

I. Data Set & Research Descriptors

1) Principal Investigator(s) & contact persons

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2) Entry Verification

a) Data Input Procedures:

The meteorological information is sampled every 5 seconds from each instrument on the weather station and stored on a Campbell Scientific CR10X datalogger. The CDMO Data Logger Program (ner30.csi) was loaded into the CR10X and controls the sensors and data collection schedule (see 2b of the Entry Verification section for the data collection schedule). The CR10X then interfaces with the PC208W software supplied by Campbell Scientific.

The data was saved as a monthly raw data file (RAW0100.dat) onto a separate hard drive and backed up onto the Waquoit Bay NERR server.

As an entire month of data becomes available, the CDMO Weather Data Management Program (WDMP) is used to convert the raw data files to an Access database. The program was developed in Visual Basic to interface with the NERR Meteorological Data Collection Schedule (see 2b of the Entry Verification section for the data collection schedule). The WDMP automatically inputs and converts the monthly raw files into an Access database. There are three main steps the WDMP performs.

First, it converts the comma delimited monthly raw data files into an Access database. Secondly, it checks the data against a predetermined set of error criteria (see Appendix G for CDMO Meteorological Data Collection Error/Anomalous Data Criteria). Finally, it produces error and summary reports. Any anomalous data are investigated and noted below in the Anomalous Data Section. Any data corrections that were performed are noted in the Data Anomaly/Data Correction Section below.

The most common reported errors/anomalies noted in the monthly error reports in 2002 were:

- 1) 1-hour average temperature greater than 10% above the maximum 15 min sample recorded in the past 1 hour.
- 2) Wind direction greater than 360 or less than 0 degrees.
- 3) 15 minute sample rainfall amount differences of over 5mm from previous sample.
- 4) Relative humidity differences greater than 25% between 15-minute samples.
- 5) Air temp differences between 15-minute samples greater than 3 degrees.
- 6) Air pressure below 980 mb

Most of these common reported errors/anomalies are artifacts of the simple flagging criteria used by the WDMP, and we have commented on the cause of such "artifactual flags" in blanket comments at the beginning of the Data Anomaly/Data Correction Section. In all cases, though reported errors/anomalies are double checked, and where data truly appear anomalous, they are compared with other regional meteorological data for verification. In 2002 data corrections were performed on some wind speed data for a period when we were using an incorrect signal conversion coefficient. Also, when power-down events occurred, we lost the earlier 5-second data for those calendar days, resulting in incorrect values of those

days' 24-hour average, maximum and minimum values. Therefore, those days' 24-hour values were deleted. Finally and unfortunately, we lost all our PAR data for the year due to using signal conversion coefficient 3 orders of magnitude too large (we were attempting to measure micro-volts as opposed to milli-volts of PAR). Since the CR10X program is geared to only save 5 digits, the PAR values maxed out at 99,999 for most of the mid-day readings causing us to lose most of the daily PAR signal. Consequently, we deleted all of our PAR data for 2002.

Both raw data files and Access databases were saved to Compact Disc for archival and backed-up on the server. SWMP Technician Kelly Chapman and Research Coordinator Chris Weidman error checked and compiled the 2002 weather data.

b) Data Collection Schedule

i) Data is collected in the following formats.

- (1) Instantaneous 5 sec sample data points are collected every 15 minutes.
- (2) Hourly averages (based on 5 sec data) are produced every 60 minutes.
- (3) Daily average, maximum, and minimum (based on 5 sec sample data) every 24 hours.

ii) 15 minute sample point parameters:

Date, Time, Air Temperature (C), Relative Humidity (%), LiCor (PAR), Barometric Pressure (mb), Wind Speed (m/s), Wind Direction, Rainfall (mm)

iii) Hourly average parameters:

Date, Time, Air Temperature (C), Relative Humidity (%), LiCor (PAR), Barometric Pressure (mb), Wind Speed (m/s), Wind Direction, Wind Direction Standard Deviation (using Yamartino's Algorithm)

iv) Daily Averages parameters:

Date, Time, Air Temperature (C), Relative Humidity (%), LiCor (PAR), Barometric Pressure (mb), Wind Speed (m/s), Wind Direction

v) Daily Maximum parameters:

Date, Time, Air Temperature (C), Time, Relative Humidity (%), Time, LiCor (PAR), Time, Barometric Pressure (mb), Time, Wind Speed (m/s), Time, battery Voltage, Time

vi) Daily Minimum parameters:

Date, Time, Air Temperature (C), Time, Relative Humidity (%), Time, LiCor (PAR), Time, Barometric Pressure (mb), Time, Wind Speed (m/s), Time, Battery Voltage, Time

c) Error/Anomalous Data Criteria

Air Temp:

- 15 min sample not greater than *max* for the day
- 15 min sample not less than the *min* for the day
- 15 min sample not greater than 3.0 C from the previous 15 minutes
- 1-hour average not greater than 10% above the greatest 15 min sample recorded in the hour

Relative Humidity:

- Not changed by more than 25% from the previous 15 minutes
- 1 hour average not greater than 10% above the greatest 15 min sample recorded in the hour

Rainfall:

- Precipitation not greater than 5 mm in 15 min
- No precipitation for the month

Wind Speed:

Wind speed greater than 65 m/s
Wind speed less than 0.5 m/s

Wind direction:

Wind direction not greater than 360 degrees
Wind direction not less than 0 degrees

Pressure:

Pressure greater than 1040 mb or less than 980 mb
Pressure changes greater than 5 mb per hour
1 hour average not greater than 10% above the greatest 15 min sample recorded in the hour

Time:

15-minute interval recorded

For all data:

Duplicate interval data

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 half-hourly 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 CR10X to produce hourly and daily averages of those measurements of air temperature, relative humidity, barometric pressure, rainfall, wind speed, and wind direction. An instantaneous sample is taken every 15 minutes and that data is stored as array 150. In 2002 we used a 1 month sampling interval. CR10X raw data are currently stored on 2 data storage modules capable in combination of storing about 3 months worth of data. The CR10X 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. This display is checked and recorded every regular work day (Mon-Fri) along with a brief visual observation of the current weather conditions. All collected data is quality checked immediately after the monthly downloads using the SWMP WDMP. 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 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 or biannual basis depending on the particular sensor. Also, once a month on download 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° 34.900' N, 70° 31.507' 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 about 9 m above sea level, 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 is mounted about 10 m away on an extended aluminum arm at a height of 3 m and is well exposed at all times to the sun in both winter and summer. The air pressure sensor is mounted next to the CR10X in the laboratory. The rain gauge is located in an open field away from trees about 50 m northwest of the laboratory and tower.

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 was collected for the entire year in 2002.

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 text format and Access data tables.

8) Associated researchers and projects

Not applicable at this time.

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

LiCor Quantum Sensor
Model #: LI-190SZ S/N Q12415
Stability: <+/-2% change over a 1 year period
Operating Temperature: -40-+65 °C
Sensitivity: typically 5µA per 1000 µmoles s⁻¹m⁻²
Light spectrum wavelength: 400 to 700 nm
Date of last calibration: 6/20/01

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 8/2002

Temperature and Relative Humidity
Model #: HMP35C
Operating Temperature: -20-+60°C
Temperature Measurement Range: -35-+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
Date of last calibration: 8/20/02

Barometric Sensor
Model #: PTP101B
Operating Range: 600-1060 hPa
Temperature: -40 to +60°C
Humidity: non-condensing
Accuracy: +/- 0.5 hPa
Stability: NA
Date of last calibration: 6/20/01

Tipping Bucket Rain Gauge
Model #: TR-525
Range: 0.1 mm
Accuracy: 1.0% at <10 mm/hour
Calibration not required. Check operation regularly.

10) Coded variable indicator and variable code definitions

Site definitions: CH=Carriage House

11) Data anomalies/Data corrections

COMMENT 1: The error message in WDMP “1 hour average greater or less than 10% above/below the greatest/least 15 min sample recorded in the hour” can occur when no real error has transpired. This occurs with WDMP for two reasons:

- a) Because hourly averages are based on all 5 sec samples in that hour and 15 min values are instantaneous 5 sec samples taken once every 15 min, it is possible for the hourly average to be above the max 15 minute value for that hour or below the 15 min for that hour. While such offsets

are generally within the 10% margin, this error flagging strategy fails when temperatures are near 0 degrees C, because 10% of 0 is 0 so the margin for error evaporates at zero. Slight temperature variations by tenths and thousandths of degrees can show up as “anomalous”. In fact the problem with this error recognition strategy is that the margin is much greater at warmer temperatures than at low temperatures around freezing.

- b) The second reason seems to be a basic problem with the WDMP program – it seems it cannot properly handle the error calculation with negative temperatures. Consequently, when temperature fall below 0 degrees C, it often indicates a greater than 10% difference when in fact the difference is often less than 10%.

COMMENT 2: The error message “wind direction greater than 360 or less than 0” can occur when slightly negative wind directions (0 to –10) are recorded. This occurs when the wind direction is in the extreme NNW (between 350 and 360). The data can be adjusted (if interested) by adding 360 to the slightly negative values.

COMMENT 3: 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.

COMMENT 4: Relative humidity differences greater than 25% between 15 min samples are not unusual with frontal passages and are usually associated with wind shifts.

COMMENT 5: Air temp differences between 15 min samples greater than 3 degrees are not unusual with frontal passages and are usually associated with wind shifts.

COMMENT 6: Intense extra-tropical cyclones and hurricanes often affect the region and air values below 980 mb are not uncommon, especially in the autumn, winter and spring months.

COMMENT 7: Wind speed was less than 0.5 m/s for more than 12 hours. During these times, the wind speed data was corrected due to an instrument calibration error. These gaps of low wind speeds are not unusual for this site. The wind speeds can be calm for long periods of time.

COMMENT 8. Missing Data Comment 2: When the CR10X is powered down for maintenance or other causes all temporary 5 sec data for that calendar date are lost at the moment of power down. When the CR10X is powered again the 5 sec data from that point on for that date are again stored in the daily temporary file for that calendar date. Consequently, the 24 hr averages, maximums and minimums for all parameters, which are calculated for the calendar date using the 5 sec data file, will be incorrect for the calendar date because only a portion of the day’s data will be used for calculation. Also, the hourly averages for the period affected by the maintenance (CR10x power outage or reboot) will be incorrect as well for similar reasons. Current protocol is to delete the 24 hr data for these dates as well as any hourly averages so affected. If desired, these missing 24 hr values can be estimated using the 15 min sample data for the calendar date.

COMMENT 9. Missing Data Comment 3: Due to the fact that we never really knew the instant the power down events occurred, it was difficult to determine the exact times without looking more closely at the data. The hourly data was not deleted based on our observation of continuous and reasonable data. The hourly data for each of the following power-down events looked reasonable and more importantly continuous; therefore the data was not deleted.

January 2002

All wind speed data for month of January were corrected by dividing by 3, due to an incorrect coefficient in the program. See Comment 7.

The wind direction data point 1/8/2002 (8) 0115 is correct and was not deleted. See Comment 2.

24 hour Data for 1/9/2002 (9) were deleted because of CR10X power-down event on that date: See Comment 8.

The following air temperature hourly average data are correct and were not deleted. See Comment 1.

Array ID	Calendar Day	Julian	Time	Error Message
101	1	1	1100	Air temp average in 1 hour data (.52581) is less than 15 minute minimum (.6072) by at least 10%
101	4	4	400	Air temp average in 1 hour data (-2.0683) is greater than 15 minute maximum (-1.9706) by at least 10%
101	4	4	600	Air temp average in 1 hour data (-3.1762) is greater than 15 minute maximum (-3.01) by at least 10%
101	8	8	1400	Air temp average in 1 hour data (-.20993) is less than 15 minute minimum (-.17865) by at least 10%
101	18	18	700	Air temp average in 1 hour data (-.45609) is less than 15 minute minimum (-.41181) by at least 10%
101	18	18	2000	Air temp average in 1 hour data (.35965) is less than 15 minute minimum (.41895) by at least 10%
101	19	19	1400	Air temp average in 1 hour data (-.49876) is less than 15 minute minimum (-.40995) by at least 10%

February 2002

All wind speed data for the month of February were corrected by dividing by 3, due to an incorrect coefficient in the program. See Comment 7.

24 hour Data for 2/15/2002 (46) were deleted because of CR10X power-down event on that date: See Comment 8.

The following wind direction data were not deleted. See Comment 2.

Array ID	Calendar Day	Julian	Time	Error Message
150	4	35	1000	Wind direction is greater than 360 or less than 0 on 4 (35) 1000 (-1.883)
150	4	35	1015	Wind direction is greater than 360 or less than 0 on 4 (35) 1015 (-3.6718)
150	11	42	2245	Wind direction is greater than 360 or less than 0 on 11 (42) 2245 (-.09415)

Air pressure data on 2/4/2002 (35) 0100 is probably due to a power down event. It was not deleted.

March 2002

The following air temperature data are correct and were not deleted. See Comment 5.

Array ID	Calendar Day	Julian	Time	Error Message
150	14	73	1530	Air temp difference from 14 (73) 1530 (14.218) to 14 (73) 1545 (10.442) is greater than 3.0 degrees C

Wind direction data 3/17/2002 (76) 0400 are correct and were not deleted. See Comment 2.

All wind speed data up until 3/21/2002 (80) 1200 were corrected by dividing by 3, due to an incorrect coefficient in the program. See Comment 7.

24 hour Data for 3/21/2002 (80) were deleted because of CR10X power-down event on that date: See Comment 8.

Relative humidity hourly average data from 3/21/2002 (80) 0100 to 0600 and 3/21/2002 (80) 1100 are correct and were not deleted. See Comment 4.

The following air temperature hourly data are correct and were not deleted. See Comment 1.

Array ID	Calendar Day	Julian	Time	Error Message
101	17	76	500	Air temp average in 1 hour data (.88453) is greater than 15 minute maximum (.76288) by at least 10%
101	19	78	2400	Air temp average in 1 hour data (.47711) is less than 15 minute minimum (.63521) by at least 10%
101	22	81	1700	Air temp average in 1 hour data (-.56143) is greater than 15 minute maximum (-.6273) by at least 10%

April 2002

The following air temperature data are correct and were not deleted. See Comment 5.

Array ID	Calendar Day	Julian	Time	Error Message
150	16	106	1400	Air temp difference from 16 (106) 1400 (19.373) to 16 (106) 1415 (23.198) is greater than 3.0 degrees C
150	17	107	930	Air temp difference from 17 (107) 930 (24.041) to 17 (107) 945 (27.306) is greater than 3.0 degrees C
150	18	108	1530	Air temp difference from 18 (108) 1530 (22.703) to 18 (108) 1545 (16.841) is greater than 3.0 degrees C
150	25	115	2230	Air temp difference from 25 (115) 2230 (10.071) to 25 (115) 2245 (4.9983) is greater than 3.0 degrees C

The following relative humidity data are correct and were not deleted. See Comment 4.

Array ID	Calendar Day	Julian	Time	Error Message
150	10	100	1700	Rel hum difference from 10 (100) 1700 (36.304) to 10 (100) 1715 (66.418) is greater than 25%

The following wind direction data are correct and were not deleted. See Comment 2.

Array ID	Calendar Day	Julian	Time	Error Message
150	18	108	730	Wind direction is greater than 360 or less than 0 on 18 (108) 730 (-5.2703)
150	20	110	1830	Wind direction is greater than 360 or less than 0 on 20 (110) 1830 (-1.8827)
150	21	111	545	Wind direction is greater than 360 or less than 0 on 21 (111) 545 (-1.6004)

The following air temperature hourly average was found to be greater than the 15 minute maximum. These data are correct and were not deleted. See Comment 1.

Array ID	Calendar Day	Julian	Time	Error Message
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101	6	96	600	Air temp average in 1 hour data (.45889) is greater than 15 minute maximum (.40994) by at least 10%
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24 hour Data for 4/2/2002 were deleted because of CR10X power-down event on that date: See Comment 8.

24 hour Data for 4/5/2002 were deleted because of CR10X power-down event on that date: See Comment 8.

24 hour Data for 4/19/2002 were deleted because of CR10X power-down event on that date: See Comment 8.

24 hour Data for 4/25/2002 were deleted because of CR10X power-down event on that date: See Comment 8.

May 2002

The relative humidity data point on 25 (145) 0145 is correct and was not deleted. See Comment 4.

The following precipitation data are correct and were not deleted. See Comment 3.

Array ID	Calendar Day	Julian	Time	Error Message
151	13	133	1845	Precip difference from 13 (133) 1845 (2.794) to 13 (133) 1900 (9.144) is greater than 5 mm
151	13	133	1900	Precip difference from 13 (133) 1900 (9.144) to 13 (133) 1915 (2.794) is greater than 5 mm
151	29	149	545	Precip difference from 29 (149) 545 (.254) to 29 (149) 600 (5.842) is greater than 5 mm

June 2002

The precipitation data from 6 (157) 0230 to 6 (157) 0245 are correct and were not deleted. See Comment 3.

The following wind speed data are correct and were not deleted. Calm conditions prevailed during period.

Array ID	Calendar Day	Julian	Time	Error Message
102	19	170	1800	Wind speed is less than 0.5 m/s from 19 (170) 1800 to 20 (171) 0700

The following wind direction data are correct and were not deleted. See Comment #2.

Array ID	Calendar Day	Julian	Time	Error Message
150	10	161	1100	Wind direction is greater than 360 or less than 0 on 10 (161) 1100 (-1.5061)

24 hour Data for 6/23/2002 (174) were deleted because of CR10X power-down event on that date: See Comment 8.

July 2002

The following wind direction data are correct and were not deleted. See Comment 2.

Array ID	Calendar Day	Julian	Time	Error Message
150	16	197	1300	Wind direction is greater than 360 or less than 0 on 16 (197) 1300 (-2.446)
150	16	197	1845	Wind direction is greater than 360 or less than 0 on 16 (197) 1845 (-2.446)

August 2002

The following relative humidity data are correct and were not deleted. See Comment 4.

Array ID	Calendar Day	Julian	Time	Error Message
150	8	220	1630	Rel hum difference from 8 (220) 1630 (43.616) to 8 (220) 1645 (68.693) is greater than 25%
150	19	231	1330	Rel hum difference from 19 (231) 1330 (65.697) to 19 (231) 1345 (100) is greater than 25%
150	21	233	745	Rel hum difference from 21 (233) 745 (-.02) to 21 (233) 800 (60.746) is greater than 25%

The following rainfall data are correct and were not deleted. See Comment 3.

Array ID	Calendar Day	Julian	Time	Error Message
150	29	241	2030	Precip difference from 29 (241) 2030 (1.524) to 29 (241) 2045 (8.636) is greater than 5 mm
150	29	241	2115	Precip difference from 29 (241) 2115 (12.7) to 29 (241) 2130 (6.858) is greater than 5 mm
150	29	241	2130	Precip difference from 29 (241) 2130 (6.858) to 29 (241) 2145 (1.524) is greater than 5 mm

24 hour Data for 8/5/2002 (217) were deleted because of CR10X power-down event on that date: See Comment 8 and below.

24 hour Data for 8/6/2002 (218) were deleted because of CR10X power-down event on that date: See Comment 8.

24 hour Data for 8/30/2002 (242) were deleted because of CR10X power-down event on that date: See Comment 8.

On 8/19/2002 (231) 1330 the weather station tower was taken down in order to check and replace the anemometer bearings and RH/ temperature probe recalibration. The maintenance on the tower ended at 14:01 and anemometer was again functioning, but RH/temperature probe was not replaced until 8/21/2002 (233) 0745. Consequently:

- 1) All Temperature, RH and wind speed and direction 15 min data from 1330 to 1400 on 8/19/2002 were deleted and replaced with 55555 codes. All hourly data for these parameters for 1400 were deleted as well.
- 2) All Temperature data from 19 (231) 1300 to 21 (233) 730 are missing (-99999). See Missing Data section 12.
- 3) All 15 min RH data from 19 (231) 1300 to 21 (233) 745 were deleted and replaced with 55555 codes where – 99999 were not recorded by the CR10X as well as all hourly data from 19 (231) 1300 to 21 (233) 0700 and daily min and max on 19 through 21. Recorded RH values were a constant 100 (max out default?) for period except one value (-0.02) at about the restart time that was clearly erroneous.
- 4) 24-hour Relative Humidity and Temperature Data for 8/19/2002, 8/20/2002 and 8/21/2002 were deleted because temperature Temperature/RH probe was out of service. For those data that were not already designated with -99999 were replaced with 55555 codes.

September 2002

Note: Hurricane Gustav passed about 200 miles south of the site on the 9/11/2002.

24 hour Data for 9/11/2002 were deleted because of CR10X power-down event on that date: See Comment 8.

24 hour Data for 9/14/2002 were deleted because of CR10X power-down event on that date: See Comment 8.

The data point 14 (257) 1630 appears to be a duplicate and was not deleted.

The following rainfall data are correct and were not deleted. See Comment 3.

Array ID	Calendar Day	Julian	Time	Error Message
151	23	266	530	Precip difference from 23 (266) 530 (1.778) to 23 (266) 545 (10.16)
151	23	266	545	Precip difference from 23 (266) 545 (10.16) to 23 (266) 600 (3.302) is greater than 5 mm
151	23	266	1030	Precip difference from 23 (266) 1030 (.508) to 23 (266) 1045 (7.112) is greater than 5 mm
151	23	266	1045	Precip difference from 23 (266) 1045 (7.112) to 23 (266) 1100 (1.016) is greater than 5 mm

October 2002

Note: Strong Northeaster on 10/16/2002.

24 hour Data for 10/16/2002 were deleted because of CR10X power-down event on that date: See Comment 8.

24 hour Data for 10/31/2002 were deleted because of CR10X power-down event on that date: See Comment 8.

The following air temperature data are correct and were not deleted See Comment 5.

Array ID	Calendar Day	Julian	Time	Error Message
150	23	296	800	Air temp difference from 23 (296) 800 (10.873) to 23 (296) 815 (7.1725) is greater than 3.0 degrees C

The following relative humidity data are correct and were not deleted. See Comment 4.

Array ID	Calendar Day	Julian	Time	Error Message
150	7	280	1845	Rel hum difference from 7 (280) 1845 (94.1) to 7 (280) 1900 (68.206) is greater than 25%

The following wind direction data are correct and were not deleted. See Comment 2.

Array ID	Calendar Day	Julian	Time	Error Message
150	14	287	1615	Wind direction is greater than 360 or less than 0 on 14 (287) 1615 (-4.1419)

November 2002

The following air temperature data are correct and were not deleted. See Comment 5.

Array ID	Calendar Day	Julian	Time	Error Message
150	7	311	1100	Air temp difference from 7 (311) 1100 (7.6237) to 7 (311) 1115 (3.9379) is greater than 3.0 degrees C

The following wind direction data are correct and were not deleted. See Comment 2.

Array ID	Calendar Day	Julian	Time	Error Message
150	3	307	45	Wind direction is greater than 360 or less than 0 on 3 (307) 45 (-3.1089)

The following temperature data are correct and were not deleted. See Comment 1.

Array ID	Calendar Day	Julian	Time	Error Message
101	4	308	600	Air temp average in 1 hour data (-.15401) is less than 15 minute minimum (-.07041) by at least 10%

December 2002

Air Pressure data from 25 (359) 1800 through 26 (360) 0045 was less than 980. These data are correct and were not deleted. See Comment 6.

The following temperature data are correct and were not deleted. See Comment 1.

Array ID	Calendar Day	Julian	Time	Error Message
101	5	339	2300	Air temp average in 1 hour data (-.03805) is greater than 15 minute maximum (-.06015) by at least 10%
101	16	350	2000	Air temp average in 1 hour data (.52313) is greater than 15 minute maximum (.46702) by at least 10%
101	16	350	2100	Air temp average in 1 hour data (-.07927) is greater than 15 minute maximum (-.19405) by at least 10%
101	26	360	2300	Air temp average in 1 hour data (-1.1511) is greater than 15 minute maximum (-1.2997) by at least 10%
101	31	365	300	Air temp average in 1 hour data (.48959) is less than 15 minute minimum (.5648) by at least 10%

12) Missing data

Missing Data Comment 1A: An incorrect LiCor sensor was being used to collect the PAR until 3/21/2002. Consequently, these data were deleted and replaced by 99999 in the raw data files by our weather station technical consultant, Richard Payne. In this case, the latter action was not the proper protocol for data deletion, but we were new at this at the time.

Missing Data Comment 1B: The remaining LiCor PAR data (3/21/2002 to 12/31/2002) for the 2002 were also incorrect because the wrong coefficient was used in the CR10X program for calculating PAR. Unfortunately, the data is not really recoverable because the incorrect coefficient that was used was too large causing the values to max out at 99999 throughout most of the mid-day periods. These data were deleted and replaced with 55555 codes.

January 2002

LiCor PAR data for the month of January are missing. See Missing Data Comment #1A.

February 2002

LiCor PAR data for the month of February are missing. See Missing Data Comment #1A.

March 2002

LiCor PAR data for the month of March are missing. See Missing Data Comment #1A and Missing Data Comment #1B.

April 2002

LiCor PAR data for the month of April are missing. See Missing Data Comment #1B.

May 2002

LiCor PAR data for the month of May are missing. See Missing Data Comment #1B.

June 2002

LiCor PAR data for the month of June are missing. See Missing Data Comment #1B.

July 2002

LiCor PAR data for the month of July are missing. See Missing Data Comment #1B.

August 2002

LiCor PAR data for the month of August are missing. See Missing Data Comment #1B.

The following data were found missing by the WDMP. This occurred during 8/5/2002 power-down event.

Array ID	Calendar Day	Julian	Time	Error Message
150	5	217	0500	Missing 150 Array data (15 minute data) from 5 (217) 0500 to 5 (217) 0615
101	5	217	0500	Missing 101 Array data (Hourly Averages) from 5 (217) 0500 to 5 (217) 0600
102	5	217	0500	Missing 102 Array data (Hourly Average Wind Parameters) from 5 (217) 0500 to 5 (217) 0600

September 2002

LiCor PAR data for the month of September are missing. See Missing Data Comment #1B.

October 2002

LiCor PAR data for the month of October are missing. See Missing Data Comment #1B.

November 2002

LiCor PAR data for the month of November are missing. See Missing Data Comment #1B.

The following data were found missing by the WDMP due to a download override.

Array ID	Calendar Day	Julian	Time	Error Message
150	1	305	1100	Missing 150 Array (15 minute data)
101	1	305	1100	Missing 101 Array (Hourly Averages)
102	1	305	1100	Missing 102 Array (Hourly Average Wind Parameters)

December 2002

LiCor PAR data for the month of December are missing. See Missing Data Comment #1B.

13) Other remarks

Monthly Rain amounts (mm)

Note: Monthly totals are not available for months where data were missing.

January 2002

6	11.176
7	3.048
8	.762
9	1.778
11	15.240
13	50.800
15	6.858
17	1.016
20	4.318
21	17.780
23	3.556
24	4.064
25	.254
30	.508
31	3.302

Monthly Total: 124.5

February 2002

1	3.048
7	2.286
10	1.524
11	4.318
17	8.890
18	14.986
19	.508
21	11.938
24	.254
27	7.874
28	.254

Monthly Total: 55.9

March 2002

3	25.654
9	.254
10	6.350
12	.762
13	9.906
16	.762
18	10.414
19	1.270
20	31.750
26	15.748
27	35.814
29	.254
30	.254

31 6.096

Monthly Total: 145.3

April 2002

1 30.734
3 .762
4 .254
6 .508
10 10.414
15 4.064
20 .254
22 10.668
23 1.016
25 22.860
28 22.860
29 .762
30 1.778

Monthly Total: 106.9

May 2002

2 5.842
3 .508
10 9.398
12 13.462
13 39.878
14 4.826
17 .508
18 42.672
29 7.620
31 9.398

Monthly Total: 134.1

June 2002

2 .254
5 1.016
6 34.036
7 16.256
12 3.302
14 4.064
15 19.050
16 2.032
17 .254
23 .254
26 .254
28 .254

Monthly Total: 81.0

July 2002

6 .254
9 .508
10 .508
22 1.778

23	.762
24	1.270
29	8.890

Monthly Total: 14.0

August 2002

5	5.334
6	.254
20	1.524
22	3.556
23	.762
24	.508
25	2.286
29	50.038
31	.254

Monthly Total: n/a

September 2002

2	33.782
3	1.524
4	1.016
11	.762
15	1.524
16	15.748
17	.254
21	.254
23	43.942
24	11.938
26	5.334
27	21.082
28	.762

Monthly Total: 137.9

October 2002

11	11.938
12	5.588
13	4.826
14	1.524
16	38.862
18	1.778
23	3.810
24	.254
26	13.208

Monthly Total: 81.8

November 2002

4	2.032
5	.508
6	19.558
10	7.620
11	4.572
12	22.606

13	26.670
15	.254
16	30.988
17	37.338
18	2.286
21	.508
22	11.684
23	.254
27	27.432
29	3.810
30	.762

Monthly Total: n/a

December 2002

1	.254
2	1.524
3	.254
4	.254
5	4.572
7	6.604
11	17.526
12	15.748
13	1.778
14	49.784
15	.254
16	12.700
18	.254
20	32.512
25	54.102
26	2.032
31	3.556

Monthly Total: 203.7