Waquoit Bay National Estuarine Research Reserve Meteorological Metadata
January 2009-December 2009
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I. Data Set & Research Descriptors

1) Principal Investigator(s) & contact persons

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2) Entry Verification

System I: CR1000, CR10X

1) Starting July 12 , 2006 at 17:45, WBNERR 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.
2) In late October 2003 a CR10X program was installed. 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.

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 that are transmitted hourly for Satellite upload; and CR1000_SWMP.dat files stores the 15 minute average 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. The CR1000 then interfaces with the Loggernet software supplied by Campbell Scientific.

Presently, data are uploaded from the CR1000 data logger to a personal computer (IBM compatible). Files are exported from LoggerNet in a comma-delimited format and upgaded 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

Chris Weidman, Research Coordinator and MaryKay Fox, Assistant Research Coordinator, error checked and compiled the meteorological data.

System II.

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. A 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. The telemetry is "Provisional" data and not the "Authentic" Dataset used for long term monitoring and study.
All the real-time meteorological data since March 9, 2004 are archived at a CDMO server and available on the web (Note this is currently a separate database from data acquired through System I methods). This data can be viewed by going to http://cdmo.baruch.sc.edu.

System III. 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. The Pyranometer was calibrated and installed November 15th, 2005. Data from this database can be obtained by contacting Chris Weidman at Chris.Weidman@state.ma.us.

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 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 anytime. All collected data is quality checked immediately after the monthly downloads. The error/anomaly reports and all monthly parameter graphs are printed and reviewed.

Campbell Scientific data telemetry equipment was installed at the WQB Carriage House meteorological station on July 2006 and transmits data to the NOAA GOES satellite, NESDIS ID #3B022462. The transmissions are scheduled hourly and contain four (4) data sets reflecting fifteen minute data sampling intervals. 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**:
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)

Sensors on the weather station are inspected monthly for damage or debris. The heated rain gauge tends to collect debris and is cleaned out every few days, particularly before and after major storms events. Sensors are removed and calibrated on a yearly or every two year basis depending on the particular sensor, unless the real-time date stream indicates a malfunction. Also, once a month on upload day, we use a compass and utilize a WeatherStation monitoring system (with a wind sensor) to run a comparative set of observations as a general check on the Campbell station sensors. **MET station sensors at WQB NERR were calibrated onsite by Richard Payne.**

Recommended calibration frequency for the MET station sensors:
- Temperature/Humidity- yearly recalibration
- Rain 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
- CR1000-every 5 years (required beginning 2014, one year initial grace period)

5) Site Location and character

The weather station is located on a 24-acre parcel of Reserve land that includes the Reserve headquarters at 41° 34’54.12 N, 70° 31’30.36 W . Wind (speed and direction), temperature and relative humidity sensors are mounted on the top of the 10-m aluminum tower next to the Carriage House, which houses our grounds facilities, classroom and laboratory. The tower is surrounded on three sides by an open parking area; its attached probes stand approximately 2.5 m above the roof peak of the adjacent building and are separated from any trees by at least 30 m. A crushed shell parking area (bleach white in color) is located directly to the south and west of the tower, with the building and its roof peak to the northeast. 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). The LiCor (PAR) sensor and an 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 barometric 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 is 11.2 m above sea level (NGVD). The top of the gauge is 1 meter above the 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.

Note: The temperatures for Waquoit Bay on the southwest corner of Cape Cod vs. for Provincetown on the northeast corner are likely to be a bit warmer in Spring and Summer and a bit colder in Autumn and Winter. Provincetown is on a very small peninsula a couple of miles wide, surrounded by colder (in Summer) Gulf of Maine waters, while Waquoit Bay is closer to the mainland of New England and is bathed by the warmer shelf waters of southern New England. Also, these averages do not include the period since 1960. The last two decades, in particular, have been known to be among the warmest recorded (last 150 years), though that may be compensated in part by the historically cold periods of mid-1960s and mid-1970s.

Meteorological data from Waquoit Bay NERR can also 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 weatherward (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). We frequently compare our observations with data from the NOAA offshore tower at the entrance to Buzzards Bay (Temperature, Wind, Air Pressure) because its current (within the hour) and archived measurements are available online (website).

Meteorological differences between the offshore Buzzards Bay Tower and our Waquoit Bay station are to be expected because of a separation of about 40 km and because of the site geographies (offshore vs. coastal land). Wind direction values generally are higher for Waquoit Bay versus Buzzards Bay Tower, meaning a more westward and northward component at the Waquoit Bay site. This is an expected result of winds encountering greater friction over land than over water causing the wind to turn more to the right over land. Average wind speeds are notably lower at Waquoit Bay by about a factor of four. Somewhat lower wind speeds are expected again because of the greater surface friction and topography encountered at land versus offshore stations, but a factor of four appears to us to be unusually large. We have verified our Wind Monitor wind speeds using a hand-held Kestrel, but our wind speeds are also lower by a factor of 2-3 compared with other nearby land stations (Otis Air Base and Hyannis Airport). The Buzzards Bay station is noted for its very high (often the highest) wind speeds recorded for even nearby offshore sites, so the fact that it has some "outlier" characteristics relative to other regional stations is to be noted. As for local topographic effects at Waquoit Bay, the site (as noted above) is about 100 m from a 6 m bluff and the surrounding area is forested with tree canopies topping out at about 10 m., so the wind sensors no doubt experience a fairly turbulent (gusty) wind stream. In contrast maximum wind speeds at Waquoit are not so different (80%)from Buzzards Bay Tower values strongly indicating that the Waquoit wind sensor is calibrated correctly and that the winds at Waquoit show more variability. Air pressure values between stations track closely with Waquoit showing only a slightly lower average of about 1 mb. Air Temperatures also track closely, with the expected land/ocean contrasts of Waquoit's land site showing more extreme hot and cold values, and with colder averages in the winter and warmer averages in the summer. Water temperatures also show a similar though more subdued set of contrasts between stations.

Other stations which are also used for reference are 1) the Woods Hole Oceanographic Institution in Woods Hole (Temperature, Air Pressure, Solar Radiation), 2) Falmouth DPW (rainfall), 3) Otis Air Force Base (wind), and 4) Hyannis Airport (Temperature, Wind, Rainfall, Air Pressure, Relative Humidity) and Menauhant Yacht Club weather station operated and maintained by Dr. Richard Taylor

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. Data were collected continuously for the entire year in 2009 from 1/1/2009 00:00 through 12/31/2009 23:45, except for when sensors were calibrated, or when sensors were removed due to failure.

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:
National Estuarine Research Reserve System (NERRS). 2012. System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: 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

Photosynthetically Active Radiation (PAR)
LiCor Quantum Sensor

Model #: LI-190SZ
Stability: <±2% change over a 1 year period
Operating Temperature: -40 to +65 °C
Sensitivity: typically 5μA per 1000 μmoles $s^{-1}m^{-2}$
Light spectrum wavelength: 400 to 700 nm
Serial Number: Q12415
Date of Calibration:5/12/2008
Dates of Sensor Use: 12/05/2008 - 6/18/2009
Serial Number: Q38878
Date of Calibration: 6/18/2009
Dates of Sensor Use: 6/18/2009 - current as of 12/31/2009
Multiplier:

01/01/2009 - 02/19/2009 = sensor removed
02/19/2009 – 07/31/2009 = 0.2153
07/31/2009 – current as of 12/31/2009 = 215.3

Total Solar Radiation
EPLAB Pyranmeter (SoRAD)
Model #: 8-48 SW/N 9698
Stability: >1% over 5 years (0.2 % per year)
Operating Temperatures: ± 1.5 percent constancy from -20 to + 40 ºC
Sensitivity: 11 microvolts/watt $meter^{-2}$ approximately
Impedance: 350 ohms approximately
Response Time: 5 seconds (1/e signal)
Linearity: ± 1 percent from 0 to 1400 watts $meter^{-2}$
Serial Number: 9698
Installed November 15th, 2005
Date of Last Calibration 3/26/2008
Dates of Sensor Use: 3/26/2008-current as of 12/31/2009

Wind Monitor
Model #05103
Range: 0-60 m/s (130 mph), threshold: 0.5 m/s (1.1 kts)
(Note: from observation we note that the monitor seems to have a lower threshold than 0.5 m/s with the wind propeller spinning and values down to 0.1 m/s being measured).
Direction Range: 360°; Threshold Sensitivity: 0.5 m/s (1.1 kts) at 10° displacement
Serial Number:NA
Date of Last Calibration(maintenance): 6/18/2009
Dates of Sensor Use: 6/18/2009 – current as of 12/31/2009

Temperature and Relative Humidity
Model #: HMP35C
Operating Temperature: -20 to +60°C
Temperature Measurement Range: -35 to +50°C
Temperature Accuracy: 0.5°C
Relative Humidity Measurement Range: 0 to 100%
RH Accuracy: ±2% RH, 0 to 90% or ±3% RH, 90-100%
Uncertainty of calibration: 0.3% RH
Serial Number: NA
Date of Last Calibration: 6/18/2009
Dates of Sensor Use: 6/18/2009 - current as of 12/31/2009

Barometric Sensor
Model #: PTP101B
Operating Range: 600-1060 hPa
Temperature: -40 to +60°C
Humidity: non-condensing

Accuracy: ±0.5 hPa
Stability: NA
Serial Number: NA
Dates of Last Calibration: 6/18/2009
Dates of Sensor Use: 6/18/2009 - current as of 12/31/2009

Heated Tipping Bucket Rain Gauge
Model #: TR-525
Range: 0.1 mm
Accuracy: 1.0% at <10 mm/hour
Serial Number: C1521
Direct calibration 12/4/2008
Dates of Sensor Use: 12/4/2008 – current as of 12/31/2009

The CR1000 has two MB Flash EEPROM that is 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.

CR1000 dates in use: 7/12/2006 - current as of 12/31/2009

Additional CR1000 specification can be found at: http://www.campbellsci.com/documents/lit/s_cr1000.pdf.

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 datalogger, 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 QAQC 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

As of 12/04/2014 the CDMO has removed all Total Solar Radiation data for 2008-2012. Please contact the WQB NERR for more information or to request those data.

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/m2 over a 15 minute interval.

Relative Humidity data greater than 100 are within range of the sensor accuracy of +/-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.**

Pyranometer Data
WQBNERR has been collecting Total Solar Radiation data since November 16th, 2005 at 3:15pm on an experimental basis. See section 9: Sensor specifications, operating range, accuracy, date of last calibration for detailed information on the Pyranometer instrumentation. **Contact Waquoit Bay NERR Research Coordinator for questions on the Pyranometer data or to request the raw data files.**

Record numbers were not included with the annual data submission to the CDMO. During the secondary review process the record numbers were copied from raw files and inserted back into the data file. Although Record numbers are not a required parameter, they are useful in the QAQC process, especially when looking for CR1000 program reloads.

1/1/2009 00:00 - 2/19/2009 16:00 all PAR data were rejected due to the sensor being removed from the station <-3> SSR CSM.

1/2/2012 14:00 Due to missing 5-second data that resulted in inaccurate 15 minute averages and totals, all data were rejected <-3> GPR CSM following a program reload at 13:55.

1/2/2009 14:45 Due to missing 5-second data that resulted in inaccurate 15 minute averages and totals, all data were rejected <-3> GPR CSM following a program reload at 14:32.

1/12/2009 14:30 All date are missing <-2> GPR CSM due to a program reload. Data at 14:45 were rejected <-3> GPR CSM due to missing 5-second data that resulted in inaccurate 15 minute averages and totals.

1/12/2009 Following the program reload at 14:45 cumulative precipitation data reset from 0.3mm to 0.0. The data from 1/12/2009 15:00 to 1/13/2009 00:00 were corrected to reflect the 0.3mm of precipitation that was recorded prior to the reset <5> CSM.

2/19/2009 15:45 Due to missing 5-second data that resulted in inaccurate 15 minute averages and totals, all data were rejected <-3> GPR CSM following a program reload at 15:42.

2/19/2009 Following the program reload at 14:45 cumulative precipitation data reset from 3.6mm to 0.0 beginning at 16:30. Cumulative precipitation data typically reset at the program reload but for unknown reasons they didn't reset until the 16:30 timestamp. The data from 2/19/2009 16:30 to 2/20/2009 00:00 were corrected to reflect the 3.6 mm of precipitation that was recorded prior to the reset <5> CSM.

2/19/2009 16:45-12/31/2009 23:45 All PAR data were rejected <-3> SIC CSM. PAR data were collected as 15 minute averages instead of 15 minute totals. Although the data were rejected, users interested in PAR averages for 2009 may still find the data useful when looking at trends. **Please note that these averages were corrected**:

- 2/19/2009 16:15 - 4/6/2009 09:00 All PAR data were rejected due to being averages. These averages were corrected and may not be accurate but some users may find them useful when looking at trends. An incorrect multiplier was used following PAR sensor calibration. These data were corrected, however, the corrections were were not made to the raw data and instead were made to the QC data that were returned after the raw data were submitted to the CDMO (See Section 2 Entry Verification for more details about the upload process). Also during these dates and times the data had to be converted to millimole/m^2/s from micromole/m^2/s by multiplying the QC value by 1000.
  Correction Formula:
  Corrected PAR Data = (Recorded PAR value x 0.516826923) x1000
  Where 0.516826923 the calculated difference between the incorrect multiplier (0.416) and the correct multiplier (0.215). [0.215/0.416 = 0.516826923]

- 4/6/2009 09:15 - 6/2/2009 16:00 All PAR data were corrected. An incorrect multiplier was used following PAR sensor calibration. These data were corrections were made to the raw. Also during these dates and times the data had to be converted to millimole/m^2/s from micromole/m^2/s.
  Correction Formula:
  Corrected PAR Data = (Recorded PAR value x 0.516826923) x1000
  Where 0.516826923 the calculated difference between the incorrect multiplier (0.416) and the correct multiplier (0.215). [0.215/0.416 = 0.516826923]

- 6/2/2009 16:15 - 7/31/2009 13:15 ALL PAR data were rejected due to being averages. These averages were corrected and may not be accurate but some users may find them useful when looking at trends. These averages were converted to millimole/m^2/s from micromole/m^2/s by multiplying raw values by 1000.

3/24/2009 10:15 All data are missing due to roof maintenance that interfered with the MET station power supply.

3/24/2009 at 10:00 and from 10:45 - 15:30 BP data were rejected <-3> SQR CSM. Roofers interfered with the BP sensor. Following the loss of power at 10:15, all 10:30 data were reject since more than likely they were not a full 15 minutes of 5-second data following the power loss. All other parameters at 10:00 and between 10:45 and 15:30 appear to be fine and are only coded as CSM.

5/1/2009 08:45 Due to missing 5-second data that resulted in inaccurate 15 minute averages and totals, all data were rejected <-3> GPR CSM following a program reload.

5/21/2009 12:45 Due to missing 5-second data that resulted in inaccurate 15 minute averages and totals, all data were rejected <-3> GPR CSM following a program reload at 12:36.

5/26/2009 09:00 Due to missing 5-second data that resulted in inaccurate 15 minute averages and totals, all data were rejected <-3> GPR CSM following a program reload at 08:50.

5/27/2009 10:30 Due to missing 5-second data that resulted in inaccurate 15 minute averages and totals, all data were rejected <-3> GPR CSM following a program reload at 10:20.

5/27/2009 Cumulative precipitation data prior to the 10:20 program reload were recorded as 0.3mm. A bucket tip was recorded between 10:15 and 10:30 and may have occurred just after the 10:20 program reload. There is no record of rain gauge maintenance during the program reload. The data were corrected to reflect the 0.3mm prior to the program reload and although a tip occurred during the same timestamp as the program reload, it was also included in the cumulative precipitation for the day as it is believed not to be maintenance related. Data were corrected from 10:15 through the midnight timestamp at 5/28/2009 00:00 <5> CSM.

6/2/2009 16:00 Due to missing 5-second data that resulted in inaccurate 15 minute averages and totals, all data were rejected <-3> GPR CSM following a program reload at 15:59.

6/2/2009 Following the program reload at 15:59 cumulative precipitation data reset from 0.5mm to 0.0. The data from 6/2/2009 16:15 to 6/3/2009 00:00 were corrected to reflect the 0.5mm of precipitation that was recorded prior to the reset <5> CSM.

6/16/2009 13:45 - 6/18/2009 12:45 Vaisala HMP 155 Air Temperature and Relative Humidity sensor was disconnected from power and was removed for maintenance and calibration <-3> SSR CSM. The HMP155 was reinstalled but still undergoing maintenance through 6/18/2009 14:00 <-3> SMT CSM.

6/16/2009 13:45 - 6/18/2009 12:45 Barometric Pressure sensor was removed for maintenance and calibration <-3>SSR CSM.

6/18/2009 13:00 - 14:00 The MET tower was lowered for maintenance so ATemp, RH and all wind data were all rejected <-3> SMT CSM. Bearing were replaced in the wind sensor while the tower was down. PAR and precipitation data were not rejected since those sensors are not located on the tower.

6/18/2009 15:00 Due to missing 5-second data that resulted in inaccurate 15 minute averages and totals, all data were rejected <-3> GPR CSM following a program reload at 15:00.

7/31/2009 13:30 Due to missing 5-second data that resulting in inaccurate 15 minute averages and totals, all data were rejected <-3> GPR CSM following a program reload.

8/12/2009 12:45 Due to missing 5-second data that resulted in inaccurate 15 minute averages and totals, all data were rejected <-3> GPR CSM following a program reload.

10/14/2009 15:30 - 16:15 total precipitation data were corrected to 0 due to maintenance at the station <5> SMT CSM. Cumulative precipitation data were corrected through the midnight timestamp, 10/15/2009 00:00 <5> SMT CSM.

Local National Weather Service Reporting Station.
Since December 2002, in the SW corner of the Reserve, at the outlet of Eel River and located at the Menauhant Yacht Club, a National Weather Service Reporting Station in East Falmouth has been recording local 24 hour weather conditions (Data Garrison https://datagarrison.com/). Dr. Doc Taylor records daily observations at 0700 and 1900 for the following weather parameters: Temperature (ºF; minimum and maximum), Precipitation (inches; rain and melted snow, snow fall, initial and endpoint times of events), Sky Conditions and Wind Direction (mph; gusts). WQBNERR compares its weather data with this station and other local weather stations which include Hyannis Airport (http://www.wunderground.com/cgi-bin/findweather/getForecast?query=02601#History), and WHOI Climate Reports (http://cis.whoi.edu/science/PO/climate/index.cfm). A complete monthly data set from the East Falmouth Reporting Station is available by contacting WQBNERR Research Coordinator.