Waquoit Bay (WQB) National Estuarine Research Reserve Meteorological Metadata
January 2015 – December 2015
Last updated: November 7, 2016

I. Data Set & Research Descriptors

1) Principal Investigator(s) & contact persons

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2) Entry Verification

System I: CR1000, CR10X

The initial weather station and CR10X program was installed in late October 2003. The old program (ner30.csi) was revised (NERR_4.CSI) to standardize the program for all sites. The revision was necessary to meet new data reporting requirements of CDMO to eliminate instantaneous data sample reporting, add cumulative daily rainfall and additional sensors.

Starting July 12, 2006 at 17:45, WQBNERR weather station was changed from the CR10X Datalogger to a CR1000 Datalogger and associated software program. The sensors for Air Temperature (C), Relative Humidity (%), Barometric Pressure (mb), Wind Speed, Wind Direction, Total Precipitation (mm), Total Photosynthetically Available Radiation (PAR), and Total Solar Radiation (SoRAD) remain the same. See section 9: Sensor specifications, operating range, accuracy, date of last calibration for sensor specifications.

On February 10th, 2005, a new EPLAB© Black and White Pyranometer was installed. It was mounted on the same structure as the PAR instrument approximately within one meters distance. This Pyranometer is an Eppley 10-and 50-junction 180^{O} pyrheliometer originally introduced by Kimball and Hobbs in 1923. The detector is a differential thermopile with the hot-junction receivers blackened and the cold-junction receivers whitened. The element is of radial wire-wound-plated construction with the black segments coated with 3M black and the white segments with Barium Sulfate. Built in temperature compensation with thermistor circuitry is incorporated to free the instrument from the effects of ambient temperature. A precision ground optical glass hemisphere of Schott glass WG295 uniformly transmits energy from 285 to 2,800 millimicrons. This hemispherical envelope seals the instrument from the weather, but is readily removable for instrument repair. The cast aluminum case carries a circular spirit level and adjustable leveling screws. Also supplied is a desiccator, which can be inspected readily. See section 9 for most recent calibration dates.

Although the Eppley pyranometer was installed in 2005 and collected data until 2014, in October 2014 research staff at Waquoit Bay realized the sensor was collecting total solar radiation data in Watt-hours per meter-squared (a measure of maximums within a 15 minute period). CDMO (Central Database Management Office) protocols require the total solar radiation data to be displayed in Watts per meter-squared (a measure of 5-second averages over a 15 minute period). Because of the discrepancy, these data have been removed from the national database but are available by request. Please contact Jordan Mora for total solar radiation data series (contact information on page 1 of this document).

The meteorological information is sampled every 5 seconds from each instrument on the weather station and stored on a Campbell Scientific CR1000 data logger. Data are output to a file in three file formats: CR1000_A5Min.dat stores 5 minute data; CR1000_GOESout.dat stores 15 minute averages and totals that are transmitted hourly for Satellite upload; and CR1000_SWMP.dat files stores the 15 minute average and total data that is submitted to CDMO on a quarterly basis for primary QAQC review. The CDMO Data Logger (NERR_4.CSI) was loaded into the CR1000 and controls the sensors.

Data are uploaded from the CR1000 data logger to a Personal Computer (IBM compatible). Files are exported from or 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.

Jordan Mora, Research Associate, error checked and compiled the meteorological data in 2015.

3) Research objectives

The principal objectives are to record meteorological information for the Waquoit Bay NERR's site that can be used: 1) as a vital reference of atmospheric data for various research projects at the reserve -- an integral part of our general NERR mission is to provide a platform for estuarine research; 2) to give meteorological context (atmospheric-forcing) for our fifteen minute SWMP water quality data, and other long-term environmental monitoring programs at the Reserve (including nutrients and shoreline change); 3) to observe and characterize important events, such as storms, heat and cold waves, droughts and heavy rainfalls; and 4) to detect trends and characterize climate variability over the long-term.

4) Research Methods

The Campbell Scientific weather station samples every 5 seconds continuously throughout the year. These data are used by the CR1000 to produce 15 minute, hourly and daily averages of those measurements of air temperature, relative humidity, barometric pressure, wind speed, and

wind direction. Precipitation and PAR are recorded as totals for each interval. As mentioned above, we generally upload data from the CR1000 storage module about once a month. CR1000 raw data are currently stored on one data storage module capable of storing about 3 months of data. The CR1000 is also cabled directly to a desktop PC where the instantaneous 5 sec data are displayed (in a LoggerNet window) and can be viewed at any time. All collected data is quality checked immediately after the monthly downloads. The error/anomaly reports and all monthly parameter graphs are printed and reviewed. Any error/anomaly messages are further investigated and the data is either corrected/rejected (if necessary) or commented on and left unchanged.

Sensors on the weather station are inspected monthly for damage or debris. See section 9 for most recent calibration dates. Also, once a month on upload day, we use a compass and utilize a Weather Station monitoring system (with a wind sensor) to run a comparative set of observations as a general check on the Campbell station sensors.

Real-time Data Methods:

In July 2006, our meteorological station was linked to a NOAA GOES © satellite system, which allowed near real-time access to our meteorological data over the internet. Campbell Scientific data telemetry equipment is used at this station to transmit to the NOAA GOES satellite, NESDIS ID #3B022462. The transmissions are scheduled hourly and contain four (4) datasets reflecting the fifteen minute data sampling interval. 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 CR1000:

Air Temperature (C)
- 15 minute average (averages from 5-second data over previous 15 minutes)
- Maximum (over previous 15 minutes)*
- Minimum (over previous 15 minutes)*
- Time Maximum (from 5-second data)*
- Time Minimum (from 5-second data)*

Relative Humidity (%)
- 15 minute average (averages from 5-second data over previous 15 minutes)

Barometric Pressure (mb)
- 15 minute average (averages from 5-second data over previous 15 minutes)

Wind Speed
- 15 minute average (averages from 5-second data over previous 15 minutes)
- Maximum (over previous 15 minutes)
- Time Maximum(over previous 15 minutes)

Wind Direction
- 15 minute average (averages from 5-second data over previous 15 minutes)
- Standard Deviation (over previous 15 minute period)

Total Precipitation (mm)
- previous 15 minute total

Cumulative precipitation
- running total of daily precipitation - sum of 15 minute totals

Total Photosynthetically Available Radiation (PAR)
- previous 15 minute total (millimoles/m^2)

**Available from the Waquoit Bay Reserve (see contact information on page 1). Not a standard CDMO parameter.*

Recommended calibration frequency for the MET station sensors:
Temperature/Humidity – yearly calibration
Rain Gauge – yearly calibration
Wind speed/direction – yearly or every 2 year inspection (depending on sensors)
Barometric Pressure – every 2 years recalibration
PAR – every 2 years recalibration
CR1000 – every 5 years (required beginning of 2014, one year initial grace period)

5) Site Location and Character

The weather station is located beside the Carriage House, an historic building which houses our education classroom and research laboratory at the Waquoit Bay Reserve Headquarters. Wind (speed and direction), temperature and relative humidity sensors are mounted at the top of a 10-m aluminum tower next to the Carriage House.

Prior to August 11th, 2015, the weather tower, which supports the wind, temperature, and relative humidity sensors, was located at 41° 34'54.12 N, 70° 31' 30.36 W. Starting on November 16th, 2015, the tower location changed to 41° 34'54.09" N, 70° 31'30.65"W. The move occurred in response to a renovation project on the Carriage House; a new ADA-compliant (Americans with Disabilities Act of 1990) ramp was built on the side of the building where the tower was previously installed. The current location is roughly 6.5 meters northwest of the past location, and instead of being on the south side of the Carriage House, the tower is now on the west side (see image below). The top of the tower exceeds the height of the building; its attached probes stand approximately 2.5 m above the roof peak of the adjacent building and are separated from any trees by 10 m. A crushed shell parking area (bleach white in color) is located to the south (20m) and west (8m) of the current tower. The tower base is 10.39 m above sea level (NGVD), approximately 100 m north from Waquoit Bay's northern shoreline. The location is most well exposed to winds from the west and south (southeast clockwise to northwest).

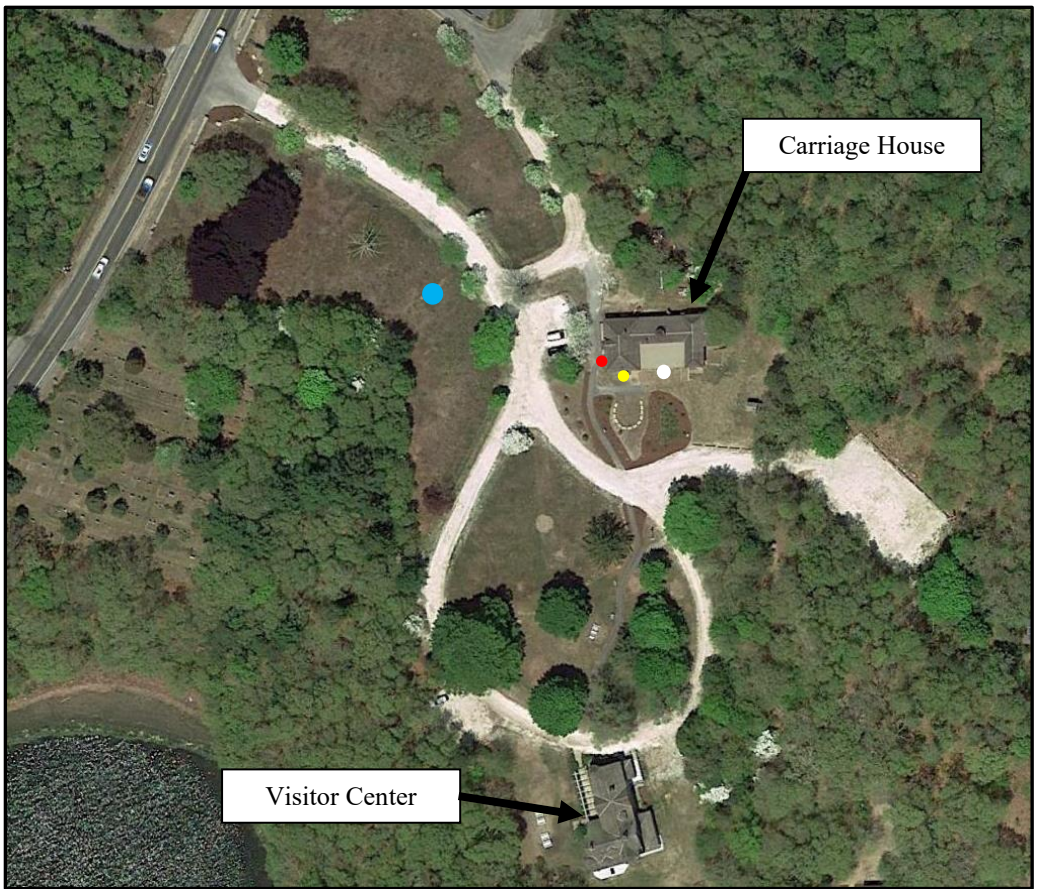

Figure 1. The image above shows the Waquoit Bay NERR Headquarters. The red circle marks the location of the current wind/temperature/relative humidity tower location (November 2015 – present). The yellow circle marks the past location of the wind/temperature/relative humidity tower (2006 – August 2015). The white circle marks the location of the photosynthetically active radiation sensor. The larger blue circle indicates the location of the precipitation gauge in the open field. The barometric pressure sensor is located inside the Carriage House in the laboratory.

The LiCor PAR sensor and EPLAB Pyranometer are mounted about 10 m away on an extended aluminum arm at a height of 3 m above the ground level and is well exposed at all times to the sun in both winter and summer. The air pressure sensor, which is mounted next to the CR1000 in the laboratory, is approximately 1.5meters in height above ground level. The rain gauge is located in an open field away from trees about 55 m northwest of the laboratory and tower and 11.2 m above sea level (NGVD). The top of the gauge is 1 meter above ground.

As for its general setting, the Waquoit Bay National Estuarine Research Reserve (WQBNERR) is located in the northeastern United States on the southern coast of Cape Cod, Massachusetts. Climatically, this region is considered temperate maritime, and experiences relatively mild winters and cool summers relative to the rest of New England because of its exposed oceanic location. Typical of the mid-latitudes (41 N), prevailing winds are from the southwest, while storm winds tend to be from the east.

The area is adjacent to one of the world's most active regions for cyclogenesis (extra-tropical cyclone formation) off the East coast of North America. These generally winter season storms are most frequent (almost weekly) from late October until late April and are locally called Nor'easters because of the NE wind direction typical to the area during the period of peak wind speeds. These storms generally develop rapidly as secondary lows off the mid-Atlantic coast

(Carolinas to New Jersey) and track northeastward passing Cape Cod either directly overhead, or to the southeast or northwest. These winter season storms are important agents of coastal erosion and shoreline alteration in the region, particularly for easterly facing coasts.

Hurricanes are also important phenomena in the region. Most years, during the period from July to November, the Cape experiences some interaction with a passing tropical storm. About once every decade the area experiences a nearby landfall, with winds exceeding hurricane threshold (>33 m/s), usually from the southerly quarter. Hurricanes are particularly important agents of change for the Cape's southern coastal areas, and can have profound effects on local estuaries, including Waquoit Bay. Typically, barrier beach over-wash (with salt marsh burial) and breaching (with new tidal inlet formation) occur during these extreme events.

Meteorological data from Waquoit Bay NERR can be compared to that from other nearby meteorological stations. These stations are located at Otis Air Force Base (10 km to the north), Falmouth Water Department-Long Pond (8 km to the west), Woods Hole Oceanographic Institution–Quisset Campus (13 km to the southwest), Hyannis Airport (23 km to the northeast), and Buzzards Bay Texas Tower (41 km to the southwest) – this latter station being a particularly valuable reference site because it is offshore and southwest with at least 15 km of unobstructed open water around it and it also records other useful sea surface parameters (wave height and direction, and ocean temperatures).

Other stations which are also used for reference include the Menauhant Yacht Club weather station operated and maintained by Dr. Richard Taylor as a Local National Weather Service Reporting Station (Data Garrison https://datagarrison.com/). Since December 2002, the National Weather Service Reporting Station has been recording daily observations at 0700 and 1900 for the following weather parameters: Temperature (°F; minimum and maximum), Precipitation (inches; rain and melted snow, snow fall, initial and endpoint times of events), Sky Conditions and Wind Direction (mph; gusts).

6) **Data Collection Period**

Weather data has been collected at the Waquoit Bay NERR Carriage House since December 2001. The current weather station has been operational since this date.

Program Reloads (EST):

02/23/2015, 14:15
03/19/2015, 10:30
03/23/2015, 9:45

Weather data was downloaded from the station for the following periods 2015 (EST):

START	END
12/09/2014, 11:30	01/20/2015, 11:00
01/20/2015, 11:15	02/19/2015, 13:30
02/19/2015, 13:45	02/23/2015, 13:45
02/23/2015, 14:15	02/25/2015, 11:30
02/25/2015, 11:45	03/19/2015, 10:15
03/19/2015, 10:30	03/23/2015, 09:30

03/23/2015, 09:45	04/08/2015, 10:15
04/08/2015, 10:30	05/21/2015, 10:30
05/21/2015, 10:45	06/23/2015, 10:45
06/23/2015, 11:00	07/31/2015, 09:30
07/31/2015, 09:45	08/12/2015, 09:45
08/12/2015, 10:00	09/02/2015, 14:45
09/02/2015, 15:00	10/23/2015, 11:15
10/23/2015, 11:30	11/24/2015, 12:00
11/24/2015, 12:15	12/31/2015, 09:45
12/31/2015, 10:00	01/29/2015, 09:15

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 process 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 2012.

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

The Waquoit Bay Meteorological Station located at the Carriage House satisfies the weather data collection requirement of a broader nationwide program, the System-Wide Monitoring Program (SWMP). Within the SWMP, additional required parameters include water quality and nutrient monitoring.

1) Water quality monitoring involves continuous measurements of water temperature, specific conductivity, salinity, dissolved oxygen (percent saturation and concentration in mg/L), depth, pH, turbidity, and chlorophyll fluorescence. These measurements are taken every 15 minutes and stored on a submersible YSI multi-parameter sonde (i.e., data logger). Sondes are rotated every 2-3 weeks for cleaning and calibration.

2) To meet the nutrient sampling requirements of the SWMP, monthly grab samples, in tandem with a 24-hour ISCO water sampler, are collected and processed for various nutrient compounds. The chemical analyses mainly focus on levels of nitrogen, phosphorous, and carbon in the water column.

The water quality monitoring and nutrient sampling occur at four water quality stations located throughout the Waquoit Bay Estuary: Childs River (tidal riverine system with high nitrogen load), Menauhant Yacht Club (closest proximity to ocean influence from Vineyard Sound), Sage Lot Pond (tidal pond surrounded by polyhaline salt marshes), and Metoxit Point (open water location inside Waquoit Bay).

9) Sensor specifications, operating range, accuracy, date of last calibration

Temperature

January 1, 2015 – December 4, 2015 (WBNERR unit)

Units: Celsius
Sensor Type: Platinum Resistance Thermometer (PRT), Thermistor (100kΩ @ 25°C)
Model #: HMP35C
Operating Temperature: -35 to +60°C
Temperature Measurement Range: -35 to +55°C
Temperature Accuracy: ±0.4°C
Date of last calibration: 6/27/2012
Dates of Sensor Use: 6/27/2012 – 12/04/2015
S/N: A4940008

Starting December 4, 2015 (Great Bay NERR unit on loan)

Units: Celsius
Sensor Type: Platinum Resistance Thermometer (PRT) 1000 Ω, IEC 751 1/3 Class B
Model #: HMP45AC
Operating Temperature: -40 to +60°C
Temperature Measurement Range: -40 to +60°C
Temperature Accuracy: ±0.4°C
Date of last calibration: 02/05/2014
Dates of Sensor Use: 12/04/2015 – current as of 12/31/2015
S/N: Z2220075

Relative Humidity (RH)

January 1, 2015 – December 4, 2015 (WBNERR unit)

Units: Percent
Sensor Type: Sensor Type: Vaisala capacitive polymer H chip
Model #: HMP35C
Relative Humidity Measurement Range: 0 to 100%
RH Accuracy:
    ±2% RH (0 to 90%)
    ±3% RH (90-100%)
Stability: 1% per year
Uncertainty of calibration: 0.3% RH

Date of last calibration: 6/27/2012
Dates of Sensor Use: 6/27/2012 – 12/04/2015
S/N: A4940008

Starting December 4, 2015 (Great Bay NERR unit on loan)

Units: Celsius
Sensor Type: HUMICAP® 180
Model #: HMP45AC
Relative Humidity Measurement Range: 0 to 100% non-condensing
RH Accuracy:
±2% RH (0 to 90%)
±3% RH (90-100%)
Stability: 1% per year
Uncertainty of calibration: 0.3% RH
Date of last calibration: 02/05/2014
Dates of Sensor Use: 12/04/2015 – current as of 12/31/2015
S/N: Z2220075

Photosynthetically Active Radiation (PAR)

Units: millimoles/m^2 (total flux)
Sensor Type: LiCor Quantum Sensor (PAR)
Model #: LI-L1190SZ
Stability: < ±2% change over a 1 year period
Operating Range
Temperature: -40°C to 65°C
Humidity: 0 to 100%
Sensitivity: typically 5µA per 1000 µmoles $s^{-1}m^{-2}$
Light spectrum wavelength: 400 to 700 nm
Date of last calibration: 09/09/2011
Multiplier: -264.77 (millivolt adapter)
S/N: Q45963
Dates of Sensor Use: 9/9/2011 - current as of 12/31/2015

Wind Speed

January 1, 2015 – December 4, 2015 (WBNERR unit)

Units: meter per second (m/s)
Sensor type: 18 cm diameter 4-blade helicoids propeller molded of polypropylene
Model: RMY 05103
Range:
0-60 m/s (134 mph)
gust survival 100 m/s (220 mph)
Direction Range: 360° Threshold Sensitivity: 0.5 m/s (1.1 kts) at 10° displacement
Accuracy: +/- 0.3 m/s
Date of last calibration: 8/1/2011, new bearings 6/27/2012
Dates of Sensor Use: 6/27/2012 – 12/04/2015
S/N: 09834

Starting December 4, 2015 (Great Bay NERR unit on loan)

Units: meter per second (m/s)

Sensor type: 18 cm diameter 4-blade helicoids propeller molded of polypropylene
Model: RMY 05103
Range:
0-60 m/s (134 mph)
gust survival 100 m/s (220 mph)
Direction Range: 360° Threshold Sensitivity: 0.5 m/s (1.1 kts) at 10° displacement
Accuracy: +/- 0.3 m/s
Date of last calibration: New in 2015
Dates of Sensor Use: 12/04/2015 - current as of 12/31/2015
S/N: 05178A

Wind Direction

January 1, 2015 – December 4, 2015 (WBNERR unit)

Units: degrees
Sensor type: balanced vane, 38 cm turning radius
Model: RMY 05103
Direction Range: 360° Threshold Sensitivity: 0.5 m/s (1.1 kts) at 10° displacement
Date of last calibration: 8/1/2011, new bearings 6/27/2012
Dates of Sensor Use: 6/27/2012 - 12/04/2015
S/N: 09834

Starting December 4, 2015 (Great Bay NERR unit on loan)

Units: degrees
Sensor type: balanced vane, 38 cm turning radius
Model: RMY 05103
Direction Range: 360° Threshold Sensitivity: 0.5 m/s (1.1 kts) at 10° displacement
Date of last calibration: New in 2015
Dates of Sensor Use: 12/04/2015 - current as of 12/31/2015
S/N: 05178A

Barometric Pressure

Units: millibars (mb)
Sensor Type: Vaisala Barocap © silicon capacitive pressure sensor
Model #: CS 105 Vaisala PTB101B
Operating Range:
Pressure: 600-1060 mb
Temperature: -40 to +60°C
Humidity: non-condensing
Accuracy: ±0.5 mb @ +20°C
Stability: ± 0.1 mb per year
Date of last calibration: 6/27/2012
Dates of Sensor Use: 6/27/2012 - current as of 12/31/2015
S/N: P5240006

Precipitation

Units: millimeters (mm)
Sensor Type: Heated Tipping Bucket Rain Gauge
Model #: 385L
Rainfall per tip: 0.01 inch

Operating range: Temperature: 0° to 50°C; Humidity: 0 to 100%
Accuracy:
±0.5% @ < 0.5" (1.25 cm)/hr rate
±2.0% @ < 3.0" (7.50 cm)/hr rate
Date of last calibration: 9/9/2011
Dates of Sensor Use: 9/9/2011 - current as of 12/31/2015
S/N: C1521

The CR1000 has two MB Flash EEPROM that are used to store the Operating System. Another 128 K Flash is used to store configuration settings. A minimum of 2 MB SRAM is (4 MB optional) is available for program storage (16K), operating system use, and data storage. Additional storage is available by using a compact flash card in the optional CFM100 Compact Flash Module. This station was installed on 7/12/2006. Additional CR1000 specification can be found at: http://www.campbellsci.com/documents/lit/s_cr1000.pdf.

S/N: 5287
Manufacture Year: 2006
Date CR1000 Installed: 07/12/2006
Date CR1000 Calibrated: NA
CR1000 Firmware Version: CR1000.Std.14
CR1000 Program Version: wqbchmet_V5_032015.cr1
Campbell Charger for CR1000: Model # CH 100, 12 V

10) Coded variable indicator and variable code definitions

Site definitions: CH = Carriage House
Station code: wqbchmet

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 data logger, 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 coded 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) Comments/Remarks (*All times appear in Eastern Standard Time)*

a) General Comments:

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.

Small negative PAR values are within range of the sensor and are due to normal errors in the sensor and the CR1000 Datalogger. The Maximum signal noise error for the LiCOR sensor is +/- 2.214 mmoles/m^2 over a 15 minute interval. **Please see note below regarding rejected PAR data.**

Relative Humidity data greater than 100 are within range of the sensor accuracy of +/-3%. Data exceeding 100% are within sensor accuracy but are flagged as rejected as part of QAQC.

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.**

b) Program Reloads (GPR):

- 02/23/2015, 14:15 – Removed Total Solar Radiation sensor from the CR1000 program.
- 03/19/2015, 10:30 – Corrected CR1000 to CDMO SOPs. However, PAR multiplier was incorrect for millivolt adapter. Data was displaying in negative values.
- 03/23/2015, 9:45 – Corrected PAR multiplier to account for millivolt adapter.

c) Specific 2015 Notes:

General:

- All data, <1> [SOC] (CSM) {CSM} - Because the data logger, CR1000, has surpassed the recommended calibration deadline of February 15, 2015, all data starting February 15th, 2015 through the end of the year are flagged as suspect (<1>) and out of calibration (SOC). Also, until 12/04/2015, all sensors had surpassed CDMO recommended calibration standards as well. Following 12/04/2015, the temperature/RH and wind sensor were replaced with units on loan from the Great Bay NERR (New Hampshire). The Great

Bay sensors meet calibration standards (see section 9 for details). However, barometric pressure, PAR, and precipitation sensors are all noncompliant. **It's important to note that while these sensors do not meet recommended calibration standards, the data appear to fall within acceptable ranges and are comparable to local weather reports. Please contact Jordan Mora (contact information on page 1) for more information and maintenance log reports.**

- 08/11/15 8:30 to 11/16/15 15:45, <-3> [SSR] (CSM) – The 30ft tower with the temperature/relative humidity and wind speed/direction sensors was taken down and the sensors removed due to interfering construction on the Carriage House. All temperature, relative humidity, and wind data are rejected following the removal of the tower until the tower was reinstalled on 11/16/2015. Tower was not resurrected into final position until 16:00 on 11/16/2015 so wind speed and direction values (WSpd, MaxWSpd, Wdir, SDWdir) are rejected until that time.

Temperature and Relative Humidity (RH):

- The temperature and humidity sensors are considered out of calibration from 1/1/2015 until the sensor was swapped on 12/4/2015. In addition, all sensors are flagged and coded as out of calibration from 2/15/2015 through the end of the year due to an out of calibration CR1000. **It's important to note that while these sensors do not meet recommended calibration standards, the data appear to fall within acceptable ranges and are comparable to local weather reports. Please contact Jordan Mora (contact information on page 1) for more information and maintenance log reports.**

- 01/29/2015 to 02/06/2015, <-3> [SQR] (CSM)– The temperature and relative humidity probe malfunctioned intermittently. Although the exact cause is unknown, the most likely reason is ice/cold weather interference. The probe was removed and cleaned on 02/06/2015 at 13:00. Once reinstalled, the tower was resurrected at 17:00. All data during intermittent periods and maintenance are rejected (-3) and flagged for QAQC (SQR) or maintenance (SMT).

- 11/16/2015 16:00 to 12/04/2015 13:30, <-3> [SSM] (CSM) – The temperature/RH probe was reconnected at the new location following Carriage House construction (see section 5 for details) and the tower was back up at 16:00 EST on 11/16/2015. However, the temperature/RH probe (SN: A4940008) failed and recorded invalid values, so all data are rejected.

Barometric Pressure (BP):

- The barometric pressure sensor is considered out of calibration beginning 6/27/2015 through the end of 2015. In addition, all sensors are flagged and coded as out of calibration from 2/15/2015 through the end of the year due to an out of calibration CR1000. **It's important to note that while these sensors do not meet recommended calibration standards, the data appear to fall within acceptable ranges and are comparable to local weather reports. Please contact Jordan Mora (contact information on page 1) for more information and maintenance log reports.**

Wind Speed and Direction (WSpd, MaxWSpd, Wdir, and SDWDir):

- The wind sensor is considered out of calibration beginning 6/27/2015 until the sensor was swapped on 12/4/2015. In addition, all sensors are flagged and coded as out of calibration from 2/15/2015 through the end of the year due to an out of calibration CR1000. **It's important to note that while these sensors do not meet recommended calibration standards, the data appear to fall within acceptable ranges and are comparable to local weather reports. Please contact Jordan Mora (contact information on page 1) for more information and maintenance log reports.**

- 11/16/2015 16:00 to 12/04/2015 13:30, <-3> [SSM] (CSM) – At 16:00 EST on 11/16/2015, the tower was reinstalled at the new location following Carriage House construction (see section 5 for details). However, the wind direction values suggest that the instrument was no longer oriented correctly following reconnection to the tower. For example, at 16:15 EST the wind direction showed 125° but based on local weather data, the wind should have been recording 280°. All wind direction data was rejected during this time period.

PAR (Photosynthetically Active Radiation)

- As of 09/02/2015 the CDMO has rejected all PAR data from 01/1/2015 - 03/19/2015 10:15 ,<-3> (CSM). These data were collected as averages instead of 15 minute totals. Although the data were rejected, users interested in PAR averages may still find the data useful when looking at trends.

- The PAR sensor is considered out of calibration from 1/1/2015 through 12/31/2015. In addition, all sensors are flagged and coded as out of calibration from 2/15/2015 through the end of the year due to an out of calibration CR1000. **It's important to note that while these sensors do not meet recommended calibration standards, the data appear to fall within acceptable ranges and are comparable to local weather reports. Please contact Jordan Mora (contact information on page 1) for more information and maintenance log reports.**

- <1> [SOC] (CSM) - ….Elevated nighttime measurements > 0.0 fall under the suspect out of calibration flagging and coding. The reason for the elevated values is unknown but may be caused by moisture seeping into the sensor. Below are the ranges of dates where elevated nighttime PAR readings were recorded:

    - 04/26/2015 to 05/04/2015
    - 05/05/2015 to 05/06/2015
    - 05/09/2015 to 05/11/2015
    - 05/15/2015 to 05/18/2015
    - 06/24/2015 to 06/27/2015
    - 07/03/2015 to 07/06/2015
    - 07/08/2015 to 07/09/2015
    - 10/17/2015 to 10/19/2105
    - 10/21/2015
    - 10/24/2015
    - 12/18/2015

- 12/25/2015 to 12/26/2015

- 03/19/2015, 10:30 to 03/23/2015, 09:30 <-3>[SIC](CSM) – In an effort to update the CR1000 program with standard formatting and units, a new program was uploaded on 03/19/2015. Unfortunately, there was an error in the PAR multiplier formula, and a corrected version had to be uploaded on 03/23/2015. All data within this timeframe are rejected.

Precipitation

- The precipitation gauge is considered out of calibration from 1/1/2015 through 12/31/2015. In addition, all sensors are flagged and coded as out of calibration from 2/15/2015 through the end of the year due to an out of calibration CR1000. **It's important to note that while these sensors do not meet recommended calibration standards, the data appear to fall within acceptable ranges and are comparable to local weather reports. Please contact Jordan Mora (contact information on page 1) for more information and maintenance log reports.**

- 01/20/2015 11:15 to 01/26/2015 14:15 – During monthly maintenance while checking the tipping bucket in the rain gauge, the heating wire became lodged preventing the bucket from tipping. This resulted in lost precipitation data until the problem was noticed and fixed on 01/26/2015 at 14:15. All data during this period has been rejected (-3). Cumulative precipitation values from 01/26/2015 14:30 - 01/27/2015 00:00 were also rejected since snowfall may have been missed prior to the bucket being repaired and we cannot be sure that those values are accurate.

- 4/8/2015, <5> [SMT] {CSM} – Bucket accidentally tipped during monthly maintenance check causing an incorrect precipitation measurement of 0.5mm starting at ~10:15 EST. Total Precipitation value at 10:15 was corrected to 0mm. Starting at 21:15 real precipitation measurements started. Cumulative Precipitation values between 10:15 to 21:00 have been corrected to 0mm; during the rain event between 21:15 and 00:00, values are subtracted by 0.5mm to adjust for the error.

- 6/23/2015, <5> [SMT] (CSM) - Bucket accidentally tipped during monthly maintenance check causing an incorrect precipitation measurement of 0.3mm at 10:45 EST. Total precipitation and Cumulative Precipitation (corrected for the remainder of the day until 6/24/2015 00:00) have been corrected to remove the false readings and to reflect the actual precipitation that occurred beginning at 18:00.

- 07/31/2015, <5> [SMT] (CSM) - Bucket accidentally tipped during monthly maintenance check causing an incorrect precipitation measurement of 0.3mm at 10:00 EST. The Total Precipitation and Cumulative Precipitation readings at 10:00 EST have been corrected to 0mm to remove the false reading. Remaining cumulative precipitation readings were corrected to 0 for the rest of the day.

- 08/12/2015, <5> [SMT] (CSM) - Bucket accidentally tipped during monthly maintenance check causing an incorrect precipitation measurement of 0.3mm at 09:45 EST. The Total Precipitation and Cumulative Precipitation readings at 09:45 EST have been corrected to 0mm to adjust for the false reading.

- 08/12/2015 to 08/22/2015, <-3> [SSM] (CSM) – Sensor malfunction due to human error. When the tipping bucket was checked during monthly maintenance, the heating wire got stuck beneath the tipping cup which restricted the movement of the tipping sensor. Although several rainstorms passed through during the week while this sensor was stuck, those precipitation data are unavailable. The problem was recognized and resolved on 08/22/2015 at 13:00 by Chris Weidman (former Research Coordinator). Cumulative precipitation was rejected for the entire day (through 8/23/2015 00:00) as a rainstorm in the morning (before the sensor was fixed) went unrecorded.

- 08/22/2015 13:00 <5> [SMT] (CSM) – Bucket was purposely tipped after removing the heating wire from underneath the tipping cup to make sure the sensor function had been restored. The total precipitation showed an incorrect reading of 2.8mm at 13:00 which was corrected to 0mm.

- 09/02/2015, <5> [SMT] (CSM) - Bucket accidentally tipped during monthly maintenance check causing an incorrect precipitation measurement of 1.0mm at 14:30 EST. The Total Precipitation and Cumulative Precipitation readings have been corrected to 0mm to remove the false reading. Remaining cumulative precipitation readings were corrected for the rest of the day.

- 10/23/2015, <5> [SMT] (CSM) - Bucket accidentally tipped during monthly maintenance check causing an incorrect precipitation measurement of 1.3mm at 10:15 EST. The Total Precipitation and Cumulative Precipitation readings have been corrected to 0mm to remove the false reading. Remaining cumulative precipitation readings were corrected for the rest of the day.

- 11/24/2015 11:30 to 11/30/2015 12:00, <-3> [SSM] (CSM) – When the heating cable was connected, it caused a disruption in the electrical circuit for the precipitation gauge. All data are rejected until the problem was identified and the heating cable was unplugged. Cumulative precipitation data are rejected until the end of the day on 11/30/2015.

- 12/31/2015 10:30 – 23:45 <5> [SMT](CSM) – The precipitation bucket was accidentally tipped during maintenance. The error was removed from total precipitation and the subsequent readings for cumulative precipitation were adjusted for the remainder of 12/31/2015.