

North Carolina (NOC) National Estuarine Research Reserve
Research Creek Meteorological Metadata
January 1 – Dec 31, 2009
Latest Update: August 26, 2015

I. Data Set and Research Descriptors

1) Principal investigator(s) and contact

Dr. John Fear, Research Coordinator
101 Pivers Island Rd.
Beaufort, NC 28516
Phone: (252) 838-0884
Fax: (252) 838-0890
Email: john.fear@ncdenr.gov

Byron R Toothman, Research Associate
5600 Marvin K. Moss Lane
Wilmington, NC 28409
Phone: (910) 962-2334
Fax: (910) 962-2410
Email: toothmanb@uncw.edu

Heather Wells, Research Associate
5600 Marvin K. Moss Lane
Wilmington, NC 28409
Phone: (910) 962-2335
Fax: (910) 962-2410
Email: wellsh@uncw.edu

2) Entry verification

Data are uploaded from the CR1000 data logger to a Personal Computer (IBM compatible). Files are exported from or LoggerNet in a comma-delimited format and uploaded to the CDMO where they undergo automated primary QAQC and become part of the CDMO's online provisional database. During primary QAQC, data are flagged if they are missing or out of sensor range. The edited file is then returned to the Reserve where it is opened in Microsoft Excel and processed using the CDMO's NERRQAQC Excel macro. The macro inserts station codes, creates metadata worksheets for flagged data and summary statistics, and graphs the data for review. It allows the user to apply QAQC flags and codes to the data, append files, and export the resulting data file to the CDMO for tertiary QAQC and assimilation into the CDMO's authoritative online database. For more information on QAQC flags and QAQC codes, see Sections 11 and 12. All data and QAQC is performed by Byron Toothman and Heather Wells.

3) Research objectives

The principal objectives are to establish long-term monitoring of the weather in the vicinity of Masonboro Island, to obtain better data on storms and to be able to correlate the weather, water quality, chlorophyll and nutrient data. In addition,

the weather data collected will be used in support of other ongoing projects within the Reserve and nearby area.

4) Research methods

Campbell Scientific data telemetry equipment was installed at the NOCRCMET station on March 15, 1997 and transmits data to the NOAA GOES satellite, NESDIS ID ##3B02028E. 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, Minimum, and their times from 5-second data:

Air Temperature (°C) (these data are not included in the dataset but are available from the NOC NERR)

Maximum and times from 5-second data:

Wind Speed, (m/s),

Wind Direction Standard Deviation (degrees) from 5-second data

Totals:

Precipitation (mm), PAR (millimoles/m²), and Cumulative Precipitation (mm)

Data are periodically compared to values recorded by other local weather stations to verify accuracy. Data are also quality checked using Excel. The reports, graphs and queries of meteorological data are reviewed. Anomalous data and errors are further investigated and data are corrected, rejected (if necessary) or left unchanged and noted in the metadata report.

The weather station and sensors are inspected monthly for cleaning and/or repair. Sensors are replaced and/or calibrated according to the manufacturer's guidelines (annually or every two years).

Recommended calibration frequency for the MET station sensors:

- Temperature/Humidity- annual recalibration
- Rain Gauge- annual recalibration
- Wind Speed/Direction- annual or every two years inspection (depending on the sensor)
- Barometric Pressure- every two years recalibration
- PAR- every two years recalibration
- CR1000-every 5 years (required beginning 2014, one year initial grace period)

5) Site location and character

The components of North Carolina's National Estuarine Research Reserve (from north to south) are: Currituck Banks, Rachel Carson, Masonboro Island, and Zeke's Island. They are located along the southeast Atlantic coast of the United States. Currently, only data from Masonboro Island and Zeke's Island components are transferred to the CDMO.

The meteorological site is located on Masonboro Island, 2.09 km from the NOC NERR lab, and approximately 76.2 meters from the Research Creek water quality deployment site. The weather station is located on an active dredge spoil island adjacent to Research Creek east of the Intracoastal Waterway. It is directly across the Intracoastal Waterway from Whiskey Creek, at 34° 9.328'N, 77° 51.054'W. The station sits at an elevation of approximately 4.88 m above sea level, slightly offset from the highest point of the spoil, which has a maximum elevation of approximately 5.8 m. The site has scrub surrounding the periphery, and grassy cover in the central areas. The weather station consists of a 3-meter aluminum tower that holds the wind sensor (wind speed and direction) at a height of 3.68 m and the Li-COR sensor at a height of 3.66 m. The temperature and relative humidity sensor is mounted on the tower at 2.39 m and the barometric pressure sensor, which is inside of the datalogger housing, is mounted at a height of 1.75 m. The rain gauge is located on a separate platform 7.62 m east south east of the tower and is mounted at a height of 1.79 m. The sensors were wired to the CR1000 (Campbell datalogger) according to the protocol in the Meteorological Monitoring SOP. There are no surrounding objects that obstruct or shade the weather station. Due to surrounding maritime forest, the wind sensor may observe the wind speed to be slightly lower than in surrounding areas depending on wind direction. The temperature may also be slightly different from nearby stations due to differences in temperature on the mainland and waters surrounding the spoil island.

6) Data collection period

Collection of meteorological data began on March 15, 1997. Instruments were deployed prior to this date; however, data were for initial testing and verification of functions, and have since been discarded. The data collection period for 2009 began on January 1 at 00:15 and ended December 31 at 23:45.

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.nerrdata.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

Meteorological data will be used to augment other research components of the System Wide Monitoring Program (SWMP) that currently include water quality, chlorophyll and nutrient monitoring. The principal objective of the water quality monitoring is to record long-term water quality data in order to observe and document any physical and chemical changes or trends in water quality over time. The objective of the chlorophyll and nutrient monitoring study is to ascertain the annual and tidal fluctuations in nutrient and chlorophyll a levels surrounding the four water quality sites.

Additional projects are ongoing and continually changing. Check with the Research Coordinator or other contact person for an updated list of research (see section I.1.).

II. Physical Structure Descriptors

9) Sensor specifications

Parameter: Temperature

Units: Celsius

Sensor type: Platinum resistance temperature detector (PRT)

Model #: HMP45C Temperature and Relative Humidity Probe

Operating Temperature: -40°C to +60°C

Range: -40°C to +60°C

Accuracy: $\pm 0.2^\circ\text{C}$ @ 20°C

Serial Number: Y1040006

Date of Last Calibration: 4/19/2006

Dates Installed: 6/28/2006-8/25/2009

Serial Number: unknown

Date of Last calibration: 5/26/2009

Dates Installed: 8/25/2009 – 1/28/2010

Parameter: Relative Humidity

Units: Percent

Sensor type: Vaisala HUMICAP® 180 capacitive relative humidity sensor

Model #: HMP45C Temperature and Relative Humidity Probe

Range: 0-100% non-condensing

Accuracy at 20°C: $\pm 2\%$ RH (0-90%) and $\pm 3\%$ (90-100%)

Temperature dependence of RH measurement: $\pm 0.05\%$ RH/°C

Serial Number: Y1040006

Date of Last Calibration: 4/19/2006

Dates Installed: 6/28/2006-8/25/2009

Serial Number: unknown

Date of Last calibration: 5/26/2009

Dates Installed: 8/25/2009 – 1/28/2010

Parameter: Barometric Pressure

Units: millibars (mb)

Sensor type: Vaisala Barocap © silicon capacitive pressure sensor

Model #: CS-105

Operating Range: Pressure: 600 to 1060 mb; Temperature: -40°C to +60°C;

Humidity: non-condensing

Accuracy: ± 0.5 mb @ 20°C; ± 2 mb @ 0°C to 40°C; ± 4 mb @ -20°C to 45°C; ± 6 mb @ -40°C to 60°C

Stability: ± 0.1 mb per year

Serial Number: W0410042

Date of Last calibration: 4/13/2006

Dates Installed: 6/5/2008-2/28/2011

Parameter: Wind Speed and Wind direction

Units: meters per second (m/s); degrees

Sensor type: Vaisala Ultrasonic Wind Sensor

Model #: 425

Range: 0 to 65 m/s (0 to 144 mph, 0 to 125 knots); 0 to 360°

Accuracy: ± 0.135 m/s (± 0.3 mph, ± 0.26 knots) or 3% of reading, whichever is greater; $\pm 2^\circ$

Serial Number: unknown

Date of last calibration: N/A (no calibration required) installed new on 07/15/02

Parameter: LI-COR Quantum Sensor

Units: mmol m⁻² (total flux)

Sensor type: High stability silicon photovoltaic detector (blue enhanced)

Model #: LI190SB

Light spectrum waveband: 400 to 700 nm

Temperature dependence: 0.15% per °C maximum

Stability: $< \pm 2\%$ change over 1 yr

Operating Temperature: -40°C to 65°C; Humidity: 0 to 100%

Sensitivity: typically 5 μ A per 1000 μ moles s⁻¹ m⁻²

Serial Number	Calibrated	Installed	Multiplier
Q99265	08/22/07	06/05/08-8/5/09	1.25616778
Q22436	06/02/09	08/05/09-11/30/09	1.27356087
Q99265	08/22/07	11/30/09 - 03/04/10	1.25616778

Parameter: Precipitation (specify if heated rain gauge)

Units: millimeters (mm)

Sensor type: Tipping Bucket Rain Gauge

Model #: TE525

Rainfall per tip: 0.01 inch

Operating range: Temperature: 0° to 50°C; Humidity: 0 to 100%

Accuracy: $\pm 1.0\%$ up to 1 in./hr; $\pm 0, -3\%$ from 1 to 2 in./hr; $\pm 0, -5\%$ from 2 to 3 in./hr

Dates of Calibration: 6/5/2008, 10/3/2009

The CR1000 has 2 MB of 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 upgrade) 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.

Date CR1000 Installed: 6/28/2006

10) Coded variable definitions - List the sampling station, sampling site code, and station code used in the data.

Sampling station:	Sampling site code:	Station code:
Research Creek	RC	nocrcmet

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, sensor errors are sensor specific, and comment codes are used to further document conditions or a problem with the data. Only one general or sensor error and one comment code can be applied to a particular data point, but some comment codes (marked with an * below) can be applied to the entire record in the F_Record column.

General Errors

GIM	Instrument Malfunction
GIT	Instrument Recording Error, Recovered Telemetry Data

GMC	No Instrument Deployed due to Maintenance/Calibration
GMT	Instrument Maintenance
GPD	Power Down
GPF	Power Failure / Low Battery
GPR	Program Reload
GQR	Data Rejected Due to QA/QC Checks
GSM	See Metadata

Sensor Errors

SDG	Suspect due to sensor diagnostics
SIC	Incorrect Calibration Constant, Multiplier or Offset
SIW	Incorrect Wiring
SMT	Sensor Maintenance
SNV	Negative Value
SOC	Out of Calibration
SQR	Data rejected due to QAQC checks
SSD	Sensor Drift
SSN	Not a Number / Unknown Value
SSM	Sensor Malfunction
SSR	Sensor Removed

Comments

CAF	Acceptable Calibration/Accuracy Error of Sensor
CCU	Cause Unknown
CDF	Data Appear to Fit Conditions
CML	Snow Melt from Previous Snowfall Event
CRE*	Significant Rain Event
CSM*	See Metadata
CVI*	Possible Vandalism/Tampering
CWE*	Significant Weather Event

13) Other remarks/notes

General

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 mmol/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.**

No data collected from April 15, 2009 12:00 through April 22, 2009 14:15. The power wire had come loose and caused the weather station to power down. Weather station was repowered at approximately 14:30 and the first readings for 15minute averages and totals were rejected.

8/5/2009 14:15 the station was powered down to swap the PAR sensor. Data at 14:30 were rejected since more than likely they were not a full 15 minutes of 5-second data.

From 8/25/2009 13:00 to 8/28/2009 03:45 there was an unexplained power down that corrected itself, possibly due to a loose wire. All data are missing for this time period. Data on 8/28/2009 4:00 were rejected since they were more than likely not a full 15 minutes of 5-second data.

Power down and program reload causing missing data and the rejection of the records immediately following on the following occasions.

11/09/2009 12:00 – 12:45

11/17/2009 11:45 – 12:30

11/30/2009 15:00 – 15:45

Wind

Throughout 2009 anomalous Max wind data values of 447 were rejected as well as all other wind parameters (wind speed, wind direction, and standard deviation wind direction). These data are flagged and coded as <-3> SSM CSM.

PAR

All PAR data flagged as “0” are coded as CSM. Users should be aware that much of the PAR data for 2009 was considered suspect or rejected.

There were many negative PAR values for this data period during the night due to possible sensor drift. If the value was outside the sensor range, it was rejected <-3> SNV CSM and if within the sensor range it was marked as suspect <1> CAF.

Occasional negative PAR values occurred during daylight hours. Data were rejected for the following dates and times:

01/10/2009 09:30 PAR value of -0.3

02/25/2009 10:00 PAR value of -1.2

03/08/2009 08:45 PAR value of -2.5, 09:00 PAR value of -2.8

03/18/2009 10:15 PAR value of -11.6

Elevated nighttime PAR data occurred during 2009. Values >0 between sunset and sunrise were flagged and coded as <1> CSM.

<http://www.sunrisesunset.com/> was used to determine sunrise and sunset times.

It is believed that elevated nighttime readings are caused by moisture intrusion

into the sensor. Until 3/13/2009 only the elevated nighttime readings were flagged and coded as <1> CSM, however, beginning 3/13/2009 the elevated nighttime readings were much higher than during the first few months. Elevated nighttime data as well as the daytime data were flagged as suspect from 3/13/2009 18:30 - 4/15/2009 11:45 and 4/22/2009 14:45 - 7/9/2009 08:00, unless otherwise flagged and coded. Following the sensor swap on 8/5/2009, elevated nighttime values were flagged and coded as <1> CSM while data coded as "0" were coded as CSM until the sensor issues worsened on 8/31/2009.

PAR data had a strange increase in baseline values occurring 07/09/2009 08:15 - 08/05/2009 14:00 and were rejected due to sensor malfunction. Night-time PAR values jumped up and did not return to normal until the PAR sensor was replaced with a recalibrated unit. Peak day-time values were also high. There is no way to distinguish errant values during this time period so all data were rejected.

PAR was repeatedly causing problems during 2009. The PAR sensor was replaced with a recalibrated unit 08/05/2009 14:15. Recalibrated sensor operated normally until September 2009 when performance became spotty and unreliable. (Between 2009 and 2010 the recalibrated probe was replaced several times as well as the CR1000 unit with no success in 2010). The CR1000 program was repeatedly replaced and adjusted in attempt to solve the issue. When this did not work, the program was rolled back to the last successful version. All PAR data from 8/31/2009 21:00 - 12/31/2009 23:45 were rejected due to sensor problems. The problem continued into the next year's (2010) data and was corrected in January 2010.

Temp/RH

1/1/2009 00:00 - 8/25/2009 12:45 ATemp and RH data are considered out of calibration and are flagged as suspect <1> SOC CSM. The sensor should have been swapped by 6/25/2008.

9/30/2009 15:30 -11/30/2009 14:45 all ATemp and RH data are considered suspect <1> SSM CSM. Air temperatures were found to be ~6° below surrounding weather stations. Data prior to 9/30/2009 were comparable to a local NWS station. Repeated troubleshooting indicated that the probe was in need of replacement. This solved the problem.

11/30/2009 16:00 A loaner ATemp/RH sensor from Campbell Scientific was installed. The loaner sensor was in place until 1/27/2010. These data collected with the loaner sensor are coded as CSM.

Precipitation

The precipitation gauge began malfunctioning, however, due to spotty precipitation in the area, it was difficult to determine when exactly the precipitation gauge stopped functioning. Data were rejected beginning 8/5/2009 14:30 <-3> SSM CSM (this was the earliest date that we could positively determine the gauge was not functioning properly) through 9/30/2009 15:15. The gauge was removed due to malfunction from 9/30/2009 15:30 through 10/3/2009 09:45 (cumulative precipitation through the end of the day 10/4/2009 00:00) <-3> SSR CSM. The sensor replaced on 10/3/2009 with a gauge that was calibrated and in good working order.

11/17/2009 12:45 -11/18/2009 00:00 After the program reload at 12:30, cumulative precipitation values reset from 0.3 to 0.0. These data were corrected back to 0.3mm since there was no other precipitation that day.