Wells (WEL) National Estuarine Research Reserve
Meteorological Metadata
January-December 2019
Latest Update: April 12th, 2021

I. Data Set & Research Descriptors

1) Principal investigator & contact persons:

Contact Persons:

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2) Entry verification:

a) Data Input Procedures:

The meteorological information is sampled every 5 seconds from each instrument on the weather station and stored on a Campbell Scientific CR1000 data logger. The CR1000 has two MB Flash EEPROM that is used to store the Operating System and another 128 K Flash is used to store configuration settings. A minimum of 2 MB SRAM (4 MB optional) is available for program storage (16K), operating system use, and data storage.

> Data are uploaded from the CR1000 data logger to a personal computer with a Windows 7 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. Jeremy Miller is responsible for all aspects of data management.

3) Research Objectives:

The principal objective is to record long-term meteorological data for Wells, in order to supplement SWMP water quality YSI data and research data, and to observe any environmental changes or trends over time.

4) Research Methods:

The CR1000 datalogger samples every 5 seconds continuously and 15 minute averages and totals are produced and recorded as 15 minute data. This data is stored within the CR1000 until it is manually downloaded through LoggerNet and uploaded to the CDMO for initial QA\QC procedures. All data are collected in Eastern Standard Time (EST).

Campbell Scientific data telemetry equipment was installed at the Laudholm Farm Weather station on 07/11/06 and transmits data to the NOAA GOES satellite, NESDIS ID #3B024184. 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.

Sensors on the weather station are inspected monthly for damage or debris. Sensors are removed and replaced with recently calibrated sensors approximately every two years, with the exception of the rain gauge and Temp/Humidity probe, which is calibrated approximately every year. Also, once a month on download day, we use regional NWS data, to run a comparative set of observations as a general check on the Campbell station sensors and hardware. The CR1000 data logger is calibrated every 5 years (required beginning 2014, one year initial grace period).

Recommended calibration frequency for the MET station sensors:

- Temperature/Humidity- yearly recalibration
- Precipitation 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/CR1000X-every 5 years (required beginning 2014, one year initial grace period)

The 15 minute Data are collected in the following formats for the CR1000:

Averages from 5-second data:
Air Temperature (°C), Relative Humidity (%), Barometric Pressure (mb), Wind Speed (m/s), Wind Direction (degrees), and Battery Voltage (volts)

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

Maximum and their times from 5-second data:
Wind Speed, (m/s)

Wind Direction Standard Deviation (degrees) from 5-second data

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.)

5) Site location and character:

The Wells National Estuarine Research Reserve (and Laudholm Farm Meteorological station) is located in York County, within the Town of Wells, on the coast of southern Maine and faces the Atlantic Ocean at an elevation of 18.62 meters above sea level. The Wells NERR is approximately 31 km (20 miles) south of Portland, Maine and 110 km (70 miles) north of Boston, Massachusetts. The reserve encompasses 1,690 acres along the Gulf of Maine coastline of tidally flushed wetlands, riparian and transitional upland fields and forests within the Little River Estuary and the larger Webhannet River Estuary. Both estuaries arise in the sandy glacial outwash plain about eight miles inland. Both rivers empty into Wells Bay, a sandy basin stretching for approximately ten miles along the Atlantic coast. Bordering each river's inlet are double spit barrier beaches attached to the mainland. The backbarrier system is approximately 5 sq. km and is composed of large intertidal marshes (predominantly S. patens and S. alterniflora), intertidal sand and mud flats, and tidal channels. The watershed for the Webhannet River estuary covers an area of 35 sq. km and has a total of 6 streams, brooks or creeks, which enter the estuary. These tributaries flow across sand and gravel deposits near the headwaters and the impermeable sandy mud of the Presumpscot Formation in the lower reaches. The Webhannet River is connected to the ocean via Wells Inlet, which has a spring tidal prism of 28,200,000 cub. m (Ward 1993). The force and volume of tidal action affect the salinity level of both rivers. In the Wells region, the annual mean wave height is almost 20 inches. The estuarine system is dominated by semi-diurnal tides having a range of 8.5 to 9.8 feet. The volume of freshwater influx into both estuaries is moderate to low (on the order of 0.5 cubic meters/second), especially in the summer, because of the rivers' relatively small drainage areas and the presence of deep glacial deposits. The relatively low flows from these two rivers taken in with the 20 inch per year average runoff of the area surrounding the estuaries combine to form a freshwater flow that is dwarfed by tidal flushing. Twelve-foot tides dwarf the freshwater flow into the Webhannet estuary, which has a drainage area of 14.1 square miles. The Webhannet estuary, fed by both Blacksmith and Depot Brooks, is adjacent to the harbor and greatly developed land. It offers a valuable opportunity for comparison with the relatively pristine Little River estuary. The land use of the Webhannet estuary include a total of 15% for wetland, fresh water, and tidal marsh; a total of 63.7 % for woodland; and a total of 18.6% for developed land (compared to a total of 5.7% development in the Little River estuary) (WNERR RMA 1996; Holden 1997).

The following information regarding annual weather patterns in the area was supplied by Maine State Climatologist Professor Gregory A. Zielinski extracted from "Monthly Station Normals of Temperature, Precipitation, Heating and Cooling Degree Days 1971-2000", Climatography of the United States No. 81, National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC. and "Daily Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, 1971-2000", Climatography of the United States No. 84: "Average monthly temperatures range from 21.6F in January to 66.7F in July with daily highs averaging just below freezing in January and lows around 11F. Daily highs in July average around 76F and daily lows around 57F. The sea breeze often keeps daily highs lower during the summer than areas inland. Annual average temperature is 44.6F. Annual precipitation is 47.07 inches, including the water equivalent of snowfall, with monthly averages ranging from 3.01 inches in July to 4.77 inches in October. August receives just 3.02 inches on average. Annual snowfall is around 66 inches." According to Zielinski, "cool ocean temperatures keep down the number of afternoon showers and especially thunderstorms resulting in low summer precipitation amounts."

The weather station is located (43 deg 20' 14.52" N, and 70 deg 32' 58.03" W) on a 32' (9.75m) telephone pole surrounded by mowed grass. The temperature and humidity probes are located on the north

side of the pole at a height of 10' (3.0m). The PAR sensor is located on the South side of the pole at a height of approx. 15'(4.6m). The Barometric pressure sensor is located within the Campbell Scientific enclosure at a height of approx. 5'(1.5m) and vented to the outside by a small length of aquarium tubing. The wind sensor is located atop the pole at approximately 33 feet (10.1m) above the ground. To the NW of the pole is the Coastal Ecology Center, a 20' high (6.1m), 111' (33.8m) long building, at a distance of 37' (11.3m), running NE/SW. Further to the NW (153'(46.6m) from the pole) is the library, in a 25'(7.6m) high wing of the barn. The barn itself is 223' (68.0m) from the station and runs NE/SW. It is 38'(11.6m) high and is the largest obstruction in the area. The rain gauge is located 9' (2.7m) southeast of the weather station pole and is situated on a post with the top of the funnel is 10' (3.0m) from the ground.

There are two SWMP water quality sampling sites in the Webhannet River estuary, and two stations in the Little River Estuary. These are located at the Webhannet River Head of Tide, at the Webhannet Inlet, at Skinner Mill on the Merriland River and at the mouth of the Little River. The tidal range at each of these sites is 2.6-2.9 meters. The station is approximately .86 KM from welsmwq, .78KM from wellmwq, 2.21 KM from welinwq, and 5.27 KM from welhtwq.

Station Code	SWMP Status	Station Name	Location	Active Dates	Reason Decommissioned	Notes
wellfmet	P	Laudholm Farm	43 deg 20' 14.52" N, 70 deg 32' 58.03" W	2001-present	NA	NA

6) Data collection period:

The Weather Station collected 15 minute data all year for 2019 starting on 1/1/2019. There are only occasional gaps in data due to sensor replacement/station maintenance.

File Start Date and Time	File End Date and Time
12/14/2018 10:30	1/30/2019 12:45
1/30/2019 13:00	2/28/2019 16:15
2/28/2019 16:30	3/27/2019 13:00
3/27/2019 13:15	4/29/2019 12:15
4/29/2019 12:30	5/30/2019 14:30
5/30/2019 14:45	6/27/2019 11:30
6/27/2019 11:45	7/25/2019 13:45
7/25/2019 14:00	8/29/2019 11:30
8/29/2019 11:45	9/27/2019 12:30
9/27/2019 12:45	10/25/2019 12:15
10/25/2019 12:30	11/26/2019 11:30
11/26/2019 11:45	1/2/2020 12:15

7) Distribution:

According to the Ocean and Coastal Resource Management Data Dissemination Policy for the NERRS System-wide Monitoring Program:

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 2019.

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:

As part of the SWMP long-term monitoring program, the Wells NERR also monitors 15-minute water quality along with monthly grab samples and diel sampling for nutrient data which may be correlated with this meteorological dataset. These data are available at www.nerrsdata.org.

RESEARCH AT THE WELLS NATIONAL ESTUARINE RESEARCH RESERVE for 2018:

(Please visit our website: www.wellsreserve.org/research.htm for further information on the Wells NERR research program):

The Research Program at the Wells NERR conducts and supports research, monitoring, workshops, and research/resource management planning of relevance at local, regional and national levels. The overall aim of our work is to produce science-based information needed to sustain or restore Gulf of Maine coastal habitats and resources, especially those found in salt marsh estuaries and watersheds. During 2017, many different studies involving scores of scientists, students, staff and volunteers focused on several related themes: 1) the quality of water resources in salt marsh estuaries and watersheds 2) land conservation strategies to protect coastal watersheds 3) factors controlling salt marsh accretion, erosion and plant community vigor 4) the value of salt marsh as habitat for fish, shellfish and birds, 5) restoration of salt marsh habitat degraded through human actions, and 6) understanding the ecology and functions of salt marsh habitat.

Estuarine Water Resource Quality

Water quality is monitored continuously at several stations with automated instruments as part of a NERRS system wide monitoring program, as well as bimonthly at 15-20 stations through our WET volunteer monitoring

program. The WET program also monitors two important biological parameters: fecal coliform bacterial contamination (an indicator of human health risk) and phytoplankton productivity (an indicator of estuarine health). These data have 1) allowed us to identify several bacterial "hot spots" that we will be working to eliminate, 2) are used to identify and open areas safe for shellfishing, and 3) have uncovered a relation between tides and low dissolved oxygen (a stressful condition for marine life) that needs further study. Our water quality work has contributed to the designation of several Priority Watersheds in coastal Southern Maine by the Maine Department of Environmental Protection.

Environmental DNA:

Environmental monitoring programs are essential for effective estuarine management, but they are often time-consuming, expensive, and subject to technical and resource limitations. Traditional monitoring methods may also miss early detection of newly-arrived invasive species or incorrectly confirm losses of rare native species that occur in low densities or at locations that are difficult to survey. Environmental DNA methods for detecting aquatic species offer an effective alternative to traditional techniques that is cost effective and highly sensitive. Wells Reserve, in partnership with University researchers and other NERRs, has been piloting the application of these methods in monitoring invasive crab species, adult and larval fish assemblages, and imperiled migratory fish species in Gulf of Maine estuarine waters. Results of these studies have shown that each application offers significant promise as well as challenges for working in a complex environment with species at various life stages. Availability of eDNA within the aquatic environment is subject to numerous biological and environmental factors and careful study design is critical for gathering reliable data. Our work illuminates the benefits and challenges of applying these new methods to monitoring aquatic species in estuaries, and provides a model for adoption by researchers and managers alike.

HABITAT VALUE FOR FISH, SHELLFISH AND BIRDS

The reserve combines long-term monitoring with periodic surveys and short-term experiments to identify species and measure trends and changes in populations of fish, crustaceans, clams and birds. We have 17 years of data on upland and shore birds with which to assess the status of resident and migratory avian populations, and several years of wading bird data that we use as a gross level indicator of salt marsh health, which appears to be stable. Our ongoing larvalfish surveys have produced the best available data for fish utilization of salt marsh estuaries in the Gulf of Maine. Since 1994 we have been conducting surveys and field experiments to look at the survival and growth of hatchery seed, juvenile and adult softshell clam with regard to habitat characteristics and predation by the invasive green crab. Benthic invertebrates have been sampled from a number of marshes from Wells to Casco Bay in hopes of gaining a better understanding of invertebrate assemblage and their value to higher trophic levels.

Salt Marsh Degradation and Restoration

Salt marsh ecosystems in the Gulf of Maine have sustained themselves in the face of sea-level rise and other natural disturbances for nearly five thousand years. Since colonial times large areas of salt marsh (up to half of the total area) have been lost through diking, draining and filling. Today, the remaining marshland is fairly well protected from outright destruction, but during the past 100 years, and especially since the 1950's, salt marshes have been divided into fragments by roads, causeways, culverts and tide gates. Most of these fragments have severely restricted tidal flow, leading to chronic habitat degradation and greatly reduced access for fish and other marine species. Since 1991, the Wells Reserve has been studying the impact of these restrictions on salt marsh functions and values, and the response of salt marshes to tidal restoration. We have been working to promote an awareness of the damage being done and the benefits of salt marsh restoration throughout the Gulf of Maine.

Research Program Update: In addition to the reserve-sponsored projects outlined above, numerous visiting investigators will be involved in on-site research. Topics include: the effects of land use, sea level, and climate on estuarine productivity; the relationship between soil nutrients and plant community patterns; the influence of soil salinity on plant community interactions; the effect of tidal restriction on marsh peat accretion; the comparative ecology of fringe marshes and back barrier marshes; habitat use by upland birds, impacts of the invasive green Crab on salt marsh communities, and the ecology of lyme disease.

"Sustaining Quality of Place in the Saco River Estuary through Community-Based Ecosystem Management"

This project will focus on understanding the effects of increasing coastal development on the health of the Saco River Estuary, and on ways to mitigate these effects. It will employ the methods of social sciences in understanding management and policy challenges, and in examining existing gaps in scientific knowledge required to address these challenges. It will also use the methods of the natural sciences to develop ecological indicators that reflect the extent and impacts of coastal development. This project is a first step in achieving the long-term goal of sustaining the structure and function of the Saco River Estuary, and could serve as a model for bringing scientists and stakeholders together to achieve similar goals.

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 #: HC2-S3
Operating Temperature: -40°C to +60°C
Range: -40°C to +60°C
Accuracy: ± 0.2 °C @ 20°C
Serial Number: 61115998
Date of Last Calibration: 12/20/17
Dates in use: 12/20/17 to 12/14/18
AND
Serial Number: 61290211
Date of Calibration: 10/22/2018
Dates in use: 12/14/2018 – current as of 12/31/2019

Parameter: Relative Humidity
Units: Percent
Sensor type: Rotronics HC2-S humidity sensor
Model #: HC2-S3
Range: 0-100% non-condensing
Accuracy at 20°C: +/- 2% RH (0-90%) and +/- 3% (90-100%)
Temperature dependence of RH measurement: +/- 0.05% RH/°C
Serial Number: 61115998
Date of Last Calibration: 10/22/2018
Dates in use: 12/14/2018 – current as of 12/31/2019

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: V4920039
Date of Calibration: 10/23/2018
Dates in Use: 12/14/2018 – current as of 12/31/19

Parameter: Wind speed
Units: meter per second (m/s)
Sensor type: 18 cm diameter 4-blade helicoids propeller molded of polypropylene
Model #: R.M. Young 05103 Wind Monitor
Range: 0-60 m/s (134 mph); gust survival 100 m/s (220 mph)
Accuracy: +/- 0.3 m/s
Serial Number: WM 82868
Date of last calibration: 10/26/2016
Dates in Use: 11/17/2016 to 12/14/2018
AND
Serial Number: WM73891
Date of Calibration: 10/25/2018
Dates in Use: 12/14/2018 – current as of 12/31/2019

Parameter: Wind direction
Units: degrees
Sensor type: balanced vane, 38 cm turning radius
Model #: R.M. Young 05103 Wind Monitor
Range: 360° mechanical, 355° electrical (5° open)
Accuracy: +/- 3 degrees
Serial Number: WM 82868
Date of last calibration: 10/26/2016
Dates in Use: 11/17/2016 to 12/14/2018
AND
Serial Number: WM73891
Date of Calibration: 10/25/2018
Dates in Use: 12/14/2018 – current as of12/31/2019

Parameter: Apogee SQ-110 Quantum sensor PAR
Units: umoles/s/m^2
Sensor type: High stability silicon photovoltaic detector (blue enhanced)
Model #: SQ-110
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
Serial Number: XXXX
Multiplier: 0.025 (this does not change)
Date of Last calibration: New Sensor
Dates in Use: 11/21/2016 – 03/27/2019
AND
Serial Number: 16741
Date of Last Calibration: 12/31/2018
Dates in Use: 03/27/2019 – current as of 12/31/2019

Parameter: Precipitation
Units: millimeters (mm)
Sensor type: Tipping Bucket Rain Gauge
Model #: TE525
Serial Number: H12182
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: 08/29/2019, previous calibration 8/28/2018

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: 07/12/2006, removed 04/13/2015 for calibration
Date CR1000 Calibrated: 04/18/2015
Dates in Use: 04/22/2015 – current as of 12/31/2019

CR1000 Firmware Version (s): OS28 was used for all of 2019 data collection

CR1000 Program Version(s): wellfmet_CR1000_7.1_42417.CR1

10) Coded variable code definitions:
Sampling Station: Laudholm Farm
Sampling site code: LF
Station code: wellfmet

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 –

[Instructions/Remove: This section details the secondary QAQC Code definitions used in combination with the QAQC flags above and requires no additional information. Include the following excerpt;]

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.

Small negative PAR values are within range of the LI-COR sensor and are due to normal errors in the sensor and the CR1000 Datalogger. The Maximum signal noise error for the LI-COR sensor is +/- 2.214 mmoles/m2 over a 15 minute interval. These values are automatically flagged and coded as <1> (CAF).

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>.

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.**

*Rapid changes in Relative Humidity and Temperature are quite common at the Wells NERR due to our close proximity to the coast and shifts in wind from the ocean to the land (and vise versa). These shifts in wind direction can dramatically affect both the temperature of the air as well as the amount of moisture there in, causing air temperatures and Relative Humidity to rise and fall sharply.

- Although data are not flagged or coded, it should be noted that April 2019 had 19 days with measurable rain.
- 08/29/2019 total precipitation data are considered suspect at 08:45 and cumulative precipitation data are considered suspect through the end of the day. The tipping bucket (containing water from rainfall earlier in the day) accidently tipped during maintenance.
- All PAR data following the sensor swap at 13:15 on 3/27/19 have been corrected to account for an incorrect sensor calibration from the manufacturer. The PAR sensor was calibrated to electric light as opposed to sunlight, and therefore all data were multiplied by 1.104 to correct for this error. Data at 13:15 were rejected due to maintenance and data from 3/27/19 13:30 through 12/31/2019 at 23:45 are flagged and coded as corrected due to the incorrect calibration.