**Lake Superior (LKS)** **NERR Meteorological Metadata**

**January through December, 2014**

**Latest Update:** March 5, 2016

**I. Data Set and Research Descriptors**

**1) Principal investigator(s) and contact persons –** Staff members responsible for the design, implementation and continuation of the data set.

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**SWMP Technicians – Joseph Ripley (UW-Superior student)**

**2) Entry verification –** This section explains how the data were verified (QAQC’d) before being sent to the CDMO to be archived into the permanent database.

Data are uploaded in the field from the CR1000 data logger to a Trimble ruggedized tablet (IBM compatible) that runs the LoggerNet program. Data files are transferred to a Personal Computer (IBM compatible) via flash drive. 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.

Tracey Ledder, LSNERR Monitoring Coordinator, is responsible for data management.

**3) Research objectives –** This section describes the nature of the monitoring program resulting in this data set.

The LKS NERR is situated on the freshwater estuary at the confluence of the St. Louis River and Lake Superior, the largest and most pristine of the Great Lakes. The Reserve is a diverse, 16,697-acre complex that contains a variety of representative terrestrial and aquatic habitats allowing for the extensive research and educational opportunities. The Reserve will provide opportunities for research and monitoring, experiential learning, and training while continuing to contribute to the protection of the ecological health of the St. Louis River Freshwater Estuary and Lake Superior coastal habitats.

The Lake Superior NERR will implement the NERR System-Wide Monitoring Program (SWMP). This will include four continuous water quality monitoring stations with monthly nutrient and chlorophyll sampling, a meteorological station, and monthly sampling at one site consisting of 12 nutrient and chlorophyll samples collected over a 24-hour period. Data will be archived at the Centralized Data Management Office (CDMO) as per established protocols. During the 2014 open water season, four continuous stations were operational by May. A LSNERR analytical laboratory will begin operation for analyses of SWMP in the summer of 2014.

In addition we have sought funding to become a NOAA Sentinel Site. This includes installing surface elevation tables, establishing permanent vegetation transects, installing water level monitoring wells, and establishing a geodetic framework for all instruments.

To promote information access by the public in a timely manner the Lake Superior NERR will seek to provide real-time water quality and meteorological information using telemetry systems (satellite and cellular). This information will be used in the Coastal Training Program (CTP) and Education programs and made available to the public online and in the Lake Superior NERR Science and Interpretive Center. The SWMP MET data was available on-line during the entire year of 2014. Water quality data was available real-time from two SWMP sites from June until November, 2014.

**4) Research methods**

Campbell Scientific data telemetry equipment was installed at the Pokegama Bay Meteorological Station (*PO*) in July, 2013, and transmits data to the NOAA GOES satellite, NESDIS ID #3B048454. The CR1000 datalogger samples every 5 seconds continuously and 15 minute averages 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 CDMO for initial QAQC procedures. The satellite 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](http://cdmo.baruch.sc.edu/).

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), Total Solar Radiation (watts/m2) (available from the Reserve), 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/m2), and Cumulative Precipitation (mm)

Sensors on the weather station are inspected monthly for damage or debris. If any is found, it is repaired and/or cleaned. Sensors are removed and sent back to Campbell Scientific for calibration either annually or every two years, depending on sensor specifications.

Recommended calibration frequency for the MET station sensors:

- Temperature/Humidity- yearly recalibration

- Rain 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

- LI-COR LI-200S - every 2 years, with recalibrations performed during the spring and summer

- CR1000-every 5 years (required beginning 2014, one year initial grace period)

**5) Site location and character –** The NERR site (general) and the research site (specific) associated with the Weather Station.

The Lake Superior NERR is located within the estuary of the St. Louis River. The St. Louis River Watershed covers approximately 3,634 square miles in northeast Minnesota and 263 square miles in northwest Wisconsin. In the upper watershed the river flows through lake clays and glacial deposits for approximately 100 miles. Near the city of Thomson the channel narrows and the river flows through a rocky rapid-filled gorge. Approximately 23 river miles upstream from Lake Superior is the Fond du Lac dam, the lowest of several dams. Below the gorge and dams the river begins to take on the characteristics of a fresh water estuary. At the mouth of the river is the largest working harbor on the Great Lakes.

The MET three-meter instrument tower is mounted on a nine-foot metal platform embedded at the bank (by helical anchors in the river bed) of the Pokegama River, within the Superior Municipal Forest, such that there is no shading and minimal wind block. Sensors are placed on the tower according to CDMO MET manual, with the exception of the rain sensor which sits at the western corner of the platform. The immediate surrounding area is riverine wetland, rising gently in elevation to forest. The Pokegama River is a tributary to the St. Louis River, entering the estuary on the Wisconsin side of Clough Island. The Pokegama River watershed measures approximately 20,144 acres, 51% of which is wetland, 37% forested, 4% developed and 6% agricultural use (the remainder is bare land or open water).

A SWMP water quality monitoring sonde was added to this station in September, 2013.

MET Geographical Location: 46.672360 -92.135614

Platform base installed at shoreline at an altitude approximately 189 meters above sea level.

The 1.9 m2 metal platform sites 2.54 m above the adjacent land surface (river berm). The three-meter instrument tower sites on the platform such that the sensors are at the following heights;

Sensor heights in meters from platform (from ground)

Temperature and Humidity: 1.75 m (4.3 m)

PAR and TotSoRad: 3 m (5.5 m)

Wind: 3.5 m (6 m)

Rain: 1.1 m (3.7 m)

Distance to Oliver Bridge SWMP: 5,350.0 meters

Blatnick Bridge SWMP: 8,925.7 meters

Barkers Island SWMP: 7,796.6 meters

**6) Data collection period**

MET data were collected for 2014 at LKS from 01/01/2014 to12/31/2014. The table below details the deployment dates for 2014.

MET Deployment Table

|  |  |  |
| --- | --- | --- |
| DEPLOYED | RETRIEVED | NOTES |
| 12/16/2013 14:30 | 01/13/2014 10:15 | New program sent with BP offset for our altitude |
| 01/13/2014 10:30 | 02/24/2014 13:15 |  |
| 02/24/2014 03:30 | 03/20/2014 11:00 | File contained previously downloaded/overlapping data |
| 03/20/2014 11:15 | 04/24/2014 9:15 |  |
| 04/24/2014 9:30 | 05/20/2014 13:00 |  |
| 05/20/2014 13:15 | 06/03/2014 12:15 | 6/3 power down, add newly calibrated sensors |
| 06/03/2014 14:00 | 07/08/2014 11:00 | 6/4, calibrate rain sensor |
| 07/08/2014 11:15 | 07/31/2014 13:00 |  |
| 07/31/2014 13:15 | 08/15/2014 10:45 |  |
| 08/15/2014 11:00 | 09/04/2014 12:00 |  |
| 09/04/2014 12:15 | 09/25/2014 11:00 |  |
| 09/25/2014 11:15 | 10/20/2014 13:45 |  |
| 10/20/2014 14:00 | 11/10/2014 10:15 |  |
| 11/10/2014 10:45 | 12/18/2014 10:45 |  |
| 12/18/2014 11:00 | 01/15/2015 12:00 |  |

**7) Distribution –** This section will address data ownership and data liability with the following excerpt from the Ocean and Coastal Resource Management Data Dissemination Policy for the NERRS System-wide Monitoring Program in the metadata.

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 2012.

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](http://www.nerrsdata.org).  Data are available in comma delimited format.

**8) Associated researchers and projects**

Four water quality SWMP stations are operated in a river-to-lake gradient in the St. Louis River. Samples were taken monthly at these four sites for the SWMP required nutrient and chlorophyll *a* analyses (as well as additional parameters of local interest). These samples are analyzed in the LKS NERR laboratory. Chlorophyll *a* laboratory analyses results will be compare to sonde readings at the same site and time in order to better understand the limitations and use of the sonde Chlorophyll fluorescence data.

The SWMP weather station was established in Pokegama Bay and is the central location of a developing Sentinel Site at LKS NERR. Several sediment elevation tables have been installed and permanent vegetation survey transects were established in 2014.

The LKS NERR cooperates with researchers at University of Wisconsin and University of Minnesota studying the biogeochemical processes in the estuary. Researchers are looking at the spatial and seasonal patterns of nutrient and organic matter processing. One outcome will be the identification of the role of anthropogenic stressors. The results will enhance our ability to interpret data from water quality monitoring in the estuary to inform management strategies.

Other research in which LKS NERR participated in 2014 included crayfish surveys, invasive aquatic plant survey, planning for wildrice habitat restoration, operation of sensors at Superior Entry, coring for a NERR blue carbon study and historical cores in the estuary for diatom assemblages, nutrient regime and sediment quality.

Other agencies working in the St. Louis River estuary include the Wisconsin and Minnesota Departments of Natural Resources, the United States Environmental Protection Agency Mid-Continent Ecological Lab, United States Fish and Wildlife Service and the United States Geological Survey. The LKS NERR participates in partnerships in the area with these agencies as well as with the City Superior, Douglas County and several non-profits.

**II. Physical Structure Descriptors**

**9) Sensor specifications –**

Parameter: Temperature

Units: Celsius

Sensor type: Platinum resistance temperature detector (PRT)

Model #: HMP45C Temperature and Relative Humidity Probe

Operating Temperature: -40°C to +60°C

Range: -40°C to +60°C

Accuracy: ± 0.2 °C @ 20°C

Serial Number: ***F4540095***

Date of Last Calibration: 11/20/2010

Date of Sensor Use: 08/15/2013-06/03/2014

Serial Number: ***F454006***

Date of Last Calibration: 03/21/2014

Date of Sensor Use: 06/03/2014 – current as of 12/31/2014

Parameter: Relative Humidity

Units: Percent

Sensor type: Vaisala HUMICAP© 180 capacitive relative humidity sensor

Model #: HMP45C Temperature and Relative Humidity Probe

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: ***F4540095***

Date of Last Calibration: 11/20/2010

Dates of Sensor Use: 08/15/2013 – 06/03/2014

Serial Number: ***F4540006***

Date of Last Calibration: 03/21/2014

Dates of Sensor Use: 06/03/2014 – current as of 12/31/2014

Parameter: Barometric Pressure

Units: millibars (mb)

Sensor type: Vaisala Barocap © silicon capacitive pressure sensor

Model #: CS-106 (Vaisala PTB110)

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: ***G3260032***

Date of Last Calibration: 08/16/2011

Dates of Sensor Use: 08/15/2013 – 06/03/2014

Serial Number: ***G3260090***

Date of Last Calibration: 04/02/2014

Dates of Sensor Use: 06/03/2014 – current as of 12/31/2014

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: WM110138

Date of Last Calibration: 04/20/2011

Dates of Sensor Use: 08/15/2013 – current as of 12/31/2014

Parameter: Wind direction

Units: degrees

Sensor type: balanced vane, 38 cm turning radius

Model #: R.M. Young 05103 Wind Monitor

Serial Number: WM110138

Date of Last Calibration: 04/20/2011

Dates of Sensor Use: 08/15/2013 – current as of 12/31/2014

Parameter: Photosynthetically Active Radiation(PAR)

Units: mmoles m-2 (total flux)

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 yr

Operating Temperature: -40°C to 65°C; Humidity: 0 to 100%

Sensitivity: typically 5 µA per 1000 µmoles s-1 m-2

**Multiplier: 1.25617, August 15, 2013**

Serial Number: **Q45936**

Date of Last Calibration: 08/24/2011

Dates of Sensor Use: 08/15/2013 – 06/03/2014

**Multiplier: 1.32662, June 3, 2014**

Serial Number: **Q45947**

Date of Last Calibration: 03/24/2014

Dates of Sensor Use: 06/03/2014 – current as of 12/31/2014

Parameter: Total Solar Radiation

Units: W m-2

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

Model #: LI200S

Light spectrum waveband: 400 to 1100 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 90 uA per 1000 W m-2

**Multiplier: *108.2368, August 15, 2013***

Serial Number: ***PY74880***

Date of Last Calibration: **6/3/2011**

Dates of Sensor Use: 08/15/2013 – 06/03/2014

**Multiplier: *117.3708, June 3, 2014***

Serial Number: ***PY74852***

Date of Last Calibration: **03/24/2014**

Dates of Sensor Use: 06/03/2014 – current as of 12/31/2014

Parameter: Precipitation (unheated rain gauge)

Units: millimeters (mm)

Sensor type: Tipping Bucket Rain Gauge (Texas Instruments)

Model #: TR-525I

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

Serial Number: ***48686-711***

Date of Last Calibration: **8/1/2011 (rechecked on deployment)**

Dates of Sensor Use: 08/15/2013 – 06/04/2014

Date of Last Calibration: **06/04/2014**

Dates of Sensor Use: 06/04/2014 – 9/25/2014

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 (4 MB optional upgrade) is available for program storage (16K), operating system use, and data storage. Additional storage is available by using a compact flash card in the optional CFM100 Compact Flash Module.

Date CR1000 Installed: July, 2013

CR1000 Firmware Version (s): LoggerNet Version 4.1(date of last change is unknown)

CR1000 Program Version(s): lkspomet\_VER5.5\_12062013.cri

**10) Coded variable definitions**

Sampling station: Sampling site code: Station code:

Pokegama River PO lkspomet

**11) QAQC flag definitions**

QAQC flags provide documentation of the data and are applied to individual data points by insertion into the parameter’s associated flag column (header preceded by an F\_). During primary automated QAQC (performed by the CDMO), -5, -4, and -2 flags are applied automatically to indicate data that is above or below sensor range, or missing. All remaining data are then flagged 0, as passing initial QAQC checks. During secondary and tertiary QAQC 1, -3, and 5 flags may be used to note data as suspect, rejected due to QAQC, or corrected.

-5 Outside High Sensor Range

-4 Outside Low Sensor Range

-3 Data Rejected due to QAQC

-2 Missing Data

-1 Optional SWMP supported Parameter

0 Passed Initial QAQC Checks

1 Suspect Data

2 *Open - reserved for later flag*

3 *Open - reserved for later flag*

4 Historical Data: Pre-Auto QAQC

5 Corrected Data

**12) QAQC code definitions**

QAQC codes are used in conjunction with QAQC flags to provide further documentation of the data and are also applied by insertion into the associated flag column. There are three (3) different code categories, general, sensor, and comment. General errors document general problems with the CR1000, sensor errors are sensor specific, and comment codes are used to further document conditions or a problem with the data. Only one general or sensor error and one comment code can be applied to a particular data point, 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 sensor and are due to normal errors in the sensor and the CR1000 Datalogger. The Maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval.

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

Data recorded for all parameters (with the exception of cumulative precipitation) at the midnight timestamp (00:00) are the 15 minute averages and totals for the 23:45-23:59 time period of the previous day. Cumulative precipitation data at the midnight timestamp (00:00) are the sum of raw (unrounded) precipitation data from 00:00 to 23:59 of the previous day. Summing each individual 15-minute total precipitation value from the same period will result in small differences from cumulative precipitation due to rounding. It is especially important to note how data at the midnight timestamp are recorded when using January 1st and December 31st data. **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.**

The 2013-2014 winter season was the coldest on record for the region since the late 1970s.

Slightly elevated nighttime PAR values were observed throughout the year and were flagged as suspect (<1> CSM). Reasons for the elevated values are unknown, but it is believed that moisture intrusion into the sensor may cause the readings to occur.

The rain sensor was covered with a bucket for the winter on November 14, 2013 to avoid freezing water blocking the interior components. The bucket was removed 4/24/2014 09:15, however, the region received a mix of snow and rain that afternoon and through the night. The rain sensor was covered for winter again on November 10, 2014 10:45.

Precipitation data on 4/24/2014 at 09:15 were rejected and cumulative precipitation values for the remainder of the day were corrected to reflect actual precipitation that occurred throughout the day.

The second set of sensors was calibrated in April 2014 for deployment. The MET was powered down at 12:16 on June 3, 2014 and newly calibrated sensors were deployed. The power down was followed by a program reload, data were rejected at 14:00.

The rain gauge was accidentally tipped during maintenance on 6/3/2014 at 14:00. Precipitation data at 14:00 are already rejected due to a program reload. Cumulative precipitation data for the rest of the day were corrected to 0.

The rain gauge was also recalibrated, with completion on June 4, 2014 (calibration tips are flagged and coded as corrected and data were corrected to 0 from 09:45 - 10:45 for total precipitation and were corrected to 0 from 09:45 through the end of the day for cumulative precipitation).

During the site visit on December 18, 2014, it was noted that the MET platform legs in the river bank had been “ice jacked” and that the platform was leaning slightly toward the northeast. The contracting engineering firm which placed the MET platform has been contacted, has visited the site, and is preparing a repair design. However, ice went out much earlier in 2015 this year than in 2014 and we will have to wait for good ice conditions in the fall of 2015 in order to make repairs (heavy equipment cannot be driven through the marsh, good ice cover prevents ecological damage). All data were coded as CSM and not considered suspect since the bubbles in the levelers for the PAR and Total Solar Radiation sensors are still within the level circles. The F\_Record and data are coded with CSM(unless otherwise flagged and coded) from 11/10/2014 10:30, the last visit to the MET station before it was discovered to be leaning, through the end of the year.