CTD Data Calibration Report for R/V Oceanus 446
prepared by Jane Dunworth-Baker
Woods Hole Oceanographic Institution

I.1 Cruise Summar

Ship: R/V Oceanus 446 **Project Name**: Line W
Dates:10-13 & 14-20 May 2008 **Por**t: Woods Hole, MA
Chief Scientist: John Toole
CTD data processor: Jane Dunworth-Baker
Hydrographer: David Wellwood

17 CTD stations
Rosette salts and dissolved oxygen plus, cfc's, DIC, SF-6, I-129,
NCTD and LADCP

I.2 Final Data Files

32OC446_docfile.doc	
32OC446.SEA	2009may.whp_btl
32OC446.SUM	2008may.sum
32OC446_ctd.zip	2008may_ctd.zip

**.CTD* One 2db averaged file per station following the WOCE format specification for CTD profiles. The final *.CTD files derive from the primary conductivity and primary oxygen sensor data. All CTD salt and oxygen data have been calibrated to the bottle salt and oxygen data. CTD temperature and pressure has been scaled with pre-cruise calibrations.

II.1 CTD Measurements

Seventeen casts were made using a SeaBird 911plus CTD configured to measure pressure, temperature, conductivity, and oxygen current. For each cast, water samples were collected at discrete intervals and analyzed for salinity and dissolved oxygen – primarily for the purpose of calibrating the CTD sensors. All casts were full water column.

II.2 Difficulties Encountered

This was a combined CTD and mooring recovery/deployment cruise. Generally CTD's are done at night and during moderate weather, while mooring work is done during the day, in good weather conditions. The Oceanus departed on saturday and returned to Woods Hole on tuesday due to bad weather. She departed again on wednesday and returned the following tuesday due to bad weather.

II.3 Equipment Configuration

A SeaBird 911plus/917 plus CTD was used throughout the cruise. It was equiped with a Digiquartz TC pressure transducer S/N 69685, two temperature sensors S/N 2265 and S/N 2271, two conductivity sensors S/N 2304 and S/N 2645, and one SBE43 oxygen sensors S/N 794. Calibrations for all CTD sensors were performed by the manufacturer before the cruise. The CTD also contained a Wetlab ECO-AFL/FL Flourometer (S/N 0297), a Chelsea/Seatech/Wetlab Cstar Transmissometer (S/N 0758), an altimeter (S/N 1133). CTD data from both the primary conductivity and oxygen sensors, and secondary conductivity sensor, were calibrated for the entire cruise. While the primary and secondary conductivity sensors were consistant throughout most of the cruise; cond-2 experienced data drop-outs in the upper water on a number of stations. Thus the primary co sensor (and primary te sensor) were chosen for the final data product for the entire cruise.

Deleted: ¶

The pylon was controlled through a dedicated personal computer using SeaBird's software SEASOFT version 7.14 for windows. A rosette frame was provided for the cruise. The frame held 22 10-liter bottles and 2 4-liter bottle to allow room for the ladcp..

II.4 Acquisition and Processing Methods

Data from the CTD were acquired at 24 hz. The CTD data were acquired by an SBE Model 11 plus CTD Deck Unit providing demodulated data to a personal computer running SeaBird software. SEASAVE version 7.14 CTD acquisition software (SeaBird) provided graphical data to the screen. Bottom approach was controlled by real time altimeter data and ship provided ocean depth information.

After each station, the raw CTD data were run through the SeaBird data conversion software listed in Table 2. CTD salinity and oxygen data were then calibrated by fitting the data to water sample salinity and oxygen data. WHOI post-processing fitting procedures are modelled after Millard and Yang, 1993.

Table 2. SeaBird Processing Software

SeaBird Module	Description (SeaBird, Version 7.14)
DATCNV	Convert the raw data to pressure, temperature, conductivity, and dissolved oxygen current.
ROSSUM	Reads in a .ROS file created by DATCNV and writes out a summary of the bottle data to a file with a .BTL extension.
ALIGNCTD	Advance conductivity approximately 0.073 seconds relative to pressure.
WILDEDIT	Checks for and marks and 'wild' data points: first pass 2.0 standard deviations; second pass 20 standard deviations.
CELLTM	Conductivity cell thermal mass correction alpha = 0.03 and 1/beta = 7.0.
FILTER	Low pass filter conductivity with a time constant of approximately 0.03 seconds. Filter pressure with a time constant of 0.15 seconds to increase pressure resolution for LOOPEDIT.
LOOPEDIT	Mark scans where the CTD is moving less than the minimum velocity (0.1 m/s) or traveling backwards due to ship roll.
DERIVE oxy.cfg	Compute oxygen from oxygen current, temperature, and pressure.
BINAVG	Average data into the 2 dbar pressure bins.
DERIVE sal.cfg	Compute salinity.
STRIP	Extract columns of data from .CNV files.
TRANS	Change .CNV file format from ASCII to binary.
SPLIT	Split .CNV file into upcast and downcast files.

Standard output nominally scaled CTD data files, used as input for final CTD calibrations, included the following variables:

name 0 = prDM: Pressure, Digiquartz [db]
name 1 = t090C: Temperature [ITS-90, deg C]
name 2 = t190C: Temperature ,2[ITS-90, deg C]
name 3 = c0mS/cm: Conductivity [mS/cm]
name 4 = c1mS/cm: Conductivity,2 [mS/cm]
name 5 = sbeox0V: Oxygen Voltage, SBE 43
name 6 = sbeox0dOC/dT: Oxygen, SBE 43 [doc/dt]
name 7 = sbeox0ML/L: Oxygen, SBE 43
#name 8 = scan: Scan Count
name 9 = nbin: number of scans per bin
name 10 = sal10: Salinity [PSU]
name 11 = sal11: Salinity, 2 [PSU]
name 12 = flag: flag

A second set of CTD data files used for LADCP processing were created, as well as a third set of files for the transmissometer data.

II.5 Summary of CTD Calibrations

PRESSURE CALIBRATION
The pressure bias of the CTD at the sea surface was monitored at the completion of each station to make sure there was no significant drift in the calibration. On deck pressure bias ranged from -0.2 to -0.4 decibars. No adjustments were applied to the CTD pressure data apart from the pre-cruise laboratory calibrations.

CONDUCTIVITY CALIBRATION
Basic fitting procedure:

Deb West-Mack's calibration gui 'ctd_gui' was used to fit primary and secondary conductivity sensor data to the water sample conductivity data. All stations were grouped together in chronological order to find the best fit. The group was fit for slope and bias. A linear pressure term (modified beta) was applied to conductivity slopes using a least-squares minimization of CTD and bottle conductivity differences. No adjustments to the calibration with time were deemed necessary.

Data Quality

The salinity water sample data appear to be of good quality.

OXYGEN CALIBRATION
Basic fitting procedure

The CTD oxygen sensor variables were fit to water sample oxygen data to determine the six parameters of the oxygen algorithm (Millard and Yang, 1993). The oxygen calibration was performed after calibrating temperature and conductivity to account for the (weak) dependence of oxygen on the CTD pressure, temperature, and conductivity (salinity).

An oxygen calibration package developed by Jane Dunworth-Baker was used to arrive at final oxygen calibrations. The package calls three fitting routines, written by Bob Millard, that use the algorithm developed by Owens and Millard (1985) for converting oxygen sensor current and temperature measurements with the time rate of change of oxygen current measurements to oxygen concentration.

Data Quality

The oxygen data appear to be of good quality, except for the oxygen data for station 8. The same person (me) sampled the oxygen for stations 1-8, and nothing unusual was noted by the hydrographer. The station 8 oxygen was titrated at the dock.

II.6 Other notable data acquisition/processing issues

At-sea logs were kept for CTD data acquisition. They include anything of note regarding each station: equipment changes, instrument behavior, equipment or operational problems. LADCP station logs were also kept for LADCP data collected during each station. An at-sea station event log was also kept during the cruise. Ray Schmitt's NCTD was attached to the rosette and collected data at most stations.

III Sampling Methods

Water samples were collected from virtually every bottle during this cruise for the determination of salinity and dissolved oxygen. The primary purpose of these measurements were to calibrate the sensors on the CTD.

III.1 Salinity

Water was collected in 200 ml glass bottles. The bottles were rinsed twice, and then filled to the neck. After the samples reached the lab temperature, they were analyzed for salinity using URI's Portasal Salimometer. The salinometer's bath temperature was set to either 24C or 27C, depending on the ship's ambient lab temperature, and was standardized once a day using IAPSO Standard Seawater Batch P-**147** (dated June-2006). The accuracy of salinity measurements is ±0.004 psu.

Formatted: Font: 11 pt, Not Bold

Formatted: Font: 11 pt

Formatted: Font: 11 pt, Not Bold

III.2 Dissolved Oxygen

Measurements were made using a modified Winkler technique similar to that described by Strickland and Parsons (1972). Each seawater sample was collected in a 150 ml brown glass Tincture bottle. When reagents were added to the sample, iodine was liberated which is proportional to the dissolved oxygen in the sample. A carefully measured 50-ml aliquot was collected from the prepared oxygen sample and titrated for total iodine content. Titration was automated using a PC controller and a Metrohm Model 665 Dosimat buret. The titration endpoint was determined amperometrically using a dual plate platinum electrode, with a resolution better than 0.001 ml. Accuracy is believed to be about 0.02 ml/l, with a standard deviation of replicate samples of 0.005. This technique is described more thoroughly by Knapp et al (1990). Standardization of the sodium thiosulphate titrant was performed daily.

IV. References

Knapp, G.P., M. Stalcup, and R.J. Stanley. 1990. Automated Oxygen Titration and Salinity Determination. WHOI Technical Report, WHOI-90-35, 25 pp.

Millard, R.C. and K. Yang. 1993. CTD Calibration and Processing Methods used at Woods Hole Oceanographic Institute. WHOI Technical Report, WHOI-93-44, 96 pp.

Owens, Brechner W. and Robert C. Millard, Jr. 1985. A New Algorithm for CTD Oxygen Calibrations. J. Phys. Oc. 15:621-631.

SeaBird Electronics, Inc. 2001. CTD Data Acquisition Software Seasoft Version 4.249 Manual.

Strickland, J.D.H. and T.R. Parsons. 1972. The Practical Handbook of Seawater Analyiss. Bulletin 167, Fisheries Research Board of Canada, 310 pp.