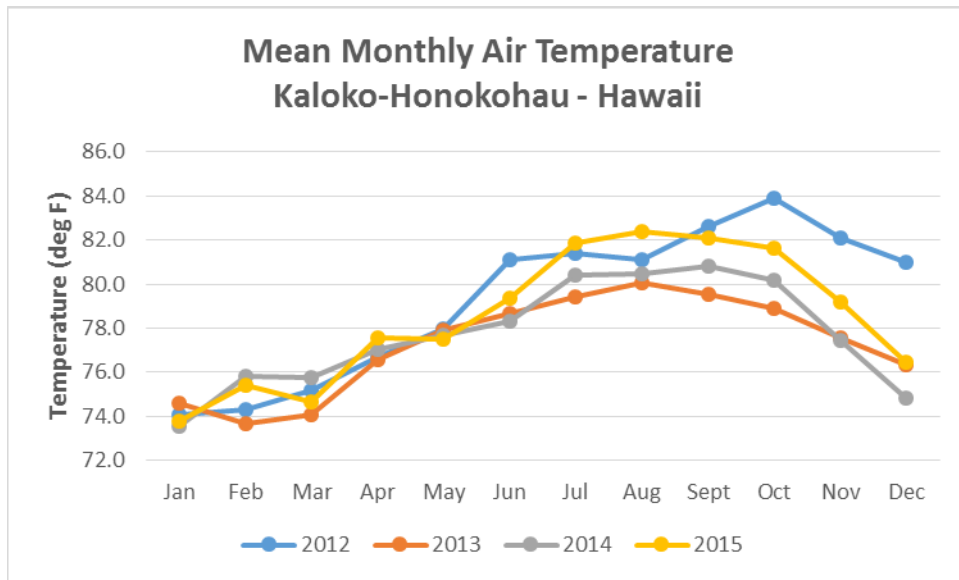
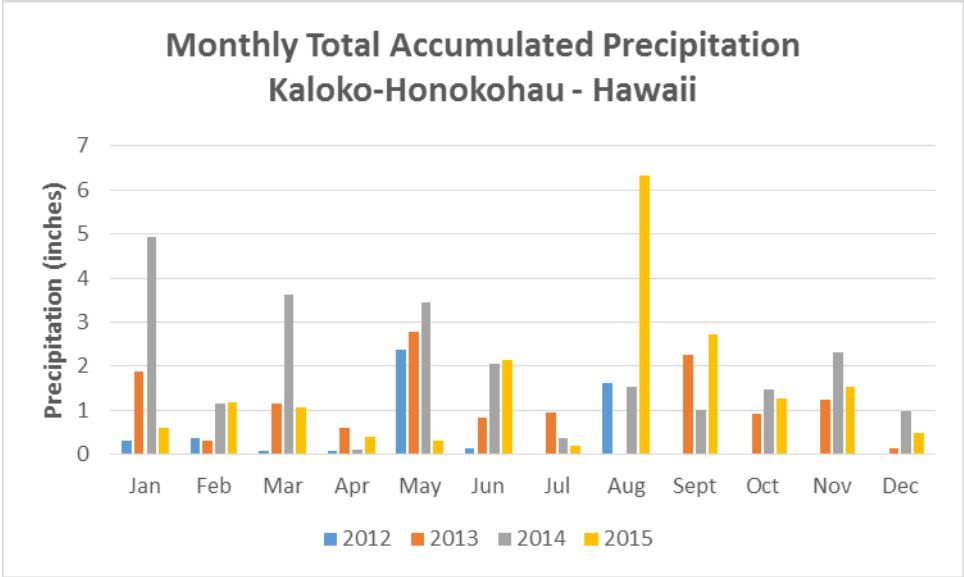


Figure 15 - Kaloko Honokohau wind rose climatology for 2012, 2013, 2014, 2015, and 2012-15.

Mean Monthly Air Temperature and Annual Precipitation





Reference Station Temperature and Precipitation Departures from Normal (1981-2010)

Pago Pago WSO Airport (2012-15)

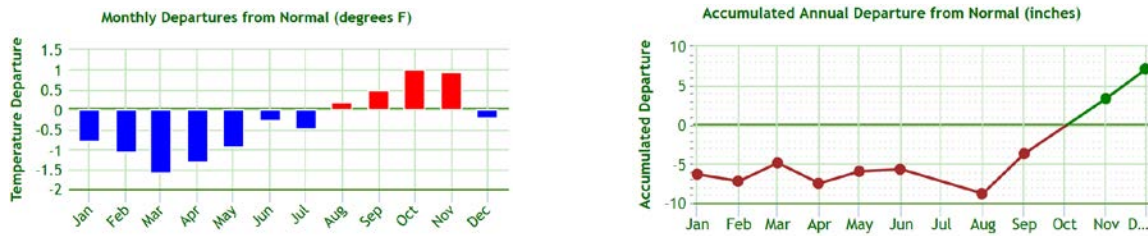


Figure 16 – Pago Pago WSO AP monthly average temperature and precipitation departures from normal - 2012.

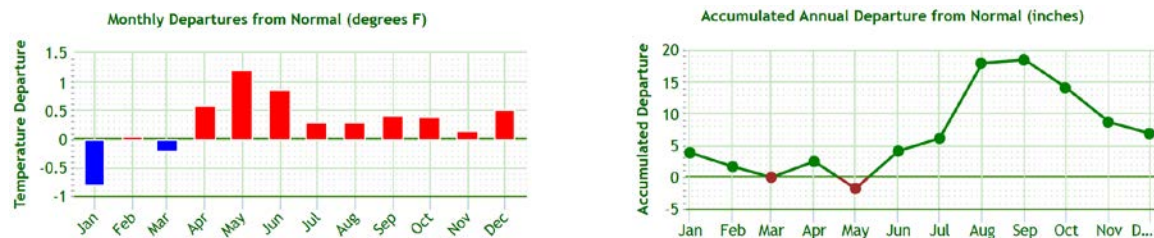


Figure 17 - Pago Pago WSO AP monthly average temperature and precipitation departures from normal - 2013.

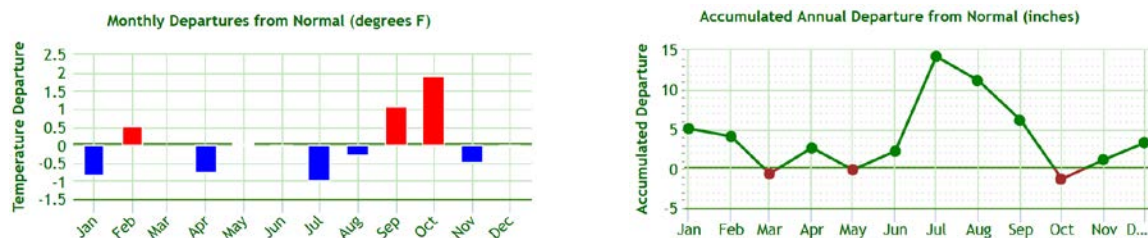


Figure 18 - Pago Pago WSO AP monthly average temperature and precipitation departures from normal - 2014.

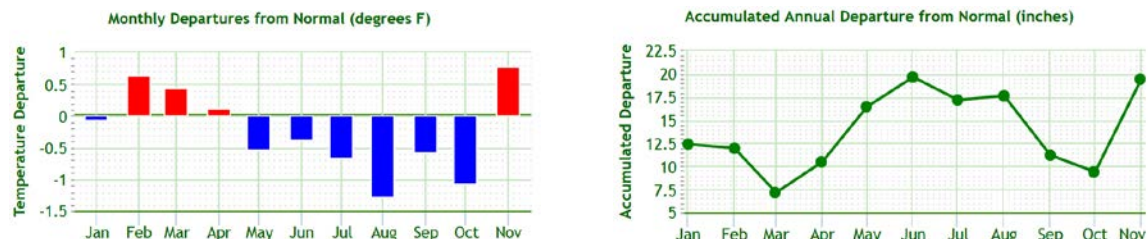


Figure 19 - Pago Pago WSO AP monthly average temperature and precipitation departures from normal - 2015.

Guam International Airport (2012-15)

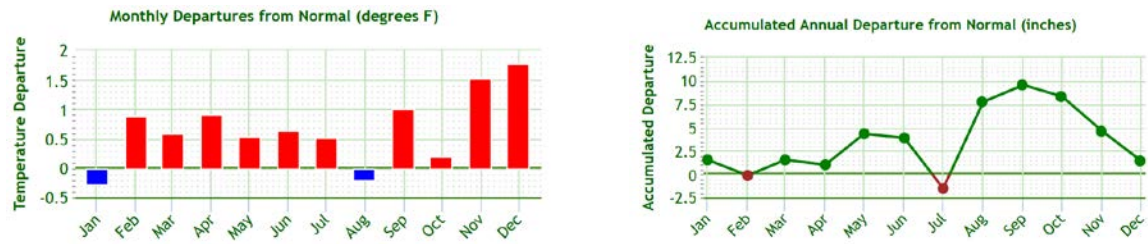


Figure 20 - Guam Intl AP monthly average temperature and precipitation departures normal - 2012.

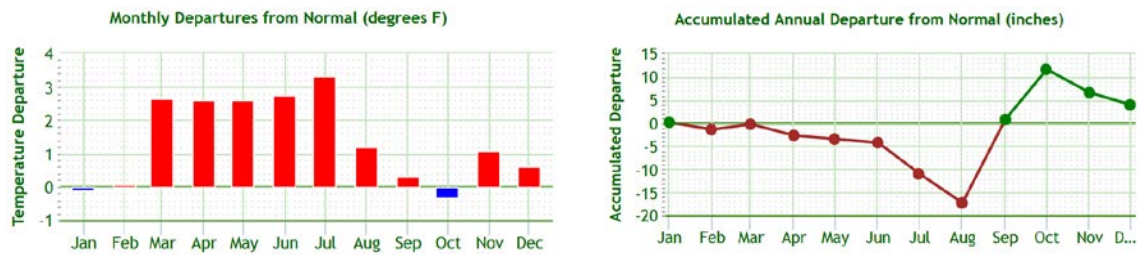


Figure 21 - Guam Intl AP monthly average temperature and precipitation departures from normal - 2013.

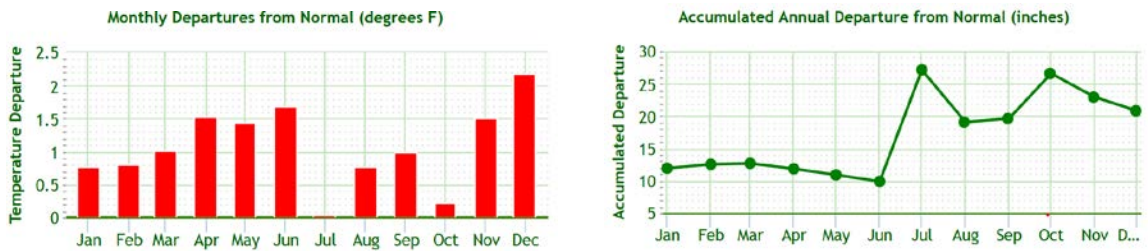


Figure 22 - Guam Intl AP monthly average temperature and precipitation departures from normal - 2014.

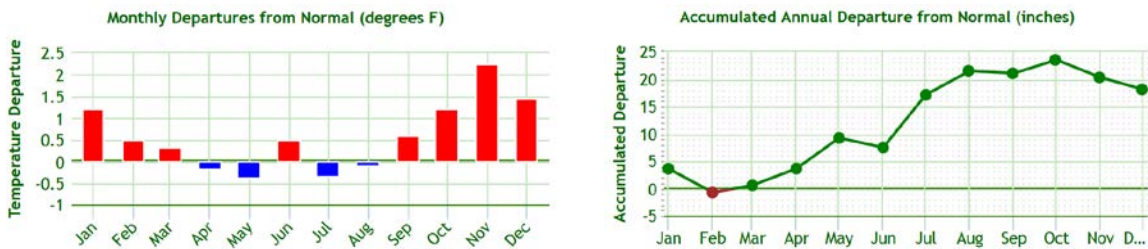


Figure 23 - Guam Intl AP monthly average temperature and precipitation departures from normal - 2015.

Saipan International Airport (2012-15)



Figure 24 - Saipan Intl AP precipitation departures from normal - 2012-13. Temperature data from the airport was missing for 2012-15.



Figure 25 - Saipan Intl AP precipitation departures from normal- 2014-15.

Hilo International Airport (2012-15)

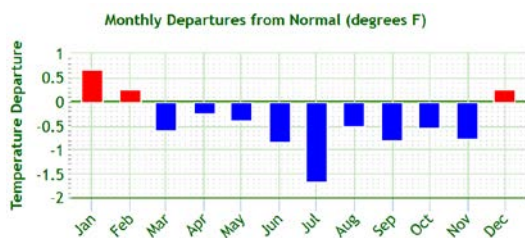


Figure 26 - Hilo Intl AP monthly average temperature and precipitation departures from normal - 2012.

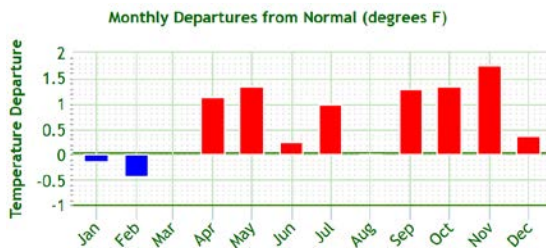


Figure 27 - Hilo Intl AP monthly average temperature and precipitation departures from normal - 2013.

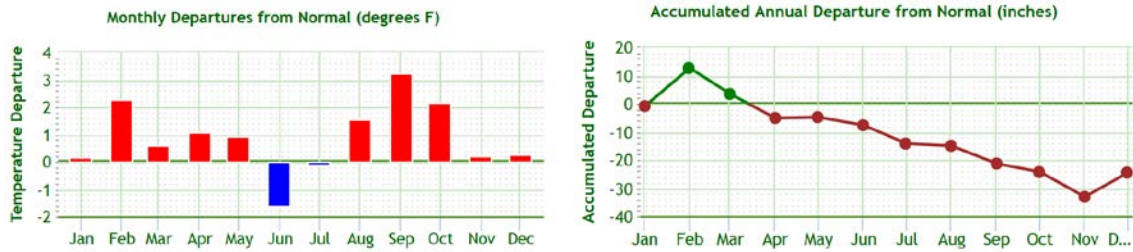


Figure 28 - Hilo Intl AP monthly average temperature and precipitation departures from normal- 2014.

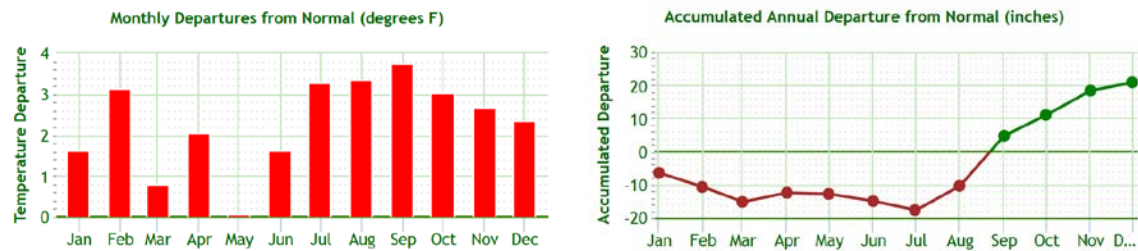


Figure 29 - Hilo Intl AP monthly average temperature and precipitation departures from normal - 2015.

Kona International Airport (2012-15)

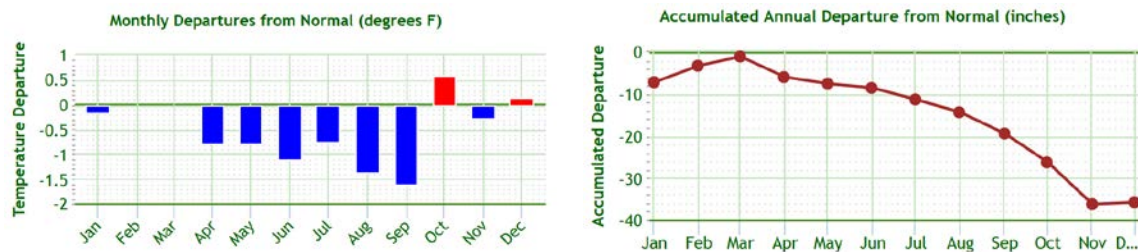


Figure 30 - Kona Intl AP monthly average temperature and precipitation departures from normal - 2012.

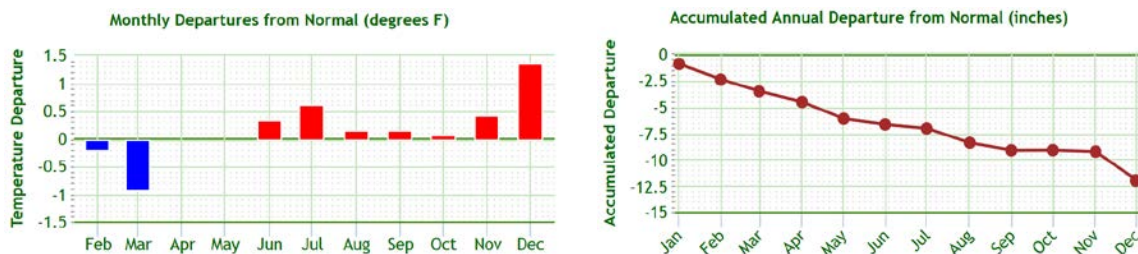


Figure 31 - Kona Intl AP monthly average temperature and precipitation departures from normal - 2013.

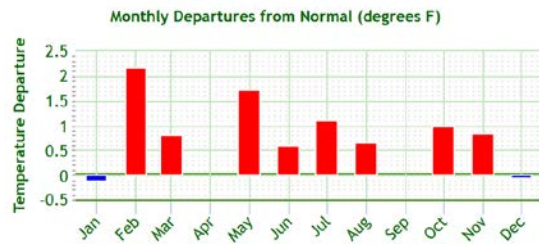
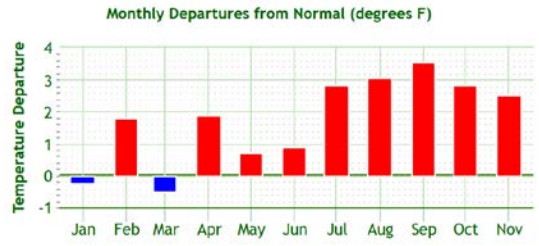


Figure 32 - Kona Intl AP average temperature and precipitation departures from normal - 2014.



Drought Summary

2012 – Hawaii and U.S. Affiliated Pacific Islands: Drought in Hawaii was resurgent in 2012, with 47.4 percent of the state affected by moderate to exceptional drought on January 3, growing to 73.2 percent by December 4. The state has been in drought for the last four years, with the December 4, 2012 peak approaching the peaks of 2008-2010. Several locations had record to near-record dry conditions in 2012, with Kahului recording the lowest rainfall for the year based on data from 1955-2012, and Honolulu having the fifth driest and Hilo eighth driest year in their 1950-2012 records. Annual rainfall at other U.S.-affiliated Pacific Island stations during 2012 was near or above normal.

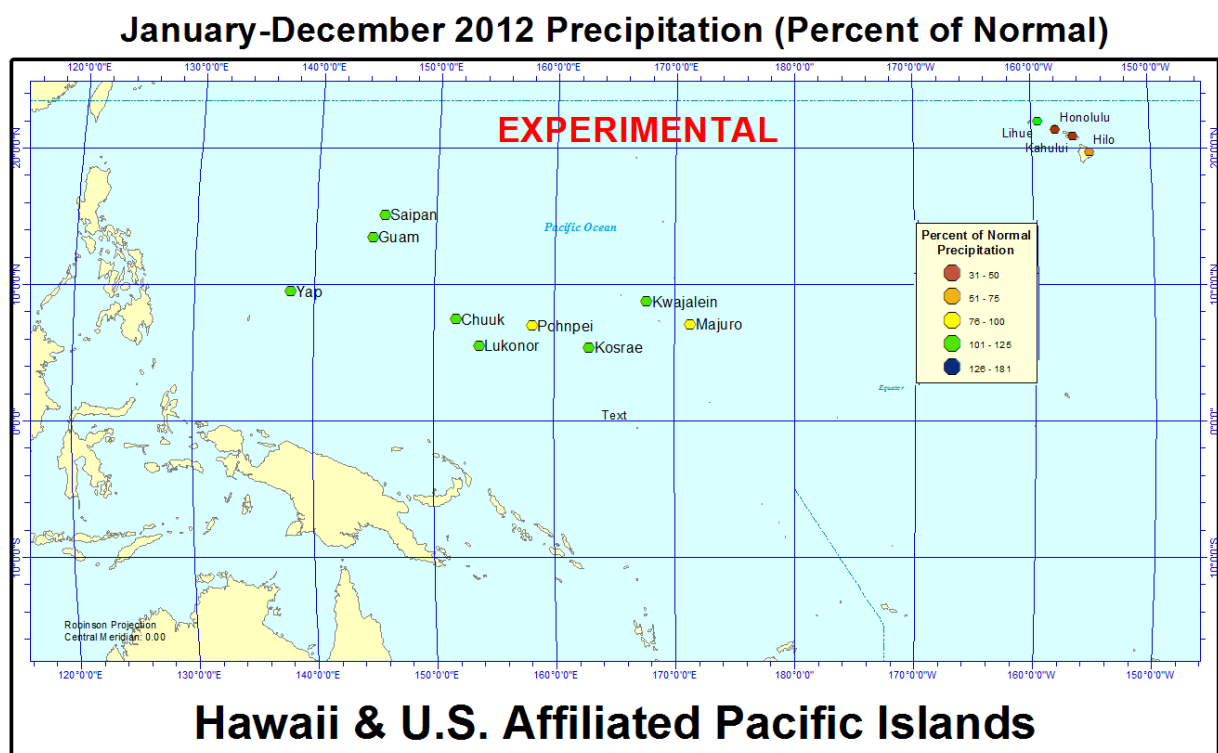


Figure 30 - NOAA National Centers for Environmental Information, State of the Climate: Drought for Annual 2012, published online January 2013, retrieved on March 21, 2016 from <http://www.ncdc.noaa.gov/sotc/drought/201213>.

2013 - Hawaii and other Pacific Islands: The year began with 63.3 percent of Hawaii in moderate to exceptional drought, according to USDM statistics. Beneficial rains steadily shrank the drought to 33.1 percent by the end of July, but dryness beginning in late summer expanded it to 67.7 percent by the middle of November. November-December rains shrank the drought area to 49.6 percent by the end of the year.

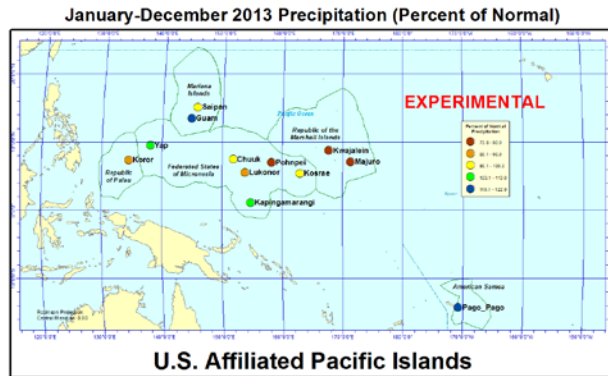


Figure 31 - 2013 Annual percent of normal precipitation for U.S. Affiliated Pacific Islands

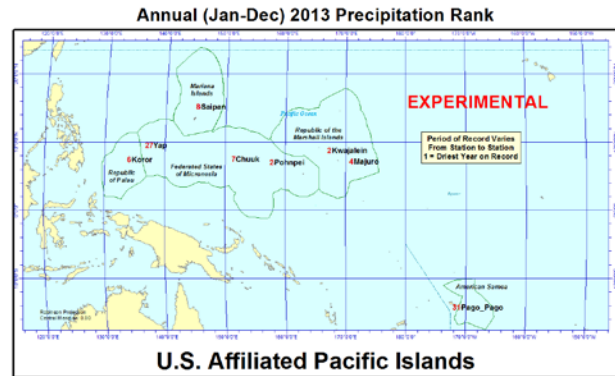


Figure 32 - 2013 Annual precipitation ranks for U.S. Affiliated Pacific Islands

January-December 2013 was drier than normal for many of the U.S.-Affiliated Pacific Islands, especially those in the Republic of the Marshall Islands. Kwajalein had the [second driest year](#) in the 1953-2013 record and Majuro ranked [fourth driest](#) in the 1954-2013 record. In the Federated States of Micronesia, Pohnpei ranked [second driest](#) in the 1953-2013 record and Chuuk had the [seventh driest year](#) in the 1991-2013 record. In the Republic of Palau, Koror ranked [sixth driest](#) in the 1953-2013 record, while in the Mariana Islands, Saipan had the [eighth driest year](#) in the 1989-2013 record.

NOAA National Centers for Environmental Information, State of the Climate: Drought for Annual 2013, published online January 2014, retrieved on March 21, 2016 from <http://www.ncdc.noaa.gov/sotc/drought/201313>.

2014 - Hawaii and U.S. Affiliated Pacific Islands: The year began with 49.6 percent of Hawaii in moderate to extreme drought, according to USDM statistics. Beneficial rains steadily shrank the drought area to below 1 percent by early April. Dryness in late fall to early winter expanded the drought area slightly, with 2.8 percent of the Hawaiian Islands in moderate drought by year's end.

NOAA National Centers for Environmental Information, State of the Climate: Drought for Annual 2014, published online January 2015, retrieved on March 21, 2016 from <http://www.ncdc.noaa.gov/sotc/drought/201413>.

2015 - Hawaii and other Pacific Islands: Dry conditions occurred across some of the U.S.-affiliated islands in the Pacific Ocean (USAPI) during parts of 2015. [Guam reported the driest February](#) in the station's 1948-2015 record. Continued dry conditions in the Republic of Palau during January-May prompted the [NOAA National Weather Service](#)

(NWS) to issue a [Drought Information Statement](#) at the beginning of June, but beneficial rains occurred over Palau during June and July. In American Samoa, Pago Pago received very low rainfall amounts for July-September, with the NWS issuing a [drought statement](#) warning of severe drought conditions. According to Global Historical Climatology Network (GHCN) data, July-September 2015 was the 11th driest July-September in the 1966-2015 record at Tafuna in American Samoa. As with Palau, beneficial rainfall returned to American Samoa in October.

Dry conditions returned to the Republic of Palau, and developed in Yap State in western Micronesia, during October-December. By October, [Kosrae was reporting water shortages](#). In [early January 2016](#), the NWS issued a [Drought Information Statement](#) for developing drought conditions in the Republic of Palau, Yap State in Micronesia, and the Marshall Islands, and a [Public Information Statement](#) for possible drought conditions that may develop in the Mariana Islands. According to GHCN data, [Yap had the driest October-December](#) in the 1951-2015 record and [Koror the second driest](#) in their 1951-2015 record. Many other stations in the western and northern parts of the USAPI region have had very dry conditions during October-December.

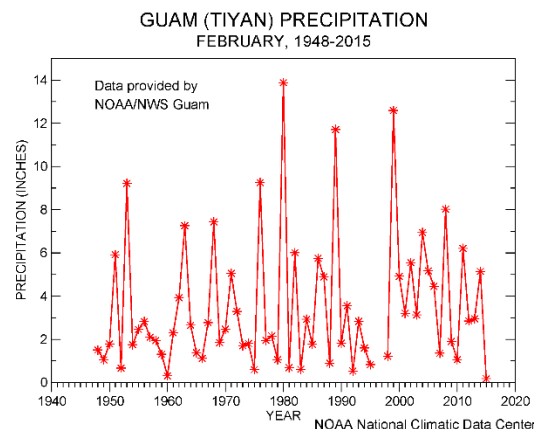


Figure 33 - Guam precipitation, February, 1948-2015.

NOAA National Centers for Environmental Information, State of the Climate: Drought for Annual 2015, published online January 2016, retrieved on March 21, 2016 from <http://www.ncdc.noaa.gov/sotc/drought/201513>.