

CTD System

Parent Category: Methods (</about-calcofi/methods.html>)

Category: CTD Methods (</about-calcofi/methods/119-ctd-methods.html>)

© Last Updated: 04 October 2017

A Sea-Bird Electronics 911plus V2 CTD collects vertical profile data at every CalCOFI station. In addition to being a dual TCO (temperature, conductivity, and oxygen) system, the CTD also interfaces with a transmissometer, fluorometer, PAR/SPAR meters, altimeter, nitrate, and pH sensor. Connected to a shipboard data-acquisition computer through an electronically-conductive winch wire, sensor data are collected and displayed real-time using Seasave V7

(<http://www.seabird.com/software/SeasaveV7.htm>) on a Windows PC. The CTD is normally lowered to terminal depth of 515 m, bottom-depth permitting, but is routinely deployed within meters from the seafloor at nearshore SCCOOS and basin stations. To ensure high resolution sampling in areas with significant hydrological and biological gradients a speed of ~30 m/min is used for the first 100 m then ~60 m/min to depth without stopping. During retrieval, the CTD is paused for at least 20 seconds at target bottle depths to adequately flush each 10 liter sample bottle prior to closure. Seawater samples are analyzed onboard (e.g., salinity, oxygen, nutrients, chl) and are used to correct measured CTD values.

The "Fish"

The 9plus (http://www.seabird.com/products/spec_sheets/911data.htm) underwater CTD is a premium real-time system that features high resolution sampling (24 Hz), pump-controlled T-C ducted flow, up to 10500 meter depth capacity, and modem channel for water sampler control. The 9plus supports dual temperature, conductivity, and oxygen sensors and up to eight auxiliary sensors with its 8-channel, 12-bit A/D converter with differential inputs and low pass filters.

The Deck Unit

The 11plus V2 (http://www.seabird.com/products/spec_sheets/911data.htm) Deck Unit includes RS-232 computer interfaces, a modem channel for real-time water sampler control (including water sampler control push buttons and status lights), NMEA 0183 interface for adding GPS position to CTD data, and 12-bit A/D input channel for surface PAR sensor. The 11plus V2 also provides a remote pressure (depth) output. Calibration coefficients are stored in EEPROM, and a separate microcontroller converts raw CTD data to temperature, depth, salinity, etc. The 11plus is also used to automatically align conductivity data in time, relative to pressure. This ensures that calculations of salinity are made using measurements from the same parcel of water.

Auxiliary Sensors

Transmissometer - The WetLabs C-Star transmissometer (<http://wetlabs.com/cstar>) uses a 25 cm pathlength at 650 nm (red) to calculate beam attenuation and total suspended particle mass. In the red part of the spectrum, attenuation due to dissolved materials is negligible, so that attenuation in the red is due primarily to particles. Light that is absorbed cannot be scattered, so that to first order the absorption and scattering processes compensate each other. The beam attenuation coefficient in the red is an excellent proxy for the total volume of particles. The beam attenuation coefficient at 650 nm depends on the nature of the particles, or their size, shape and internal index of refraction distribution.

Fluorometer - Since CalCOFI 1311NH (Nov 2013), the Wetlabs ECO/FL fluorometer has been deployed. The ECO/FL fluorometer is a single channel fluorometer that delivers both high resolution and wide dynamic range using 14 bit digital processing. The fluorometer is operated without a pump and is set to a standard chlorophyll-a range of 0–125ug/l. Shipboard deck tests are done periodically using a known standard to verify the sensor is operational, determining the maximum voltage.

Prior to Nov 2013, the Seapoint chlorophyll fluorometer (<http://www.seapoint.com/scf.htm>) is a high-performance, low power instrument for in situ measurements of chlorophyll a. Its high sensitivity and wide dynamic range enable measurement of chlorophyll a in a wide variety of conditions. The fluorometer is operated without a pump and can be set to

one of four gain settings. Normally the fluorometer is configured with a 10x gain setting which yields a sensitivity of 0.33V/(µg/l) and a range of 0 - 15 µg/l. Shipboard deck tests are done periodically using a known standard to verify the sensor is operational.

Underwater and Surface PAR - Biospherical's QSP-2300

(ftp://ftp.biospherical.com/pub/manuals/PDF_instrument/QSP_QCP2300_Manual.pdf) and QSP-240 (<http://www.biospherical.com/BSI%20PDFs/Brochures/QSR-2000.pdf>) are used to measure Photosynthetically Active Radiation (PAR) above and below the water's surface. Interfacing with the CTD, the QSP-2300 measures the widely variant underwater light field during each profile by defining the exponential decay of light with depth. The QSP-240 connects to the SBE11plusV2 deck unit and feeds surface PAR data directly into each CTD cast file. Properly calibrated, these sensors can output values in either microEinsteins/cm2 or quanta/second/cm2.

Sonar Altimeter - The Teledyne Benthos altimeter (<http://www.seabird.com/document/an95-setting-altimeter-sea-bird-profiling-ctd>) uses a wide beam angle for reliable and accurate range measurements and is primarily used during operations near the benthos. With this sensor, and with accomodating weather, it is possible to profile within meters of the botom at shallow and basin stations.

Nitrate Sensor - As of CalCOFI 1611SR, CalCOFI has deployed a Satlantic ISUS V3 (firmware of V2 was upgraded during last servicing in 2016). The firmware update allows batch downloading via USB cable of ISUS data files plus DI 0 nitrate self-calbration using Satlantic ISUScom software. This allows us to readjust the 0 NO3 baseline when it shifts as the lamp ages or optics change. Otherwise the sensor behaves and responds like the V2 used on previous cruises.

Satlantic's ISUS (<http://www.satlantic.com/details.asp?ID=11&CategoryID=2&SubCategoryID=0>) V2 ultraviolet spectrophotometer uses absorption spectroscopy to measure in situ dissolved chemical species. Nitrate is one of the main nutrients required for growth of phytoplankton. Understanding the distribution of nitrate in the oceans is essential to understanding biological processes. The ISUS is a chemical-free, solid-state instrument that offers accurate and continuous nitrate concentration measurements. By illuminating a sample of seawater with UV light onto an UV spectrometer, the absorption spectra can be measured. The calibration process of the system creates a library of absorption spectra for the main absorbing species in this region of the spectrum. An optimization process adjusts the concentrations of the calibrated species spectra until the computed spectrum matches the measured one.

Links • CCE LTER ISUS (http://cce.lternet.edu/data/methods/isuus_nitrate_sensor_cce/)

pH Sensor - The SBE 18 pH sensor (http://www.seabird.com/products/spec_sheets/18data.htm) (AN 18-1) uses a pressure-balanced glass-electrode Ag/AgCl-reference pH probe to provide in situ measurements at depths up to 1200 meters. The replaceable pH probe is permanently sealed and is supplied with a soaker bottle attachment that prevents the reference electrode from drying out during storage. The sensor is routinely calibrated between cruises with a range of known buffer solutions, and if needed, can be calibrated while at sea as well.

Carousel Water Sampler - The SBE 32 carousel water sampler (http://www.seabird.com/products/spec_sheets/32data.htm) is a magnetically-activated mechanism that triggers a lanyard release on a pylon which initiates bottle closure. Made from titanium, acetal plastic, and other corrosion-resistant materials the latch array's modular construction makes trigger replacement easy while at sea should bottle triggering become inconsistent.

Equipment History

CTD

- 2009 - present : SBE 911plusV2
- 1998 - 2009 : SBE 911plus
- 1993 - 1998 : SBE 911

Conductivity

Oxygen

- 2003 - present : SBE 43
- 1993 - 2003 : SBE 13
- RINKO 1211 & 1611

Fluorometer

PAR

- 2010 - present : Biospherical QSP-2300
- 1993 - 2010 : Biospherical QSP-200L

Water Sampler

- 1993 - present : SBE 4

- 11-2013-present: Wetlabs

- 1998 - present : SBE 32

- 2000 - 2013 : Seapoint

- 1993 - 1998 : General Oceanics

- 1993 - 2000 : SeaTech

- Spares : SCUFA, Chelsea

Temperature

- 2009 - present : SBE 3plus

- 1993 - 2009 : SBE 3F

Transmissometer

- 2000 - present : WetLabs
650nm

- 1993 - 2000 : SeaTech 650nm

ISUS

- 201611 - present: ISUS v3 (Frank's)

- 200610 - 201607: ISUS v2

- 2004 - 200604: MBARI-ISUS (LTER0506-
imploded)