ACE Basin (ACE) NERR Meteorological Metadata
January – December 2024
Latest Update: 08/18/2025

I. Data Set and Research Descriptors

1) Principal investigator(s) and contact persons –

SCDNR/Marine Resources Division
217 Fort Johnson Road
Charleston, SC 29422
(843) 953-9300

ACE Basin NERR field station
15717 Bennett's Point Road
Green Pond, SC 29441
(843) 844-8822

Contact Persons:
Dr. Denise Sanger, Research Coordinator
Contact: Sangerd@dnr.sc.gov (843) 953-9074

2) Entry verification –

a) Data Input Procedures:
Meteorological data is recorded in 15-minute intervals and stored in a Campbell Scientific CR1000X data logger. ACE staff uses a data storage card to serve as a back-up for the CR1000X data logger. The program that controls the sampling, schedule, and storage of data by the CR1000X is provided by CDMO.

The CR1000X is interfaced with the Campbell Scientific's LoggerNet software. ACE staff downloads and troubleshoots LoggerNet programs with a direct connection to the weather station, using a laptop computer and a USB cable. The GOES satellite system also uploads all 15-minute meteorological data summaries to a NOAA server every hour. These multiple methods of data retrieval ensure that all measured parameters are reported.

b) Data are uploaded from the CR1000X data logger to a personal computer with Windows 10 or newer operating system. 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.

Denise Sanger was responsible for data and data management tasks. Jessica Kinsella, Jack Brittain, George Riekerk, Sara Holgate, and Fred Hall helped with downloading data and completed deployment logs during 2024.

3) Research objectives –

The meteorological long-term monitoring program at the ACE Reserve began on March 2, 2001. The principal objective of the program is to record long-term meteorological data for the ACE Basin NERR, in order to observe any environmental changes or trends over time. The weather station is located at the Bennett's Point field station on Mosquito Creek, a navigable tributary of the Ashepoo River. A Campbell electronic data logger is programmed to monitor temperature, relative humidity, barometric pressure, wind speed and direction, rainfall, and Photosynthetically Active Radiation (PAR). The logger is programmed to record the parameters at fifteen-minute intervals.

4) Research methods –

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 at 0:01:10 after the hour 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 were collected in Eastern Standard Time (EST) for the entire year.

The data are downloaded monthly, and in-situ weather conditions are measured with a Kestrel 500 hand-held during the 15-minute reading prior to the download. The in-situ readings are used to verify the accuracy of the readings by the sensors. 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.

The 15-minute data are collected in the following formats for the **CR1000/CR1000X**:

Averages from 5-second data:

Air Temperature (°C), Relative Humidity (%), Barometric Pressure (mb), Wind Speed (m/s), Wind Direction (degrees), Battery Voltage (volts)

Maximum and Minimum Air Temperature (°C) and their times from 5-second data (these data are available from the reserve)

Maximum Wind Speed (m/s) and time from 5-second data

Wind Direction Standard Deviation (degrees)

Totals:

Precipitation (mm), PAR (millimoles/m^2), and Cumulative Precipitation (mm) (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.)

Sensors are removed and sent back to Campbell Scientific for calibration according to the following guidelines:

- Temperature/Humidity- yearly recalibration
- Precipitation Gauge- yearly recalibration
- Wind Speed/Direction- yearly or every 2 years (depending on the sensor) recalibration
- Barometric Pressure- every 2 years recalibration CS-105 and CS-106; yearly recalibration BaroVUE10
- PAR- every 2 years recalibration
- CR1000/CR1000X- every 5 years

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 37231 ha (92,000 ac) of tidal marshes. Of this, 26547 ha (65,600 ac) are salt marshes, 5504 ha (13,600 ac) are brackish marshes and 4897 ha (12,100 ac) are freshwater marshes. Interspersed within these three tidal marsh zones are approximately 10522 ha (26,000 ac) of managed wetlands, marsh impoundments, and hammock islands. St. Helena Sound comprises approximately 9659 ha (23,870 ac) 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 of the Ashepoo River. The weather station's latitudinal and longitudinal coordinates are: 32.55934 N and -80.45456 W and is located at sea level elevation. The station is ~ 90 m (295 ft) from the creek (800 m [2624 ft] from the Ashepoo River) in a grassy field, 80 m (262.5 ft) to the southwest of the field station. The closest wind obstructions are oak trees, 25 m (82 ft) to the south and southwest of the weather station and 70 m (230 ft) from a public paved road. The closest SWMP water quality station, Mosquito Creek, is approximately 1655 m (5430 ft) from the weather station.

The Campbell Scientific data logger and the barometric pressure sensor (sensor body at 1.5 m [4.92 ft] and sensor tube at 1.0 m (3.28 ft) are enclosed in a Campbell Scientific enclosure box with moisture/humidity indicators and desiccant packets. A 6.1 m 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 at a height of 6.1 m (20.0 ft) and the temperature/relative humidity sensor is attached approximately halfway up the tower at a height of 3.3 m (10.9 ft). The solar panel is attached to a 2.5 m (8.2 ft) long arm and is oriented at approximately 175-degrees. The tipping bucket rain gauge (1.3 m [4.27 ft] height) is located 2.5 m (8.2 ft) to the southeast of the box on a concrete level platform. The sensors are wired to the CR1000X data logger following the protocol in the CDMO MET SOP, 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.

Tower and sensor heights	**Height (*meters*)**	**Notes**
Tower	6.1 m	
Enclosure	1.2 m	bottom
Temperature/Relative Humidity	3.35 m	
Barometric Pressure	1.5m	1.5 m from tower; 0.4 m inside enclosure
Wind	6.1 m	
PAR	6.1 m	
Precipitation gauge	1.3 m	2.5 m from enclosure

Station Code	Station Name	SWMP Status	Location	Active Dates	Reason Decommissioned	Notes
ACEBPMET	Bennett's Point	P	32° 33' 33.64 N, 80° 27' 16.41 W	03/01/2001 -	NA	NA

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. The end times below marked with an asterisk (*) coincide with the last actual reading in that deployment so the times will not be in consecutive order with the following deployment start time. The gap between the end time of one deployment and the begin time of the next deployment is attributed to either missing or rejected data due to in field maintenance, battery failure, or collector error.

File Start Date and Time	File End Date and Time
12/01/2023 11:45	01/11/2024 15:30
01/11/2024 14:45	02/08/2024 10:15
02/08/2024 10:30	03/18/2024 12:30
03/18/2024 12:45	04/16/2024 09:30*
04/16/2024 13:45	04/17/2024 11:15*
04/17/2024 12:00	05/23/2024 10:15
05/23/2024 10:30	06/19/2024 10:30
06/19/2024 10:45	07/11/2024 09:00
07/11/2024 09:15	08/15/2024 09:15
08/15/2024 09:30	09/30/2024 09:00
09/30/2024 09:15	10/31/2024 10:15
10/31/2024 09:15	11/21/2024 12:30
11/21/2024 12:45	12/18/2024 12:00
12/18/2024 12:15	01/08/2025 12:00

7) Distribution –

NOAA retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The NERRS retains the right to be fully credited for having collected and processed 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 2024.
>
> 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 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 trends in water quality over time. The six sampling sites are in separate tributaries of the South Edisto and Ashepoo Rivers. Two sites represent altered areas or "treatment" sites, two sites represent pristine areas within the Reserve, and two sites expand ACE monitoring into the oligohaline and limnetic zones of the South Edisto River.

Edisto Island (EI) – approximately 14 km (8.70 mi) from the weather station, GPS coordinates: 32.50399 N and -80.32470 W. In January 2015, Edisto Island station replaced Big Bay (BB) station as a primary station, and it is one km upstream of the Big Bay station (See the 2014 metadata report for a description of the Big Bay station). It is located on the dock of the Edisto Interpretive Center at Edisto Beach State Park with a boat landing nearby. There is low residential development and docks upstream of the site. The Edisto Island station is bordered by *Spartina alterniflora* marsh, and American oyster forms a reef along the creek bank. The Edisto Island station is designated as a "treatment" site because of the land use practices in the surrounding area.

Fishing Creek (FC) – approximately 8 km (4.97 mi) from the weather station, GPS coordinates: 32.63593 N and -80.36556 W. 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. The Fishing Creek monitoring station is designated as a "control" site because there is no development in the immediate area, and boat traffic is relatively light in the creek.

Mosquito Creek (MC) – approximately 2 km (1.24 mi) from the weather station, GPS coordinates: 32.5558 N and -80.4380 W. 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. Agriculture fields and impounded wetlands are found upstream of the monitoring station. The Mosquito Creek station is designated as a "treatment" site because of the land use practices in the surrounding area.

St. Pierre Creek (SP) – approximately 9 km (5.59 mi) from the weather station, GPS coordinates: 32.52800 N and -80.36144 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. The St. Pierre Creek station is designated as a "control" site.

Grove Plantation (GP) – approximately 12 km (7.46 mi) from the weather station, GPS coordinates: 32.6637 N and -80.4130 W. The station is in the South Edisto River proper and located at the Grove Plantation unit of the ACE Basin National Wildlife Refuge (NWR), which is owned and managed by the US Fish and Wildlife Service (USFWS). The station is surrounded by tidal freshwater fringe marsh and managed wetlands (aka "waterfowl impoundments"). The upland area is dominated by pine-mixed hardwood forest that is characterized by several species of oaks and pines. During years of normal rainfall, the salinity at this station generally is below 1 psu, but it will increase if rainfall is low.

Jehossee Island (JI) – approximately 9 km (5.59 mi) from the weather station, GPS coordinates: 32.6209 N and -80.3965 W. The station is in the South Edisto River proper and located at the Jehossee Island unit of the ACE Basin NWR, which is owned and managed by the USFWS. The station is surrounded by *Spartina cynosuroides* fringe marsh and managed wetlands (aka "waterfowl impoundments"). The upland area is dominated by inland maritime forest that is characterized by slash pine, live oak, and cabbage palmetto.

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 the 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 were measured at two stations during a complete tidal cycle each month. In January of 2002, the nutrient monitoring protocol (NUT) was added to the NERR System Wide Monitoring Program (SWMP). Nutrient levels are now measured at one station during a complete tidal cycle each month, and surface grabs samples are collected from the primary stations once a month during an ebb tide. Nutrient samples are analyzed for ammonia, nitrite & nitrate, orthophosphate, and chlorophyll a concentrations.

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

II. Physical Structure Descriptors

9) Sensor specifications –

Parameter: Temperature and Relative Humidity

Units: Temperature- Celsius; Relative Humidity- %
Model #: HMP45C
Operating Temperature: -40 to +60 °C
Temperature Measurement Range: -40 to +60 °C
Temperature Accuracy: ± 2% °C @ 20 °C
Relative Humidity Measurement Range: 0 - 100% non-condensing
RH Accuracy: ± 2% RH (0 - 90%) and ± 3% (90 - 100%)
Uncertainty of calibration: ± 1.2% RH

Temp/RH sensor 1 (Serial Number: D3520073)
Date of last calibration: 03/13/2014
Previous Calibrations: N/A
Date of Sensor Use: 07/23/2014 – 04/18/2016
Retired: 04/18/2016

Temp/RH sensor 2 (Serial Number E3010019)
Date of Last Calibration: 02/02/2016
Previous Calibrations: 01/28/2010, 05/03/2013

Dates of Sensor Use: 04/18/2016 – 03/03/2017
Retired: 03/03/2017

Temp/RH sensor 3 (Serial Number: A1710045)
Date of last calibration: 01/28/2017
Previous Calibrations: N/A
Date of Sensor Use: 03/03/2017 – 04/12/2018
Retired: 04/12/2018

Model #: EE181
Operating Temperature: -40°C to +60 °C
Temperature Measurement Range: -40°C to +60°C
Temperature Accuracy: ± 2% °C @ 23°C
Relative Humidity Measurement Range: 0 - 100% non-condensing
RH Accuracy: –15 to 40 °C: ≤90% RH ± (1.3 + 0.003 • RH reading) % RH
–15 to 40 °C: >90% RH ± 2.3% RH
–25 to 60 °C: ± (1.4 + 0.01 • RH reading) % RH
–40 to 60 °C: ± (1.5 + 0.015 • RH reading) % RH
Temperature dependence of RH measurement: typically, 0.03% RH/°C
Note: This sensor caps relative humidity values at 100%, measured values >100% are altered to 100%

Temp/RH sensor 1 (Serial Number: 17101600008188)
Dates of Last Calibration: 02/04/2020
Previous Calibrations: 03/22/2017 (purchased 03/12/2018)
Dates of Sensor Use: 03/18/2020 – 03/29/2021
Retired: 03/02/2022

Temp/RH sensor 2 (Serial Number: 1841160000234D)
Dates of Last Calibration: 02/07/2023
Previous Calibrations: 10/16/2018 (purchased 03/01/2019), 03/17/2021
Dates of Sensor Use: 04/04/2019 – 03/18/2020, 03/29/2021 – 05/04/2022
Retired: 05/04/2023, pins sheared

Temp/RH sensor 3 (Serial Number: 21281600077814)
Dates of Last Calibration: 03/04/2024
Previous Calibrations: 07/16/2021 (purchased 03/02/2022)
Dates of Sensor Use: 05/04/2022 – 06/08/2023, 04/16/2024 – current as of 12/31/2024

Temp/RH sensor 4 (Serial Number: 222016000109CE)
Dates of Last Calibration: 05/20/2022
Previous Calibrations: N/A (purchased 05/04/2023)
Dates of Sensor Use: 06/08/2023 – 04/16/2024

Parameter: Barometric Pressure
Units: millibars (mb)
Model #: PTB110
Operating Range: 500 mb to 1100 mb
Supply Voltage: 12 VDC at 12 mA
Accuracy: ±0.3 mb @ 20 °C
±0.6 mb @ 0 to 40 °C
±1 mb @ –20 to 45 °C
±1.5 mb @ –40 to 60 °C

Stability: ±0.1 mb per year
Operating Temperature Range: -40 to +60 °C

Barometric Pressure sensor 1 (Serial Number: N0650251)
Date of last calibration: 02/07/2022
Previous Calibrations: 05/23/2018 (purchased 05/29/2018)
Date of Sensor Use: 06/26/2018 – 09/23/2020, 05/04/2022 –04/16/2024

Barometric Pressure sensor 2 (Serial Number: R1510517)
Date of last calibration: 03/04/2024
Previous Calibrations: 04/08/2019 (purchased 02/2020)
Date of Sensor Use: 09/23/2020 – 05/04/2022, 04/16/2024 – current as of 12/31/2024

Parameter: Wind speed and Wind direction

Units: Wind speed- meter per second (m/s); wind direction- degrees
Model #: 3001-L RM Young Wind Sentry Set (1)
Model #: 3002-L RM Young Wind Sentry Set (2)
Wind Speed Sensor Type: 12 cm diameter 4-blade helicoids propeller molded of polypropylene
Range: 0-50 m/s (112 mph); gust survival 60 m/s (134 mph)
Accuracy: ± 0.5 m/s (1.1 mph)
Wind Direction Sensor Type: balanced vane, 16 cm turning radius
Range: 360° mechanical, 355° electrical
Accuracy: ± 5°

Wind Speed/Direction sensor 1 (Serial Number: 2365M3)
Date of last calibration: 02/07/2016
Previous Calibrations: 10/31/2008, 03/02/2013
Date of Sensor Use: 04/18/2016 – 03/03/2017
Retired: 03/03/2017
Wind Speed/Direction sensor 2 (Serial Number: N/A)
Date of last calibration: 01/31/2017
Previous Calibrations: 06/21/2007, 02/04/2010, 05/06/2013

Date of Sensor Use: 03/03/2017 – 04/27/2018
Retired: 04/27/2018

Model #: R.M. Young 5103 Wind Monitor
Wind Speed Sensor Type: 18 cm diameter 4-blade propeller molded of polypropylene
Range: 0-100 m/s (224 mph)
Accuracy: ± 0.3 m/s (± 0.6 mph) or 1% of reading
Wind Direction Sensor Type: balanced vane, 38 cm turning radius
Range: 360° mechanical, 355° electrical
Accuracy: ± 3°

Wind Speed/Direction sensor 1 (Serial Number: WM158630)
Date of last calibration: 02/09/2022
Previous Calibrations: 12/21/2017 (purchased 03/12/2018)
Date of Sensor Use: 04/27/2018 – 03/18/2020, 05/04/2022 –04/16/2024

Wind Speed/Direction sensor 2 (Serial Number: WM166288)
Date of last calibration: 02/22/2024

Previous Calibrations: 12/20/2018 (purchased 02/07/2019)
Date of Sensor Use: 03/18/2020 – 05/04/2022, 04/16/2024 – current as of 12/31/2024

Parameter: Photosynthetic Active Radiation (PAR)

LI-COR Quantum Sensor
Units: mmoles m-2 (total flux)
Model #: LI-190
Stability: < ± 2% change over a 1-year period
Operating Temperature: -20 to +65 °C
Sensitivity: Typically, 30 μA per 100 klux
Light Spectrum Wavelength: 400 to 700 nanometers
Calibration Factor: 264.70 μmol m^{-2} s^{-1} per mV
Multiplier History and Calibration Dates and Dates Installed:

LI-COR sensor 1 (SN# Q35240)
Calibrated 07/2005 – Installed Aug. 22, 2005 – multiplier 1.36
Calibrated 10/2008 – Installed Sept. 30, 2009 – multiplier 2.18
Calibrated 02/2012 – Installed Mar. 16, 2012 – multiplier 3.12
Retired: 03/03/2016

LI-COR sensor 2 (SN# Q31559)
Calibrated 09/2002 – Installed May 3, 2003 – multiplier 1.27
Calibrated 06/2007 – Installed Apr. 22, 2008 – multiplier 1.34
Calibrated 02/2010 – Installed Dec. 9, 2010 – multiplier 1.38
Calibrated 05/2013 – Installed Feb. 27, 2014 – multiplier 1.54
Calibrated 04/2016 – Installed May 06, 2016- multiplier 1.54
Retired: 03/03/2017

Apogee Quantum Sensor
Units: mmoles m-2 (total flux)
Model #SQ110
Stability: < ± 2% change over 1 yr
Sensitivity: 0.2mV per μmol s^{-1} m^{-2}
Operating Temperature: -40°C to 70°C; Humidity 0 to 100%
Light spectrum waveband: 410 to 655 nm
Temperature dependence: 0.06 ± 0.06% per °C
Cosine Response: 45° zenith angle: ± 2%; 75° zenith angle: ± 5%
Set multiplier of 0.025
Calibration Dates and Dates Installed:

Apogee sensor 1 (Serial Number: 22346)
Date of last calibration: 03/13/2024
Previous Calibrations: 02/01/2017 (purchased 2/21/2017), 01/15/2020
Dates of Sensor Use: 03/03/2017 – 04/12/2018, 03/18/2020 – 05/04/2022 (post-cal = 809.0/stnd = 872.6), 04/16/2024 – current as of 12/31/2024

Apogee sensor 2 (Serial Number: 25319)
Date of last calibration: 02/17/2022
Previous Calibrations: 02/01/2018 (purchased 3/20/2018)
Date of Sensor Use: 04/12/2018 – 03/18/2020, 05/04/2022 –04/16/2024 (post-cal = 762.1/stnd = 858.2)

Parameter: Precipitation

Units: millimeters (mm)
Tipping Bucket Rain Gauge
Texas Electronics
Model #: TR-525I
Calibration: 0.01 inch per tip (0.254 mm per tip)
Accuracy: ± 3% (Rates of 1 to 6 inches per hour/25 to 152 mm per hour)
Calibration Dates and Dates Installed:

Rain Gauge 1 (Serial Number: 23864-399)
Date of last calibration: 04/10/2017
Previous Calibrations: 07/18/2006, 03/08/2010, 02/07/2011, 02/20/2012, 05/24/2012, 06/07/2012, 12/09/2012, 2/27/2014, 04/28/2016
Date of Sensor Use: 07/27/2006 – 04/27/2018
Retired: 04/27/2018

Rain Gauge 2 (Serial Number: 74041)
Date of last calibration: 04/19/2024
Previous Calibrations: 09/11/2017, 06/26/2018, 04/04/2019, 03/18/2020, 04/23/2021, 05/20/2022, 04/27/2023
Date of Sensor Use: 04/27/2018 – 05/23/2024

Units: millimeters (mm)
Tipping Bucket Rain Gauge
Texas Electronics
Model #: TR-525I
Calibration: 0.200 mm per tip
Accuracy: ± 1% (Rates of 0 to 2 inches per hour/50 mm per hour)
Calibration Dates and Dates Installed:

Rain Gauge 3 (Serial Number: 98953-0524)
Date of last calibration: 05/07/2024
Date of Sensor Use: 05/23/2024 – current as of 12/31/2024

Datalogger

CR1000:

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.

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: Temp: -35 to +65 °C
Baud rates: 9600, 76800
Power requirements: 5 ± 0.3 VDC @ 100 mA

CR1000 logger 1 (Serial Number: 005202)
Date of last calibration: 01/30/2012

Previous Calibrations: 06/01/2006
Dates of datalogger use: 06/29/2006 – 03/16/2012, 03/03/2017 – 05/04/2022 (internal battery replaced 05/03/2017)
Retired: 05/04/2022

CR1000 logger 2 (Serial Number: 46152)
Date of last calibration: 2012
Previous Calibrations: N/A (purchased 01/23/2012)
Dates of datalogger use: 03/16/2012 – 03/03/2017
Retired: 05/04/2022

CR1000 Firmware Version: CR1000_OS_31.02
Last update: 04/10/2017

CR1000 Program Version: ACEBPMET_CR1000_5.5.2_031720
ACEBPMET_CR1000_5.5.1_062618
ACEBPMET_5.5.1_042718
ACEBPMET_5.5.1_040218
ACEBPMET_5.5.1_050317
ACEBPMET_5.5_041017
ACEBPMET_5.5_030217
ACEBPMET_5.5_050616
ACEBPMET_5.5_022714

GOES Transmitter: Campbell Scientific, Inc. HDR GOES Transmitter
Model Number: TX312
Serial Number: 1338
Date Installed: 06/30/2006
Retired: 05/04/2022

CR1000X:

The CR1000X has a total onboard memory of 128 MB of flash and 4MB of battery backed SRAM. There is 8 MB of flash memory reserved for loading the operating system and 1MB of flash reserved for configuration settings. SRAM is used for the CRBasic program operating memory, communication memory, and data storage, with 72 MB of flash for extended data storage. Additional data storage expansion is available with a removable microSD flash memory card of up to 16 GB.

PN #31932
Storage capacity:
Program storage: 4 MB SRAM +72 MB flash (storage expansion of up to 16 GB with removable microSD flash memory card)
Processor: Renesas RX63N (32-bit with hardware FPU, running at 100MHz)
Operating system:
Operating range: Temp: -40° to +70°C
Baud rates: 1200
Power requirements: 10 to 18 Vdc input

CR1000X logger 1 (Serial Number: 13915)
Date of last calibration:
Previous Calibrations: N/A (purchased 2020)
Dates of datalogger use: inactive

CR1000X logger 2 (Serial Number: 13916)
Date of last calibration: 11/20/2019
Previous Calibrations: (purchased 2020)
Dates of datalogger use: 05/04/2022 – current as of 12/31/2024

CR1000X Firmware Version: CR1000X.Std.07.02
Last update: 04/17/2024

CR1000X Program Version: ACEBPMET_CR1000X_V6.0.2_052324.CR1X
ACEBPMET_CR1000X_V6.0.2_042822.CR1X

Transmitter: Campbell Scientific, Inc. HDR GOES Transmitter
Model Number: TX321
Serial Number: 2335
Date Installed: 05/04/2022

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, 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/CR1000X, 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. The missing data are flagged as <-2>.

After an edit to the CR1000 program was made on 04/10/2017 11:15, Relative Humidity data greater than 100 are within range of the sensor accuracy of +/-3% and are flagged and coded as suspect, <1> (CAF). Values greater than 103 are rejected <-3> (SQR).

Data recorded for all parameters (except for 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.**

All Parameters Blanket Statement for Bennett's Point Weather Station

Rejected Data (Flag <-3>)

Data for all parameters (except total precipitation and cumulative precipitation) were rejected on 04/16/2024 at 13:45. The CR1000X was powered down at 09:45 to install a calibrated temperature/relative humidity sensor, barometric pressure sensor, wind sensor, PAR sensor, and an attempt to calibrate the rain gauge. No rain fell while the technicians were on site. Due to uncertainty related to the averaging of 5 second readings, the value is flagged and coded as <-3> [GMT] (CSM).

Data for all parameters (except total precipitation and cumulative precipitation) were rejected on 04/17/2024 at 12:00. The CR1000X was powered down to update the operating system. No rain fell while the technicians were on site. Due to uncertainty related to the averaging of 5 second readings, the value is flagged and coded as <-3> [GPR] (CSM).

Data for all parameters (except total precipitation and cumulative precipitation) were rejected on 05/23/2024 at 10:30. A new rain gauge was installed with a different increment per tip. The program was changed to reflect this and uploaded to CR1000X. No rain fell while the technicians were on site. Due to uncertainty related to the averaging of 5 second readings, the value is flagged and coded as <-3> [GPR] (CSM).

Missing Data (Flag <-2>)

Data were missing for all parameters on 04/16/2024 at 09:45 to 13:30. The CR1000X was powered down at 09:45 to install a new temp/RH sensor, barometric pressure sensor, wind sensor, PAR sensor, and an attempt to calibrate the rain gauge. The installation was completed at 13:30 and the CR1000X was powered back on. No rain fell while the technicians were on site. The values are flagged and coded as <-2> [GMT] (CSM).

Data were missing for all parameters on 04/17/2024 at 11:30 to 11:45. The CR1000X was powered down to conduct an operating system update. The values are flagged and coded as <-2> [GPR] (CSM).

Temperature/Relative Humidity

Rejected Data (Flag <-3>)

Data values for temperature and relative humidity were rejected on 03/18/2024 at 13:00. The sensor was briefly unplugged for maintenance. Due to uncertainty related to the averaging of 5 second readings, the values are flagged and coded as <-3> [SMT] (CSM).

Data values for temperature and relative humidity were rejected on 06/19/2024 at 10:00 to 10:15 due to sensor briefly unplugged during maintenance at 10:00. Due to uncertainty related to the averaging of 5 second readings, the values are flagged and coded as <-3> [SMT] (CSM).

Barometric Pressure

No additional flagging or coding was required.

Wind Speed/Direction

Rejected Data (Flag <-3>)

Data values for wind speed and direction were rejected on 05/02/2024 at 10:00 due to the anemometer was briefly bumped during maintenance. Due to uncertainty related to the averaging of 5 second readings, the values are flagged and coded as <-3> [SMT] (CSM).

Total Precipitation

Passed Initial QAQC Checks (Flag <0>)

The pre-calibration check of the tipping bucket rain gauge on 04/02/2025 recorded the left bucket tipped at an average of 3.51 mL while the right bucket tipped at an average of 4.30 mL. The ideal range is 3.68 mL to 3.76 mL per tip. To determine when the tipping bucket calibration might have changed, the tipping bucket rain gauge was compared to the manual rain gauge. On 08/09/2024, the difference between the two gauges changed from positive to negative. Data from 08/09/2024 – 00:00 to 12/31/2024 – 23:45 are flagged and coded as <0> (CSM). While the data are not

considered suspect, users should be aware that there were differences between the two gauges before and after 08/09/2024. See the comparisons below.

Date Range	Tipping Bucket Rain Gauge (mm)	Manual Rain Gauge (mm)	Difference (mm)
01/11/2024 - 02/06/2024	56.6	44.2	12.4
02/06/2024 - 03/03/2024	105.7	18.3	87.4
05/02/2024 - 05/23/2024	62.7	62.5	0.2
New Rain Gauge Installed			
05/23/2024 - 06/06/2024	43.4	42.7	0.7
06/06/2024 - 07/09/2024	93	90.9	2.1
07/09/2024 - 08/09/2024	515	478.5	36.5
08/09/2024 - 09/10/2024	*77.4*	*82.3*	*-4.9*
09/10/2024 - 10/15/2024	*35.6*	*55.6*	*-20.0*
10/15/2024 - 11/15/2024	*84*	*83.6*	*0.4*
11/15/2024 - 12/18/2024	*18.4*	*21.1*	*-2.7*
12/18/2024 - 01/08/2025	*58*	*64.0*	*-6.0*
01/08/2025 - 02/03/2025	*50.4*	*52.1*	*-1.7*
02/03/2025 - 03/07/2025	*41.4*	*42.4*	*-1.0*
03/07/2025 - 04/02/2025	*49*	*51.8*	*-2.8*

Corrected Data (Flag <5>)
The rainfall data from the following entries were recorded as rainfall during sensor maintenance, when the rain gauge bucket was accidentally tipped. No rain fell while the technicians were onsite. The data were corrected to a 0 reading and are flagged and coded <5> [SMT] (CSM).

03/18/2024 – 13:15 05/23/2024 – 10:45

Total PAR

Rejected Data (Flag <-3>)
Data values for PAR were rejected on 05/02/2024 at 09:45 to 10:15 due to maintenance. A new PAR mounting bracket was installed. On 04/16/2024, the previous bracket was found to be not level. The values are flagged and coded as <-3> [SMT] (CSM).

Data values for PAR were rejected on below dates and times due to quick wipe of sensor during monthly maintenance and uncertainty of 5 second readings. The values are flagged and coded as <-3> [SMT] (CSM).

07/11/2024 – 09:00 08/15/2024 – 09:15 09/30/2024 10:45

Suspect Data (Flag <1>)
Beginning in January and continuing through sensor swap, small elevated nighttime PAR values were recorded. All nighttime PAR readings greater than 0.0 mmoles/m^2 are flagged and coded as <1> (CSM). Those data values appear satisfactory; however, data users should be aware of possible data inconsistencies. https://www.sunrisesunset.com was used to determine the cutoff between daytime and nighttime.

There were noticeable changes in PAR values following the swap to a freshly calibrated sensor (assumed to be accurate), SN22346, on 04/16/2024. Apogee reported a -11.2 % post cal drift for the sensor that was installed from 05/04/2022 to 04/16/2024 (SN25319). Acceptable drift is +/- 2% for this sensor. All PAR data 1 year prior to the sensor swap, from 04/16/2023 to 04/16/2024 09:30 are flagged and coded as <1> [SSD] (CSM). PAR data for the

remainder of this deployment, 05/04/2022 – 04/16/2023, are flagged and coded <0> (CSM) and users should note that drift for that period may have exceeded acceptable limits as well. 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.

During the sensor swap on 04/16/2024, the PAR sensor bracket was rusted and needed to be replaced. The PAR sensor was swapped and re-installed on the damaged bracket. A new bracket was purchased and installed on 05/02/2024 but staff had trouble leveling the sensor. On 05/23/2024, the sensor was leveled. There was a slight increase in the readings (expected due to previous PAR sensor post-calibration readings) followed a slight decrease after leveling the PAR sensor. The data from 04/16/2024 – 14:00 to 05/23/2024 – 10:15 (unless another flag/code was applied) are flagged and coded <1> (CSM).

Cumulative Precipitation

Passed Initial QAQC Checks (Flag <0>)

The pre-calibration check of the tipping bucket rain gauge on 04/02/2025 recorded the left bucket tipped at an average of 3.51 mL while the right bucket tipped at an average of 4.30 mL. The ideal range is 3.68 mL to 3.76 mL per tip. To determine when the tipping bucket calibration might have changed, the tipping bucket rain gauge was compared to the manual rain gauge. On 08/09/2024, the difference between the two gauges changed from positive to negative. Data from 08/09/2024 – 00:00 to 12/31/2024 – 23:45 are flagged and coded as <0> (CSM). See comparisons above.

Corrected Data (Flag <5>)

The rain gauge bucket was accidentally tipped several times during sensor maintenance; however, no rain fell while the technicians were onsite. The data from the accidental tips were corrected and are flagged and coded as <5> [SMT] (CSM) for the following entries.

03/18/2024 – 13:15 to 03/19/2024 – 00:00 05/23/2024 – 10:45 to 05/24/2024 – 00:00

14) Station History –

Bennett's Point:

2001 - Station became active with CR10X data logger. No data collected until **March** due to battery issues. Data collection stopped in **June**. PC208W software used to download data. Parameters measured are: temperature, humidity, barometric pressure, rainfall, wind speed and direction and PAR. Sensors are located on 3-meter galvanized poles on top of control box.
2002 - Data collection resumed in **January**
2002 - NADP – National Atmospheric Deposition Program – began in **January**
2003 - All new sensors installed on **May 3** and old ones sent back to be calibrated
2003 - A 15-foot galvanized tower installed on which the sensors are positioned
2005 - All newly calibrated sensors installed on **August 22**
2006 - CR10X datalogger replaced with the CR1000 datalogger and PC208W software replaced with LoggerNet Software on **June 29**
2006 - NL115 Ethernet cable installed to allow for downloading data and troubleshooting from Charleston office
2006 - GOES satellite telemetry equipment installed to view real-time weather data
2006 - Rain tipping bucket calibrated on **July 18**
2006 - NL115 Ethernet cable cut by workers in **December**
2007 - NL115 Ethernet cable destroyed by squirrels and lost connection in **September**
2007 - NADP (National Atmospheric Deposition Program) ended in **December**
2008 - New CR1000 program with Cumulative Precipitation parameter uploaded in **March**
2008 - All newly calibrated sensors installed on **April 22**
2009 - All newly calibrated sensors installed on **September 30**
2010 - Rain tipping bucket calibrated on **January 1**
2010 - Rain tipping bucket calibrated on **March 18**
2010 - Newly calibrated sensors (except Temp/RH) installed on **December 9**

2012 - Newly calibrated sensors installed on **March 16**
2012 - New CR1000 datalogger installed on **March 16**
2012 - Rain bucket calibrated on **June 7**
2012 - Rain bucket calibrated on **December 19**
2013 - Barometric pressure calibrated on **May 16**
2013 - Newly calibrated Temp/RH sensor installed on **July 31**
2014 - Newly calibrated sensors (except Temp/RH) installed on **February 27**
2014 - Rain bucket calibrated on **February 27**
2014 - Rain bucket calibrated on **March 31**
2014 - Newly calibrated Temp/RH sensor installed on **July 23**
2015 - New battery installed on **November 25**
2016 - Newly calibrated sensors (except PAR) installed on **April 18**
2016 - Newly calibrated PAR sensor installed on **May 6**
2017 - Newly calibrated CR1000 datalogger installed on **March 3**
2017 - Newly calibrated sensors (except LiCor PAR and Barometric Pressure) installed on **March 3**
2017 - LiCor PAR sensor was replaced with an Apogee PAR sensor on **March 3**
2017 - New CR1000 program (ACEBPMET_5.5_030217) uploaded on **March 3**
2017 - Rain bucket calibrated on **April 10**
2017 - New Campbell OS V31.02 uploaded on **April 10**
2017 - New CR1000 program (ACEBPMET_5.5_041017) uploaded on **April 10**
2017 - New CR1000 program (ACEBPMET_5.5.1_050317) uploaded on **May 3**
2018 - New Temp/RH and PAR sensor installed on **April 12**
2018 - New CR1000 program (ACEBPMET_5.5.1_040218) uploaded on **April 12**
2018 - New wind sensor and rain gauge installed on **April 27**
2018 - New CR1000 program (ACEBPMET_5.5.1_042718) uploaded on **April 27**
2018 - New barometric pressure sensor installed and rain bucket field calibrated on **June 26**
2018 - New CR1000 program (ACEBPMET_5.5.1_062618) uploaded on **June 26**
2019 - New Temp/RH sensor installed, and rain gauge field calibrated on **April 4**
2020 - New Temp/RH, Wind sensor, and PAR sensor installed, and rain gauge calibrated on **March 18**
2020 - New CR1000 program (ACEBPMET_5.5.2_031720) uploaded on **March 18**
2020 - New barometric pressure sensor installed on **September 23**
2021 - New external battery installed on **January 28**
2021 - Newly calibrated Temp/RH sensor installed on **March 29**
2021 - Rain bucket calibrated on **April 23**
2021 - New external battery installed on **June 30**
2022 - System refresh-new box installed with CR1000X (ACEBPMET_CR100X_V6.0.2_042822.CR1X), newly calibrated PAR, Wind, and barometric sensors as well as new Temp/RH sensor installed on **May 4**
2022 - Rain bucket calibrated on **May 20**
2022 - Battery replaced on **August 23**
2023 - Updated CR1000X OS version to CR1000X.Std.06.02 on **March 29**
2023 - Rain bucket calibrated on **April 27**
2023 - New Temp/RH sensor installed on **June 8**
2024 - System refresh- newly calibrated Temp/RH, barometric, wind, and PAR sensors installed on **April 16**
2024 - Updated CR1000X OS version to CR1000X.Std.07.02 on **April 17**
2024 - New PAR sensor mounting bracket installed on **May 2**
2024 - New rain gauge installed and new CR1000X program due to change in tip (ACEBPMET_CR1000X_V6.0.2_052324.CR1X) uploaded on **May 23**