Chesapeake Bay Maryland (CBM) **NERR Meteorological Metadata**
January 2009 – December 2009
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

Meteorological information is sampled every five seconds from each weather station sensor 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. Pre-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 in Maryland in support of the National Estuarine Research Reserve's (NERR) 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 and nutrient amounts (as monitored by the SWMP effort), and 4) to collect ancillary data in support of other research efforts.

4) Research methods

Campbell Scientific CR1000 data telemetry equipment was installed at the CBM station on 10/31/2006 and transmits data to the NOAA GOES satellite, NESDIS ID #3B0071EA. The transmissions are scheduled hourly and contain four (4) data sets reflecting 15 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 available in the dataset but are available from the Reserve)

Maximum and their times from 5-second data:
Wind Speed, (m/s)

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

Totals:
Precipitation (mm), PAR (millimoles/m^2), and Cumulative Precipitation (mm)

At the Chesapeake Bay Maryland reserve, the following error/anomalous data criteria are used:

Air Temp:
- Sample not greater than 45°C or less than -40°C

Relative Humidity:
- Sample not greater than 100% or less than 0%

Barometric Pressure:
- Sample not greater than 1060mb or less than 900mb

Wind Speed:
- Wind speed not greater than 30m/s

Wind Direction:
- Wind direction not greater than 360 degrees or less than 0 degrees

Rainfall:
- Precipitation not greater than 25mm in 15 minutes

Photosynthetically Active Radiation (PAR):
- Sample not greater than 5000 mmol/m^2 or less than 0 mmol/m^2

Time:
- 15 minute interval recorded

For all data:

- No duplicate data

Campbell Scientific data telemetry equipment is used at this station to transmit to the NOAA GOES satellite, NESDIS ID #3B0071EA. The transmissions are scheduled hourly and contain four (4) datasets reflecting the 15 minute data-sampling interval. The telemetry is "Provisional" data and not the "Authentic" Dataset used for long term monitoring and study. This data can be viewed by going to http://cdmo.barush.sc.edu.

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 fouling and are cleaned as needed. Monthly maintenance log sheets are also completed and sensors are checked either with a handheld Kestrel 4000 or against a local NWS station. The rain gauge tends to frequently collect debris and is therefore checked as often as possible, with suggested checks prior to the onset of storm events. Simultaneous rain data are also recorded by the Jug Bay Wetlands Sanctuary daily and, therefore, provides supplemental rain data. 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 of the Chesapeake 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 weather station is situated at 38°46' 50.76" N, 76°42' 29.52" W. The station is situated on the north end of the Jug Bay marsh, along a tidal creek that feeds the Patuxent River. 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 the 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 3-5m above mean water and are not shaded. The wind speed and direction sensor and PAR sensor 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 blind. The tipping rain gauge is mounted on the boardwalk railing, a few meters from the other sensors. 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.

Sensors 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

6) Data collection period

Weather data has been collected at the CBM NERR Jug Bay site since August 2000. The current weather station has been operational since this date. The Maryland Department of Natural Resources took over the operation and maintenance of the station in 2004. Data was collected for the entire year of 2009, 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 five 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 any trends in the water quality and nutrient data sets. For more information about the SWMP water quality monitoring and nutrient data collection efforts, refer to the Chesapeake Bay Maryland Reserve data sets 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 in 2004. Both the Jug Bay and Otter Point Creek meteorological stations are currently on telemetry.

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 last calibration for each sensor. A description of the CR1000 is also listed below.

Parameter: Temperature
Units: Celsius
Sensor type: Platinum resistance temperature detector (PRT)
Model #: HMP45AC 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: 04/12/2007
Dates Installed: 7/26/2007-3/30/2010

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: +/- 2% RH (0-90%) and +/- 3% (90-100%)
Temperature dependence of RH measurement: +/- 0.05% RH/°C
Date of Last calibration: 04/12/2007
Dates Installed: 7/26/2007-3/30/2010

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
Date of Last calibration: 04/04/2007
Dates Installed: 7/26/2007-3/30/2010

Parameter: Wind speed

Units: meter per second (m/s)
Sensor type: 18 cm diameter 4-blade helicoids propeller molded of polypropylene
Model #: R.M. Young 05103 Wind Monitor
Range: 0-60 m/s (134 mph); gust survival 100 m/s (220 mph)
Accuracy: +/- 0.3 m/s
Date of last calibration: 04/12/2007
Dates Installed: 7/26/2007-3/30/2010

Parameter: Wind direction
Units: degrees
Sensor type: balanced vane, 38 cm turning radius
Model #: R.M. Young 05103 Wind Monitor
Range: 360° mechanical, 355° electrical (5° open)
Accuracy: +/- 3 degrees
Date of last calibration: 04/12/2007
Dates Installed: 7/26/2007-3/30/2010

Parameter: Photosynthetically Active Radiation
Units: mmoles 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: <±2% change over 1 yr
Operating Temperature: -40°C to 65°C; Humidity: 0 to 100%
Sensitivity: typically 5 μA per 1000 μmoles s-1 m-2
Multiplier: 0.74 (added on 6/12/2008) *Note: This multiplier is incorrect. The correct multiplier is 1.183. Please see Section 13 for further information.
Date of last calibration: 04/12/2007
Dates Installed: 7/26/2007-3/30/2010

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: 05/05/2005

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 available for program storage (16K), operating system use, and data storage.
Date CR1000 Installed: 10/31/2006

10) Coded variable definitions

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

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
CDF	Data Appear to Fit Conditions
CML	Snow melt from previous snowfall event
CRE*	Significant Rain Event
CSM*	See Metadata
CCU	Cause Unknown
CVT*	Possible Vandalism/Tampering
CWE*	Significant weather event

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 mmoles/m2 over a 15 minute interval.

Relative Humidity data greater than 100 are within range of the sensor accuracy of +/-3%.

Data recorded for all parameters (with the exception of cumulative precipitation) at the midnight timestamp (00:00) are the 15 minute averages and totals for the 23:45-23:59 time period of the previous day. Cumulative precipitation data at the midnight timestamp (00:00) are the sum of raw (unrounded) precipitation data from 00:00 to 23:59 of the previous day. Summing each individual 15-minute total precipitation value from the same period will result in small differences from cumulative precipitation due to rounding. It is especially important to note how data at the midnight timestamp are recorded when using January 1st and December 31st data.

Ancillary Met Data Source – Local NWS Station:
http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KMDDEALE1

The relative humidity probe at the Jug Bay weather station experienced a complete failure during 2009 that was not noticed by the Chesapeake Bay reserve technicians until 2010. It could not be pin-pointed as to exactly when the probe failed, however it is believed to have been sometime around 4/21/2009. April 21st at 19:00 was chosen as the start of the malfunction as the relative humidity values drop from this point on and never fully rise again to the area's typical historical values. It is important to take note of the monthly log from 4/9/2009 as further evidence that the probe failed around this time. It is commented on the meteorological log from 4/9/2009 that the technicians observed some corrosion on the temperature and relative humidity electronics during their monthly visit to the weather station.

All air temperature data (see above explanation for relative humidity) are flagged as suspect and coded as out of calibration (1 SOC CSM) from 7/26/2009-12/31/2009.

All precipitation data for 2009 are flagged as suspect and coded as out of calibration (1 SOC CSM).

PAR data were corrected from 1/1/2009 00:00 to 12/31/2009 23:45. 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).

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 ~1year 3 months prior 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.

Elevated nighttime PAR readings occurred throughout the year in 2009. Even though elevated nighttime data are flagged as corrected, along with the rest of the data for that time period, those nighttime data >0 mmols/m2 are still considered suspect. Reasons for elevated nighttime PAR readings are unknown, but it is suspected that moisture intrusion may be the cause.

Significant weather events:
- Monthly maintenance was not performed on the weather station during the month of December due to hazardous weather conditions including snow and freezing rains. The Reserve experienced a large snowfall of approximately 20 inches on December 18-19 (see NOAA weather history). Due to the fact that the technicians must drive on off-road terrain to reach the weather station, the snow made the station inaccessible for the remainder of December. Data for December are coded with {CSM} in the F_Record.

- A significant rainfall event occurred on 8/22/2009 between the hours of approximately 15:30 and 18:45. During this time, rainfall rates reached an upwards of around 2.5 inches per hour. Cumulative precipitation data are flagged and coded <1> [SOC] (CRE) from 15:30 through 8/23/2009 00:00.

DateTimeStamp	TotPrcp	F_TotPrcp
08/22/2009 15:30	0.3	<1> [SOC] (CRE)
08/22/2009 15:45	1.0	<1> [SOC] (CRE)
08/22/2009 16:00	2.8	<1> [SOC] (CRE)
08/22/2009 16:15	12.2	<1> [SOC] (CRE)
08/22/2009 16:30	25.9	<1> [SOC] (CRE)
08/22/2009 16:45	22.4	<1> [SOC] (CRE)
08/22/2009 17:00	14.5	<1> [SOC] (CRE)
08/22/2009 17:15	7.1	<1> [SOC] (CRE)
08/22/2009 17:30	3.0	<1> [SOC] (CRE)
08/22/2009 17:45	0.5	<1> [SOC] (CRE)
08/22/2009 18:00	1.5	<1> [SOC] (CRE)
08/22/2009 18:15	0.8	<1> [SOC] (CRE)
08/22/2009 18:30	0.3	<1> [SOC] (CRE)

08/22/2009 18:45 0.3 <1> [SOC] (CRE)