

I. Data Set & Research Descriptors

1) Principal Investigator(s) & contact persons

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2) Entry Verification

System I.

- 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 CR10X data logger. Data are output to a file in three arrays: array 15 stores 15 minutes average, max and min data; array 60 stores hourly average, max and min data; and array 144 stores daily (24 hr) average, max and min data. The CDMO Data Logger (NERR_4.CSI) was loaded into the CR10X and controls the sensors. The CR10X then interfaces with the PC208W software supplied by Campbell Scientific.

Historically, at the end of every month, in the first few days of the new month, the data are uploaded from the CR10X data logger and / or storage module to a personal computer (IBM compatible) and saved as a deployment or "monthly" raw data file (DATA000.dat) onto a separate hard drive and backed up onto the Waquoit Bay NERR server. The server data is itself backed-up everyday offsite by a server located at the Massachusetts Dept. of Conservation and Recreation headquarters in Boston, MA. Files are exported from the PC208W or LoggerNet in a comma-delimited format (.dat) and opened in Microsoft Excel for pre-processing with the EQWin format macro (EQWinFormat.xls) that was developed by the CDMO to reformat the header columns, insert station codes, insert a date column (mm/dd/yyyy), correct the time column format and reformat the data to the appropriate number of decimal places. The pre-processed file is then ready to be copied into the EQWin weather.eqi file where data can be QA / QC checked and archived in a database. In practice at Waquoit Bay NERR, we also scan the raw data in both the earlier formats as well, just after uploading to look for significant time gaps and other gross anomalies, and similarly in the Excel format. EQWin queries, reports and graphs are used to look for outliers and other significant anomalies. Any anomalous or missing data are investigated and then noted below in the Anomalous / Suspect Data and Missing Data sections. Any Data corrections or substitutions (from real-time database or other source) are noted and any deleted data sections are noted in the Deleted Data sections.

Presently, data are uploaded from the CR1000 data logger to a personal computer (IBM compatible). Files are exported from PC208W 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 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

The most common reported errors/anomalies noted in the monthly error reports in 2007 were:

- Total PAR Licor data values with negative readings that ranged from -0.10 to -0.20.
- Relative Humidity percentages data values above 100%.

In all cases in 2007, these two most commonly reported anomalies were found to be valid data and retained. All reported errors/anomalies are double checked, and where data truly appear anomalous, they are compared with other regional meteorological data for verification.

Chris Weidman, Research Coordinator and MaryKay Fox, Assistant Research Coordinator, error checked and compiled the meteorological data for 2007.

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>.

Air Temperature (C)

- 15 minute average (over previous 15 minute period)
- Maximum (available from WQB NERR)
- Minimum (available from WQB NERR)
- Time Maximum
- Time Minimum

Relative Humidity (%)

- 15 minute average (over previous 15 minute period)

Barometric Pressure (mb)

- 15 minute average (over previous 15 minute period)

Wind Speed

- 15 minute average (over previous 15 minute period)
- Maximum

Wind Direction

- 15 minute average (over previous 15 minute period)
- Standard Deviation (over previous 15 minute period)

Total Precipitation (mm)

- previous 15 minute total

Total Photosynthetically Available Radiation (PAR)

- previous 15 minute total (millimoles/ m²)

Total Solar Radiation (SORad) (available from WQB NERR)

- previous 15 minute total (285 to 2,800 millimicrons)

Data from this database can be obtained by contacting Chris Weidman at Chris.Weidman@state.ma.us.

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° pyrliometer 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

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. However, it is noted that in 2004, due to a staffing shortage, no data were uploaded from late July 2004 until early December 2004. However, our real-time system indicated that accurate data were being collected for almost all of that time period. CR1000 raw data are currently stored on 2 data storage modules capable in combination of storing about 4 or more months of data. The CR1000 is also cabled directly to a desktop PC where the instantaneous 5 sec data are displayed (in a PC208W 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. Any error/anomaly messages are further investigated and the data is either corrected/deleted (if necessary) or commented on and left unchanged.

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 an annual basis depending on the particular sensor, unless the real-time data stream indicates a malfunction. Also, once a month on upload day, we use a handheld Kestrel 4000, to run a comparative set of observations as a general check on the Campbell station sensors.

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° 34.895 N, 70° 31.511' W. Wind (speed and direction), temperature and relative humidity sensors are mounted on a 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 EPLAB Pyranometer are mounted about 10 m away on an extended aluminum arm at a height of 3 m above the ground level and are 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 1.5 meters in height above groundlevel. . The rain gauge is located in an open field away from trees about 55 m northwest of the laboratory and tower at 41° 34.908' N, 70° 31.546' W and 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 (WBNERR) 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 brush 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.

Average temperature and rainfall conditions for the period 1882-1960 for Provincetown (about 50 km to the northwest) (Ptown) are shown in the table below in comparison with Waquoit Bay (WQB) monthly values for 2002.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Ptown Temp (C)	-0.6	-1.1	1.7	6.7	11.7	17.2	20.6	20.0	17.2	12.2	6.7	1.7	9.5
WQB Temp (C)	0.0	3.3	5.7	10.0	13.6	18.2	22.8	22.8	18.6	11.0	6.7	1.1	11.2
Ptown Ppt (cm)	9.9	8.7	9.4	9.0	7.5	7.0	6.8	8.1	8.4	8.7	8.1	9.2	100.8
WQB Ppt (cm)	12.5	5.6	14.5	10.7	13.4	8.1	1.4	6.5	13.8	8.2	19.9	20.4	135.0

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). A comparison of monthly data for 2002 between the Buzzards Bay Tower and Waquoit Bay SWMP data is shown in the table below:

Buzzards Bay Tower and Waquoit Bay (*data*) Monthly Meteorological Statistics for 2002

Note: Water temps in Waquoit Bay are from Menauhant SWMP Station

Month	Wdir	Wspd m/s	Gust m/s	Wave ht	Baro	Air T	Water T
Jan mean	243 (249)	9.0 (2.1)	10.0	1.3	1013.1 (1011)	4.0 (3.9)	5.7 (3.3)
Jan min	----	1.4 (0.0)	1.5	0.3	986.1 (980)	-4.5 (-4.7)	4.5 (0.6)
Jan max	----	21.5 (16.6)	24.6	2.9	1031.6 (1031)	11.1 (13.7)	8.0 (5.8)
Feb mean	220 (237)	8.6 (3.1)	9.5	1.1	1016.0 (1014)	3.1 (3.3)	4.6 (3.7)
Feb min	----	0.6 (0.0)	0.7	0.3	995.7 (992)	-6.9 (-9.7)	3.6 (1.0)
Feb max	----	21.0 (14.4)	23.6	3.1	1037.6 (1036)	11.1 (13.7)	6.1 (6.9)
Mar mean	179 (186)	8.8 (2.5)	9.6	1.3	1020.3 (1018)	4.5 (5.7)	5.1 (5.8)
Mar min	----	0.4 (0.0)	0.5	0.4	998.0 (998)	-6.6 (-5.5)	4.4 (3.2)
Mar max	----	20.0 (18.0)	22.0	3.7	1038.8 (1038)	12.7 (17.9)	5.9 (9.8)
Apr mean	201 (214)	7.6 (2.4)	8.3	0.9	1018.4 (1016)	8.0 (10.0)	7.9 (10.9)
Apr min	----	0.4 (0.0)	0.5	0.2	997.6 (995)	-0.9 (-2.0)	5.6 (6.7)
Apr max	----	21.6 (17.1)	25.4	2.3	1039.5 (1038)	22.4 (31.2)	10.2 (16.3)
May mean	200 (194)	7.8 (2.0)	8.5	0.9	1016.5 (1015)	11.4 (13.6)	11.1 (14.2)
May min	----	0.2 (0.0)	0.7	0.3	993.2 (990)	5.3 (2.4)	9.1 (10.4)
May max	----	22.1 (16.6)	24.6	2.4	1028.4 (1027)	19.6 (24.9)	14.5 (20.3)
Jun mean	175 (216)	6.9 (1.6)	7.5	0.8	1016.0 (1015)	16.2 (18.2)	15.3 (19.1)
Jun min	----	0.0 (0.0)	0.0	0.4	998.2 (996)	9.7 (5.9)	13.6 (14.9)
Jun max	----	18.6 (10.7)	20.3	1.8	1033.6 (1033)	26.2 (31.3)	18.5 (24.3)
Jul mean	207 (218)	6.6 (1.4)	7.0	0.7	1014.8 (1014)	20.6 (22.8)	18.7 (23.4)
Jul min	----	0.0 (0.0)	0.0	0.4	1005.3 (1004)	15.7 (11.2)	16.0 (21.5)
Jul max	----	15.9 (11.8)	17.1	1.6	1024.8 (1024)	29.4 (34.2)	21.5 (26.5)
Aug mean	178 (207)	6.4 (1.4)	6.8	0.6	1017.5 (1017)	21.2 (22.8)	20.0 (24.3)
Aug min	----	0.1 (0.0)	0.3	0.3	1005.4 (1006)	15.6 (11.7)	18.1 (20.6)
Aug max	----	14.2 (11.4)	14.9	1.4	1034.4 (1035)	25.9 (33.5)	22.9 (28.1)
Sep mean	180 (192)	7.1 (1.7)	7.7	0.8	1017.7 (1017)	18.8 (18.6)	19.0 (21.0)
Sep min	----	0.2 (0.0)	0.5	0.3	988.3 (992)	12.6 (7.8)	17.7 (19.0)
Sep max	----	21.2 (15.7)	24.5	2.9	1033.1 (1033)	23.9 (27.9)	20.6 (23.4)
Oct mean	177 (206)	8.5 (1.9)	9.5	0.9	1019.0 (1018)	12.5 (11.0)	16.4 (15.2)
Oct min	----	0.7 (0.0)	1.1	0.2	995.1 (995)	2.8 (-1.4)	13.2 (9.6)
Oct max	----	19.9 (13.2)	23.0	3.3	1030.3 (1029)	22.0 (24.9)	19.2 (21.3)
Nov mean	204 (241)	10.1 (2.5)	11.2	1.3	1013.0 (1012)	8.0 (6.7)	11.3 (9.0)
Nov min	----	0.1 (0.0)	0.5	0.3	987.2 (983)	-5.0 (-7.3)	8.5 (3.9)
Nov max	----	20.6 (15.8)	23.0	3.2	1028.4 (1028)	17.2 (21.1)	13.3 (14.2)

Dec mean	246 (254)	9.6 (2.8)	10.7	1.2	1014.2 (1013)	2.6 (1.1)	6.3 (3.3)
Dec min	----	0.0 (0.0)	0.0	0.3	974.3 (975)	-8.0 (-9.5)	4.4 (1.2)
Dec max	----	21.4 (17.2)	24.6	3.1	1036.4 (1035)	12.7 (13.0)	9.6 (6.7)
Ann mean	201 (218)	8.1 (2.1)	8.9	1.0	1016.4 (1015.0)	10.9 (11.5)	11.8 (12.8)
Ann min	----	0.0 (0.0)	0.0	0.2	974.3 (975)	-8.0 (-9.7)	3.6 (0.6)
Ann max	----	22.1 (18.0)	25.4	3.7	1039.5 (1038)	29.4 (34.2)	22.9 (28.1)

Meteorological differences between the offshore Buzzards Bay Tower and our Waquoit Bay station are to be expected both 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). A comparison of daily data from WBNERR and Buzzards Bay Tower and Falmouth DPW is shown below for the Month of December 2001.

Waquoit Bay(WQB) vs Buzzards Bay Tower(BUZ) and Falmouth DPW(FAL): December 2001

Note: ppt is only measured once a day at Falmouth DPW.

DAY	WQB Temp	BUZ Temp	WQB Baro	BUZ Baro	WQB WSpd	BUZ WSpd	WQB WDir	BUZ WDir	WQB PPT	FAL PPT
1	15.4	14.8	1014.1	1015.7	2.8	10.3	244	200	0.762	0.000
2	9.3	11.5	1021.4	1019.8	1.3	7.0	319	296	0	0.000
3	7.8	8.8	1024.0	1025.7	1.6	5.6	267	268	0.254	0.000
4	11.1	10.6	1024.4	1024.9	1.0	8.0	251	245	0	0.508
5	13.6	12.1	1022.9	1025.7	1.0	6.0	211	216	0	0.000
6	15.0	13.5	1014.2	1020.0	2.4	8.9	239	224	0	1.016
7	11.3	12.5	1012.9	1013.2	1.1	7.0	288	257	1.27	0.000
8	4.7	8.3	1019.3	1019.0	1.1	7.0	10	214	2.54	13.208
9	2.7	3.9	1016.2	1016.3	2.2	9.2	356	74	15.24	0.508
10	4.9	3.4	1027.3	1026.7	1.5	6.1	245	265	0.254	0.000
11	8.3	8.9	1025.2	1026.5	1.1	6.2	21	138	3.302	0.000
12	7.6	7.4	1030.0	1029.9	1.5	9.3	43	31	0	0.508
13	10.7	8.3	1015.6	1024.6	1.4	5.6	151	83	4.064	2.540
14	11.7	10.9	1010.6	1013.6	1.5	7.4	251	239	4.826	0.000

15	6.2	9.6	1014.1	1009.4	3.4	8.4	331	200	0.508	0.762
16	0.6	2.1	1026.4	1026.4	2.0	10.1	329	333	0	0.000
17	3.3	3.6	1014.6	1025.2	1.3	4.1	43	98	6.604	19.812
18	6.8	8.9	990.9	997.5	3.3	8.8	314	218	28.702	10.668
19	6.2	5.7	1006.9	1002.6	2.5	13.2	290	284	0	0.000
20	7.3	8.7	1002.1	1006.8	3.2	5.6	322	213	0	0.000
21	2.9	4.6	1008.2	1005.1	4.2	13.4	314	289	0	0.000
22	0.3	0.9	1021.7	1019.7	2.7	11.9	325	324	0	0.000
23	2.6	1.9	1019.2	1024.1	0.9	5.2	258	314	0	0.000
24	9.2	9.2	1004.7	1011.6	1.8	7.1	189	168	19.304	10.160
25	2.1	4.5	1012.2	1009.2	1.3	8.8	302	276	0	5.080
26	1.3	2.8	1006.9	1014.0	0.6	3.9	9	160	2.54	6.350
27	-0.4	0.3	1000.0	1002.1	2.9	8.4	296	230	0.254	0.000
28	1.7	0.2	1002.8	1004.7	2.3	11.5	275	264	1.27	0.000
29	2.2	3.0	1004.0	1004.3	2.7	12.1	286	256	0	0.000
30	-0.1	0.7	1007.2	1007.5	3.4	10.2	284	278	0	0.000
31	-1.1	-1.1	1011.6	1011.6	3.0	11.6	287	270	0	0.000
Mean	5.97	6.47	1013.9	1015.6	2.0	8.32	237.1	223.4	91.694	72.078
SD	0.85	0.80	1.66	1.63	0.16	0.47	18.7	13.5		

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 2007 from 1/1/2007 00:00 through 12/31/2007 23:45, except for when sensors were calibrated and a 15 day period in December when the datalogger failed Data were downloaded from the logger on the following dates:

2007 WQBNERR METEROLOGICAL DATA

Raw Data File Name	Data Range Dates	
CR1000_SWMP_QC.dat.backup	121306 09:15 - 021307 16:30	File Size
CR1000_SWMP_QC.dat.1.backup	021307 16:45 - 022007 10:30	882 KB
CR1000_SWMP_QC.dat.2.backup	022007 10:45 - 030607 11:30	101KB
CR1000_SWMP_QC.dat.3.backup	030607 11:45 - 061407 14:00	197 KB
CR1000_SWMP_QC.dat.4.backup	061407 14:15 - 071007 11:00	1MB
CR1000_SWMP_QC.dat.5.backup	071007 12:00 - 072507 09:30	370 KB
CR1000_SWMP_QC.dat.6.backup	072507 10:15 - 073007 12:45	213 KB
CR1000_SWMP_QC.dat.7.backup	073007 13:30 - 080107 14:30	77 KB
CR1000_SWMP_QC.dat.8.backup	080107 15:00 - 110507 14:30	33 KB
CR1000_SWMP_QC.dat.9.backup	110507 14:45 - 112607 10:00	1 MB
CR1000_SWMP_QC.dat.10.backup	112607 10:15 - 112707 13:45	286 KB
CR1000_SWMP_QC.dat.11.backup	112707 14:00 - 112807 14:15	17 KB
CR1000_SWMP_QC.dat.12.backup	112807 14:30 - 112907 14:15	15 KB

CR1000_SWMP_QC.dat.13.backup	112907 14:30 - 113007 13:15	14 KB
ATT1024247.txt	113007 13:45 - 120307 09:15	13 KB
DATA MISSING	120307 09:30 - 121907 11:15	39 KB
ATT6310127.txt	121907 11:15 - 010208 14:45	167 KB

As noted above data were also collected continuously in near real-time since 03/09/2004 to currently, and archived on a server now at CDMO.

7) Distribution

According to the Ocean and Coastal Resource Management Data Dissemination Policy for the NERRS System-wide Monitoring Program,

NOAA/ERD retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The PI retains the right to be fully credited for having collected and processed the data. Following academic courtesy standards, the PI and NERR site where the data were collected will be contacted and fully acknowledged in any subsequent publications in which any part of the data are used. Manuscripts resulting from the NOAA/OCRM supported research that are produced for publication in open literature, including refereed scientific journals, will acknowledge that the research was conducted under an award from the Estuarine Reserves Division, Office of Ocean and Coastal Resource Management, National Ocean Service, National Oceanic and Atmospheric Administration. The data set enclosed within this package/transmission is only as good as the quality assurance/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. NERR weather data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Section 1 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 homepage) and online at the CDMO home page <http://cdmo.baruch.sc.edu>. Data are available in comma separated format.

8) Associated researchers and projects

This data is part of a larger data set associated with the System Wide Monitoring Program (SWMP) that includes Water Quality and Nutrient Data.

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

LiCor Quantum Sensor
Model #: LI-190SZ S/N Q12415
Stability: $\leq \pm 2\%$ change over a 1 year period
Operating Temperature: -40 to +65 °C
Sensitivity: typically 5 μA per 1000 $\mu\text{moles s}^{-1}\text{m}^{-2}$
Light spectrum wavelength: 400 to 700 nm
Date of last calibration: 11/07/07

EPLAB Pyranometer(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 °C
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
Installed November 15th, 2005
Calibrated 7/30/2007

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

Calibration not required. Bearings replaced 6/14/2007, 10/4/2007

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: $\pm 2\%$ RH, 0 to 90% or $\pm 3\%$ RH, 90-100%

Uncertainty of calibration: 0.3% RH

Calibration: 6/14/2007

Barometric Sensor

Model #: PTP101B

Operating Range: 600-1060 hPa

Temperature: -40 to +60°C

Humidity: non-condensing

Accuracy: ± 0.5 hPa

Stability: NA

Calibration: 6/14/2007

Heated Tipping Bucket Rain Gauge

Model #: TR-525

Range: 0.1 mm

Accuracy: 1.0% at <10 mm/hour

Direct calibration 12/1/2007

Campbell Scientific CR10X Wiring Panel has 128K of flash memory (EEPROM), in which it stores the operating system and its program (that it uses to run the weather station). Additionally, there is 128K of SRAM, which it uses to run the program and store its measurements and for final data storage.

Additional CR10X specification can be found at: http://www.campbellsci.com/documents/lit/s_cr10x.pdf

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.

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. 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	<i>Open-reserved for later flag</i>
3	<i>Open-reserved for later flag</i>
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.

General Errors

GIM	Instrument Malfunction
GMT	Instrument Maintenance
GPF	Power Failure/Low Battery
GQR	Data Rejected Due to QAQC checks
GPR	Program Reload
GPD	Power Down

Sensor Errors

SIC	Incorrect Calibration Constant, Multiplier, or Offset
SSN	Not a Number/Unknown Value
SNV	Negative Value
SOC	Out of Calibration
SSM	Sensor Malfunction
SSR	Sensor Removed

Comments

CAF	Acceptable Calibration/Accuracy Error of Sensor
CDF	Data Appear to Fit Conditions
CRE	Significant Rain Event
CSM	See Metadata

13 Comments on Data

1) 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.

2) 15 min sample rainfall amount differences of over 5mm in 15 minutes can occur during storms and indicate intense ppt bursts during thunderstorms or frontal passages.

3) Small negative PAR values sometimes occur at night. These small values are within the range of the sensors. The maximum signal noise error for the LICor sensor is +/- 2.214 mmoles/m² over a 15 minute interval. These data have been retained.

- a) PAR sensor had to be replaced several times during the year. Additionally, the calibration constant was incorrectly entered into the program so this data was corrected and coded to indicate this data. The following dates and time and associated Flagging and codes were applied:

07/30/07 13:30 to 11/26/07 10:00 Incorrect multiplier in program. Corrected data, incorrect multiplier
11/26/07 10:15 to 11/30/07 13:15 Incorrect constant, all data Flagged -3 and coded [SIC]. For those dates and times, PAR data greater than 9999.9 were also changed to NAN due to size limitations of the CDMO database.

4) Relative Humidity data greater than 100% have been observed; these data are within the range of the sensor accuracy of +/- 3%. These data have been retained.

5) The Datalogger failed in late November and was replaced this year. The following dates summarize the missing due to this failure:

- a) 11/30/07 13:45 to 12/3/07 09:15: Two sensors, the Air Temp [AT] and the Relative Humidity [RH] failed and short-circuited the Data logger. Data was flagged as suspect[1] and coded as "See Metadata"
b) 12/3/07 09:30 to 12/19/07 11:15. Datalogger failed. No data was recorded. Datalogger was replaced and the Temp and RH sensors were taken off and datalogger programmed for AT=RH=-99. Sensors replaced 1/2/08 14:45.

6) Sensors calibration occurred at different times this year. Different sensors were out of operation at various times while others continued in operation. The calibration and replacement events resulted in several categories of corrupted or incorrect data (anomalous NAN, missing data, and deleted data. (See note below in other remarks).

2007 Weather Sensor Calibration dates

LiCor PAR L1190SZ	9/26/06
Eppley 8-48 SORAD	7/30/07
Vaisala Temp/RH/BP	6/14/07,
Anemometer Wind	6/14/07, 10/4/07
Rain Gauge	12/1/05

7) Precipitation data 8/13/07 00:00 to 10/30/07 23:45 were Flagged -3 and coded CPD (Power down) due to the field cable disconnected during those dates.

8) The Vaisala Air Temp and Relative Humidity sensor had to be replaced several times during the year. Some dates the tower that the sensors are located on was lowered, the sensor taken off and the tower was returned upright. At other dates, the tower was left down until the sensor was recalibrated and reconnected to the tower wiring. The following dates and time and associated Flagging and codes were applied:

06/12/07 11:45- to 6/14/2007 13:15	RH/AT sensor removed
06/14/07 13:30-14:30	RH/AT sensor replaced
12/19/07 11:15-14:45	RH/AT sensor removed replaced 01/02/08 14:45

9) Anemometer Wind Speed and Wind Direction sensor

06/12/07 11:45 to 13:00 Tower down on ground
06/14/07 13:30 to 14:30 Tower down on ground to replace bearings in Anemometer
10/03/07 14:15 to 10/04/07 16:00 Tower down on ground for entire time to replace Nose Cone on the
Wind Sensor and replaced bearings. Data for SDWDir, Max WSP, MaxWSpdT removed

10) 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.

11) 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 (°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). WBNERR 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 WBNERR Research Coordinator.