

Chesapeake Bay Maryland (CBM) NERR Meteorological Metadata
January 2005-December 2005
Latest Update: **October 19, 2023**

I. Data Set and Research Descriptors

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2) Entry Verification

a) Data input procedures:

The meteorological information is sampled every 5 seconds from each instrument on the weather station and stored on a Campbell Scientific CR10X data logger and 4M Storage Module. Data are output to a file in three arrays: array 15 stores 15 minute average, max and min data; array 60 stores hourly average, max and min data; and array 144 stores daily average, max and min data. The CDMO Data Logger Program (NERR_4.2.CSI) was loaded into the CR10X on January 21, 2005 and controls the sensors. Using PC208W, or Loggernet software technicians are able to interface with the CR10X. The NERR_4.2 CSI program was upgraded to change the midnight stamp to 0000. On April 29, 2005 the CR10X program was upgraded to NERR_4.2.CSI to change the midnight stamp back from 0000 to 2400. On October 31, 2006 the CR10x and SM4M hardware were removed and a CR1000 was installed. The new CR1000 and it's program (version 3) collected only 15 minute data.

Data are uploaded from the CR10X data logger or 4M storage module, and CR1000 (after 10/31/2006) to the hard drive of a Personal Computer (IBM compatible) in comma-delimited format (.DAT). Then the file is opened in Microsoft Excel for pre-processing with the EQWin format macro that was developed by the CDMO to reformat the header columns, insert station codes, insert a date column (mm/dd/yyyy), correct the time column format and reformat the data to the appropriate number of decimal places. Data after 10/31/2006 also under went a PERL conversion tool (to make this new data

string compatible with the old data.)The pre-processed file is then ready to be copied into the EQWin weather.eqi file where the data are QA/QC checked and archived in a database. EQWin queries, reports and graphs are used to discover data set outliers (values which fall outside the range that the instrument is designed to measure) and large changes in the data. EQWin is also used to generate statistics, view graphs, create customized queries and reports of the data, cross query the water, weather and nutrient data and finally export the data to the CDMO. Pre-processing, data verification, and data upload to the CDMO server was performed by John Zimmerelli.

Data are retrieved from the CR10X by NERR technicians performing manual monthly downloads of the data directly from the CR10X, SM4M, and CR1000 using a laptop and PC208W, or Loggernet software. Data can also be retrieved via cellular telemetry and is sometimes done instead of a manual download on site. This data are saved on the laptop as a raw file. This data are then transferred to a disk at the field office for archiving. Data are archived on a disk at the field office and on the CDMO server. This station has been transmitting via Satellite Telemetry since the fall of 2005. This data is transmitted to the Hydro-meteorological Automated Data System (HADS) website and then forwarded to the CDMO website.

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 fifteen min 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.baruch.sc.edu>.

b) Data collection schedule:

CR10X

- i) 15-minute average, maximum and minimum data are averages of 5-second readings for Air Temperature (oC), Relative Humidity (%), Barometric Pressure (mb) and Wind Speed (m/s).
- ii) Hourly average, maximum, and minimum data are averages of 5-second readings for Air Temperature (oC), Relative Humidity (%), Barometric Pressure (mb), Wind Speed (m/s), and Wind Direction (degrees). Hourly totals for PAR (mmol/m²) and Precipitation (mm) are totals of 15-minute readings.
- iii) Daily average, maximum and minimum data are averages of 5-second readings for Air Temperature (oC), Relative Humidity (%), Barometric Pressure (mb), Wind Speed (m/s), and Wind Direction (degrees). Daily totals for PAR (mmol/m²) and Precipitation (mm) are totals of 15-minute readings.

CR1000

- i) 15 minute data are averages/totals of 5 second sampling over the period of 15 minutes.
- ii) Parameters collected during each interval include:
Date, Julian date, Time, Average Temperature (°C), Maximum and Minimum Temperature, Time at maximum and minimum temperature, Relative Humidity, Barometric Pressure, Wind speed, Wind Direction, Standard deviation of wind direction, Maximum Wind Speed, Time at maximum wind speed, Total Precipitation (for that interval), Total Photosynthetically Active Radiation (for that interval), and Battery Voltage.

Data were stored on a Campbell Scientific storage module (SM4M), which was retrieved monthly. After 10/31/2006, 15 minute data were stored on the CR1000 and retrieved monthly. The data were downloaded and pre-processed as described in Section 2. QA/QC of the data was conducted using EQWin. EQWin queries were based on the following anomalous data criteria:

c) Error/anomalous data criteria:

Air Temp:

- 15 min sample not greater than max for the day
- 15 min sample not less than the min for the day
- Sample not greater than 50 C or less than -30 C

Relative Humidity:

- Sample not greater than 100% or less than 0%

Pressure:

- Sample not greater than 1060 mb or less than 900 mb

Wind Speed:

- Wind speed not greater than 30 m/s
- Wind speed not less than 0.5 m/s for 12 consecutive hours

Wind Direction:

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

Rainfall:

- Precipitation not greater than 5 mm in 15 min

Photosynthetically Active Radiation (PAR):

- Sample not greater than 5000 mmol/m² or less than -0.5 mmol/m²

Time:

- 15-minute interval recorded

For all data:

- No duplicate data

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 (as monitored by the SWMP effort) and to collect ancillary data in support of other research efforts.

4) Research Methods

The Campbell Scientific weather station samples every 5 seconds continuously throughout the year. Data are used by the CR10X to produce 15 minute averages, maximum and minimums (array 15), hourly averages, maximums and minimums (array 60) and daily averages, maximums and minimums (array 144) of air temperature, relative humidity, barometric pressure, rainfall, wind speed, and wind direction. 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 EQWin and EQWinFormat 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, deleted (if necessary), or commented on and left unchanged.

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 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 new sensors on October 31, 2006. Old sensors will be sent back to Campbell Scientific for calibration and rotated every year 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 deg 46' 50.6" N and 76 deg 42'29.1" 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 CR10x/CR1000 is in a weatherproof box situated on the inside of the building, while the probes are fixed to the roof of the building so as not to be impacted by the structure. The probes are approximately 5m above mean water and are not shaded. 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 mainstem 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 date. Data was collected for the entire year in 2006, starting at 00:15:00 hrs on January 1st to 23:45:00 hrs on December 31st.

7) Distribution

NOAA/ERD retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The PI retains the right to be fully credited for having collected and processed the data. Following academic courtesy standards, the PI and NERR site where the data were collected will be contacted and fully acknowledged in any subsequent publications in which any part of the data are used. Manuscripts resulting from this NOAA/OCRM supported research that are produced for publication in open literature, including refereed scientific journals, will acknowledge that the research was conducted under an award from the Estuarine Reserves Division, Office of Ocean and Coastal Resource Management, National Ocean Service, National Oceanic and Atmospheric Administration. The data set enclosed within this package/transmission is only as good as the quality assurance 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.

NERR water quality data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Section 2.2-1 Principal investigators and contact persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page <http://cdmo.baruch.sc.edu/>. Data are available in text tab-delimited format, Microsoft Excel spreadsheet format and 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 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 data. For more information about the SWMP water quality monitoring effort, 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, CR10x, and 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: $\pm 0.2^\circ\text{C}$ @ 20°C

Date of Last calibration: 3/1/2005 until 11/2006 and then 3/31/2006

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: 3/1/2005 until 11/2006 and then 3/31/2006

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: 3/1/2005 until 11/2006 and then 3/31/2006

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 (130 mph); gust survival 100 m/s (220 mph)

Accuracy: $\pm 2\%$

Date of last calibration: 3/1/2005 until 11/2006 and then 3/31/2006

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: $\pm 5\%$

Date of last calibration: 3/1/2005 until 11/2006 and then 3/31/2006

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 moles s⁻¹ m⁻²

Date of last calibration: 4/4/2005 until November and then 3/31/2006

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; $\pm 3\%$ from 1 to 2 in./hr; $\pm 5\%$ from 2 to 3 in./hr

Date of Last calibration: 5/5/2005

Storage Module

Model #: SM4M

Storage capacity: 2 million low-resolution data values

Program storage: stores up to 8 programs with a total capacity of 128 KB

Processor: Hitachi H8S

Operating system: 64 KB, flash memory based, user downloadable

Operating range: Temperature: -35° to +65°C

Baud rates: 9600, 76800

Memory type: user selectable for either ring style (default) or fill and drop.

Power requirements: 5 ± 0.3 VDC @ 100 mA

Campbell Scientific CR10X Wiring Panel has 128K of flash memory (EEPROM), in which it stores the operating system and its program (that it uses to run the weather station). Additionally, there are 128K of SRAM, which it uses to run the program and store its measurements and for final data storage.

Campbell Scientific CR1000 Wiring Panel has 2MB Flash EEPROM that is used to store the Operating System. Another 128K for Flash is used to store configuration settings. A minimum of 2 MB SRAM is available for program storage, operating system use, and data storage.

10) Coded variable definitions:

cbm – Chesapeake Bay Maryland, JB - jug bay, met – meteorological, Atemp – Air Temperature(C), AvgVol - Average Battery Voltage(volts), BP - Barometric Pressure(mb), IRR0_N - Incident Irradiance($\mu\text{mol}/\text{m}^2/\text{s}$), MaxTemp - Maximum Air Temperature(C), MaxTempT -Maximum Air Temperature Time, MaxBP - Maximum Pressure(mb), MaxBPT - Maximum Pressure Time, MaxRH - Maximum Relative Humidity(%), MaxRHT - Maximum Relative Humidity Time, MaxWSpd - Maximum Wind Speed(m/s), MaxWSpdT - Maximum Wind Speed Time(m/s), MinTemp - Minimum Air Temperature(C), MinTempT - Minimum Air Temperature Time, MinBP - Minimum Pressure(mb), MinBP - Minimum Pressure Time, MinRH - Minimum Relative Humidity(%), MinRHT - Minimum Relative Humidity Time, MinWSpd - Minimum Wind Speed(m/s), MinWSpdT - Minimum Wind Speed Time, RH - Relative Humidity(%), WdirWind –Direction(deg), WINDIR - Wind Direction, WSpd - Wind Speed(m/s), WINSPD - Wind Speed.

11) Anomalous/Suspect data:

Arrays:

During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at www.nerrsdata.org/get/landing.cfm throughout the fall of 2022.

The following rain data are considered valid although it is outside the range of the sensor. Data were verified with external met station:

1/14/2006 @ 3:45

5/11/2006 @ 19:30, 19:45, 20:00

5/11/2006 @ 20:15 possible heavy rains throughout the region.

7/6/2006 @ 2:15 to 2:45

7/22/2006 @ 21:31, 21:45

8/7/2006 @4:00

9/1/2006 @ 16:30

9/5/2006 @ 5:45, 09:00

June

Rain data on 6/23/2006 @ 0915, 1000(60 minute) and 24:00(144 array) are considered to be anomalous. Rain data from clogged funnel from earlier storm in the morning. Storm verified by local weather station.

12) Deleted data:

Arrays:

During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at www.nerrsdata.org/get/landing.cfm throughout the fall of 2022.

The following rain data deleted, out of sensors range. Data unverifiable through external source:

5/14/2006 @ 16:30, 17:00, 24:00

7/3/2006 @ 14:15, 15:00, 24:00

7/22/2006 @ 20:00(15, 60), 24:00

8/7/2006 @ 20:30 to 21:00, 21:00(60), 24:00

9/2/2006 @ 0:30, 0:45, 1:00(60), 24:00

The following precipitation data were considered invalid and deleted due to cleaning of the sensors tipping buckets:

April

4/18/2006 @ 12:00 (15 minute and 60 minute arrays)

4/18/2006 @ 24:00 (144 array)

August

8/23/2006 @ 12:00 (15 minute and 60 minute arrays)

8/23/2006 @ 24:00 (144 array)

All readings on 10/31/2006 at 15:45, when a new program was installed, were deleted. Not all 5 second data were collected during that fifteen minute interval, resulting in inaccurate averages and totals.

The following Wind Speed data were deleted due to program malfunction. The word NAN (Not a number) was inserted into the dataset. There is currently an unknown reason for this issue. Data @12:15 each day from 11/2/2006 to 12/31/2006 were deleted. The new program no longer create 60 and 144 arrays requiring no deletion of this data.

13) Missing data:

Arrays:

During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at www.nerrsdata.org/get/landing.cfm throughout the fall of 2022.

All data on 10/31/2006 from 13:45 to 1530 are missing due to station power down for CR1000, new MET sensor installation, and program upload. New program no longer generated 60 and 144 arrays and required no deletion of this data.

14) Other remarks/notes:

On 10/19/2023 this dataset was updated to include embedded QAQC flags for anomalous/suspect data. System-wide monitoring data beginning in 2007 were processed to allow for QAQC flags and codes to be embedded in the data files rather than detailed in the metadata alone (as in the anomalous/suspect, deleted, and missing data sections above). Prior to 2007, rejected data were deleted from the dataset so they are unavailable to be used at all, but suspect data were only noted in the metadata document. Suspect data flags <1> were embedded retroactively in order to allow suspect data to be easily identified and filtered from the dataset if desired for analysis and reporting purposes. No other flags or codes were embedded in the dataset and users should still refer to the detailed explanations above for more information.

Arrays:

During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at www.nerrsdata.org/get/landing.cfm throughout the fall of 2022.

Precipitation:

During the initial years of NERRS SWMP weather data collection the CR10X programming was inconsistent in how precipitation values were recorded. For most reserves, zeros were not recorded when rainfall had not occurred between 2001-2003, instead no rainfall was represented by a blank cell. The CDMO verified which datasets were impacted by this issue for the 2001-2006 datasets and inserted zeros when the metadata indicated that no precipitation occurred and data were not missing for other reasons. In some cases, zero values for precipitation data were evaluated and removed where the metadata confirmed that no rainfall should have been in the dataset. The pre-2007 data did not go through a thorough QAQC process again at that time (in addition to previous QAQC); however, if discrepancies were noticed between what was documented in the metadata and what was in the dataset, additional updates may have been made. The updated datasets were uploaded to the database and made available through the various data applications at www.nerrsdata.org/get/landing.cfm throughout early 2023.

RH data of 0% to 103% are within the range of error for the sensor. Any data that fall in this range are considered valid.

PAR:

Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X Datalogger. The Maximum signal noise error for the Licor sensor is +/- 2.214 mmols/m2 over a 15 minute interval. These data have been retained.

Ancillary Met Data Source:

http://www.wunderground.com/history/airport/KNAK/2004/7/1/DailyHistory.html?req_city=NA&req_stat_e=NA&req_statename=NA

Various other local weather stations available through the web.