OCNMS Mooring Data Description

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Updated by K. Hough, 2019-12-13
Updated by K. Hough, 2022-02-09
Updated by K. Hough, 2022-12-02

Please visit manufacturers' websites for more information about the instrumentation used on OCNMS moorings. The following is specifically for data users.

Instrumentation, with "nicknames" used to label processed data in MATLAB structures:

"T"
Onset HOBO TidbiT temperature logger TBI-32 -05+37 or UTBI-001

- measures water temperature
- TBI-32-05+37 precision ~ 0.2 degrees C, UTBI-001 precision 0.02
- deployed throughout the water column, from 1m above the bottom to 1m below the surface
- samples every 2, 8 or 10 minutes, depending on year and site

units:

- degree C (+/- 0.2 manufacturer's stated accuracy)

notes:
The TidbiT data files are identified by their altitude, except that the shallowest TidbiT planned for every deployment, identified with the MLLW altitude (e.g. TB...042 at XX042 mooring) is actually deployed on the surface float tether, <1m below the surface. These are therefore at a depth of about 1m, not at a fixed altitude. And the "060" TidbiTs on the 065m moorings are actually located midway on the tether between the subsurface float at 55m and the surface. The actual depth will depend quite a bit, and probably not predictably, on current speed, type of line used that year (sometimes buoyant, sometimes not), and tide level.

"T39" - starting in 2019
Sea-Bird Electronics 39 Temperature Recorder, Optional Configuration

- measures water temperature
- deployed 1m above the bottom
- samples every 2 or 10 minutes

units:

- degree C (+/- 0.002 manufacturer's stated accuracy)

notes:
These instruments are temperature only.

"CT"
Sea-Bird Electronics 37-SM MicroCAT

- measures temperature and conductivity
- usually deployed either 1m above the bottom, or 4m below mean lower low water
- samples every 1, 2 or 10 minutes
- 2011 and later sampling averages 4 samples over ~4 seconds every 10 minutes

units:

- degree C (+/- 0.002 manufacturer's stated accuracy)
- S/m (+/-0.0003 manufacturer's stated accuracy)
- PSS-1978 (psu)
- sigma-theta (2010 and later)

notes:
These instruments do not have pressure sensors, and all computed parameters (conductivity, salinity, density) are calculated assuming a pressure of (MLLW depth at site) – (altitude). This is usually less than the actual pressure, but resulting errors are small.

"CTPO"

Sea-Bird Electronics 16+ or 19+ SEACAT with pumped Sea-Bird 43 dissolved oxygen

- measures temperature, conductivity, pressure and dissolved oxygen
- deployed 1m above the ocean floor
- 2010 and later sampling averages 10 samples over 4 seconds every 10 minutes (after 25 second pump time)

Sea-Bird Electronics 37 SMP-ODO MicroCAT with pumped Sea-Bird 63 optical dissolved oxygen - starting in 2019

- measures temperature, conductivity, pressure and dissolved oxygen optically
- deployed 1m above the ocean floor
- SBE 37: samples every 10 minutes, nTau = 7.0; SBE 63: averages 2 samples every 4 seconds (after pump runs via adaptive pump control)

units:

- degree C (+/- 0.002 manufacturer's stated accuracy)
- S/m (+/-0.0003 manufacturer's stated accuracy)
- db (+/- 0.1% manufacturer's stated accuracy)
- m depth
- mg/l and ml/l oxygen
    - SBE 16+/19+ with SBE 43: +/- 2% manufacturer's stated accuracy
    - SBE 37/SBE 63: larger of ± 3 µmol/kg (0.07 ml/L, 0.1 mg/L) *or* +/- 2% manufacturer's stated accuracy
- sigma-theta (some files)

notes:

The only instruments which measure pressure (and therefore depth).

"CTO" - starting in 2012

Sea-Bird Electronics 37 SMP-IDO MicroCAT with dissolved oxygen

- measures temperature, salinity, and dissolved oxygen
- deployed 1m above the ocean floor
- samples every 10 minutes

units:

- degree C (+/- 0.002 manufacturer's stated accuracy)
- S/m (+/-0.0003 manufacturer's stated accuracy)
- mg/l and ml/l oxygen (+/- 2% manufacturer's stated accuracy)
- sigma-theta

notes:

These instruments do not have pressure sensors, and all computed parameters (conductivity, salinity, density) are calculated assuming a pressure of (MLLW depth at site) – (altitude). This is usually less than the actual pressure, but resulting errors are small.

"CTP" – starting in 2021

Sea-Bird Electronics 16+ or 19+ SEACAT

- measures temperature, conductivity, pressure
- deployed 1m above the ocean floor
- sampling averages 10 samples over 4 seconds every 10 minutes (after 25 second pump time)

units:

- degree C (+/- 0.002 manufacturer's stated accuracy)
- S/m (+/-0.0003 manufacturer's stated accuracy)
- db (+/- 0.1% manufacturer's stated accuracy)
- m depth
- sigma-theta (some files)

"VT" (velocity & temperature)
Falmouth Scientific 2D-ACM

- measures horizontal current velocity using acoustic time-of-flight temperature to 0.5 degrees C
- usually deployed 4m below MLLW
- takes a 2-minute average of 2 Hz samples every half-hour

units:

- cm/s (+/- 2% or 1 cm/s manufacturer's stated accuracy)
- angular degrees (+/- 2 manufacturer's stated accuracy)
- degrees C (+/- 0.5 manufacturer's stated accuracy)
- various other units for diagnostic data (e.g. V, m/s)

notes:
Directional accuracy is likely much less than stated, as the compasses must be calibrated on-site whenever the batteries are changed, and we have no way to check the accuracy.

"F", "FTN", "FN" ("T" for temperature, "N" for nephelometry)
WETLabs FLNTUSB

- measures chlorophyll fluorescence (a proxy for phytoplankton biomass) and turbidity
- some measure temperature, as well
- usually deployed 4m below MLLW
- 2011 and later sampling 5 1-second averages of 30 readings each are recorded *approximately* every half-hour

WETLabs FLSB/DFLSB

- measures chlorophyll fluorescence (a proxy for phytoplankton biomass)
- deployed 4m below MLLW
- 2011 and later sampling averages 200 samples (total ~1 second) *approximately* once per hour

units:

- microgram/liter (99% linearity manufacturer's stated accuracy)
- NTU (99% linearity manufacturer's stated accuracy)
- degree C (no accuracy specified)

notes:
Temperature was not processed prior to 2010. All fluorescence measurements must be calibrated with local samples to be accurate, which OCNMS does not do.

General Notes:

Site locations have varied over the years, and in these shared documents there is an Excel document listing the latitude/longitude for each site name for each year. A site location of, for example, "CA015", is on our Cape Alava transect, at a nominal MLLW depth (as is used on nautical charts) of 15 meters. But that location may be different in different years.

Since our moorings are essentially sub-surface, everything is measured as an altitude, not a depth. "CTPO" instruments have pressure data, and a depth is computed from that at each sample. Other instruments do not have pressure, and the depth they are at is a little trickier to come up with. A "T" (Onset TidbiT temperature logger) sensor at altitude "010" on a mooring at depth "042" is nominally (perhaps not in fact) at a depth of 32 m below MLLW. Were one trying to compute actual depth, you'd need to run a tidal model. Were one to want a single average depth, one would still need to run a model to compute an average water level at the site, or get the average depth from a "CTPO" instrument on the same mooring or nearby and adjust with that, if available.

The exceptions to this are: The "top" "T" sensor is named at the water depth (e.g. "042"), but is actually immediately below the small surface float. Thus, this one really does have a fairly fixed depth, most of the time, of 1m or less. However, it is rarely at the named depth, i.e. the data in T_CA042_mmddyy_042 are actually collected at ~1m below surface, which is normally going to be higher, but sometimes lower than the "042" altitude used in the name.

The other exception is only on 65m or 100m deep moorings, which have a "T" thermistor attached to a tether line half-way between the subsurface float (at MLLW-10m for those depths) and the surface float. This one is called "060" at an "065"m site, or "095" at a "100"m site. But in fact it has a very poorly defined depth and altitude that could be well below the nominal altitude (if the tide level is -0.5m and the tether line loops downward, altitude could be 50m for a "060" instrument, if the tide level is +2m, and the line rises vertically, it could be on the surface at 67m. This will depend on tide, current, waves, etc., line material (buoyant or not) as the tether line is taut or slack etc.

All measured values are now being low-pass filtered by a 5 day, 40 hour half-power, Hann windowed sinc filter. This filter is variously known as "cosine-Lanczos", "C-L 121", "Lancz7", and has been used by OSU researchers for decades (see Mooers, C. N. K., and R. L. Smith (1968), Continental Shelf Waves off Oregon, *J. Geophys. Res.*73(2), 549–557, doi:10.1029/JB073i002p00549, or Mooers, (1968), A compilation of observations from moored current meters and thermographs (and of complementary oceanographic and atmospheric data). Vol. 2. Oregon continental shelf, August-September 1966). It might not be the ideal filter for your purposes. Also, this filter is run after de-trending such that the first and last data values are zero, and the convolution process used essentially zero-pads the original time series, and the low-pass filtered dataset is the same length as the raw data. Values changing steeply near the beginning or end can generate transients and ringing in the first and last 60 hours of a time series, and those data will be "corrupted" by the zeros (i.e. biased towards the first/last value of the time series).

Not all variables were low-pass filtered in the 2009 and earlier datasets, and the filter was very slightly different. Differences between the "new" filter and "old" one, though, should be below the accuracy of the instruments.

2000 through 2009 data were processed with minimal documentation. The processing scheme was similar to that currently used, but quality control efforts etc. are not documented. For example I believe, but am not certain, that some oxygen measurements were adjusted in some way to better match CTD casts.

These historic data do not always have the same data stored as the more recent data, and lack the metadata described below. There will only be time series.

2010 and later data were/are being processed with different software. The first step is throwing out data before 20 minutes after the anchor drop time, and throwing out data after the mooring pickup has commenced. Obviously bad data are then removed - e.g. batteries going low, causing a pressure measurement to jump, temperatures exceeding normal values or greatly different from nearby sensors, conductivities which cause apparent density inversions etc. At the moment that is all that is being done. More stringent quality control may be implemented in the future.

ALL DATES AND TIMES PRIOR TO 2014 ARE PDT (UTC-7)!!!!!
STARTING IN 2014, DATES AND TIMES ARE UTC.

Data structure:

Data files/structures contain all the data returned by one instrument from one download. This is typically 4 to 6 weeks of data. They have not (yet) been combined or gridded in any way. Recent names are of the format PPP_TTDDD_YYMMDD_AAA, where PPP (1 to 4 characters) describes the parameters measured (as above), TT is the transect location, DDD is the nominal MLLW depth at the mooring, YYMMDD is the day (again, PDT) that particular instrument was deployed (data should start on that day), and AAA is the altitude above bottom for the instrument, as described above.

In some early years, "TTDDD" may be "TTN" where moorings were numbered consecutively offshore, "AAA" may only be "AA", some altitudes may be composed of letters, not numbers (e.g. "SS" probably means "surface", but probably implies 4m below MLLW), and some files did not have any altitude specified. Any completely undescribed altitudes on the mooring have been filled with "999". If you cannot figure out the depth/altitude of an instrument, or it appears incorrect, please contact me and I can investigate.

As an example, "CTPO_CA015_070501_001", labels data are from an instrument measuring conductivity, temperature, pressure, and oxygen (aka pumped SBE16 w/ SBE43 oxygen) deployed at site Cape Alava 15m, on May 1, 2007, at an altitude of 1 meter off the bottom. All the data files/structures conform to this general structure oftype_location_deploydate_altitude.

Data are grouped together and "zip"ped by instrument type, year, and one file containing everything.

Each MATLAB structure has a name as described above, and top level fields that may include:

```
    file: [1x1 struct]
      db: [1x1 struct]
    data: [1x1 struct]
  lpdata: [1x1 struct]
```

"`file`", if present, contains some limited metadata about the original source file, such as:

`XXXX.file.header` - any text header from the raw data file
`XXXX.file.collabels` - cell array containing text labels for each column from original data file

"`db`", if present, contains some more metadata extracted from our database:

```
          FileID: 'T_TH042_090709_020'
       ShortName: 'T'
            Site: 'TH042'
      Deployment: 'TH042_090709'
             Alt:  20
  InstrumentType: 'TBI-32'
    SerialNumber: '640941'
  DeploymentTime: '2009-07-09 12:54:00'
    RecoveryTime: '2009-08-22'
         Comment: 'recovered 2010-10-12'
```

"`data`" contains the timestamp and all data series. For example a "CTPO" file might have:

```
    time: [4040x1 double] (MATLAB datenum)
```

```
         temp: [4040x1 double] (deg. C.)
         lpft: [4040x1 double] (low-pass (40 hour) filtered temp)
       oxy_mg: [4040x1 double] (mg/l)
       oxy_ml: [4040x1 double] (ml/l)
     salinity: [4040x1 double] (from PSS 1978)
        dens:  [4040x1 double] (sigma-theta)
        depth: [4040x1 double] (m)
 conductivity: [4040x1 double] (S/m)
```

Or an "FTN" (fluorometer, WETLabs ECO FLNTUSB) instrument:

```
      time: [1093x1 double]  (MATLAB datenum)
       chl: [1093x1 double]  (micrograms/l)
 turbidity: [1093x1 double]  (NTU - nephelometric turbidity units)
      temp: [1093x1 double]  (temperature, degrees C)
```

"`lpdata`" for 2010 and on contains all the variables in "data", except for "time", as low-pass filtered versions. Exact data stored depend on both the instrument, and when the data were processed. For example, density ("dens") was added with data from 2010, and conductivity was not low-pass filtered prior to 2010.

Note that salinity computed from low-pass conductivity and temperature will NOT give you the same value as the low-pass filtered salinity, since the equations are non-linear.

Current meter data has one difference: low-pass filtered speed, direction and heading have been recomputed from the respective smoothed east and north vectors.

To use the data within MATLAB, you will need some of the MATLAB structure commands, like "isfield" and "fieldnames" to automate any data processing. If you load a bunch of data structures, but only want to work with a specific year or instrument type, you can get a cell array (containing character arrays) containing all the data sets with conductivity with:

```
>> list = who('-regexp','\w*C\w*_\w+\d+_\d{6}_(\w|\d)+')
```

or all from the year 2008 with:

```
>> list = who('-regexp','\w+_\w+\d+_08\d{4}_(\w|\d)+')
```

or all thermistors from site TH042 for 2008:

```
>> list = who('-regexp','T_TH042_08\d{4}_(\w|\d)+')
```

This is the most accurate specification of the regular expression - you can usually be much less specific.

Using the data is not too complicated:

```
>> CTPO_CA015_050910_001.data

ans =

      pres: [4063x1 double]
      cond: [4063x1 double]
      temp: [4063x1 double]
    oxy_mg: [4063x1 double]
    oxy_ml: [4063x1 double]
      time: [4063x1 double]
```

```
   sal: [4063x1 double]
 dens:  [4063x1  double]
 depth: [4063x1 double]
```

```
>>plot(CTPO_CA015_050910_001.data.time,CTPO_CA015_050910_001.data.oxy_ml)
```

for a time series of bottom oxygen, or

```
>>plot(CTPO_CA015_050910_001.data.sal,CTPO_CA015_050910_001.data.temp,'.')
```

for a primitive T-S diagram.

If you encounter any problems, or have suggestions for changes, please contact the OCNMS survey technician at 360-457-6622.