

Hudson River (HUD) NERR Meteorological Metadata
January 2009 - December 2009
Latest Update: November 6, 2013

I. Data Set & 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 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.

The Research Coordinator, Sarah Fernald, is responsible for data management and data entry verification.

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:

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 one to 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

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

- i) 15-minute data are averages of 5-second readings for Air Temperature ($^{\circ}\text{C}$), Relative Humidity (%), Barometric Pressure (mb), Wind Speed (m/s), Wind Direction (degrees) and Battery Voltage (Volts).
- ii) 15-minute data are totals of 15-minute readings for Total Precipitation (mm), Total Photosynthetically Active Radiation (PAR) (mmoles/m^2) and Cumulative Precipitation (mm).

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

Rainfall:

-Precipitation not greater than 25 mm in 15 min

Photosynthetically Active Radiation (PAR)

-Sample not greater than $5000 \text{ mmol}/\text{m}^2$ or less than $0 \text{ mmol}/\text{m}^2$

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 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>.

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 were collected for the entire year in 2009 from January 1 00:00 through December 31 23:45.

7. Distribution:

According to the Ocean and Coastal Resource Management Data Dissemination Policy for the NERRS System-wide Monitoring Program, 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 the 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/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 weather data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Section 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 comma separated 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, operating range, accuracy, date of last calibration:

Parameter: Temperature

Units: Celsius

Sensor type: Platinum resistance temperature detector (PRT)

Model #: HMP45C Temperature and Relative Humidity Probe

Serial # A3510056

Operating Temperature: -40°C to +60°C

Range: -40°C to +60°C

Accuracy: ± 0.2 °C @ 20°C

Date of Last calibration: August 7, 2008

Dates Sensor Installed: August 25, 2008

Parameter: Temperature

Units: Celsius

Sensor type: Platinum resistance temperature detector (PRT)

Model #: HMP45C Temperature and Relative Humidity Probe

Serial # Z3140055
Operating Temperature: -40°C to +60°C
Range: -40°C to +60°C
Accuracy: ± 0.2 °C @ 20°C
Date of Last calibration: July 29, 2009
Dates Sensor Installed: September 28, 2009

Parameter: Relative Humidity
Units: Percent
Sensor type: Vaisala HUMICAP® 180 capacitive relative humidity sensor
Model #: HMP45C Temperature and Relative Humidity Probe
Serial # A3510056
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: August 7, 2008
Dates Sensor Installed: August 25, 2008

Parameter: Relative Humidity
Units: Percent
Sensor type: Vaisala HUMICAP® 180 capacitive relative humidity sensor
Model #: HMP45C Temperature and Relative Humidity Probe
Serial # Z3140055
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: July 29, 2009
Dates Sensor Installed: September 28, 2009

Parameter: Barometric Pressure
Units: millibars (mb)
Sensor type: CS-105 Vaisala Barocap © silicon capacitive pressure sensor
Model #: PTB101B
Serial # W5040014
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: March 28, 2007
Dates Sensor Installed: May 9, 2007

Parameter: Barometric Pressure
Units: millibars (mb)
Sensor type: CS-105 Vaisala Barocap © silicon capacitive pressure sensor
Model #: PTB101B
Serial # A4010033
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: August 4, 2009
Dates Sensor Installed: September 28, 2009

Parameter: Wind speed
Units: meter per second (m/s)
Sensor type: 12 cm diameter cup wheel assembly, 40 mm diameter hemispherical cups
Model #: 3001 Met One Wind Set
Range: 0-50 m/s (112 mph); gust survival 60 m/s (134 mph)
Accuracy: +/- 0.5m/s (1.1mph)
Date of last calibration: August 12, 2008
Dates Sensor Installed: December 5, 2008

Parameter: Wind speed
Units: meter per second (m/s)
Sensor type: 12 cm diameter cup wheel assembly, 40 mm diameter hemispherical cups
Model #: 3001 Met One Wind Set
Range: 0-50 m/s (112 mph); gust survival 60 m/s (134 mph)
Accuracy: +/- 0.5m/s (1.1mph)
Date of last calibration: July 21, 2009
Dates Sensor Installed: September 28, 2009

Parameter: Wind direction
Units: degrees
Sensor type: balanced vane, 16 cm turning radius
Model #: 3001 Met One Wind Set
Range: 360° mechanical, 355° electrical (5° open)
Accuracy: +/- 5%
Offset: 0.2
Date of last calibration: August 12, 2008
Dates Sensor Installed: December 5, 2008

Parameter: Wind direction
Units: degrees
Sensor type: balanced vane, 16 cm turning radius
Model #: 3001 Met One Wind Set
Range: 360° mechanical, 355° electrical (5° open)
Accuracy: +/- 5%
Offset: 0.2
Date of last calibration: July 21, 2009
Dates Sensor Installed: September 28, 2009

Parameter: Photosynthetically Active Radiation (PAR)
Units: mmols m⁻² (total flux)
Sensor type: High stability silicon photovoltaic detector (blue enhanced)
Model #: LI190SB
Serial # Q22456
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
Date of last calibration: March 30, 2007

Multiplier (s): 1.72

Dates Sensor Installed: May 09, 2007

Parameter: Photosynthetically Active Radiation (PAR)

Units: mmols m⁻² (total flux)

Sensor type: High stability silicon photovoltaic detector (blue enhanced)

Model #: LI190SB

Serial # Q35329

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

Date of last calibration: July 23, 2009

Multiplier (s): 1.49

Dates Sensor Installed: September 28, 2009

Parameter: Precipitation (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: +/- 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: September 16, 2009

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°C; Storage -50° to +70°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

Date CR1000 Installed: January 18, 2007

10. Coded variable indicator and variable code definitions:

Sampling Station:

Field Station at Tivoli Bays

Sampling Site Code:

FS

Station Code:

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.

General Errors

GIM	Instrument Malfunction
GIT	Instrument Recording Error, Recovered Telemetry Data
GMC	No Instrument Deployed due to Maintenance / Calibration
GMT	Instrument Maintenance
GPD	Power Down
GPF	Power Failure / Low Battery
GPR	Program Reload
GQR	Data Rejected Due to QA/QC Checks
GSM	See Metadata

Sensor Errors

SIC	Incorrect Calibration Constant, Multiplier or Offset
SNV	Negative Value
SOC	Out of Calibration
SSD	Sensor Drift
SSN	Not a Number / Unknown Value

SSM	Sensor Malfunction
SSR	Sensor Removed
Comments	
CAF	Acceptable Calibration/Accuracy Error of Sensor
CDF	Data Appear to Fit Conditions
CRE	Significant Rain Event
CSM	See Metadata
CVT	Possible Vandalism / Tampering

13) Other remarks/notes

Data are missing due to equipment or associated specific sensors not being deployed, equipment failure, time of maintenance or calibration of equipment, or repair/replacement of a sampling station platform. Any NaNs in the dataset stand for “not a number” and are the result of low power, disconnected wires, or out of range readings. If additional information on missing data is needed, contact the Research Coordinator at the reserve submitting the data.

Small negative PAR values are within the 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.

CSM – data coded “See Metadata”

Please note that the 3001 MET One Wind Set has an offset of 0.2 and does not record values of 0.

PAR Flagging and Coding:

Please note the different reasons for flagging and coding below. At times there were overlaps in PAR flagging and coding, ex. acceptable calibration (CAF), sensor drift (SSD), and elevated nighttime readings sometimes occurred on the same dates. For those overlaps, the most appropriate flagging and coding combination was chosen.

There were noticeable changes in PAR values following the swap to a freshly calibrated sensor (assumed to be accurate) on 9/28/2009. Apogee reported a -6.82% post cal for the sensor that was installed from 5/9/2007-9/28/2009 (Q22456) during calibration on 9/24/2012. Acceptable drift is +/- 2%/yr for this sensor. PAR data for 2009 are flagged and coded as <1> SSD CSM until the sensor swap on 9/28/2009. PAR data for the remainder of 2009 are flagged and coded <0> CSM and users should note that drift for that period may have exceeded acceptable limits as well. The sensor that was installed from 9/28/2009-10/3/2011 (Q35329) was also calibrated in 9/2012 and had a post cal drift of -19.1%. 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 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 and coded as <1> CSM (or SSD CSM, see above note about drift). 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.

09/16/09 10:15

Powered down at 10:10 in order to calibrate tipping bucket. Powered up at 10:25. Missing data for period 09/16/09 10:15. Cumulative precipitation data 9/16/09 10:30-9/17/09 00:00) that were recorded during the calibration were rejected.

09/28/09 10:45 – 11:15

The system was powered down at 10:40 in order to replace sensors with newly calibrated ones, causing missing data for period 10:45 – 11:15. New sensors include: Wind speed, Wind Direction, Temperature/RH, PAR (Par multiplier = 1.49), & Barometric pressure.