SBC LTER: Oceans Mooring data: Instruments and data processing

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Overview/Background: Near-shore oceanographic moorings are deployed at sites along the mainland coast of the Santa Barbara Channel and north of Pt. Conception at 8-20 meters depth.

The instrument complement included ADCP (Currents/waves), CTD (Hydrography) and Optics data (Fluorescence, Beam Attenuation, and Volume Scattering Function), as well as thermistors located near bottom, near surface and mid water column. Thermistors, CTDs and ADCPs have been maintained at all sites since initial establishment. VSF, fluorometers, and nitrate analyzers were deployed occasionally for specific research investigations. Less continuous pH, oxygen, and wave/pressure data were also collected at selected sites and various times. Those data are available in different products and are not fully described here

All sensor data from a single site are organized into annual files by interpolating onto a common 20-minute time base. Text versions of these annual files are concatenated. The 20-min mooring format is referred to internally as a 'monster file' due to large complement of measured and derived variables. Most processing is performed using Matlab but some sensors require manufacturer's proprietary software to generate machine readable raw data.

Methods:

Field Collection.

Sites maintained by SBC LTER:
Alegria (ALE)*
Arroyo Quemado (AQM)**
Arroyo Quemado (ARQ)
Naples (NAP)
Arroyo Burro (ARB)**
Mohawk (MKO)
Carpinteria (CAR)

*site recently adopted by SBCLTER **site terminated

A typical near-shore mooring is diagramed in Figure 1. Deployment details are maintained internally, contact sbclter@msi.ucsb.edu for more information.

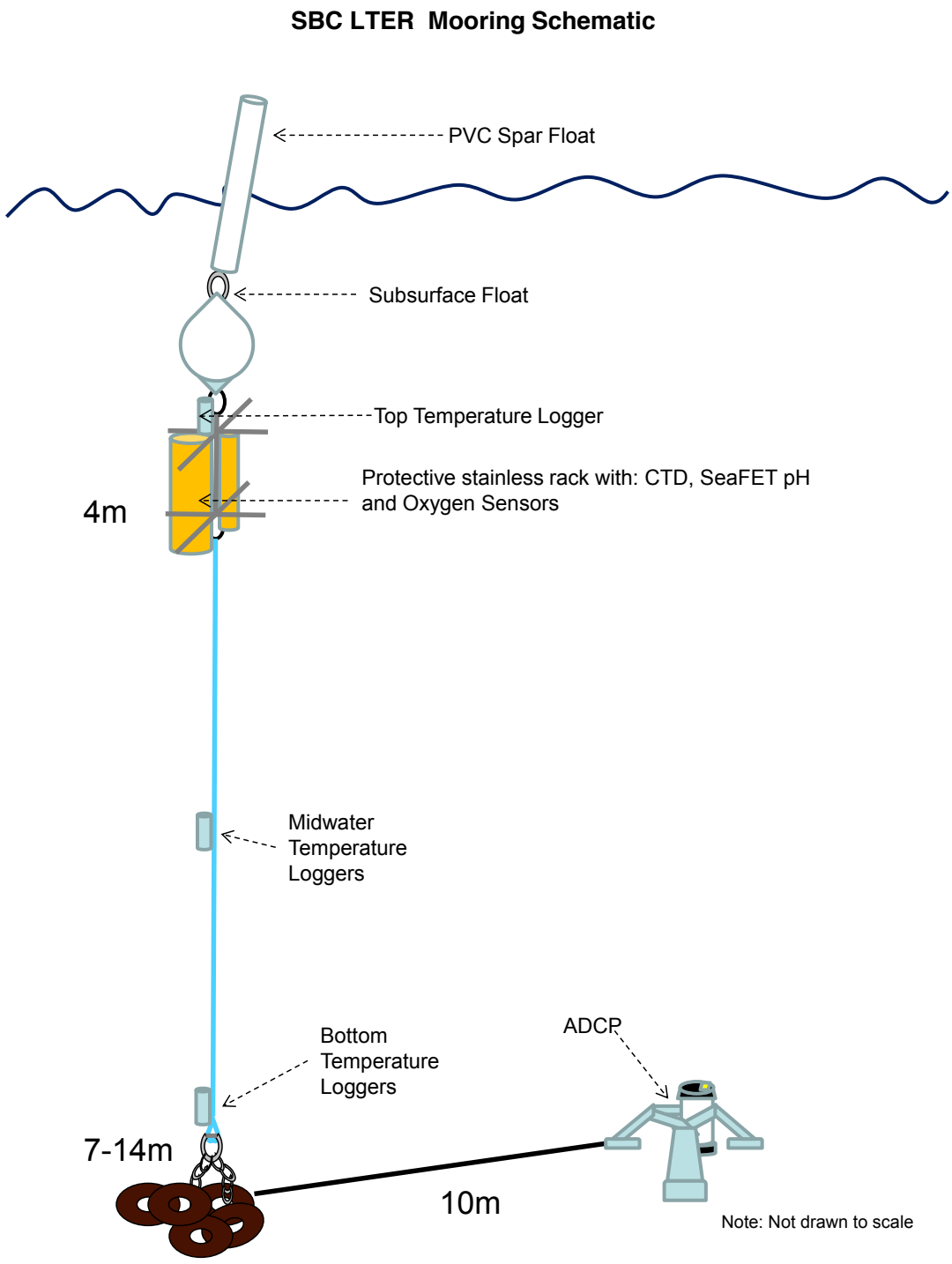

Figure 1. Schematic shows the general layout of an SBC LTER instrument mooring. The ADCP is mounted on the seafloor, approximately 10 meters away and not physically attached to the mooring anchor. pH and oxygen sensors are not deployed at all sites.

Instrument list (all)

Temperature thermistors: Onset Computer Corp. (TBIC32+4+27) (Hobo UTBI-001)

Acoustic Doppler Current Profiler (ADCP): RDI Instruments (Work Horse, 600 kHz)

Fluorometer: WETLabs Inc. (intermittently deployed)

Volume scattering function (VSF): ECO-VSF, WETLabs Inc. (intermittently deployed)

In-situ nitrate auto-analyzer (NAS): W.S. Oceans (intermittently deployed)

CTD: SeaBird (SBE37)

pH: (SeaFET) (iPhat) Deployed intermittently. Data and methods available elsewhere.

Oxygen: D-Optologger, TBD, planned for 2014

Laboratory Processing.

Moored instruments were and continue to be recovered, downloaded, serviced, and exchanged on a roughly bi-monthly schedule. Typically, the raw sensor data are downloaded from the instruments using the manufacturer software. The raw data files are uploaded to a data entry directory on the file server and archived within subdirectories named with the upload date to allow easy identification of new data files.

Preprocessing - Thermistors:

There are two different models of the Onset StowAway Tidbit Temp Loggers on the subsurface moorings. The older version (Onset Computer Corp. TBIC32+4+27) was custom engineered to improve resolution within our temperature range and generates a raw data file with a (.dtf) extension. The model we have been phasing in (Hobo UTBI-001) is an off-the-shelf model that provides us with similar resolution and generates raw data files with a (.hobo) extension.

The .dtf and .hobo raw data files are exported to machine readable text files using Hoboware Pro (v 3.6.1). These files, as well as the newly created .txt files are uploaded to a temporary directory on the file server for further processing.

Subsequent processing steps include inspection of the coincident temperature time series from the near surface, mid water column, and near bottom thermistor to check for inversions (ex. top tidbit labeled as bottom), to confirm that all 3 were actually deployed at the correct site, and to identify and clip the pre- and post-deployment out of water data, if any. A data file for each individual sensor deployment is generated and is identified with a .30.1.mat extension. These files are the final single deployment data product and are used as input to the monster file.

Preprocessing - Acoustic Doppler Current Profiler (ADCP): RDI Instruments, 600 kHz

The raw RDI Workhorse ADCP (.000) files are downloaded to a Windows machine for inspection within RDI's WinADCP software. This application is a convenient tool for inspecting the raw ADCP data and also facilitates identification of the first and last valid ensembles within a deployment. The ensemble numbers are used later within the Matlab scripts to clip the pre- and post-deployment out-of-water data. Additionally, the time of the first ensemble is used for file naming. WinADCP is only used for inspection and no output files are generated.

Concatenation of multiple files and/or renaming of single files from a deployment are required prior to the Matlab processing steps:

For example: Let's say you had a Naples deployment and the raw files were name NAP99000.000 and NAP99001.000. Your first good ensemble was found to be on July 6th, 2020. On a unix machine you can concatenate these files and generate a compliant file name with the following command:

cat NAP99000.000 NAP99001.000>NAP99X_015ADCP015R00_20200706.10.1.000

If there was only 1 file for this deployment NAP99000.000 you would have to rename it to be compliant:

mv NAP99000.000 NAP99X_015ADCP015R00_20200706.10.1.000

The Matlab processing steps generate two additional files for each deployment.

The .20.1 mat file is simply a version of the raw RDI * .000 file in Matlab format output from the mfile rdradcp.m.

The .30.1.mat file is a fully processed single deployment file where out of water data (both pre- and post- deployment as well as above the fluctuating sea surface) have been removed. All files (.10, .20, .30) are archived and ready for monsterfication.

Preprocessing - CTD:

The moored SBE37CTD data is pretty straightforward. Machine readable .asc files are downloaded directly from the instrument and have already had the calibrations applied. Since these are moored instruments the SBE data processing modules used for a profiling CTD are not required.

Output files which have had the pre- and post-deployment out-of-water data removed are given the extension .30.1.mat and archived for subsequent insertion into the monster file.

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Preprocessing - Fluorometer: WETLabs Inc.

These data are included within the moored CTD data files

Preprocessing - Volume scattering function (VSF): ECO-VSF, WETLabs Inc.

These data are included within the moored CTD data files

Preprocessing - In-situ nitrate auto-analyzer (NAS): W.S. Oceans

Preprocessing - Oxygen: tbd

Preprocessing - SeaFET: [data and processing methods available in another data package]

Data Processing, 20-min "Monster file".

Individual Monster files are annual files generated from preprocessed moored sensor data collected at one site. Single deployment data that may have been collected at differing sample intervals is 1 hour low-pass filtered (Butterworth filter) to remove noise and then interpolated onto a common 20-minute time base. All monster files for a particular year have the same number of rows and columns. Annual files for a leap year will have time records (rows) for Feb 29 as well. The first data record is always yyyy0101 00:00:00. The last is always yyyy1231 23:40:00. Time records yet to be filled (e.g., in the future) are removed from the concatenated text files but remain in the annual .mat versions.

Column descriptions:

COLUMN	DATA DESCRIPTION	INSTRUMENT
1)	Matlab serial time (GMT)	n/a
2)	Year	ADCP
3)	Month	ADCP
4)	Day	ADCP
5)	Decimal Day	ADCP
6:21)	East Velocity 2m-17m HAB (m/s)	ADCP
22:37)	North Velocity 2m-17m HAB	ADCP
38:53)	Mean Beam Intensity 2m-17m bins	ADCP
54)	Temperature (C)	ADCP
55-57)	Temperature(Top-Mid-Bottom)	Tidbits
58- 73)	Percent Good, Field 3	ADCP
74)	unused	n/a
75)	unused	n/a
76)	unused	n/a
77)	Pressure (db)	SBE37
78)	Temperature (C)	SBE37
79)	Conductivity (S/m)	SBE37
80)	Salinity (PSU)	SBE37
81)	Density (sigma-theta)	SBE37
82)	Chl fluorescence (volts)	SBE37
83:86)	unused	n/a
87)	Depth (m)	ADCP

Recently we've included additional variables within the (site)_monster_yyyy.mat files:

'uv_tide' contains the tidal component to the measured adcp velocity calculated with T_tide.m. The rows (times) correspond exactly to the rows in 'monster'. The columns correspond to the adcp velocity columns in 'monster' columns 6 through 37. Tides can be removed from 'monster' by subtracting 'uv_tide' from those columns.

'z_bin_avg' is the average depth of each adcp bin calculated from the sea surface location. Also calculated are the fluctuating bin depths 'z_bins' and the fluctuating water depth 'z_waterdepth'.

References:

Other references to papers if appropriate