ACE Basin National Estuarine Research Reserve
Meteorological Metadata Report
January – December 2007
Latest Update: April 17, 2017

I. Data Set and Research Descriptors

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2) Entry Verification

a) Data Input Procedures:

Meteorological data is recorded in 15-minute intervals and stored in a Campbell Scientific CR1000 datalogger. ACE staff uses a data storage card to serve as a back-up for the CR1000 datalogger. The program that controls the sampling, schedule, and storage of data by the CR1000 is provided by CDMO.

The CR1000 is interfaced with the Campbell Scientific's Loggernet software. An ethernet connection between the weather station and adjacent Bennett's Point NERR field station allows ACE staff to download data and trouble shoot station problems remotely using Loggernet software. The GOES satellite system also uploads all 15-minute meteorological data summaries to a NOAA server every hour. ACE staff also use a notebook computer as a safeguard against data loss, downloading weather data directly via a 9 pin serial cable. These multiple methods of data retrieval ensure that all measured parameters are reported.

b) QA/QC Procedures:

Data are uploaded from the CR1000 data logger to a Personal Computer (IBM compatible). Files are exported from LoggerNet in 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 processed in Microsoft Excel using the CDMO's NERRQAQC Excel macro. The macro inserts station codes, creates metadata worksheets for flagged data, 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. Outliers, suspect data, erroneous data, and other data flagged by the NERRQAQC macro are evaluated based on monthly field logs and NOAA historical data for the area. For more information on QAQC flags and QAQC codes, see Sections 11 and 12.

Patrick Williams and Justin Hart are responsible for the above tasks.

3) Research objectives (Campbell Weather Station):
The principal objective of the Weather Monitoring Program is to record long-term meteorological data for the ACE Basin NERR in order to observe any environmental changes or trends over time.

4) Research methods
For data collection, the CR1000 dataloggers are programmed to record data at 15-minute intervals. 15-minute data averages are based on continuous 5-second readings for air temperature (Centigrade), relative humidity (%), barometric pressure (mb), wind direction and wind speed (m/s). 15-minute precipitation (mm) and PAR ($mmol/m^2$) data are totaled from 5-second readings.

In-situ weather conditions are measured to verify the accuracy of the readings by the sensors, using a Kestrel 400 hand-held. After downloading data, sensors on the weather station are inspected for damage or debris. If any problems are found, it is repaired and/or cleaned. Tree limbs and other shrubs are cut back to prevent obstruction of the sensors. Sensors are removed and sent back to Campbell Scientific for calibration at a minimum frequency of every two years.

Campbell Scientific data telemetry equipment was installed at the Bennett's Point station on 06/30/2006 and transmits data to the NOAA GOES satellite, NESDIS ID #3B01E672. 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.

Data collected underwent the QA/QC process described in 2b.

5) Site location and character

The ACE Basin National Estuarine Research Reserve (NERR) is located on the Southeastern Atlantic coast of the United States, including portions of Charleston, Colleton and Beaufort Counties in South Carolina. The study area encompasses the Ashepoo, Combahee, and South Edisto River basins, which empty into St. Helena Sound. Diverse estuarine wetlands provide extensive and complex habitat types for fish and wildlife. The NERR consists of approximately 92,000 acres of tidal marshes. Of this, 65,600 acres are salt marshes, 13,600 acres are brackish marshes and 12,100 acres are freshwater marshes. Interspersed within these three tidal marsh zones are approximately 26,000 acres of managed wetlands, marsh impoundments, and hammock islands. St. Helena Sound comprises approximately 23,870 acres of open coastal marine and estuarine waters.

The weather station is located at the Bennett's Point field station on Mosquito Creek, a navigable tributary off of the Ashepoo River. The weather station's latitudinal and longitudinal coordinates are: 32° 33.5623'N, 80° 27.2715'W and is located at sea level elevation. The station is approximately 90 m from the creek (800 m from the Ashepoo River) in a grassy field, 80 m to the southwest of the field station. The closest wind obstructions are oak trees, 25 m to the south and southwest of the weather station and 70 m from a public paved road. The closest SWMP water quality station, Mosquito Creek, is approximately 1655m from the weather station.

The Campbell Scientific data logger and the barometric sensor (sensor body at 1.5m and sensor tube at 1.0m) are enclosed in a Campbell Scientific enclosure box with moisture/humidity indicators and 2 desiccant packets. A 15 foot galvanized steel tower elevates the sensors above potential barriers and enhances the performance of each sensor. The PAR sensor and anemometer are attached to a cross-bar at the top of the tower and the temperature/relative humidity sensor is attached approximately half way up the tower. The solar panel is attached to a 2.5 m long arm, and is oriented to the east at approximately 47-degrees. The tipping bucket rain gauge (1.3 m height) is located 2.5 m to the southeast of the box on a concrete level platform. The sensors are wired to the CR1000 data logger following protocol in the CDMO Manual, with minor changes made in order to facilitate the function of upgraded sensors. A new larger enclosure box and solar panel were necessary with the installation of the GOES telemetry system.

6) Data collection period

Weather data have been collected at the ACE Basin NERR Bennett's Point weather station since the station became operational in March 2001. Data was collected for the entire year in 2007 from January 1 at 00:00 through December 31 at 23:45, with the exception of:

> PAR data between January 10, 2007 @ 19:30 and January 11, 2007 @ 7:00 – PAR multiplier was not entered. The data has been flagged accordingly with '<-3>'.

PAR data between March 8, 2007 @ 11:45 and April 10, 2007 @ 10:30 – PAR multiplier was not entered. The data has been flagged accordingly with '<-3>'.

Wind Speed values between March 8, 2007 @ 11:45 and May 8, 2007 @ 10:30 – Wind speed multiplier and offset values were incorrect. The incorrect values were a multiplier of 0.098 and an offset of 0. The correct multiplier is 0.75 and the correct offset value is 0.2. The data has been corrected and flagged accordingly with '<5>'.

7) Distribution

According to the Ocean and Coastal Resource Management Data Dissemination Policy for the NERRS System-wide Monitoring Program, is as follows.

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 weather data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Principal investigators and contact persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page http://cdmo.baruch.sc.edu/. Data are available in comma separated format.

8) Associated researchers and projects

The NERR Water Quality Monitoring Project is a study which records long-term water quality data for the ACE Basin in order to observe any changes or tends in water quality over time. The four sampling sites are in separate tributaries of the South Edisto and Ashepoo Rivers. Two sites represent an urban or "treatment" site, and the other two

sites represent pristine areas with in the Reserve. A salinity gradient is also observed between theses four sites:

Big Bay Creek - approximately 14 kilometers from the weather station, GPS coordinates: 32.4941 N and -80.3241 W. The station is surrounded by residential and commercial development and subject to nonpoint source pollution.

St. Pierre Creek - approximately 9 kilometers from the weather station, GPS coordinates: 32.5233 N and -80.3568 W. The station is surrounded by a wide expanse of Spartina alterniflora marsh. Extensive mud flats and oyster reefs fringe the banks. Development in the immediate area is sparse, and this creek is subject to light boat traffic.

Fishing Creek – approximately 12 kilometers from the weather station, GPS coordinates: 32.6358 N and -80.3655W. The station is near Jehossee Island, a protected USFWS property, and is surrounded by extensive *Spartina cynosuroides* marsh and vast mud flats. The upland area is characterized by slash pine, live oak, and cabbage palmetto.

Mosquito Creek – approximately 2 kilometers from the weather station, GPS coordinates: 32.5558 N and -80.4380W. The station is surrounded by agriculture fields and impounded wetlands. A public boat landing and a commercial seafood business with three commercial shrimp boats and a fueling station are located about 0.8 km (0.5 mi) downstream of the monitoring station.

Measurements for all sites are taken every fifteen minutes over an approximate two-week or four week collection period (depending upon fouling previously experienced and future fouling rate expected).

In July 1997, the Reserve staff initiated nutrient monitoring study. The objective of the study is to ascertain the annual and tidal fluctuations in nutrient levels near our two data logger sites. Nutrient levels are measured during a complete tidal cycle each month, and the samples are analyzed for ammonia, nitrite & nitrate, orthophosphate, and chlorophyll a concentrations. In January of 2002, the nutrient monitoring protocol (NUT) was added to the NERR System Wide Monitoring Program (SWMP).

Dr. Charles Wenner of SCDNR/Marine Resources Research Institute received funding through the National Marine Fisheries Service in January of 2001 to continue an ongoing survey of red drum (*Sciaenops ocellatus*) in the South Edisto and Combahee River basins, by electro-fishing in tidal freshwater and low salinity brackish water. Although red drum are the target species, all catches are separated, measured and weighted to provide a distribution and population size for each species.

In February 2006, the ACE Basin NERR installed a RASSL – Remote Access Satellite Sensor Link – transmitter unit to the deployment structure at the Mosquito

Creek water quality sampling station, and in August 2006 installed an additional transmitter unit at the Big Bay station. North Star Science and Technology, funded by a CITCEET grant, designed a compact field satellite communicator. The transmitter unit, compatible with YSI 6 series data sondes, communicates directly to the sonde and asks the sonde to take an additional reading once an hour. This additional reading is not stored by the data sonde and does not interfere with the scheduled SWMP data collection. The additional hourly reading is then transmitted via a satellite link. The provisional data is posted to a secure website provided and maintained by North Star Science and Technology. Access to this website can be obtained by contacting the Reserve research staff.

The ACE Basin NERR received initial funding from the U.S. Environmental Protection Agency to establish a National Atmospheric Deposition Program site in the Reserve. Sampling efforts began on January 1, 2002 and ended in December 2007 due to funding restrictions. Weekly precipitation samples were collected and analyzed for atmospheric pollutants. The precipitation collector located on Bear Island, a Wildlife Management Area inside the NERR.

On September 19, 2006 the South Carolina Algal Ecology Laboratory began screening water samples from the ACE BASIN. Algal assemblages are being identified at these sites to monitor these areas and identify any harmful algal blooms. If a bloom is present, the fixed sample will be counted to determine algal density. These water samples are also being processed for HPLC (High Performance Liquid Chromatography), which will identify the pigments that are present in the water at that time, and can be later analyzed for estimates of algal community biomass.

The results from these studies and addition studies conducted in the ACE Basin can be obtained by contacting the Reserve.

II. Physical Structure Descriptors

9) Sensor specifications

LiCor Quantum Sensor (PAR)

Model #: LI-190SZ
Stability: < +/- 2% change over a 1 year period
Operating Temperature: -20 to +65 degree C
Sensitivity: Typically 30 nA per 100 klux
Light Spectrum Wavelength: 400 to 700 nanometers
Date of last calibration: 06/29/2005

Wind Sentry (Anemometer)

Model #: 03001
Range: 0-50 m/s; 360o Mechanical

Date of last calibration: Exact date is unknown; Purchase date 07/01/2005

Temperature and Relative Humidity
Model #: HMP45AC
Operating Temperature: -40 to +60 degree C
Temperature Measurement Range: -40 to +60 degree C
Temperature Accuracy: +/- 2% degree C @ 20 degree C
Relative Humidity Measurement Range: 0 - 100% non-condensing
RH Accuracy: +/- @% RH (0 - 90%) and +/- 3% (90 - 100%)
Uncertainty of calibration: +/- 1.2% RH
Date of last calibration: 04/25/2005

Barometric Sensor
Model #: PTB101B
Calibrated Range: 26" - 32" (Standard)
Supply Voltage: 12 VDC at 12 mA
Accuracy: +/- 0.7 of span
Operating Temperature Range: -22 to +55 degree C
Date of last calibration: 05/13/2005

Tipping Bucket Rain Gauge
Texas Electronics
Model #: TR-525I
Calibration: 0.01 inch per tip
Accuracy: +/- 3% (Rates of 1 to 6 inches per hour)
Date of last calibration: August 2006

Storage Module
Model # SM4M
Storage capacity: 2 million low-resolution data values
Program storage: stores up to 8 program with a total capacity of 128 KB
Processor: Hitachi H8S
Operating system: 64 KB, flash memory based, user downloadable
Operating range: Temp: -35 to +65 degree C
Baud rates: 9600, 76800
Power requirements: 5 +/- 0.3 VDC @ 100 mA

The CR1000 has 2 MB of Flash EEPROM that is used to store the Operating System. Another 128 K Flash is used to store configuration settings. A minimum of 2 MB SRAM is available for program storage (16K), operating system use, and data storage. Additional storage is available by using a compact flash card in the optional CFM100 Compact Flash Module
Date CR1000 Installed: June 30, 2006

10) Coded variable definitions

Sampling station:	Sampling site code:	Station code:
Bennett's Point	BP	acebpmet

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, 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 check
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
GMT	Instrument Maintenance
GPF	Power Failure / Low Battery
GQR	Data Rejected Due to QA/QC Checks
GPR	Program Reload
GPD	Power Down

Sensor Errors

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

13) Other remarks/notes

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

Small negative PAR values are within range of the sensor and are due to normal errors in the sensor and the CR1000 Datalogger. The Maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval.

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

During 2017 the CDMO discovered an incorrect line in the CR1000 programming. If RHumidity>100 And RHumidity<108 Then RHumidity=100. A decision was made by the DMC during 2006 to discontinue correcting >100 RH values to 100. This change was never made in our program and has remained in each updated version until it was removed during 2017. By correcting all values >100 during data collection we may have missed erroneous values that could have indicated a problem with the RH sensor. CSM coding was added to all RH data from 2007 until the programming change in 2017.

Precipitation data for 7/02/2007 @ 00:45 are suspect due to precipitation rates being great enough to be outside the +/- 3% accuracy range of the rain gauge (see section 9 Sensor Specifications). This data has been flagged with a CSM "See Metadata" comment.

PAR data between January 10, 2007 @ 19:30 and January 11, 2007 @ 7:00 are missing due to an erroneous CR1000 program. The PAR multiplier was accidentally omitted from the newly uploaded program. These data point are marked with <-3> "Rejected Data" and CSM "See Metadata" comments.

PAR data for 3/08/2007 @ 11:45 to 4/10/2007 @ 10:30 are missing due to an erroneous CR1000 program. The PAR multiplier was accidentally omitted from the newly uploaded program. These data points are marked with <-3> “Rejected Data” and CSM “See Metadata” comments.

Wind Speed data between March 8, 2007 @ 12:00 and May 8, 2007 @ 10:30 were erroneous due to wind speed multiplier and offset values being entered incorrectly. The incorrect values were a multiplier of 0.098 and an offset of 0. The correct multiplier is 0.75 and the correct offset value is 0.2. The data have been corrected and flagged accordingly with ‘<5>’.

Fifteen minute data collected for March 8, 2007 at 11:45, May 8, 2007 at 10:45 and June 21, 2007 at 10:45 all occurred during times when new programs were being uploaded to the CR1000 datalogger, which deletes the five second data saved previous to the upload in the datalogger. Therefore, these data points are averages and totals of discontinuous five second data. All parameters for these data points have been marked with a <-3> “Rejected Data” flag.