Chesapeake Bay Maryland (CBM) **NERR Meteorological Metadata**
January 2016 – December 2016
Latest Update: January 17, 2018

I. Data Set and Research Descriptors

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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. 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, and 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 station 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 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 minutes averages, maximums, minimums, and totals. Data are manually downloaded on site, or is telemetered via cellular technology to a desktop PC at the MD DNR Annapolis Field Office. Typically, data are transferred or uploaded once monthly throughout the year. 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. Data are collected in Eastern Standard Time (EST) for the entire year.

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) and time from 5-second data
- Wind Direction Standard Deviation (degrees)
- Totals:
  - Precipitation (mm), PAR (millimoles/m^2), and Cumulative Precipitation (mm)

Recommended calibration frequency for the MET station sensors:

- Temperature/Humidity- yearly recalibration

- Rain Gauge- yearly recalibration
- Wind Speed/Direction- yearly or every 2 years (depending on the sensor)
- Barometric Pressure- every 2 years recalibration
- PAR- every 2 years recalibration
- CR1000-every 5 years (required beginning 2014, one year initial grace period)

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 bi-weekly specifically to check the rain gauge 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, providing supplemental rain data. Old sensors are sent back to Campbell Scientific for calibration and are rotated every year or two years to maintain current calibration requirements.

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 and 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.

SWMP Station Timeline:

Station Code	Station Name	SWMP Status	Location	Active Dates	Reason Decommissioned	Notes
CBMJBMET	Jug Bay	P	38° 46' 50.76 N, 76° 42' 29.52 W	07/01/2003 -	NA	NA

6) Data collection period

Meteorological data have been collected at the Chesapeake Bay Maryland NERR Jug Bay site since August 2000. The current weather station has been operational since this time. Weather data at the JUG Bay site for 2016 were collected from 01/01/2016 00:00:00 to 12/31/2016 23:45:00.

Start and end date and times of 2016 raw data files submitted to the CDMO:
CBMJBMET010116.csv : 01/01/2016 00:00:00 – 01/31/2016 23:45:00
CBMJBMET020116.csv : 02/01/2016 00:00:00 – 02/29/2016 13:30:00
CBMJBMET022916.csv: 02/29/2016 14:15:00 – 03/31/2016 23:45:00
CBMJBMET040116.csv : 04/01/2016 00:00:00 – 04/30/2016 23:45:00
CBMJBMET050116.csv : 05/01/2016 00:00:00 – 06/16/2016 09:15:00
CBMJBMET060616.csv : 06/16/2016 09:30:00 – 06/30/2016 23:45:00 *Incorrectly named*
CBMJBMET070116.csv : 07/01/2016 00:00:00 – 07/31/2016 23:45:00
CBMJBMET080116.csv : 08/01/2016 00:00:00 – 09/03/2016 23:45:00
CBMJBMET090416.csv : 09/04/2016 00:00:00 – 09/30/2016 23:45:00
CBMJBMET100116.csv : 10/01/2016 00:00:00 – 11/30/2016 23:45:00
CBMJBMET120116.csv : 12/01/2016 00:00:00 – 12/31/2016 23:45:00

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:
NOAA National Estuarine Research Reserve System (NERRS). System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: http://www.nerrsdata.org/; *accessed* 12 October 2016.

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 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 Chesapeake Bay Maryland 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.

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. These 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 have been telemetered since 2005.

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: ± 0.2 °C @ 20°C
Serial Number: Y1120038
Date of Calibration: 04/04/2013
Dates of Sensor Use: 06/25/2014 – current as of 12/31/2016

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
Serial Number: Y1120038
Date of Calibration: 04/04/2013
Dates of Sensor Use: 06/25/2014 – current as of 12/31/2016

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: Y0820021
Date of Calibration: 04/16/2013
Dates of Sensor Use: 06/25/2014 – current as of 12/31/2016

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 03101-5 Wind Monitor
Range: 0-50 m/s (112 mph); gust survival 60 m/s (134 mph)
Accuracy: +/- 0.5 m/s
Serial Number: 21908M3
Date of Calibration: 04/15/2015
Dates of Sensor Use: 04/23/2015 – current as of 12/31/2016
Parameter: Wind direction
Units: degrees
Sensor type: balanced vane, 16 cm turning radius
Model #: R.M. Young 03301-5 Wind Monitor
Range: 360° mechanical, 355° electrical (5° open)
Accuracy: +/- 5 degrees
Serial Number: 21908M3
Date of Calibration: 04/15/2015
Dates of Sensor Use: 04/23/2015 – current as of 12/31/2016

Parameter: Photosynthetically Active Radiation (PAR)
LI-COR Quantum Sensor
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: 1.51
Serial Number: Q31552
Date of Calibration: 04/05/2013
Dates of Sensor Use: 06/25/2014 – 02/29/2016

Parameter: Photosynthetically Active Radiation (PAR)
LI-COR Quantum Sensor
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: 1.40
Serial Number: Q22439
Date of Calibration: 11/13/2015
Dates of Sensor Use: 02/29/2016 – current as of 12/31/2016

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
Serial Number: N/A
Date of Calibration: 07/23/2014
Dates of Sensor Use: 07/23/2014 – 09/14/2016
Date of Calibration: 09/14/2016
Dates of Sensor Use: 09/14/2016 – current as of 12/31/2016

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.
CR1000 Serial Number: 5080
Date CR1000 Installed: 10/31/2006 - 01/28/2015
Date CR1000 Calibrated: unknown

Date CR1000 Installed: 02/11/2015 - current as of 12/31/2016
Date CR1000 Calibrated: 02/06/2015

CR1000 Firmware Version (s): Std. 22 Installed 11/04/2007
CR1000 Program Version(s): CBMJBMET_V6.0_111511.CR1
CBMJBMET_V6.0_062714.CR1

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
CCU	Cause unknown
CDF	Data appear to fit conditions
CML	Snow melt from previous snowfall event
CRE*	Significant rain event
CSM*	See metadata
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. These values are automatically flagged and coded as <1> (CAF).

The PAR sensor was disconnected from the CR1000 on 1/11/2016 at 10:45 AM in order to swap the sensor out with a newly calibrated one. After disconnecting the sensor, the technician discovered that the roof of the bird blind where the PAR sensor is located was inaccessible due to broken ladder supports. The old PAR sensor was wired back in to the CR1000 between 11:00 – 11:15 AM. The 11:15 AM PAR value is rejected as it was not a full 15 minutes of data.

The PAR sensor was removed for a sensor swap on 2/29/16 at 11:30 AM. The newly calibrated PAR sensor was connected at 11:42 AM. The 12:00 PM reading was a full 15 minutes of data. The technician was blocking the wind sensor during the PAR sensor swap, so all 11:45 AM wind values are rejected.

Data were downloaded and the station was powered down at 13:45 on 2/29/2016. A new program with the new PAR multiplier was sent to the station at 14:12. The 14:15 values are not from a full 15 minutes and were rejected. All PAR data from 2/29/2016 at 12:00 PM to 13:30, when the new PAR sensor was installed to when the new program was sent, has been corrected to account for the new PAR multiplier.

PAR values for the following dates and times are rejected in the data as a result of technicians wiping the PAR sensor clean during the monthly visit. PAR values rejected as not a full 15 minutes of data.

03/24/2016 08:45
04/20/2016 08:00

The DNR field office lost the ability to remote connect to the weather station at some point during May of 2016 due to the IP address of DNR's modem being accidentally assigned to a different station. Once the IP address was correctly reassigned but the field office was still unable to remotely connect, a technician went to the weather station to troubleshoot. Data was downloaded on station on 06/16/2016 at 09:15. The station and modem were powered down around 09:35 in order to attempt a reset of the modem. The first attempt did not succeed so the station was powered down a second time around 09:45. All data from 09:30 to 10:00 are rejected as the values are not a full 15 minutes of data.

Total precipitation data for the following dates and times were corrected in the data. The associated cumulative precipitation data were also corrected for the remainder of the day but are not listed. Field personnel were cleaning the rain gauge at these times.

04/05/2016 07:45 0.254 mm corrected to 0 mm
07/07/2016 08:00 1.27 mm corrected to 0 mm

08/04/2016 08:15 3.302 mm corrected to 0 mm

Precipitation data for the following dates and times (along with the associated cumulative precipitation data) were corrected. Field personnel were performing the monthly check on the weather station at this time, however, water was found in the tipping bucket of the rain gauge. The buckets needed cleaned so the field tech manually tipped the buckets, causing a precipitation value to be recorded. While it was rain water present in the tipping buckets on both occasions, it cannot be known the actual amount present. A small rain event had occurred the morning of 7/20/16, explaining the presence of water in the tipping bucket, however, it was not enough to tip the bucket. A rain event had not occurred on 8/17/16 or the previous day. A rain event did occur the night of 8/15/16, so the water present on 8/17/16 may have been left over from that event. A rain event occurred later in the day on 8/17/16, so the value of the "false" tip from the morning was subtracted out from the cumulative precipitation values.

07/20/2016 07:15 0.254 mm corrected to 0 mm
08/17/2016 07:45 1.106 mm corrected to 0 mm

Field personnel calibrated the rain gauge on 09/14/2016 from 08:15 to 09:45. Total precipitation data for the following dates and times were corrected to 0 mm in the data. The associated cumulative precipitation data were also corrected to zero for the remainder of the day but are not listed

09/14/2016	08:15	2.794 mm
	08:30	9.144 mm
	08:45	2.794 mm
	09:00	3.048 mm
	09:15	4.572 mm
	09:30	5.842 mm
	09:45	3.81 mm

The rain gauge was considered out of calibration beginning on 07/23/2016 because it had been previously calibrated on 07/23/2014. All total and cumulative precipitation data between 07/23/2016 00:15 and 09/14/2016 08:00 when the rain gauge was most recently calibrated are flagged <1> SOC CSM to indicate being out of calibration.

Relative Humidity data greater than 100 are within range of the sensor accuracy of +/-3% and are flagged and coded as suspect, <1> (CAF).

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.**

The temperature/relative humidity sensor was installed on 06/25/2014 and was considered out of calibration beginning 06/25/2016. All temperature and relative humidity data beginning on 06/25/2016 00:15 until the end of the year are flagged and coded <1> SOC CSM to indicate being out of calibration.

Please note that the 3301 Wind Monitor has an offset of 0.2 and does not record values of 0.

Significant Weather Events of 2016 (record marked in data as {CWE} in the F_Record):

- Winter Storm Jonas passed through the area from 1/22/2016 00:15 – 1/25/2016 00:00, bringing blizzard conditions and around 30 inches of snow.
- A severe winter thunderstorm occurred on 2/16/2016 06:00 - 2/17/2016 00:00.
- A string of severe winter thunderstorms occurred from 2/23/2016 05:30 thru 2/25/2016 00:00, bringing with them flooding, damaging winds, hail, and small tornadoes touching down in the area.
- Flash flooding occurred in the area on 7/30/2016 13:15 - 7/31/2016 00:00. The flooding was so severe it wiped out part of an historic town, Ellicott City, located approximately 40 miles north of the reserve, with 5.52 inches of rain falling in the span of 90 minutes.