He‘eia (HEE) NERR Meteorological Metadata 2022
January 01, 2022 – December 31, 2022
Latest Update: September 5, 2024

I. Data Set and Research Descriptors

1) Principal investigator(s) and contact persons –

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2) Entry verification –

Data are uploaded from the CR1000X data logger to a personal computer with a Windows 7 or newer operating system. Files are exported from LoggerNet in a comma-delimited format and uploaded to the CDMO where they undergo automated primary QAQC and become part of the CDMO’s online provisional database. During primary QAQC, data are flagged if they are missing or out of sensor range. The edited file is then returned to the reserve where it is opened in Microsoft Excel and processed using the CDMO’s NERRQAQC Excel macro. The macro inserts station codes, creates metadata worksheets for flagged data and summary statistics, and graphs the data for review. It allows the user to apply QAQC flags and codes to the data, append files, and export the resulting data file to the CDMO for tertiary QAQC and assimilation into the CDMO’s authoritative online database. For more information on QAQC flags and QAQC codes, see Sections 11 and 12. All QAQC was performed by Gus Robertson and Shimi Rii.

3) Research objectives –

We have been installing our WQ sites as part of SWMP for the past 3 years, choosing sites through thoughtful discussions with our stakeholders and partners about the feasibility and usefulness of our collected data to short-term restoration objectives and monitoring long-term natural and anthropogenic change. Our monitoring program currently consists of 3 official WQ SWMP sites in our watershed and ahupua‘a (Hawaiian social-ecological land division), with 1 pending in the upper watershed. The overall goal is to track the physical and biogeochemical parameters of the He‘eia Stream water that originates in our upper watershed that then move through invasive wetland vegetation and restored agro-ecology, and finally flow out towards an estuarine ancient Hawaiian fishpond and Kāne‘ohe Bay. The meteorological station in the hoi (wetland) of Kāko‘o ‘Ōiwi was installed in August 2021 for the purpose of providing real-time weather data to place these WQ measurements in the context of weather parameters. The location of the MET station (Lono Circle) was also chosen due to its central site within the wetland, providing accurate and unobstructed measures of weather parameters. The meteorological data is useful for resource managers at Kāko‘o ‘Ōiwi and Paepae o He‘eia who can track live and cumulative rainfall for determining crop cycles as well as estimating runoff and stream water flow. All other data are useful for better understanding and management of Indigenous food crops and coastal aquaculture in He‘eia.

4) Research methods –

Campbell Scientific data telemetry equipment was installed at the Lono Circle (LC) station on 08/13/2021 and transmits data to the NOAA GOES satellite, NESDIS ID #3B052656. The transmissions are scheduled hourly at 00:39:30 after the hour and contain four (4) data sets reflecting fifteen minute data sampling intervals. The Local Standard Time for this station is Hawaii Standard Time (HST). Upon receipt by the CDMO, the data undergoes the same automated primary QAQC process detailed in Section 2 above. The “real-time” telemetry data become part of the provisional dataset until undergoing secondary and tertiary QAQC and assimilation in the CDMO’s authoritative online database. Provisional and authoritative data are available at http://cdmo.baruch.sc.edu.

The 15-minute data are collected in the following formats for the **CR1000X**:

Averages from 5-second data:

Air Temperature (°C), Relative Humidity (%), Barometric Pressure (mb), Wind Speed (m/s), Wind Direction (degrees), Battery Voltage (volts)

Maximum and Minimum Air Temperature (°C) and their times from 5-second data (these data are available from the reserve)

Maximum Wind Speed (m/s) and time from 5-second data

Wind Direction Standard Deviation (degrees)

Totals:

Precipitation (mm), PAR (millimoles/m^2), and Cumulative Precipitation (mm) (Cumulative precipitation is no longer available via export from the CDMO. Please contact the reserve or the CDMO for more information or to obtain these data.)

Recommended calibration frequency for the MET station sensors:

- Temperature/Humidity- yearly recalibration
- Precipitation Gauge- yearly recalibration
- Wind Speed/Direction- yearly or every 2 years (depending on the sensor)
- Barometric Pressure- every 2 years recalibration
- PAR- every 2 years recalibration
- CR1000X-every 5 years

5) Site location and character –

He‘eia (11.5 km^2), O‘ahu, Hawai‘i, extends from the summit of the Ko‘olau mountain range to the fourth largest wetland in the islands. He‘eia wetland historically contained productive flooded-field agroecosystems (taro fields, called lo‘i), culminating in a coastal, Native Hawaiian aquaculture system called a loko i‘a on the coastal edge of Kāne‘ohe Bay, highly valued for immense marine diversity. Ha‘ikū and ‘Ioleke‘a basins contribute ~2.0 cfs perennial flow as He‘eia Stream. State-wide, He‘eia remains one of the few watersheds actively managed from ridge to reef. The He‘eia NERR comprises a 1,385-acre region within this He‘eia watershed, or ahupua‘a (Hawaiian social-ecological land division), including the wetland within Kāko‘o ‘Ōiwi and an 800-year old He‘eia Fishpond (stewarded by Paepae o He‘eia).

The MET station (Lono Circle, LC; 21.431345° N, 157.815278° W) is located centrally within the He‘eia wetland, providing accurate and unobstructed measures of weather data. It is located 0.90 km (0.56 mi), 1.15 km (0.72 mi), and 2.17 km (1.35 mi) away from the SWMP water quality stations Wai 2, Kaho‘okele, and Reef 9, respectively. LC MET station is placed on a 4-ft deep concrete platform reinforced with rebar, covered with coral and earth rubble, with natural vegetation surrounding the platform. The tower is not near any wind socks and does not receive any shading from nearby structures. Its nearest structure, a one-story utility house, is located ~200 ft away. The sensors are placed according to manufacturer and CDMO Manual: the rain gauge is located ~1 m above the ground and ~1.5 m southeast of the tower; on the tower, the PAR sensor is located on the southwest corner of the tower at approximately 3 m off the ground, the temperature and relative humidity sensors are located the northwestern corner approximately 1.75 m off the ground, the wind sensor faces close to true north and is situated 3 m high, and the barometric pressure sensor is located in the telemetry box at a height of 1.37 m with subsequent tube connecting outside with end of the tub at 1.25 m. The elevation of the concrete slab is 3.72 m above mean seal level.

Station Code	SWMP Status	Station Name	Location	Active Dates	Reason Decommissioned	Notes
LC	P	Lono Circle	21.431345° N, 157.815278° W	8/13/2021 - present	NA	NA

6) Data collection period –

Site	Start date / time	End date / time
heelcmet	12/20/2021 15:00	01/20/2022 13:30
	01/20/2022 13:45	02/19/2022 14:45
	02/19/2022 15:00	03/17/2022 15:15
	03/17/2022 15:30	04/16/2022 10:00
	04/16/2022 10:15	05/20/2022 15:45
	05/20/2022 16:00	06/17/2022 16:45
	06/17/2022 17:00	07/15/2022 16:45
	07/15/2022 17:00	08/13/2022 11:30
	08/13/2022 11:45	09/12/2022 08:45
	09/12/2022 09:00	10/13/2022 08:00
	10/13/2022 08:15	11/15/2022 08:30
	11/15/2022 08:45	12/08/2022 15:30
	12/08/2022 15:45	01/09/2023 08:30

7) Distribution –

NOAA retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The NERRS retains the right to be fully credited for having collected and processed the data. Following academic courtesy standards, the NERR site where the data were collected should be contacted and fully acknowledged in any subsequent publications in which any part of the data are used. The data set enclosed within this package/transmission is only as good as the quality assurance and quality control procedures outlined by the enclosed metadata reporting statement. The user bears all responsibility for its subsequent use/misuse in any further analyses or comparisons. The Federal government does not assume liability to the Recipient or third persons, nor will the Federal government reimburse or indemnify the Recipient for its liability due to any losses resulting in any way from the use of this data.

Requested citation format:
NOAA National Estuarine Research Reserve System (NERRS). System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: http://www.nerrsdata.org/; *accessed* 12 October 2022.

NERR meteorological data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Principal Investigators and Contact Persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page www.nerrsdata.org. Data are available in comma delimited format.

8) Associated researchers and projects –

As part of the SWMP long-term monitoring program, He'eia NERR also collects 15-minute water quality data (at 3 SWMP WQ sites) and monthly grab samples for inorganic nutrient and chlorophyll *a* data (at SWMP WQ sites and 7 other monthly monitoring sites) which may be correlated with this meteorological dataset. At these sites, we also collect total suspended solids (TSS) and particulate carbon and nitrogen (PC/PN) on a monthly basis, and environmental DNA (eDNA) to assess fish, plankton, and invertebrate biodiversity on a quarterly schedule. The SWMP 15-minute water quality data are available at www.nerrsdata.org. For other data, please contact the Research Coordinator.

II. Physical Structure Descriptors

9) Sensor specifications –

Parameter: Temperature
Units: Celsius
Sensor type: Pt1000 Class A
Model #: EE181 Temperature and Relative Humidity Probe
Operating Temperature: -40°C to +60°C
Range: -40°C to +60°C
Accuracy: ±0.2 °C @ 23°C
Serial number, dates of calibration and use: *1818160001217E, new, installed 8/13/2021 – current as of 12/31/2022*

Parameter: Relative Humidity
Units: Percent
Sensor type: HC101
Model #: EE181 Temperature and Relative Humidity Probe
Range: 0-100% non-condensing
Accuracy: –15 to 40 °C: ≤90% RH ± (1.3 + 0.003 • RH reading) % RH
–15 to 40 °C: >90% RH ± 2.3% RH
–25 to 60 °C: ± (1.4 + 0.01 • RH reading) % RH
–40 to 60 °C: ± (1.5 + 0.015 • RH reading) % RH
Temperature dependence of RH measurement: typically 0.03% RH/°C
Note: This sensor caps relative humidity values at 100%, measured values >100% are altered to 100%
Serial number, dates of calibration and use: *1818160001217E, new, in service 08/13/2021 – current as of 12/31/2022*

Parameter: Barometric Pressure
Units: millibars (mb)
Sensor type: Vaisala Barocap © silicon capacitive pressure sensor
Model #: CS-106 (PTB110)
Operating Range: Pressure: 500 to 1100 mb; Temperature: -40°C to +60°C;
Humidity: non-condensing
Accuracy: ± 0.3 mb at +20°C, ± 0.6 mb at 0°C to 40°C, ± 1 mb at -20°C to +45°C, ± 1.5 mb at -40°C to +60°C
Stability: ± 0.1 mb per year
Serial number, dates of calibration and use: *N5320136, new, in service 08/13/2021 – current as of 12/31/2022*

Parameter: Wind speed
Units: meter per second (m/s)
Sensor type: 18 cm diameter 4-blade helicoids propeller molded of polypropylene
Model #: R.M. Young 05108-L22 Wind Monitor
Range: 0-100 m/s (224 mph)
Accuracy: +/- 0.3 m/s
Serial number, dates of calibration and use: *WM160930, new, in service 08/13/2021 – current as of 12/31/2022*

Parameter: Wind direction
Units: degrees
Sensor type: balanced vane, 38 cm turning radius
Model #: R.M. Young 05108-L22 Wind Monitor

Serial number, dates of calibration and use: *WM160930, new, in service 08/13/2021 – current as of 12/31/2022*

Parameter: Photosynthetically Active Radiation (PAR)
Units: mmoles m-2 (total flux)
Sensor type: Quantum Sensor; high stability silicon photodiode (blue enhanced) in anodized aluminum case with acrylic diffuser
Model #SQ110 Apogee Quantum Sensor
Light spectrum waveband: 410 to 655 nm
Temperature dependence: 0.06+/-0.06% per °C
Stability: <±2% change over 1 yr
Operating Temperature: -40°C to 70°C; Humidity 0 to 100%
Cosine Response: 45° zenith angle: +/- 2%; 75° zenith angle: +/- 5%
Sensitivity: 0.2mV per µmol s-1 m-2
Multiplier: 0.025 (even though this does not change it should still be included)
Serial number, dates of calibration and use: *SQ-110-L-10-25267, new, in service 08/13/2021- current as of 12/31/2022*

Parameter: Precipitation
Units: millimeters (mm)
Sensor type: Tipping Bucket Rain Gauge
Model #: TE525
Rainfall per tip: 0.01 inch
Operating range: Temperature: 0° to 50°C; Humidity: 0 to 100%
Accuracy: +/- 1.0% up to 1 in./hr; +0, -3% from 1 to 2 in./hr; +0, -5% from 2 to 3 in./hr
Serial number, dates of calibration and use: *74149-917, new, in service 08/13/2021 – current as of 12/31/2022*

Datalogger:
CR1000X:
The CR1000X has a total onboard memory of 128 MB of flash and 4MB of battery backed SRAM. There is 8 MB of flash memory reserved for loading the operating system and 1MB of flash reserved for configuration settings. SRAM is used for the CRBasic program operating memory, communication memory, and data storage, with 72 MB of flash for extended data storage. Additional data storage expansion is available with a removable microSD flash memory card of up to 16 GB.

Date CR1000X Installed: 08/13/2021 – current as of 12/31/2022
Date CR1000X Calibrated: new, S/N 12872

CR1000X Firmware Version (s): Version 5.01 10/13/2021

CR1000/CR1000X Program Version(s): HEELCMET_CR1000x_6.0.3_092321_V2C

10) Coded variable definitions -

Sampling station:	Sampling site code:	Station code:
Lono Circle	LC	heelcmet

11) QAQC flag definitions –

QAQC flags provide documentation of the data and are applied to individual data points by insertion into the parameter's associated flag column (header preceded by an F_). During primary automated QAQC (performed by the CDMO), -5, -4, and -2 flags are applied automatically to indicate data that is above or below sensor range, or missing. All remaining data are then flagged 0, as passing initial QAQC

checks. During secondary and tertiary QAQC 1, -3, and 5 flags may be used to note data as suspect, rejected due to QAQC, or corrected.

-5 Outside High Sensor Range
-4 Outside Low Sensor Range
-3 Data Rejected due to QAQC
-2 Missing Data
-1 Optional SWMP supported parameter
0 Passed Initial QAQC Checks
1 Suspect Data
2 *Open - reserved for later flag*
3 *Open - reserved for later flag*
4 Historical Data: Pre-Auto QAQC
5 Corrected Data

12) QAQC code definitions –

QAQC codes are used in conjunction with QAQC flags to provide further documentation of the data and are also applied by insertion into the associated flag column. There are three (3) different code categories, general, sensor, and comment. General errors document general problems with the CR1000/CR1000X, sensor errors are sensor specific, and comment codes are used to further document conditions or a problem with the data. Only one general or sensor error and one comment code can be applied to a particular data point, but some comment codes (marked with an * below) can be applied to the entire record in the F_Record column.

General Errors

GIM	Instrument malfunction
GIT	Instrument recording error, recovered telemetry data
GMC	No instrument deployed due to maintenance/calibration
GMT	Instrument maintenance
GPD	Power down
GPF	Power failure / Low battery
GPR	Program reload
GQR	Data rejected due to QA/QC checks
GSM	See metadata

Sensor Errors

SDG	Suspect due to sensor diagnostics
SIC	Incorrect calibration constant, multiplier or offset
SIW	Incorrect wiring
SMT	Sensor maintenance
SNV	Negative value
SOC	Out of calibration
SQR	Data rejected due to QAQC checks
SSD	Sensor drift
SSN	Not a number / unknown value
SSM	Sensor malfunction
SSR	Sensor removed

Comments

CAF	Acceptable calibration/accuracy error of sensor
CCU	Cause unknown

CDF	Data appear to fit conditions
CML	Snow melt from previous snowfall event
CRE*	Significant rain event
CSM*	See metadata
CVT*	Possible vandalism/tampering
CWE*	Significant weather event

13) Other remarks/notes –

Data are missing due to equipment or associated specific sensors not being deployed, equipment failure, time of maintenance or calibration of equipment, or repair/replacement of a sampling station platform. Any NANs in the dataset stand for "not a number" and are the result of low power, disconnected wires, or out of range readings. If additional information on missing data is needed, contact the Research Coordinator at the reserve submitting the data.

Relative Humidity data greater than 100 are within range of the sensor accuracy of +/-3% and are flagged and coded as suspect, <1> (CAF). Values greater than 103 are rejected <-3>.

Data recorded for all parameters (with the exception of cumulative precipitation) at the midnight timestamp (00:00) are the 15 minute averages and totals for the 23:45-23:59 time period of the previous day. Cumulative precipitation data at the midnight timestamp (00:00) are the sum of raw (unrounded) precipitation data from 00:00 to 23:59 of the previous day. Summing each individual 15-minute total precipitation value from the same period will result in small differences from cumulative precipitation due to rounding. It is especially important to note how data at the midnight timestamp are recorded when using January 1st and December 31st data. **Note: Cumulative precipitation is no longer available via export from the CDMO. Please contact the reserve or the CDMO for more information or to obtain these data.**

Flags

Lono Circle

Date Range	Flag/Code	Comment
01/01/2022 00:00 12/31/2022 23:45	<-3> (CSM), <0>CSM	Due to an error in the wind direction programming, values logged read 0 degrees anytime wind degree was >149. This error largely affected Kona (SSW) and NNW wind periods with some scattered instances that seemed to happen in the late evening/morning. Both wind direction and SDWDir were rejected when values were 0 and there was measurable wind speed. All data not rejected are coded with CSM to make data users aware of the programming issues. Those data are believed to be accurate.
01/01/2022 00:00 01/02/2022 00:00	{CSM} {CWE}	Significant storm event that affected all parameters: decrease in temperature, barometric pressure, and PAR, and increase in wind speed, change in wind direction, and large increase in cumulative precipitation. https://waterdata.usgs.gov/hi/nwis/uv?cb_00060=on&cb_00065=on&format=gif_default&site_no=16275000&period=&begin_date=2021-12-30&end_date=2022-01-13

03/17/2022 15:45	<-3> [SMT](CSM)	Routine Cleaning of the rain gage. Cumulative rejected through the end of the day.
05/17/2022 10:15 05/25/2022 10:30	<1> (CSM)	A notable high and low temperature variation that was likely due some oxidation on the mesh guard on the temperature sensor. Relative humidity values are temperature dependent and are also considered suspect. https://tidesandcurrents.noaa.gov/met.html?bdate=20220517&edate=20220610&units=metric&timezone=GMT&id=1612480&interval=6
09/12/2022 09:15	<-3> [SMT](CSM)	Removed temperature/relative humidity sensor from gill shield for cleaning and temp check.
10/21/2022 08:15 10/21/2022 16:31	(CSM)	Notably high temps, with no clear reason why. RH is temperature dependent and also included in coding.
12/18/2022 12:00 12/20/2022 20:30	{CSM, CWE}	A notable storm event with a significant drop in barometric pressure.
12/19/2022 01:00 02/28/2023 08:15	<-3> (CSM)	A notable WSW wind that seemingly shifted the junction box to 121 degrees instead of 180(true south) resulting in an Inaccurate wind direction and SDWDir readings. https://tidesandcurrents.noaa.gov/met.html?bdate=20221219&edate=20221220&units=standard&timezone=GMT&id=1612480&interval=6