Wells (WEL) National Estuarine Research Reserve Meteorological Metadata
January-December 2005
Latest Update: **October 18, 2023**

I. Data Set & Research Descriptors

1) Principal investigator & 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 CR10X data logger and SM4 storage module. Data are output to a file in three arrays: array 15 stores 15 minute average, max and min data; array 60 stores hourly average, max and min data; and array 144 stores daily average, max and min data. The CDMO Data Logger Program (NERR_4_1.CSI) was loaded into the CR10X and controls the sensors. The CR10X then interfaces with the PC208W software supplied by Campbell Scientific.

Data are uploaded from the CR10X data logger or storage module to a Personal Computer (IBM compatible). The data was saved as a monthly raw data file (LF050101.dat, indicating year/month/day as yymmdd). Files are exported from PC208W in a comma-delimited format (.DAT) and opened in Microsoft Excel for pre-processing with the EQWin format macro (EQWinFormat.xls) that was developed by the CDMO to reformat the header columns, insert station codes, insert a date column (mm/dd/yyyy), correct the time column format and reformat the data to the appropriate number of decimal places. The pre-processed file is then ready to be copied into the EQWin weather.eqi file where the data are QA/QC checked and archived in a database. Viewing data in Excel and EQWin queries, reports and graphs are used to discover data set outliers (values which fall outside the range that the instrument is designed to measure) and large changes in the data. EQWin is also used to generate statistics, view graphs, create customized queries and reports of the data, cross query the water, weather and nutrient data and finally export the data to the CDMO. Any anomalous data are investigated and noted below in the Anomalous Data/Suspect Data section. Any data corrections that were performed are noted in the Deleted Data section below.

The most common reported errors/anomalies in 2005 were:

1) Slightly negative LiCor (Photosythetically Active Radiation, or PAR).
2) Relative Humidity slightly over 100%.
3) 15 minute sample rainfall over 5mm.

All errors of these types were checked. The first two, slightly negative PAR and relative humidity slightly over 100% can both be explained by sensor drift (for PAR) or a combination of limits of accuracy and sensor drift (for Relative Humidity). See sections 11, 12 and 13 for additional details. When power-down events occurred, we lost the earlier 5-second data for those calendar days, resulting in incorrect values of those days' 24-hour average, maximum and minimum values. Therefore, those days' 24-hour values were deleted. Any data corrections that were performed are noted in the Data Correction section below. Both raw data files (.dat format), Excel pre-processed files and EQWin database files were saved to the SWMP laptop computer (Panasonic Toughbook CF-28), and backed up to the Wells NERR on campus server and a Maxtor One-Touch external hard drive.

Cayce Dalton was responsible for data management until his departure in July 2005. From that point forward, Jeremy Miller was responsible for data management.

b) Data Collection Schedule
Data is collected in the following formats and at the following intervals:

1) 15 minute averages are calculated from 5 second samples sorted by date and time except for PAR and precipitation data that are summed from 5 second samples sorted by date and time.

2) Hourly averages are calculated from 5 second samples sorted by date and time except for PAR and precipitation data that are hourly totals calculated from 5 second samples.

3) Daily average, maximum with time, and minimum with time are calculated from 5 second samples sorted by date and time except for PAR and precipitation data which are 24 hour totals calculated from 5 second samples.

ii) 15 minute sample point parameters: Date, Time, Air Temperature (°C), Relative Humidity (%), LiCor (PAR), Barometric Pressure (mb), Wind Speed (m/s), Wind Direction; Rainfall (mm).

iii) Hourly average parameters: Date, Time, Air Temperature (°C), Relative Humidity (%), Barometric Pressure (mb); Wind Speed (m/s), Wind Direction, Wind Speed Maximum.

iv) Hourly total parameters: LiCor (PAR); Rainfall (mm)

v) Daily Average parameters: Date, Time, Air Temperature (°C), Relative Humidity (%), Barometric Pressure (mb); Wind Speed (m/s), Wind Direction, Wind Direction Standard Deviation (using Yamartino's Algorithm).

vi) Daily Total parameter: LiCor (PAR); Rainfall (mm).

vii) Daily Maximum parameters: Date, Time, Air Temperature (°C), Time, Relative Humidity (%), Time, Barometric Pressure (mb), Time, Wind Speed (m/s), Time,

viii) Daily Minimum parameters: Date, Time, Air Temperature (°C), Time, Relative Humidity (%), Time, Barometric Pressure (mb), Time, Wind Speed (m/s), Time,

c) Error/Anomalous Data Criteria

Air Temperature:
ATempOutliers.eqr or ATempOutlierReport.eqw
- Sample not greater than 50 degrees Celsius (C)
- Sample not less than -40 degrees Celsius (C)
- 15 minute averages not greater than the max for the day, 15_144MaxTemp.eqg
- 15 minute averages not less than the min for the day, 15_144MinTemp.eqg

Relative Humidity:
RHOutliers.eqr or RHOutlierReport.eqw
- Sample not greater than 100 percent humidity (%)
NOTE: Sensor accuracy limitations and sensor drift can be responsible for percent humidity reading slightly higher than 100 percent.
- Sample not less than 0 percent humidity (%)
- 15 min, 15_144MaxRH.eqg
- 15 minute averages not less than the min for the day, 15_144MinRH.eqg

Barometric Pressure:
BPOutliers.eqr or BP OutlierReport.eqw
- Sample not greater than 1060 millibars (mb)
- Sample not less than 900 millibars (mb)
- 15 minute averages not greater than the max for the day, 15_144MaxBP.eqg
- 15 minute averages not less than the min for the day, 15_144MinBP.eqg

Wind Speed:
WSpdOutliers.eqr or WspdOutlierReport.eqw
- Sample not greater than 30 meters per second (m/s)
- Sample not less than 0.5 meters per second (m/s) for 12 hours consecutively, WspdOutlier.eqg

Wind Direction:
WdirOutliers.eqr or WdirOutlierReport.eqw
- Sample not greater than 360 degrees
- Sample not less than 0 degrees

Precipitation:
TotPrcpOutliers.eqr or TotalPrcpOutliersReport.eqw
- 15 minute total not greater than 5 millimeters (mm)
NOTE: A few outliers were noted in this dataset and are addressed in sections 11, 12 or 13 below.

Solar Radiation (LiCor):
TotPAROutliers.eqr or TotPAROutlierReport.eqw
- 15 minute total not greater than 5000 millimoles per meter squared (mmol/m^2)
- 15 minute total not less than 0 millimoles per meter squared (mmol/m^2)
NOTE: slightly negative values can be due to sensor drift and have not been removed from the dataset.

Time:
checked in the EQWinformat.xls macro
- 15-minute interval recorded

For all data:
checked in EQWin during data validation
- Duplicate interval data

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 Campbell Scientific weather station samples every 5 seconds continuously throughout the year. These data are used by the CR10X to produce 15 minute averages, maximum and minimums (array 15), hourly averages, maximums and minimums (array 60) and daily averages, maximums and minimums (array 144) of air temperature, relative humidity, barometric pressure, rainfall, wind speed, and wind direction. (see section 2 on Entry verification for more detailed info on data format and intervals) In 2004 we used a two to four month sampling interval. CR10X raw data are currently stored on an "SM4" 4 megabyte data storage module capable in combination of storing about 6 months worth of data. The CR10X is also cabled directly to a Marisys marine computer which stores the 15 minute, hourly and daily averages and makes them available via a web page to computers on our local network. The CR10X and the SM4 can also be accessed by unplugging the weather station from the Marisys computer and plugging in to our Panasonic CF-28 laptop with Windows 2000 and PC208W software. Direct connection to a laptop allows viewing of real-time data. It is also the method by which we download data.

Ideally, all collected data are quality checked immediately after the monthly downloads using EQWin. However, staff turnover in 2005 resulted in these checks being delayed as new staff members gradually learned all the elements of the program. The reports, graphs and queries of meteorological data are reviewed. Any errors or anomalous data are further investigated and the data are either corrected or deleted (if necessary) or commented on and left unchanged.

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, which is calibrated approximately every year. Also, once a month on download day, we use a handheld Kestrel 4000, to run a comparative set of observations as a general check on the Campbell station sensors.

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 20.244 Latitude, 70 deg 33.000 Longitude) on a 32' 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'. To the NW of the pole is the Coastal Ecology Center, a 20' high, 111' long building, at a distance of 37', running NE/SW. Further to the NW (153' from the pole) is the library, in a 25' high wing of the barn. The barn itself is 223' from the station and runs NE/SW. It is 38' high and is the largest obstruction in the area. The rain gauge is located 9' southeast of the weather station pole and is situated on a post with the top of the funnel is 10' from the ground.

There are two SWMP water quality sampling sites in the Webhannet River estuary. These are located at the Webhannet River Head of Tide, at the Webhannet

Inlet, at Skinner Mill on the Merriland River and near the . The tidal range at each of these sites is 2.6-2.9 meters.

6) Data collection period
Weather data has been collected at the Wells NERR since December 1996. Data was collected for the entire year in 2005, with the exception of occasional gaps in the data which are due to weather station maintenance or malfunction.

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

NOAA/ERD retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The PI retains the right to be fully credited for having collected and processed the data. Following academic courtesy standards, the PI and NERR site where the data were collected will be contacted and fully acknowledged in any subsequent publications in which any part of the data are used. Manuscripts resulting from the NOAA/OCRM supported research that are produced for publication in open literature, including refereed scientific journals, will acknowledge that the research was conducted under an award from the Estuarine Reserves Division, Office of Ocean and Coastal Resource Management, National Ocean Service, National Oceanic and Atmospheric Administration. The data set enclosed within this package/transmission is only as good as the quality assurance/quality control procedures outlined by the enclosed metadata reporting statement. The user bears all responsibility for its subsequent use/misuse in any further analyses or comparisons. The Federal government does not assume liability to the Recipient or third persons, nor will the Federal government reimburse or indemnify the Recipient for its liability due to any losses resulting in any way from the use of this data.

NERR weather data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Section 1 Principal investigators and contact persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page http://cdmo.baruch.sc.edu. Data are available in text format and Access data tables.

8) Associated researchers and projects

WELLS NATIONAL ESTUARINE RESEARCH RESERVE RESEARCH AT THE RESERVE for 2005 (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 2004-2005 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 systemwide 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.

Seacoast Watershed Information Manager (Project S.W.I.M.)

The Seacoast Watershed Information Manager (Project S.W.I.M.) will be an online resource to help local planners and the public evaluate, conserve, and restore coastal watershed resources along the Maine and New Hampshire seacoast by developing a website that describes the region and its resources, provides access to GIS data and other relevant information, and includes a decision-support tool that examines the impact of growth and development on water resources. It will include:

- A Narrative that informs local resource planners and the public by describing development impacts, water resources, and land use.
- Socioeconomic Analysis focused on water resource use as it relates to human activities.
- Land Use Change Assessments focusing on shoreland and permeability.
- A Data Clearinghouse providing users access to key data needed for local and regional-scale resource management.
- A GIS-based Decision Support Tool to help communities manage and protect water resources by considering how water supply, water quality and land use change are affected by land use planning decisions.

The Project focuses on the coastal watersheds from the Cocheco and Salmon Falls River in New Hampshire to the Kennebunk River in Maine. These 15 watersheds include 38 municipalities and cover 1,800 square miles. The Wells National Estuarine Research Reserve is the lead partner with support from NOAA’s Coastal Services Center Landscape Characterization and Restoration Program and the Great Bay National Estuarine Research Reserve.

Salt Marsh Habitats and Communities

Factors that control the dynamics and vigor of salt marsh plant communities and marsh peat formation consequently determine the ability of a salt marsh to persist in the face of sea level rise. Through a combination of experimental manipulations and long term monitoring, a number of multi-year studies are currently producing data to answer questions concerning the sustainability of salt marsh habitats in this region. These studies are looking at nutrient-plant relations, plant community responses to physical and hydrologic disturbance, and the relative contribution of short-term natural events (e.g. storms) and human activities (dredging, tidal restriction) on patterns of sediment accretion and

erosion. The Reserve's marshes and beaches are already among the best studied sites in the U.S. with regard to long term accretion and erosion (over thousands of years).

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 10 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 periodic larval, juvenile and adult fish 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 severly 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, and the ecology of lyme disease.

"Ecological Functions of Fringing Salt Marshes Susceptible to Oil Spills in Casco Bay, Maine". We examined the ecological function of 9 different fringing marsh systems in Casco Bay that ranged from undisturbed to disturbed. Physical parameters measured included sedimentation rates, total suspended solids, and tidal range. Biological parameters included primary production, macroinvertebrate community composition and secondary production (4cm sediment cores), and resident and transient nekton community composition (fyke net). The project is still under way.

"BENTHIC HABITAT CORRELATES OF JUVENILE FISH DISTRIBUTION IN THE BIGELOW BIGHT AND ADJACENT ESTUARIES: LINKAGES BETWEEN FISH, HABITATS, SUBSTRATE AND HUMAN

ACTIVITY". This recent project was a collaboration between the Wells N.E.R.R. and several members of the local fishing community. Through the use of beam trawls, gill nets, fish traps, van veen ponar, and a sediment profile imager (SPI camera), we are attempting to correlate benthic habitat type to juvenile groundfish and invertebrate assemblages in estuarine, near shore, and offshore habitat. Stations were also established near dredge spoil dump sites as well as sewage outflow to determine the impacts of human activity on the coast to benthic habitat.

The Wells NERR Research Department also worked on the following project: In partnership with the York Rivers Association and the Town of York, the Wells Reserve conducted a survey of the York River watershed. In this survey, volunteers looked for sources of pollution within a 250-foot buffer of the river and its tributaries (erosion, trash and debris and runoff from roads and lawns could have a negative impact on water quality). Most pollutants entering water bodies come from such undefined sources. Therefore, this type of survey is the best way to begin to address the problems of pollution in a water body. The idea of the project was to work with the community and landowners to help them understand the problems that come from these types of pollution and learn activities they might be able to do on their own land that would help prevent this pollution from entering the water. The results of the survey will become part of a Watershed Management Plan to improve and restore the water quality of the York River.

The Wells NERR Research Dept. is involved with the following CICEET* Projects:

Project Title: Estuarine Responses to Dredging: Analysis of Sedimentary and Morphological Change in Back Barrier Marsh to Aid Local Management and Develop a Regional Management Tool Principal Investigator (s): Michele Dionne, Wells NERR, ME; Duncan Fitzgerald, Boston University; Joe Kelley, University of Maine; David Burdick and Larry Ward, University of New Hampshire
Management Issue: Coastal management tool for assessing the impacts of dredging in estuaries. Project Summary: An adequate supply of sediment is essential for maintaining salt marshes. Human activities, such as channel dredging and tidal restriction due to road construction, can alter water flows in estuaries and result in dramatic changes in salt marsh sediment supply, affecting the speed of salt marsh erosion. The objective of this project is to determine the impact of dredging and tidal restriction on salt marshes in the Wells NERR. A digital coastal management guide will be created on CD ROM, providing coastal managers with useful conceptual models for predicting the impacts of dredging and other activities that affect water flow and sediment deposition in salt marshes.

June Ficker Project Title: Monitoring avian productivity and survivorship

Outside Researchers: Theresa Theodose, Ph.D., University of Southern Maine Project Title: Relationships between soil nutrient availability and species composition of a high salt marsh in southern Maine.

David Burdick, Ph.D. and Roelof Boumans, Ph.D. University of New Hampshire, University of Maryland Project Title: Sediment dynamics in salt marshes: functional assessment of accretionary biofilters

Peter Rand, M.D., Chuck Lubelczyk, Robert Smith, M.D. Maine Medical Center Project Title: Ecological determinants of the spread of the tick vector of Lyme disease and other pathogens.

II. Physical Structure Descriptors

9) Sensor specifications, operating range, accuracy, date of last calibration.

Parameter: Photosynthetically Active Radiation (PAR)
Sensor: CSI LI-COR Quantum Sensor
Units: mmoles m-2 (total flux)
Operating Temperature: -40 to 65°C
Sensor type: High stability silicon photovoltaic detector (blue enhanced)
Model #: LI190SB
Light spectrum waveband: 400 to 700 nm
Temperature dependence: 0.15% per °C maximum
Stability: < +/-2% change over 1 year
Operating Temperature: -40°C to 65°C; Humidity: 0 to 100%
Sensitivity: typically 5 µA per 1000 µmoles s-1 m-2
Date of last calibration: 06-24-2004

Parameter: Wind speed
Units: meter per second (m/s)
Sensor type: 3-cup anemometer, Integrated in CSI Wind Sentry module
Model #: 03001
Operating Temperature: -50° to +50°C assuming non-riming conditions
Range: 0 to 50 m/s
Accuracy: +/-0.5 m/s
Threshold: 0.5 m/s
Date of last calibration: 06-24-2004

Parameter: Wind direction
Units: degrees of a 360 degree circle
Sensor: Balanced vane, 16 cm turning radius, integrated in CSI Wind Sentry module
Model #: 03001
Operating Temperature: -50° to +50°C assuming non-riming conditions
Range: 360° mechanical, 355° electrical (5° open)
Accuracy: +/-5°
Threshold: 0.8 m s-1 (1.8 mph) at 10° displacement, 1.8 m s-1 (4 mph) at 5° displacement
Date of last calibration: 06-24-2004

Parameter: Temperature
Units: degrees Celsius
Sensor type: 1000 ohm PRT, part of CSI Temperature and Relative Humidity Probe
Model #: HMP45C
Operating Temperature: -40 to +60°C
Range: -39.2° to +60°C
Accuracy: +/- 0.2 °C @ 20°C
Date of Last calibration: 02/24/2004

Parameter: Relative Humidity
Units: percent
Sensor type: CSI Temperature and Relative Humidity Probe
Model #: HMP45C
Operating Temperature: -40 to +60°C
Range: 0.8-100% non-condensing
Accuracy: +/-2% RH (0-90%) and +/-3%(90-100%)
Temperature Dependence: +/-0.05% RH/°C

Stability: Better than 1% RH per year
Date of Last calibration: 02/24/2004

Parameter: Barometric Pressure
Units: millibar
Sensor type: CSI Barometric Sensor
Model#: CSI 105 (also known as Vaisala PTB101B)
Operating Range: Pressure: 600-1060 mb
Temperature: -40 to +60C
Humidity: non-condensing
Total Accuracy:
+/-0.5 mb @ +20 degrees C
+/-1.5 mb @ 0° to 40 degrees C
+/-2.0 mb @ -20 degrees to +45 degrees C
+/-3.0 mb @ -40 degrees to +60 degrees C
Stability: +/- 0.1 mb per year
Date of Last calibration: 06/24/2004

Parameter: Precipitation
Units: mm
Sensor type: Electrically Heated Tipping Bucket Rain/Snow Gauge
Model #: 385/385M (also know as Met One 385)
Range: 0.1mm to unlimited
Resolution: 0.1 mm
Accuracy: +/-0.5%<0.5"(1.27 cm)/hr rate
           +/-2.0%<3.0"(7.62 cm)/hr rate
Operational Temperatures: -20° to 50°C; 0 to 100% RH
Date of Last calibration: 09/24/05

Storage 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: Temperature: -35° to +65°C
Baud rates: 9600, 76800
Memory type: user selectable for either ring style (default) or fill and drop.
Power requirements: 5 +/-0.3 VDC @ 100 mA

Campbell Scientific CR10X Wiring Panel has 128K of flash memory (EEPROM), in which it stores the operating system and its program (that it uses to run the weather station). Additionally, there is 128K of SRAM, which it uses to run the program and store its measurements and for final data storage.

10) Coded variable code definitions

Sampling Station: Laudholm Farm
Sampling site code: LF
Station code: wellfmet

11) Anomalous/Suspect Data

Arrays:
During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and

daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at www.nerrsdata.org/get/landing.cfm throughout the fall of 2022.

NOTE: Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X Datalogger. The Maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval. These data have been retained.

NOTE: Relative Humidity data sometimes show values slightly higher than 100% (usually less than 103%). The sensor's accuracy is listed at +/-3% in the range of 90-100%, and sensor drift is +/-1% over a year. Relative humidity data up to 104% are not deleted from the data. They are not noted below.

January 2005
The RH data from 1/13/2005 @ 14:45 through 1/14/2005 @ 01:15 is considered suspect due to the super saturated values.

February 2005
No Suspect or anomalous data

March 2005
The following 15 minute RH data is considered suspect because the readings are very noisy, although they seem to coincide with temperature changes.
Wellfmet 03/11/2005 04:30 through 16:15
Wellfmet 03/30/2005 12:15 through 03/31/2005 02:00

The following 15 minute RH data is considered suspect/anomalous due to the rapid changes in value over 15 minute intervals.

Station_Code	ArrayId	Date	Time	ATemp	RH
wellfmet	15	03/23/2005	12:15	06.1	038
wellfmet	15	03/23/2005	12:30	04.4	056

Station_Code	ArrayId	Date	Time	ATemp	RH
wellfmet	15	03/18/2005	16:30	04.4	063
wellfmet	15	03/18/2005	16:45	05.0	036

April 2005
The following RH data is suspect because of the large variations in the readings. This could be caused by changes in temperature so the data has been retained.
Wellfmet 04/14/2005 14:30 through 16:00

The following 15 minute RH data is suspect due to the sharp drop in value from one reading to the next.
Wellfmet 4/19/2005 23:15 to 23:30

May 2005
The following RH data is suspect/anomalous due to the sharp drop to extremely low readings. At some points of this data the temperature (degrees C) is close or equal to the %RH (in the teens).
Wellfmet 5/12/2005 03:15 through 19:00

The following RH data is suspect do to the amount of "noise" or variability between each reading.
Wellfmet 5/13/2005 22:45 through 5/14/2005 15:00

June 2005
The following 15 minute and hourly precipitation data is considered suspect due to the extremely high reading. The data was retained and deemed accurate due to a serve rain storm during the data event.
Wellfmet 15 06/14/2005 04:45 8.1mm
Wellfmet 144 06/14/2005 24:00 26.7mm

July 2005
The following RH data show suspect/anomalous sharp jumps in value between 15 minute intervals.
Wellfmet 7/22/2005 @ 18:15 74% to 94% at 18:45

The RH data from late July and early August is very "noisy" however the changes in RH seem to correspond with constantly shifting temperatures so data was retained. (See actual data set [wellfmet2005] for details.)

August 2005
The following precipitation data is suspect due to the extremely high value over a 15 minute period but due to heavy rains the data was retained.
Wellfmet 08/01/2005 18:30 8.9mm
Wellfmet 08/29/2005 02:45 7.1mm

September 2005
The following RH data is considered suspect do to the "noise" or variability between readings as well as sharp increases/decreases in values.
Wellfmet 9/19/2005 07:00 through 18:45

The following precipitation data is considered suspect because of the high values over 5mm in a 15 minute interval however they were just over and deemed accurate by comparison with other sources.
Wellfmet 09/17/2005 23:00 6.6mm
Wellfmet 09/29/2005 14:45 5.3mm

October 2005
The following drop/increase in %RH is considered suspect/anomalous but retained because sensor showed no signs of failure.
Wellfmet 10/31/2005 10:15 64% to 31% at 11:00
Wellfmet 10/31/2005 16:15 27% to 75% at 16:45

The following precipitation data is considered suspect due to the high values during a 15 minute period however these readings were taken during extreme rain fall an deemed accurate or reasonable.
Wellfmet 10/08/2005 12:15 9.9mm

November 2005
No suspect/anomalous data.

December 2005
The following peak in RH is considered suspect.
Wellfmet 12/7/2005 16:15 through 17:45

The following precipitation data is suspect due to the high reading during a 15 minute interval. Heavy snowfall corresponds with the data which is just above the limit so it was retained and considered accurate.
Wellfmet 12/16/2005 13:00 5.1mm

12) Deleted data:

Arrays:
During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at www.nerrsdata.org/get/landing.cfm throughout the fall of 2022.

All deleted data is denoted by blank spaces.

January
No Deleted Data

February
No Deleted data

March
No Deleted Data

April
No deleted data

May
No Deleted Data
June
No Deleted Data
July
No Deleted Data
August
No deleted data

September
No deleted data

October
No deleted data

November
No Deleted Data

December
No Deleted Data

13) Missing data:

Arrays:
During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at www.nerrsdata.org/get/landing.cfm throughout the fall of 2022.

Data are missing due to equipment or associated specific probes not being deployed, equipment failure, time of maintenance or calibration of equipment, or repair/replacement of a sampling station platform. For more details on deleted data, see the Deleted Data Section (12.). If additional information on missing data are needed, contact the Research Coordinator at the reserve submitting the data. Blank spaces within other data are not missing but deleted (see section 12). Missing data means ALL parameters are missing for a certain date and time.

14) Other Remarks:

On 10/18/2023 this dataset was updated to include embedded QAQC flags for anomalous/suspect data. System-wide monitoring data beginning in 2007 were processed to allow for QAQC flags and codes to be embedded in the data files rather than detailed in the metadata alone (as in the anomalous/suspect, deleted, and missing data sections above). Prior to 2007, rejected data were deleted from the dataset so they are unavailable to be used at all, but suspect data were only noted in the metadata document. Suspect data flags <1> were embedded retroactively in order to allow suspect data to be easily identified and filtered from the dataset if desired for analysis and reporting purposes. No other flags or codes were embedded in the dataset and users should still refer to the detailed explanations above for more information.

Arrays:
During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at www.nerrsdata.org/get/landing.cfm throughout the fall of 2022.

Precipitation:
During the initial years of NERRS SWMP weather data collection the CR10X programming was inconsistent in how precipitation values were recorded. For most reserves, zeros were not recorded when rainfall had not occurred between 2001-2003, instead no rainfall was represented by a blank cell. The CDMO verified which datasets were impacted by this issue for the 2001-2006 datasets and inserted zeros when the metadata indicated that no precipitation occurred and data were not missing for other reasons. In some cases, zero values for precipitation data were evaluated and removed where the metadata confirmed that no rainfall should have been in the dataset. The pre-2007 data did not go through a thorough QAQC process again at that time (in addition to previous QAQC); however, if discrepancies were noticed between what was documented in the metadata and what was in the dataset, additional updates may have been made. The updated datasets were uploaded to the database and made available through the various data applications at www.nerrsdata.org/get/landing.cfm throughout early 2023.

LiCor:
Prior to the installation of the new NERR_4.CSI program on 11/01/2003, all values less than 0 were altered in the raw data to read 0. These values may indicate an incorrect multiplier, calibration problems, or a sensor malfunction. Because these values are changed in the raw data, we cannot confirm that they are all valid data points.

Relative Humidity:
Prior to the installation of the new NERR_4.CSI program on 11/01/2003, all values over 100% were altered in the raw data to read 100%. These values may indicate super saturated air, calibration problems, or a sensor malfunction. Because these values are changed in the raw data, we cannot confirm that they are all valid data points.

Notable storms:

Severe rainstorm on October 7th and 8th

Thunderstorms and urban flooding occurred on June 10th 2005

Nor'easter on March 8th 2005 brought high winds and snowfall

January 21st-23rd Blizzard and cold snap setting State record low temperatures