

Hudson River (HUD) NERR Meteorological Metadata
January 01, 2014 – December 31, 2014
Latest Update: September 19, 2016

I. Data Set and Research Descriptors

1) Principal investigator(s) and contact persons

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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 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.

Persons responsible for data verification are the Research Assistant and the Research Coordinator.

3) Research objectives –

The objective of this study is to monitor the meteorological conditions at the Tivoli Bays component site of the Hudson River National Estuarine Research Reserve. Measurements of air temperature, relative humidity, barometric pressure, precipitation, photosynthetically active radiation, and wind speed and direction are taken throughout the year at the Tivoli Bays Field Station. A water quality-monitoring program has been ongoing since 1991 at this component site, and the meteorological data will help provide ancillary data. This will help us to better understand the relationships between the atmospheric conditions and aquatic environments at this site.

4) Research methods –

Campbell Scientific data telemetry equipment was installed at the field station on 11/14/2005 at 16:30 and transmits data to the NOAA GOES satellite, NESDIS ID #3B00B4F4. 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 QA/QC process detailed in Section 2 above. The “real-time” telemetry data become part of the provisional dataset until undergoing secondary and tertiary QA/QC and assimilation in the CDMO’s authoritative online database. Provisional and authoritative data are available at <http://cdmo.baruch.sc.edu>.

Data are backed-up to a PC file appended hourly via serial connection to the CR1000. The data are downloaded and pre-processed as described in Section 2. QA/QC flags are applied on the following anomalous data criteria:

Air Temperature:

- Sample not greater than 45 C or less than -40 C

Relative Humidity:

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

Pressure:

- Pressure greater than 1060 mb or less than 900 mb

Wind Speed:

- Wind speed greater than 30 m/s or less than 0 m/s

Wind Direction:

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

Precipitation:

- Total Precipitation not greater than 25 cm in 15 min
- Cumulative Precipitation not greater than 1000mm in 15 min

Photosynthetically Active Radiation (PAR)

- Sample not greater than 5000 mmol/m² or less than 0 mmol/m²

Time:

- 15-minute interval recorded

For routine maintenance, sensors are investigated at least once a month to ensure there is no damage or blockage to the sensors. According to Campbell Scientific, sensors are to be calibrated every year or two 2 years, depending on the sensor, for proper data collection. After that time, the sensors are removed from the tower, and shipped to their respective manufacturers for proper and professional calibration. In order to avoid missing data, a second set of sensors is calibrated and available to be installed on the tower to continue data collection. The CR1000 controller is calibrated once every five years in accordance with Campbell Scientific recommendations.

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)

For data collection, the CR1000 datalogger is programmed to collect data in the following formats:

- 15-minute data are averages of 5-second readings for Air Temperature (°C), Relative Humidity (%), Barometric Pressure (mb), Wind Speed (m/s), Wind Direction (degrees) and Battery Voltage (Volts).
- 15-minute data are totals of 15-minute readings for Total Precipitation (mm), Total Photosynthetically Active Radiation (PAR) (mmoles/m²) and Cumulative Precipitation (mm).
- The highest or lowest 5-second readings within the 15-minute data are recorded as follows (maximum and minimum air temperature are not in the dataset but are available from the Reserve) : Maximum Air Temperature (°C), Maximum Air Temperature Time (hh:mm), Minimum Air Temperature (°C), Minimum Air Temperature Time (hh:mm), Standard Deviation Wind Direction (Deg), Maximum Wind Speed (m/s), Maximum Wind Speed Time (hh:mm).

5) Site location and character –

The Hudson River National Estuarine Research Reserve (HUDNERR) is a multi-component site totaling approximately 5,000 acres. Each component of the reserve is referenced by River Mile (RM) of the Hudson River in New York State proceeding north from the southern tip of Manhattan (RM 0). The reserve includes the following four component sites: Piermont Marsh, Rockland County (RM 24)(41°02'30"N 73°54'15"W), Iona Island, Rockland County (RM 45)(41°18'15"N 73°58'45"W), Tivoli Bays, Dutchess County (RM 98)(42°02'15"N 73°55'10"W), and Stockport Flats, Columbia County (RM 124)(42°02'30"N 73°46'00"W). The four component sites include open water, tidal wetland, and adjacent upland buffer habitats and are representative of the diverse plant and animal communities that occupy the salinity gradient within the Hudson River Estuary. Development within the watersheds of the four component sites ranges from predominantly urban/suburban to forested/agricultural.

The weather station (FS) is located at the Tivoli Bays component site in Annandale, NY (42°01'05.52"N 73°55'01.20"W). A 30 foot (9.14m), aluminum tower is used to elevate some of the weather monitoring equipment. The tower is on the deck of an office building, on the west side, 9 feet (2.7m) off the ground. The wind anemometer, wind speed, and light sensors are located at the top of the tower, 39 feet (11.9m) off the ground. The datalogger and the barometric pressure sensor are enclosed within a fiberglass case attached to the tower, 12 feet (3.7m) off the ground. A heated rain gauge is next to the tower, attached to the building, 16 feet (4.9m) off the ground. The temperature/humidity sensor is next to the tower, attached to the deck handrail, 12 feet (3.7m) off the ground. GOES telemetry equipment includes a larger solar panel and battery, a larger enclosure to house the battery, a Campbell TX-312 transmitter, associated GPS for time synchronization and a Yagi antenna.

Although trees surround the area, the tree line begins approximately 60 feet from the tower in most directions. The trees are at similar heights to the tower, but the sensors are not shaded at that location. The tower is approximately 1.2 miles Southeast of the Tivoli South Bay water quality monitoring station, 2.3 miles Southeast of the Tivoli North Bay water quality monitoring station, and 0.2 miles Northwest of the Saw Kill Creek water quality monitoring station.

6) Data collection period –

Weather data have been collected at the Field Station at Tivoli Bays since July 1999. Weather data provided in this document were collected between 01/01/2014 at 00:00 through 12/31/14 at 23:45.

Data Retrieval intervals were as follows:

hudsfsmet011514	12/30/13 @12:00 - 02/28/14 @14:30*
hudsfsmet022814	10/08/13 @ 12:00 - 04/24/14 @ 11:15*
hudsfsmet042414	04/24/14 @ 11:30 – 05/02/14 @ 12:45
hudsfsmet050214	05/02/14 @ 13:00 – 05/22/14 @ 12:30
hudsfsmet052214	05/22/14 @ 12:45 – 06/17/14 @ 12:15
hudsfsmet061714	06/17/14 @ 12:30 – 07/15/14 @ 12:15
hudsfsmet071514	07/15/14 @ 12:30 – 08/06/14 @ 11:45
hudsfsmet080614	08/06/14 @ 12:00 – 08/26/14 @ 10:15
hudsfsmet082614	08/26/14 @ 10:15 – 10/07/14 @ 12:30
hudsfsmet100814	10/07/14 @ 00:00 – 12/05/14 @ 13:45*
hudsfsmet120514	12/05/14 @ 14:00 – 01/14/15 @ 14:15

*Note that some file names and data intervals do not match due to CR1000 settings to append data.

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 2012.

NERR meteorological data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Principal Investigators and Contact Persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page www.nerrsdata.org. Data are available in comma delimited format.

8) Associated researchers and projects

The Hudson River NERR water quality-monitoring program examines the physical and chemical constituents of the tributary waters and the tidal waters of the freshwater tidal marshes at the Tivoli Bays component site. Measurements include seston, dissolved oxygen, alkalinity, pH, temperature, salinity, conductivity, and concentrations of nitrate, phosphate, sulfate, and chloride. These data are used to identify long-term trends and to determine the relationship between meteorological conditions and the aquatic environments at this site.

Associated researchers working at the Tivoli Bays component site include scientists from the Cary Institute of Ecosystem Studies in Millbrook, NY, Yale School of Forestry and Environmental Studies in New Haven, CT, Bard College, Annandale-on-Hudson, NY, Simon's Rock College, Great Barrington, MA, Cornell University Center for the Environment, Cornell Institute for Resource Systems, Cornell Department of Natural Resources, Ithaca, NY, State University of New York College of Environmental Science and Forestry, Syracuse, NY and Rensselaer Polytechnic Institute in Troy, NY.

II. Physical Structure Descriptors

9) Sensor specifications –

Parameter: Temperature

Units: Celsius

Sensor type: PT100 RTD, IEC 751 1/3 Class B, with calibrated signal conditioning

Model #: HC2-S3 Temperature and Relative Humidity Probe

Operating Temperature: -40°C to +60°C

Range: -40°C to +60°C

Accuracy: ± 0.1 °C @ 23°C

Serial Number: 61102825

Date of Last Calibration: 04/12/2013

Dates of Sensor Use: 10/02/2013 - 08/10/2015

Parameter: Relative Humidity

Units: Percent

Sensor type: ROTRONIC® Hygromer IN-1

Model #: HC2-S3 Temperature and Relative Humidity Probe

Range: 0-100% non-condensing

Accuracy at 23°C: $\pm 0.8\%$ RH with standard configuration settings

Temperature dependence of RH measurement $\pm 3\%$ (-40 to 60°C)

Serial Number: 61102825

Date of Last Calibration: 04/12/2013

Dates of Sensor Use: 10/02/2013 - 08/10/2015

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: W5040014

Date of Last Calibration: 09/12/2013

Dates of Sensor Use: 10/02/2013 - 08/10/2015

Parameter: Wind speed

Units: meter per second (m/s)
Sensor type:
Model #: R.M. Young 05103-45 Wind Monitor
Range: 0-100 m/s (224 mph)
Accuracy: +/- 0.3 m/s or 1%

Parameter: Wind direction
Units: degrees
Sensor type: balanced vane, 57 cm turning radius
Range: 360°
Accuracy: +/- 3°

Serial Number: WN125404
Date of Last Calibration: 04/23/2013
Dates of Sensor Use: 10/02/2013 - 09/11/2015

Parameter: Photosynthetically Active Radiation
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: <±2% change over 1 yr
Operating Temperature: -40°C to 65°C; Humidity: 0 to 100%
Sensitivity: typically 5 µA per 1000 µmol s⁻¹ m⁻²

Serial Number: Q30333
Multiplier Value: 1.35
Date of Last Calibration: 09/06/2013
Dates of Sensor Use: 10/02/2013 - 08/10/2015

Parameter: Precipitation (heated rain gauge)
Units: millimeters (mm)
Sensor type: Tipping Bucket Rain Gauge
Model #: RM52202-L
Rainfall per tip: 0.1mm
Operating range: -20°C to +50°C (heated); Humidity: 0 to 100%
Accuracy: 2% up to 25 mm/hr, 3% up to 50 mm/hr
Serial Number: 27014-7
Date of Calibration: 10/03/2013
Dates of Sensor Use: 10/02/2013 – 10/07/2014
Serial Number: 27014-7
Date of Calibration: 10/07/2014
Dates of Sensor Use: 10/07/2014 – 08/10/2015

Transmitter
Model #: TX312
On-board memory: Non-volatile flash for setup parameters. 16 Kbytes for data.
Data Transmission Rates: 100, 300 and 1200 BPS
Transmit Power: 5.6 Watts for 100 and 300 bps, 11.2 watts for 1200 bps
Frequency range: 401.701 MHz – 402.09850 MHz
Channel bandwidth: 100/300 BPS 1.5 KHz; 1200 BPS 3 KHz

Time Keeping: Initial setting accuracy: ± 100 microseconds synchronized to GPS; Drift ± 10 milliseconds/day over operating temperature range; GPS scheduled updates are 1 at power up and once per day thereafter. Once every 28 hours required for continual operation.

Operating range: -40° to $+60^{\circ}\text{C}$; Storage -50° to $+70^{\circ}\text{C}$; 0-99% RH, non-condensing

Power requirements: 10.8 to 16 VDC, 5 mA during GPS fix and 2.6 Amps during transmission

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 Data Logger

Serial Number 5083

Date of Calibration: 06/05/2006

Date of Installation: 01/18/2007

CR1000 Data Logger

Serial Number J8743

Date of Calibration: 03/2013

Date of Installation: 10/02/2013 - current as of 12/31/2014

CR1000 Firmware Version (s):

OS 24 Installed on 03/19/2012

OS 26 Installed on 10/03/2013

CR1000 Program Version(s):

HUDFSMT_6.0_100311

Dates Used: 10/03/2011- 10/08/2013

HUDFSMT_6.0_100813

Dates Used: 10/08/2013 - Current as of 12/31/2014

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

Sampling station:	Sampling site code:	Station code:
Field Station at Tivoli Bays	FS	hudfsmet

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 mmol/m² over a 15 minute interval.

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

Data recorded for all parameters (with the exception of cumulative precipitation) at the midnight timestamp (00:00) are the 15 minute averages and totals for the 23:45-23:59 time period of the previous day. Cumulative precipitation data at the midnight timestamp (00:00) are the sum of raw (unrounded) precipitation data from 00:00 to 23:59 of the previous day. Summing each individual 15-minute total precipitation value from the same period will result in small differences from cumulative precipitation due to rounding. It is especially important to note how data at the midnight timestamp are recorded when using January 1st and December 31st data. **Note: Cumulative precipitation is no longer available via export from the CDMO. Please contact the Reserve or the CDMO for more information or to obtain these data.**

Data Coded CWE (Significant Weather Events)

The CWE code was used for snow events while rain events were coded as CRE. Anything >20mm over 24 hours was considered a significant rain/weather event.

The precipitation gauge used in this location is heated via an electric heating element fed from an external power source. During certain snow drifts, heavy snowfalls, extreme cold temperatures, or external power outages, the rate of melting snow in the tipping bucket may be delayed resulting in false 15 minute readings. Data flagged CWE around snow events may appear longer in duration than actual the actual precipitation event. Melting snow rates are dependent on many factors, and may impact the duration of the event as it appears in the data.

01/10/14 @ 05:45 – 01/11/14 @ 00:00

02/13/14 @ 06:15 – 02/16/14 @ 00:00

03/29/14 @ 11:30 – 03/31/14 @ 00:00

04/15/14 @ 11:15 – 04/16/14 @ 00:00

Data Coded CRE (Significant Rain Events)

The CWE code was used for snow events while rain events were coded as CRE. Anything >20mm over 24 hours was considered a significant rain/weather event.

04/29/14 @ 15:00 – 05/01/14 @ 07:00 total precipitation, 05/02/14 00:00 cumulative

05/16/14 @ 04:00 – 05/17/14 @ 15:15 total precipitation, 05/18/14 00:00 cumulative

06/25/14 @ 03:30 – 06/29/14 21:30 total precipitation, 06/30/14 @ 00:00 cumulative

07/15/14 @ 19:00 – 07/15/14 @ 23:45 (total precipitation only, cumulative rejected through 7/16/14 @ 00:00)

07/23/14 @ 16:45 – 07/23/14 @ 23:30 total precipitation, 07/24/14 @ 00:00 cumulative

10/15/14 @ 19:00 – 10/16/14 @ 08:15 total precipitation, 10/17/14 00:00 @ cumulative

10/21/14 @ 07:45 – 10/23/14 @ 19:30 total precipitation, 10/24/14 @ 00:00 cumulative

Data Coded CSM (See Metadata)

Elevated nighttime PAR values were recorded throughout the year. All nighttime PAR data was compared to sunrise and sunset times as per www.sunrisesunset.com. Any values greater than 0.0 were flagged as <1> (CSM). The values are considered questionable and likely related to colder temperatures and/or higher moisture conditions. The highest occurrence of these nighttime readings was observed and noted in the winter months.

Total and cumulative precipitation are considered suspect and coded as SSM CSM from 5/22/14 12:45 through 6/17/14 12:15. The gauge was clogged and full for an unknown duration. Dates and times for the flagging and coding fell between visits to the MET station.

Upon data retrieval on 7/15/14 it was noted that the rain gauge funnel was clogged completely full of water. The water was not able to drain into the tipping buckets. The clog was cleared and the collected water was allowed to pour through. A spike in data was recorded @ 12:15 on 7/15/14 due to this blockage clearing. Based on data QAQC and other local weather station references, it appears that this clog occurred somewhere on or around 7/3/14. All precipitation data from this point (7/3/14 16:45) to the point of clearing is marked suspect, as it cannot be accurately determined when the instrumentation malfunction occurred. The spike at 12:15 was rejected as were precipitation data from 12:30 - 18:45 for maintenance. A significant rainfall event was observed after the clog was cleared. The cumulative rainfall for the data were flagged as rejected, but the incremental precipitation from 19:00 until 23:45 were coded as significant rainfall.

All data are missing from 8/6/14 12:00 - 13:00 due to a power down for station maintenance. Data at 13:15 were rejected since more than likely they aren't a full 15 minutes of 5-second data.

Cumulative precipitation values on 8/6/14 13:15 - 14:00 were rejected due to the gauge being tipped during maintenance. Cumulative precipitation values from 14:15 through the end of the day

at 8/7/14 00:00 were corrected by subtracting 0.1mm (tip during maintenance) from the recorded value.

All data are missing from 10/7/14 12:45 - 13:00 due to station maintenance. Data at 13:15 were rejected since more than likely they aren't a full 15 minutes of 5-second data.

Beginning 12/05/14 14:00 cumulative precipitation began logging when no total precipitation values were recorded. At other times total precipitation values were recorded when cumulative was not. Since we cannot say with confidence that either value is correct all cumulative precipitation and total precipitation records were flagged as rejected from 12/05/14 14:00 - 12/31/14 23:45.