

Chesapeake Bay Maryland (CBM) NERR Meteorological Metadata
January 2010 – December 2010
Latest Update: May 27, 2014

I. Data Set and Research Descriptors

1) Principal investigator(s) and contact persons

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2) Entry verification

The meteorological information is sampled every 5 seconds from each instrument on the weather station and stored on a Campbell Scientific CR1000 data logger. Data are uploaded from the CR1000 data logger to a Personal Computer (IBM compatible). Files are exported from 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. Processing, data verification, and data upload to the CDMO server was performed by Lauren Cunningham.

3) Research objectives

The principal objectives are to record meteorological information for the Chesapeake Bay National Estuarine Research Reserve (NERR) in Maryland in support of the National Estuarine Research Reserve's System Wide Monitoring Program (SWMP). This information is available for the following: 1) to track and record atmospheric and meteorological conditions useful to help understand and explain additional data collected concurrently 2) to create a database capable of detecting long-term changes in weather patterns 3) to record and identify the impact of storms, hurricanes, heavy rain and other episodic weather events capable of influencing other environmental conditions such as water quality (as monitored by the SWMP effort) and to collect ancillary data in support of other research efforts.

4) Research methods

Campbell Scientific data telemetry equipment was installed at the Chesapeake Bay Maryland NERR Jug Bay site in August 2000 and transmits data to the NOAA GOES satellite, NESDIS ID #3B0071EA. The transmissions are scheduled hourly and contain four (4) data sets reflecting the 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 Campbell Scientific weather station samples every 5 seconds continuously throughout the year. Data are used by the CR1000 to produce 15 minute averages, maximums, and minimums. Data are manually downloaded on site, or is telemetered via cellular technology to a desktop PC at the DNR Annapolis Field Office. Typically, data are transferred or uploaded once monthly throughout the year. All collected data are quality checked after the monthly downloads using the CDMO Excel macro. The reports, graphs and queries of meteorological data are reviewed and any errors or anomalous data are further investigated and the data are corrected, rejected (if necessary), or commented on and left unchanged.

The 15 minute Data are collected in the following formats for the **CR1000**:

Averages from 5-second data:

Air Temperature (°C), Relative Humidity (%), Barometric Pressure (mb), Wind Speed (m/s), Wind Direction (degrees), Battery Voltage (volts)

Maximum and Minimum Air Temperature (°C) and their times from 5-second data (these data are available from the Reserve)

Maximum Wind Speed, (m/s) from 5-second data

Wind Direction Standard Deviation (degrees)

Totals:

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

A minimum of monthly maintenance is conducted on the sensors, probes and weather station in accordance with NERR guidelines. At this time, sensors on the weather station are inspected for damage, debris, and/or fouling and cleaned as needed. Monthly maintenance log sheets are also completed and sensors are checked with a handheld Kestrel 4000 or a local National Weather Station to ensure comparative readings. Additional checks are often done weekly and bi-weekly specifically to check the rain gauge and Li-COR sensors for fouling. The rain gauge frequently tends to collect debris and is therefore checked as often as possible, with suggested checks prior to onset of storm events. Simultaneous rain data are also recorded by the Jug Bay Wetlands Sanctuary daily and therefore provides supplemental rain data. Sensors were removed and replaced with newly calibrated sensors on March 30, 2010. Old sensors are to be sent back to Campbell Scientific for calibration and rotated every year or two years to maintain current calibration requirements.

The recommended calibration frequency for the sensors is:

- Temperature/Humidity- annual recalibration
- Rain Gauge- annual recalibration
- Wind Speed/Direction- bi-annual recalibration
- Barometric Pressure- bi-annual recalibration
- PAR- bi-annual recalibration

5) Site location and character

The Chesapeake Bay National Estuarine Research Reserve in Maryland consists of three components; Otter Point Creek on the Bush River along the upper western shore of the Chesapeake Bay, Jug Bay along the Patuxent River in the middle Bay, and Monie Bay on the lower eastern shore of the Chesapeake Bay. The weather station is located at the Jug Bay Component of the Reserve, specifically at the Jug Bay

Wetlands Sanctuary. The station is situated on the north end of the Jug Bay marsh, along a tidal creek that feeds the Patuxent River. The weather station is situated at 38°46' 50.76" N, 76°42' 29.52" W. The station is housed in a small bird blind situated at the end of a boardwalk in the Jug Bay marsh. The boardwalk extends about 50m from an elevated old railroad track out into the marsh. The CR1000 and BP sensor are in a weatherproof box situated on the inside of the building, while the other probes are fixed to the roof or side of the building so as not to be impacted by the structure. The probes are approximately 5m above mean water and are not shaded. The wind speed and direction sensor and PAR sensors are mounted directly to the roof of the blind. The temperature/relative humidity sensor is mounted directly below those sensors on the side of the building. The tipping rain gauge is mounted on the boardwalk railing, a few meters from the other sensors.

Sensor heights from the marsh surface (meters):

Temperature/humidity: 3.9

PAR: 5.2

Wind speed/direction: 5.4

Rain bucket: 3.9

BP: 3.4

Wind speed may be slightly altered at the site due to proximity of the historic railroad bridge that splits the marsh. The old railroad bridge is on an elevated berm that sits about 2-2.5m above mean water. The berm runs east to west and the boardwalk that houses the weather station runs perpendicular to the berm in the north/south direction. From 1995-2002, the weather station was also the site of a YSI datalogger that recorded water quality at the site. Due to problems with the shallow nature of the site, the water quality component was moved in 2003, approximately 500m westward, from the tidal creek to the main stem of the Patuxent River.

6) Data collection period

Weather data has been collected at the Chesapeake Bay Maryland NERR Jug Bay site since August 2000. The current weather station has been operational since this time. Data was collected for the entire year in 2010, starting at 00:00:00 hrs on January 1st to 23:45:00 hrs on December 31st.

7) Distribution

NOAA 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. 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:

<http://cdmo.baruch.sc.edu/>; accessed 12 October 2012.

NERR water quality 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 <http://cdmo.baruch.sc.edu/>. Data are available in comma delimited format.

8) Associated researchers and projects

Data are most commonly used in support of the System Wide Monitoring Program (SWMP) and to help explain the relationships between water quality, nutrients, and meteorological conditions. Three of the four SWMP water quality sites are located at the Jug Bay component of the Reserve and therefore the collection of meteorological data provides additional information helpful for analyzing and detecting trends in water quality and nutrient data that are collected by the Reserve. For more information about the SWMP water quality monitoring and nutrient monitoring efforts, refer to the Chesapeake Bay Maryland Reserve water quality data on the CDMO website <http://cdmo.baruch.sc.edu/>.

Additional research and data that is available at the Jug Bay component of the Reserve is sediment erosion data and water quality data collected by Jug Bay Wetlands Sanctuary staff. Various sediment erosion tables (SET) are installed and monitored at the site annually to track changes in sedimentation levels. Dr. Marta Ceroni is one of the lead PI's on the sediment effort, while Chris Swarth is the lead PI for supplemental water quality monitoring efforts. Additional information, to include their contact information, can be obtained through the Research Coordinator.

A second weather station was installed at the Otter Point Creek component of the Reserve as well as a vented tide gauge in 2004. Both the Jug Bay and Otter Point Creek meteorological stations were telemetered in 2005.

II. Physical Structure Descriptors

9) Sensor specifications

The weather station records temperature, relative humidity, barometric pressure, wind speed, wind direction, light as measured by a LI-COR Quantum Sensor, and precipitation. The following is a list of the above parameters along with a parameter description, units, sensor type, model number, range of measurement, accuracy, and date of the last calibration for each sensor. Similar information for the storage module, CR1000, is also listed below.

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: ± 0.2 °C @ 20°C

Date of Last calibration:

Sensor installed from 01/01/2010 – 03/30/2010: 04/12/2007

Sensor installed from 03/30/2010 – 12/31/2010: 03/02/2009

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

Date of Last calibration:

Sensor installed from 01/01/2010 – 03/30/2010: 04/12/2007

Sensor installed from 03/30/2010 – 12/31/2010: 03/02/2009

Parameter: Barometric Sensor

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

Date of Last calibration:

Sensor installed from 01/01/2010 – 03/30/2010: 04/12/2007

Sensor installed from 03/30/2010 – 12/31/2010: 03/10/2009

Parameter: Wind speed

Units: meter per second (m/s)

Sensor type: 12 cm diameter cup wheel assembly, three 40 mm diameter hemispherical cups

Model #: R.M. Young 03001-L Wind Monitor

Range: 0-50 m/s (112 mph); gust survival 60 m/s (134 mph)

Accuracy: ± 0.5 m/s

Date of last calibration:

Sensor installed from 01/01/2010 – 03/30/2010: 04/12/2007

Sensor installed from 03/30/2010 – 12/31/2010: 03/05/2009

Parameter: Wind direction

Units: degrees

Sensor type: balanced vane, 16 cm turning radius

Model #: R.M. Young 03001-L Wind Monitor

Range: 360° mechanical, 355° electrical (5° open)

Accuracy: ± 5 degrees

Date of last calibration:

Sensor installed from 01/01/2010 – 03/30/2010: 04/12/2007

Sensor installed from 03/30/2010 – 12/31/2010: 03/05/2009

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: $\leq \pm 2\%$ change over 1 yr

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

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

Multiplier:

Sensor installed from 01/01/2010 – 03/30/2010: 1.183

Sensor installed from 03/30/2010 – 12/31/2010: 1.562

Date of last calibration:

Sensor installed from 01/01/2010 – 03/30/2010: 04/12/2007

Sensor installed from 03/30/2010 – 12/31/2010: 03/03/2009

Date Installed:

Installation dates of 07/26/2007 and 03/30/2010

Parameter: Precipitation

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: +/- 1.0% up to 1 in./hr; +0, -3% from 1 to 2 in./hr; +0, -5% from 2 to 3 in./hr

Date of Last calibration: 5/5/2005

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: 10/31/2006

10) Coded variable definitions

Sampling station:	Sampling site code:	Station code:
Jug Bay	JB	cbmjbm

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 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	
SIC	Incorrect Calibration Constant, Multiplier or Offset
SIW	Incorrect Wiring
SMT	Sensor Maintenance
SNV	Negative Value
SOC	Out of Calibration
SSD	Sensor Drift
SSN	Not a Number / Unknown Value
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
CCU	Cause Unknown
CVT	Possible Vandalism/Tampering

13) Other remarks/notes

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.

Occasional elevated nighttime PAR data were recorded during 2010. With a few exceptions, the data were below the maximum signal noise for the sensor. Data were rejected when they exceeded 2.214 mmol/m². Reasons for the elevated readings are unknown; however, it is suspected that moisture in the sensor may be causing these elevated readings, as it was observed that these readings typically occurred during or immediately following a precipitation event.

PAR data were corrected from 1/1/2010 00:00 to 3/30/2010 07:15. An incorrect multiplier was used when the data were first collected. To make corrections, the data were divided by the incorrect multiplier (0.74) and then multiplied by the correct multiplier (1.183).

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.

The relative humidity sensor installed at the weather station from 01/01/2010 through the 03/30/2010 sensor swap was not working correctly due to corroded electronics. All relative humidity data generated during this time was rejected.

All air temperature data (see above explanation for relative humidity) are flagged as suspect and coded as out of calibration (1 SOC CSM) from 01/01/2010 through the 03/30/2010 sensor swap.

PAR flagging and coding explanations:

There were noticeable changes in PAR values following the swap to a freshly calibrated sensor (assumed to be accurate) on 03/30/2010. Campbell Scientific reported a -14.9% post cal drift (-3.76%/year) for the sensor that was installed from 07/26/2007 to 03/30/2010 (Q22439). Acceptable drift is +/- 2% for this sensor. All PAR data ~1 year 3 months prior to the sensor swap, from 01/01/2009 to 03/30/2010 are flagged and coded as <5> SSD CSM (<5> instead of <1> because the data were corrected due to an incorrect multiplier). PAR data for the remainder of this deployment (07/26/2007 to 12/31/2008) are flagged and coded <0> CSM and users should note that drift for that period may have exceeded acceptable limits as well. If users are comfortable assuming that drift was linear (in a real world environment it is unlikely to be entirely linear), these data may be 'corrected' for assumed linear drift at the user's discretion using manufacturer's instructions.

PAR data were corrected from 1/1/2010 00:00 to 03/30/2010 07:15. An incorrect multiplier was used when the data were first collected. To make corrections, the raw data were divided by the incorrect multiplier (0.74) and then multiplied by the correct multiplier (1.183).

Elevated nighttime PAR readings occurred throughout the year in 2010. Even though elevated nighttime data are flagged as corrected, along with the rest of the data from 1/1/2010 through the 3/30/2010 sensor swap, those nighttime data >0 mmols/m² are still considered suspect. Elevated nighttime readings following the sensor swap are flagged and coded as <1> CSM. Reasons for elevated nighttime PAR readings are unknown, but it is suspected that moisture intrusion may be the cause.

All precipitation data for 2010 are flagged as suspect and coded as out of calibration (1 SOC CSM). If precipitation data were corrected, they were flagged and coded as <5> SOC CSM.

Precipitation data (total precipitation and the associated cumulative precipitation) for the following dates and times were corrected in the data set. Field personnel were performing their monthly maintenance on the precipitation sensor at these times. Personnel had to unclog the funnel as documented in the field logs; therefore, the data generated was erroneous.

04/13/2010 08:00 0.254mm corrected to 0mm

06/10/2010 08:30 1.524mm corrected to 0mm

10/21/2010 07:45 0.254mm corrected to 0mm

The precipitation bucket had several inches of ice in the funnel when field technicians visited the site on 12/14/2010 at 10:15. One side of the tipping arm also had ice accumulated on it and was constantly "tipped". The technicians were unable to remove the ice during the visit. A technician revisited the weather station on 12/16/2010 at 11:20 and removed the ice from the funnel and tipping arm. The area experienced snow and freezing rains on 12/13/2010. Precipitation data was flagged as suspect beginning on 12/13/2010 at 16:00 as this is when accumulated precipitation was recorded and air temperatures were below freezing. Therefore, it is unknown as to exactly when the ice accumulated. Flagging continues as suspect until 12/14/2010 at 10:15, the time of the site visit as, after this point, it is known that there was accumulated ice in the funnel and tipping arm. From 12/14/2010 at 10:30 until 12/16/2010 at 11:30 all precipitation data is rejected. Associated cumulative precipitation data is continued to be rejected until 12/17/2010 at 00:00.

Data are missing on 3/30/2010 07:30 to 13:15 due to multiple attempts at a program reload following sensor swaps. The initial reload attempt was with an incorrect program file, therefore, the weather station was without a program until the correct program file was obtained and loaded. The program

successfully loaded at 13:30, however, data at that time stamp were rejected due to most likely not being a full 15 minutes of 5-second data.

The record number reset to 0 on 7/27/2010 15:15. No power down or program reload is documented for this time. The reason for this reset is unknown. The cumulative precipitation values from 7/27/2010 15:15 through 7/28/2010 00:00 were corrected from 0mm to 0.3mm.

Monthly maintenance was not performed on the weather station during the months of January and February due to hazardous weather conditions including snow storms and freezing rains. The area experienced record breaking snowfalls in the beginning of February (upwards of 70 inches of accumulated snow by February 10). Due to the fact that the technicians must drive on off-road terrain to reach the weather station, the weather conditions made the station inaccessible during these months.

Ancillary MET Data Source:

<http://www.wunderground.com> (Either Queenswood or Rolling Acres stations)