

Padilla Bay (PDB) NERR Meteorological Metadata
January through December 2008
Latest Update: April 18, 2011

I. Data Set and Research Descriptors

1) Principal investigator(s) and contact persons –

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2) Entry verification –

Data are uploaded from the CR1000 data logger to an Itronix Go Book III laptop (IBM compatible). Files are exported from LoggerNet in a comma-delimited format, transferred to ECY network file storage via thumbdrive 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 Padilla Bay NERR 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 graphs the data for review. In the secondary QAQC process, data are reviewed with graphs created to determine if there are any outliers, suspect, or erroneous data that were not part of the flagging process. The macro also 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. Files are compiled quarterly and submitted after the secondary QAQC is completed. A final yearly file is compiled from the quarterly files, QAQC'd a final time and submitted with metadata to CDMO. For more information on QAQC flags and QAQC codes, see Sections 11 and 12. Heath Bohlmann and Nicole Burnett completed this process for entry verification for the 2008 data. Heath Bohlmann completed final verification and this metadata. Doug Bulthuis reviewed final datasheets and metadata.

3) Research objectives –

The principal objective is to measure and record meteorological data at Padilla Bay for use in studies investigating correlations between meteorological data and water quality data, biological data, or other phenomenon in Padilla Bay and its watershed.

4) Research methods –

From January 1 through December 31, 2008 data were downloaded about once a month from the weather station. The sensors are visually inspected for debris or damage when the data are downloaded. Due to the location of the weather station in the middle of flat farm fields, the sensors require very little cleaning. The most common problem occurs seasonally from air borne seeds partially blocking the rain gauge funnel. To mitigate this problem weeds near the site are cut before they set seed. While at the station downloading data a Kestrel 4000 Pocket Weather Tracker is used to make a general, comparative check of the Campbell station sensors. Suspicious precipitation data were checked against weather data from this area posted on Washington State University's website. All sensors are calibrated on a regular basis unless otherwise noted in section 14) Other/Remarks and Notes. Specifically, the PAR and barometer sensors are sent to Campbell Scientific or the manufacturer every two years for calibration. The temperature (and relative humidity) and wind sensors are sent to Campbell Scientific or the manufacturer every year for calibration. The rain gauge is calibrated in house every year. The QAQC process described in Section 2 above is also used to check for sensor drift and malfunctions.

Campbell Scientific data telemetry equipment was installed at the Padilla Farm station on 11/11/05 and transmits data to the NOAA GOES satellite, NESDIS ID #3B005706. (Where 3B335706 is the GOES ID for that particular station.) 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>.

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), Battery Voltage (volts), Wind Direction Standard Deviation (degrees)(began reporting as a standard parameter on 11/04/2008)

Maximum, Minimum, and their times from 5-second data (these data are not available in the dataset, but are available from PDB NERR):

Air Temperature (°C),

Maximum and their times from 5-second:

Wind Speed (m/s) (began reporting as a standard parameter on 4/17/2008)

Totals:

Precipitation 15 min. (mm), PAR 15 min. (millimoles/m²), and Cumulative Daily

Precipitation (mm) (began reporting as a standard parameter on 4/17/2008)

5) Site location and character –

Padilla Bay (48° 30' N; 122° 30' W) is a shallow embayment in northern Puget Sound located in the greater Puget Sound-Georgia Basin estuary. It is an "orphaned" estuary in that the Skagit River, which formed the delta mud flats of Padilla Bay, no longer enters the bay directly. The tide flats are dominated by the eelgrass *Zostera marina*, which covers approximately 3,000 ha. *Zostera japonica*, a recent invader to the region, now covers about 800 ha of the bay. Tides are mixed semi-diurnal with a mean range of 1.5 m. Salinity varies from about 15 to 31 PSU. Most of the land in the 9300 ha Padilla Bay watershed is agricultural,

and is drained by four sloughs which empty into the bay. Some freshwater from the Skagit now enters Padilla Bay from the south through the Swinomish Channel which connects Padilla Bay to Skagit Bay. Other major freshwater flows into this area of the Puget Sound-Georgia Basin estuary are from the Fraser and Nooksack Rivers to the north. Padilla Bay is bordered on the east and south by flat, diked farmland; farther to the east are foothills of the Cascade Range. March Point, on the western edge of the reserve, is the site of two large oil refineries. To the north and west are the San Juan Islands of northern Puget Sound.

The weather station is located near the southeast corner (122° 28' 4.81" W; 48° 27' 50.58" N) of Padilla Bay on a 40 hectare demonstration farm that is owned by the Reserve. Flat fields that are farmed for seasonal crops surround the site. Access is off of Bayview-Edison Road about 150 m down a gravel driveway. Elevation of the weather station is near mean sea level though the station has yet to be surveyed.

The sensors are mounted on a 3 m tower that is secured to a concrete pad as specified by the manufacturer, Campbell Scientific. The relative humidity/temperature sensor is mounted 2 m high, the wind and PAR sensors are at the top of the tower 3 m above ground level and the barometric pressure sensor is 1 m above the ground. The rain gauge is mounted on a cement cylinder approximately 3 feet high. Surrounding the site is a six foot high chain link fence for security. The weather station is about 300 m from the diked edge of the bay and approximately 4 km SE of the Bayview Channel YSI deployment site and about 4 km south of the Padilla Bay NERR Laboratory.

6) Data collection period –

January 1 at 00:00 to December 31 at 23:45 2008. Data have been collected at the Padilla Farm weather station since January 1, 2001.

7) Distribution –

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

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

8) Associated researchers and projects –

In coordination with the SWMP weather data collected at Padilla Bay, water quality and nutrient data are also collected. The water quality part of SWMP consists of placing YSI 6600 datasondes at four sites within the reserve boundaries. The sondes collect such parameters as water temperature, salinity, dissolved oxygen, depth, pH, and turbidity. The nutrient component of SWMP consists of monthly grab samples taken at each of the same four sites and monthly diel sampling taken at one of the sites (Bayview Channel Site). The nutrients analyzed include but are not limited to nitrate, nitrites, ammonium, silicate, orthophosphate, and chlorophyll.

Other projects at Padilla Bay include a zooplankton monitoring project (monthly sampling) and a barnacle settlement project. The sampling for each of these projects occurs at the three water quality/ nutrient sampling sites within the bay.

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: $\pm 0.2^\circ\text{C}$ @ 20°C

Calibration Frequency: 1 year

Date of Last calibration: 02/13/2009

Date of previous calibration: 12/05/2007

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: $\pm 2\%$ RH (0-90%) and $\pm 3\%$ (90-100%)

Temperature dependence of RH measurement: $\pm 0.05\%$ RH/°C

Calibration Frequency: 1 year

Date of Last calibration: 02/13/2009

Date of previous calibration: 12/05/2007

Parameter: Barometric Sensor

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

Calibration Frequency: 2 years

Date of Last calibration: 7/17/2008

Date of previous calibration: 8/15/2006

Parameter: Wind speed

Units: meter per second (m/s)

Sensor type: 12 cm diameter cup wheel assembly, 40 mm diameter hemispherical cups

Model #: R.M. Young 03001-5 Wind Sentry

Range: 0-50 m/s (112 mph); gust survival 60 m/s (134 mph)

Accuracy: $\pm 2\%$

Calibration Frequency: 1 year

Date of last calibration: 2/13/2009

Date of previous calibration: 12/5/2007

Parameter: Wind direction

Units: degrees

Sensor type: balanced vane, 16 cm turning radius

Model #: R.M. Young 03001-5 Wind Sentry

Range: 360° mechanical, 355° electrical (5° open)

Accuracy: $\pm 5\%$

Calibration Frequency: 1 year

Date of last calibration: 2/13/2009 (See comments in section 13)

Date of previous calibration: 12/05/2007

Parameter: LI-COR Quantum Sensor

Units: mmol 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: $\leq \pm 2\%$ change over 1 yr

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

Sensitivity: typically 5 μ A per 1000 μ moles s⁻¹ m⁻²

Calibration Frequency: 2 years

Date of last calibration: 7/17/2008

Date of previous calibration: 8/15/2006

PAR Multiplier: 1.419 (Jan 01 @ 00:00 to July 17 @ 09:15)
1.595 (July 17 @ 09:30 to Dec 31 @ 23:45)

Parameter: Precipitation

Units: millimeters (mm)

Sensor type: Tipping Bucket Rain Gauge

Model #: RG-2000-C

Rainfall per tip: 0.01 inch

Operating range: Not specified

Accuracy: $\pm 1.0\%$ at 14 inches per hour

Calibration Frequency: 1 year

Date of last calibration: 12/4/2008

Date of previous calibration: 3/19/2008

CR1000 Measurement and Control System
Date Installed: Aug/01/2006

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.

10) Coded variable definitions -

Sampling station:	Sampling site code:	Station code:
Padilla Farm	PF	pdbpfmet

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 weather station, sensor errors are sensor specific, and comment codes are used to further document conditions or a problem with the data. Only one general or sensor error and one comment code can be applied to a particular data point.

General Errors

GIM	Instrument Malfunction
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

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

Comments

CAF	Acceptable Calibration/Accuracy Error of Sensor
CDF	Data Appear to Fit Conditions
CRE	Significant Rain Event
CSM	See Metadata
CVT	Possible Vandalism/Tampering

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 (please see principal investigators and contact persons in section 1).

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

Cumulative precipitation data are recorded from 00:00 to 23:59 with the daily total recorded at the midnight mark (00:00). The midnight CumPrecp value is actually the total from the previous day.

The following records were missing or rejected because of problems that occurred during the data downloading process. All of the parameters for the 15 minute interval in which the data was downloaded were flagged as missing. QAQC protocol is to then reject all of the parameters from the next 15 minute interval due to inaccurate averages.

01/18/2008 14:15 All Missing
01/18/2008 14:30 All Rejected

Data rejected due to sensor maintenance. Wind sensor was adjusted from magnetic north to true North

02/14/2008 09:00 Wind Dir
02/14/2008 09:15 Wind Dir

Data rejected due to sensor maintenance. Wind sensor was slightly adjusted to true North with better compass.

03/19/2008 08:45 Wind Dir

PAR 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.

All PAR data from July 17 @ 09:30 to Dec 31 @ 23:45 were adjusted post data download, due to an incorrect PAR multiplier in the sensor programming. Original data was divided by the incorrect PAR multiplier, then multiplied by the correct multiplier to get the corrected value. $(\text{original data}/1.419)*1.595 = \text{corrected data}$.

07/17/2008 09:30 TotPAR - 12/31/2008 23:45 TotPAR

PAR values greater than 2.214 were recorded during some nights during the last four months of the year. The causes for such values being recorded are not known. Rejection times at dusk and dawn were based on having a < 2.0 change in the PAR value in conjunction with a preceding fall or subsequent rise in values. PAR values greater than 2.214 that were recorded during the night were rejected. Daytime PAR values recorded during this time period were also flagged as suspect on dates when the nighttime values were rejected.

09/11/2008 00:00 TotPAR - 12/28/2008 00:00 TotPAR