

Padilla Bay (PDB) NERR Meteorological Metadata
January – December 2005
Latest Update: **October 17, 2023**

I. Data Set & Research Descriptors

1) Principal investigator & contact persons:

Contact Persons:

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2) Entry verification

a) Data Input Procedures:

The instruments on the weather station sample meteorological conditions every 5 seconds and store it on a Campbell Scientific CR10X datalogger. Data are logged to a file in three arrays of 15 minute (15), hourly (60) and daily (144) averages with maximums and minimums except for PAR and precipitation, which are totaled for each time period. The data are downloaded approximately once a month in the field to a Toshiba Windows OS laptop computer connected to the SM4M storage module using Campbell Scientific software PC208W. On December 10th a new Itronix Go Book III laptop replaced the Toshiba laptop to download the data. Files are exported from PC208W in a comma-delimited format (.DAT) and opened in Microsoft Excel for pre-processing with the EQWin format macro 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 QA/QC checked in Excel for outliers (values which fall outside the range that the instrument is designed to measure) and data gaps and then QA/QC checked in DeltaGraph for rapid changes in the data and for suspect data. The data are then copied into the EQWin weather .eqi file where the data were archived in a database and exported to the CDMO. Edited and raw files were archived on a PC hard drive, an external hard drive and on compact disk at Padilla Bay NERR. Nicole Burnett completed this process of entry verification for the 2005 data. Nicole Burnett and Doug Bulthuis completed final verification and this metadata documentation.

Any anomalous data were investigated and noted in the Anomalous Data/Suspect Data section. Any missing data were noted in the Missing Data section.

The most common errors/anomalies noted in 2005 were:

1. Small negative (< 1) PAR values that are within the one year stability range for the probe.
2. Relative Humidity > 100 but ≤ 102 .

All errors/anomalies were double checked with other data that could support such "anomalous" weather changes and noted in Section 11.

c) Error/Anomalous Data Criteria

Air Temp:

- Sample not greater than 50 C or less than -40 C
- 15 minute averages not greater than the *max* for the day
- 15 minute averages not less than the *min* for the day

Relative Humidity:

- Sample not greater than 100% or less than 0%
- 15 minute averages not greater than the *max* for the day
- 15 minute averages not less than the *min* for the day

Pressure:

- Sample not greater than 1060 mb or less than 900 mb
- 15 minute averages not greater than the *max* for the day
- 15 minute averages not less than the *min* for the day

Wind Speed:

- Wind speed not greater than 30 m/s or less than 0.5 m/s for 12 consecutive hours

Wind Direction:

- Wind direction not greater than 360 degrees or less than 0 degrees

Precipitation:

- Total precipitation not greater than 5 mm in 15 min

Solar Radiation:

- Sample not greater than 5000 mmol/m² or less than -0.5 mmol/m²

Time:

- 15 minute time interval recorded

For all data:

- No duplicate data

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, 2005 data were downloaded about once a month from the weather station. The screen on the Toshiba laptop used to download the weather data intermittently failed during 2005. Downloads of weather data were not consistent the last half of the year, until the laptop was replaced with an Itronix Go Book III in December, 2005. The sensors are visually inspected for debris or damage when the data is 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. During 2005, weeds and debris filled and blocked the rain gauge. The blockage was discovered on October 18th, 2005. Data from July 11th to September 27th were consistent with rain data collected at a nearby site by Washington State University, but should be interpreted with caution. From September 27th to October 18th the rainfall data were not consistent with the nearby site and were deleted (See section 12). 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. On occasion very high or very low barometric pressures were checked against weather data posted on a NOAA weather website for this area.

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 350 ha of the bay. Tides are mixed semi-diurnal with a mean range of 1.55m. 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.

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 and the wind and PAR sensors are at the top of the tower 3 m above ground level. The tipping-bucket rain gauge is bolted to a slab of wood that is attached to the top of a 55 gallon metal drum filled with water for stability, the top of the rain gauge is 1.2 m above ground level. 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 Research Reserve laboratory. On November 11, 2005 telemetry equipment was installed to transmit data in real time through a GOES satellite.

6) Data collection period

January 1 at 00:00 to December 31 at 24:00

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.

8) Associated researchers and projects:

None

II. Physical Structure Descriptors

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

Parameter: Temperature and Relative Humidity

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

Date of last calibration: April, 2003; new sensor November 2005

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

Date of last calibration: New sensor November 2003

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: $\pm 2\%$

Date of last calibration: December 2000

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: $\pm 5\%$

Date of last calibration: December 2000

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: <±2% change over 1 yr
Operating Temperature: -40°C to 65°C; Humidity: 0 to 100%
Sensitivity: typically 5 µA per 1000 µmol s⁻¹ m⁻²
Date of last calibration: December 2000

Parameter: Precipitation (unheated)
Units: millimeters (mm)
Sensor type: Tipping Bucket Rain Gauge
Model #: RG-2000-C
Rainfall per tip: 0.01 inch
Operating range: Not specified
Accuracy: +/- 1.0% at 14 inches per hour
Date of last calibration: November 2003

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 indicator and variable code definitions:

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

11) Anomalous Data/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.

Negative PAR data have been observed during the night of all months: 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 PAR sensor is +/- 2.214 mmol/m² over a 15 minute interval. These data have been retained.

Relative humidity values >100 but ≤ 102 % were common during the winter months of 2005. These are within the accuracy range of this sensor. These data have been retained.

Wind speed values were < 0.5 m/s for 14 consecutive hours in June. These data would be expected during prolonged calm periods. These data have been retained.

During January and February the Marysis program was operating to attempt to collect and transmit real time from the weather station. However, the Marysis program interfered with storage of the data on the CR10X. When the data were downloaded from the CR10X, data were missing. Some of the data during this time were collected from the Marysis website when the data were missing from the CR10X. The accuracy of the transmission and display of data on the Marysis website was never confirmed. Data during these two months should be interpreted with caution.

The precipitation data from 7/11 to 10/18 is suspect data. Data was not downloaded from the weather station during this period of time. When it was downloaded on 10/18 the rain gauge funnel was severely clogged with debris. The precipitation data was compared to other local data. The data from 7/11 to 9/27 appeared correct and were retained. However, the precipitation data from 9/28 to 10/18 did not appear correct and were deleted (see section 12 deleted data).

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.

Problems with real time data transmission hardware (Marysis) that was installed in 2004 caused missing data from 1/3 at 14:30 through 1/14 at 15:45. The 15 min and hourly total at 1600 on 1/14 and the daily total for 1/14 were deleted. A similar problem occurred on January 20, 2005 causing a loss of data from 1/20 at 14:15 through 1/31 at 15:30. The 15 min data at 1545, and the hourly total at 1600 on 1/31, as well as, the daily total for 1/31 were deleted.

Data was not logged on 2/1 at 00:15. This missing data is due to persisting problems with the real time hardware (Marysis). The hourly total for 1:00 on 2/1 and the daily total for 2/1 for those parameters were deleted.

On March 22, 2005 a new program was uploaded for a time change. Data is missing on 3/22 at 15:30. The 15 min data at 15:45 and hourly total at 1600 on 3/22, as well as, the daily total for 3/22 were deleted.

Some inconsistency with the precipitation data in June were noticed on several days (11th, 12th, 16th, 17th, 21st, 26th, and 27th). On these days there were no records of precipitation in the 15 minute data or the hourly data; however, there were daily totals. These totals were compared to another local source of data and appeared correct. Since the 15 minute and 60 minute data were recorded at zero all of the precipitation data (15 min, 60 min and daily totals) on those days were deleted.

On October 18, 2005 data were downloaded from the weather station. It was noted that the rain gauge funnel was severely clogged at that time. The weather data had not been downloaded previous to this since 7/11/05 because of difficulties with the laptop computer used for downloads. When the precipitation data were compared to another local source it became apparent the data collected from 9/28 at 00:00 to 10/18 at 14:15 were not correct. These data have been deleted as well as the 15:00 hourly total and daily total for 10/18.

On November 15, 2005 the GOES Telemetry equipment was installed causing errors in the data from 10:45 to 15:15. These data were deleted as well as the hourly total at 1600 and the daily total.

On December 10, 2005 a new program for time change was uploaded at 12:52. The 15 minute and hourly total were deleted for 13:00, as well as, the daily total for 12/10.

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 is needed, contact the Research Coordinator at the reserve submitting the data.

Missing Data Comment 1: On February 2, 2005 the data for the month of January were downloaded. Previous problems with real time data transmission hardware (Marysis) that was installed caused missing data from 1/3 at 14:30 through 1/14 at 15:45.

Missing Data Comment 2: On January 20, 2005 the data were downloaded, but the Marysis Telemetry was plugged into the CR10X causing a loss of data from 1/20 at 14:15 through 1/31 at 15:30.

Missing Data Comment 3: All parameters from 2/1 at 00:15 were missing except the air temperature parameters. These missing data are unexplained.

Missing Data Comment 4: On March 22, 2005 a new program was uploaded for a time change. Data are missing on 3/22 at 15:30.

Missing Data Comment 5: On November 15th, 2005 the GOES telemetry equipment was installed at the weather station. Data are missing on 11/15 from 11:00 to 13:00.

14) Other Remarks/notes

On 10/17/2023 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.

A macro in Excel is used to preprocess the data once they have been downloaded. The new macro used to correctly format the time and date did not work properly for the months January, February, and March. Data recorded at midnight of a day had to be manually changed so that the time stamp was 24:00 of that day (not the following day). In order to change the time the cells had to be formatted as [hh]:mm instead of the normal time format.

It was anticipated that the Wind Sentry set and Quantum Sensor would be replaced in 2004, this did not happen which resulted in these sensors being overdue for calibration. The sensors were last calibrated in November of 2000. Comparative checks of the wind speed with the handheld Kestral 4000 show good correlation with the Wind Sentry.

The rain gauge was due for calibration around November 2004, this did not happen which resulted in this sensor being overdue for calibration. Comparative checks to other local precipitation data show a good correlation with the rain gauge.

The PAR sensor was due for calibration around November 2002, this did not happen which resulted in this sensor being overdue for calibration. The data for PAR appear to be correct.

The barometer was due for calibration around November 2005, this did not happen which resulted in this sensor being overdue for calibration for the last month of 2005. The barometric pressure data appear to be correct.