LMG10-06

Palmer Station opening and

B-114-L, James T. Hollibaugh

Cruise Data Report

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Introduction

The LMG data acquisition systems continuously log data from a suite of instrumentation throughout the cruise. This document describes the format of that data and its location on the distribution CDs. It also contains important information that may affect how this data is processed such as instrument failures or other known problems with acquisition.

The data collected during this cruise is distributed on a CD-ROM written in ISO9660 level-1 format. This data format has very strict requirements on filenames and organization. However, it is readable by virtually every computing platform.

All of the data has been archived with the Unix "tar" command and/or compressed using Unix "gzip" compression. Tar files have a ".tar" extension and Gzipped files have a ".gz" extension. Tools are available on all platforms for uncompressing and de-archiving these formats. On Macintosh, Stuffit Expander with DropStuff will open a tar archive and uncompress gzipped and Unix compressed files. For Windows, WinZip, a shareware utility included on this CD (remember, it is shareware) will open these files.

In some cases to adhere to the ISO9660 format the .tar extension was removed. When we tarred the files then gzip the tar archive the name of the file became *File*.tgz. This name does not follow the 8.3 naming convention of the ISO9660 format. On Windows and Mac Platforms Winzip and Stuffit Expander handles this just fine. When they expand the *File*.gz the expanded file becomes *File*.tar, which both software packages can handle. On Unix platforms gunzip expands *File*.tgz but it does not append the .tar extension. So you may not recognize the file as a tar archive, but OS does recognize it as a tar archive. If you use the file command it will return saying it is a tar file. The below tar command will un-archive the file just fine.

IMPORTANT: Read the last section in this document, Acquisition Problems and Events, for important information that may affect the processing of this data.

Archive Data Extraction

It is often useful to know exactly how an archive was produced when expanding its contents. Tar files were created using the following commands:

```
tar cvf archive-file files-to-be-archived
```

To create a list of the files in the archive:

```
tar tvf  archive-file  > contents.list
```

To extract the files from the archive:

```
tar xvf  archive-file file(s)-to-extract
```

G-zipped files will have a ".gz" extension on the filename. These files can be decompressed after de-archiving, using:

```
gunzip filename.gz
```

CD Directory Structure

```
ADCP:
ADCP.tar

Cal:
InstCoef.txt

CTD:
CTD Data

Imagery:
Imag.tar

Maps:
(various)

Process:
JGOF.tar
PCO2.tar
PROC.tar
QC.tar

Report:
Report.doc

RVDAS:
NAV Data
Underway Data

Utility:
Acrobat
Winzip

XBT:
XBT Data

XCTD:
XCTD Data
```

Distribution Contents

ADCP

/Adcp/

This directory contains a tar file of gentoo's proc directory, which contains a database of the averaged ping data, Matlab m-files used in processing the data, and daily graphs of the currents. For more information contact Teri Chereskin at tchereskin@ucsd.edu. Processed data is usually available shortly after the cruise at http://currents.soest.hawaii.edu

Calibration

/Cal/

The tar files in the Cal directory contain images of calibration sheets for each of the following systems: Sound Velocity Probe (SVP_CALS.TAR), Meteorological System (MET_CALS.TAR), Underway System (UW_CALS.TAR), and CTD_CALS.pdf.

Refer to the InstCoef.txt file along with the specific instrument calibration sheets, both located in this directory, for information on how the RVDAS data was collected and processed.

CTD

CTD/

CTD/Scripts/

This directory contains the control files used for preliminary processing of the data. Processing performed by the vessel technicians is for *quality control purposes* ***only***, as a check that the instruments are performing correctly.

CTD//raw

Contains the raw data from the instrument.

CTD/process

Contains the files generated as a result of the preliminary post processing. For more details, refer to the SBE Data Processing documentation available on the SeaBird website (http://www.seabird.com).

Ice Images

/ICE_IMAGE/

This directory contains .jpg files of Terrascan ice imagery sent to the ship from Palmer station to aid in navigation of the ship and science.

Isobar Charts

/Isobars/

This directory contains GIF and JPEG image files. The GIF's are an analysis of mean sea level pressure from the National Center for Environmental Prediction's Medium Range Forecast Model. They are updated every 6 hours. Naming the convention is as follows yyjjj.hh.gif where yy is the year, jjj is the day number, and hh is the hour.

Data and Science Report

/Report/

Copies of this report in MS Word, HTML, and text formats.

Sitrep

/Sitrep/

If this directory exists, it contains copies of the vessels Daily Situation Report.

XBT

/XBT/

If this directory exists, it contains data from Expendable Bathythermographic (XBT) “Deep Blue” probes were used to obtain water column temperature profiles. The dataset includes the following files:

dat.zip	The probe drop schedule and other configuration files.
efiles.zip	The edited data files.
log.zip	The log files for drop and GPS positioning.
nav.zip	The navigation files.
sfiles.zip	The raw data files.
*.pdf	Scanned images of the paper log sheets.

XCTD

/XCTD/

If this directory exists, it contains data from Expendable Conductivity, Temperature, and Depth (XCTD) digital probes were used to obtain water column temperature and Salinity profiles. Two files are created for each drop .RDF files contain the raw data, and the .EDF contain the exported ascii data.

TCO2

/TCO2/

If this directory exists, it contains the log sheet for the TCO2 sample during the Drake Transect Sampling. For further information on this data, contact Tim Newberger at ***tnewberg@ldeo.columbia.edu***

Salts

/SALT/

If this directory exists, it contains the log sheet for the Salt sample take during the Drake Transect Sampling, also a spreadsheet containing the Salt sample and TSG comparison. These samples are normally analyzed with a Guildline Autosalinometer.

Drifters

/DRIFTERS/

This directory contains the log sheet for the drifter buoys released during the Drake Transect.

Science

/Science/

If this directory Is populated, it will contain various files, data, digital photos, and/or other information collected by the individual scientists.

Maps

/Maps/

If this directory is present, it contains maps generated by vessel staff or provided by the science party. Maps may be in any number of formats, some of which may be proprietary or vendor specific. Maps generated by the Marine Electronics and Instrument Specialists are typically JPEG images.

WAYPOINTS

/WAYPTS/

If this directory is present, it contains files in CSV format detailing various navigation waypoints.

QC Plots

/QC_PLOTS/

Postscript files of data stored each day on RVDAS for quality control analysis during the cruise. There are 3 types of files, named metXXX.ps, navXXX.ps, and oceanXXX.ps, where XXX is represents the Julian day. Met files are a summary of the data from the meteorological instruments, Nav files are a summary of navigational data, and Ocean files are a summary of the underway seawater and bathymetry data.

JGOFS Data Set

/JGOF/

The JGOFS data set consists of a single file produced each day named jg<julian_day>.dat.gz where <julian_day> is the day the data was acquired. The ".gz" extension indicates that the individual files are compressed before archiving. The daily file consists of 22 separate columnar fields in text format, which are described below. The JGOFS data set is obtained primarily by applying calibrations to raw data and decimating to whole minute intervals. However, several fields are derived measurements from more than a single raw input. *Note: Null, unused, or unknown fields are filled with 9's in the JGOFS data.*

Additionally, 3 separate QC plots are generated daily by the ET using the JGOFS data set. These plots include TSG and Bathymetry data, meteorological data, and navigation data. The files are called ocean<julian_day>.ps, met<julian_day>.ps, and nav<julian_day>.ps respectively.

Field	Data	Units
01	GMT date	dd/mm/yy
02	GMT time	hh:mm:ss
03	PCOD latitude (negative is South)	Ddd.dddd
04	PCOD longitude (negative is West)	Ddd.dddd
05	Ships speed	Knots
06	GPS HDOP	-
07	Gyro Heading	Degrees (azimuth)
08	Course over ground	Degrees (azimuth)
09	Mast PAR	μEinsteins/meters^2 sec
10	Sea surface temperature	°C
11	Conductivity	S/m
12	Sea surface salinity	PSU
13	Sea depth (uncorrected, calc. sw sound vel. 1500 m/s)	meters
14	True wind speed (port windbird)	meters/sec
15	True wind direction (port windbird)	degrees (azimuth)
16	Ambient air temperature	°C
17	Relative humidity	%
18	Barometric pressure	mBars
19	Sea surface fluorometry	μg/l
20	Transmissometer	Vols (0-5 FSO)
21	PSP	W/m^2
22	PIR	W/m^2

RVDAS

/RVDAS/

RVDAS (Research Vessel Data Acquisition System) was developed at Lamont-Doherty Earth Observatory of Columbia University and has been used on the R/V Maurice Ewing for several years. It was adapted for use on the Nathaniel B. Palmer and her sister ship, the R/V Laurence M. Gould.

Below you will find detailed information on the data included. Be sure to read the "Significant Acquisition Events" section below for important information about data acquisition during this cruise.

Meteorological and Light Data

Measurement	File ID	Collect. Status	Rate	Instrument
Air Temperature	lmwx	continuous	1 sec	R. M. young 41372VC
Relative Humidity	lmwx	continuous	1 sec	R. M. young 41372VC
Wind Speed/Direction	lmwx	continuous	1 sec	R. M. young 5106
PAR, (Photosynthetically-Available Radiation)	lmwx	continuous	1 sec	BSI QSR-240
Barometer	lmwx	continuous	1 sec	R. M. young 61201
GUV & PUV	lguv	continuous	1 sec	GUV2511 & PUV2510
PIR (LW radiation)	lmwx	continuous	1 sec	Eppley PIR
PSP (SW radiation)	lmwx	continuous	1 sec	Eppley PSP
Port Ultrasonic Wind Speed/Direction	lmwx	continuous	1 sec	Gill Wind Observer II

Navigational Data

Measurement	File ID	Collect. Status	Rate	Instrument
Attitude GPS	lash	continuous	1 sec	Ashtec ADU-2
Trimble GPS	tgps	civilian mode	1 sec	Trimble 20636-00SM
Gyro	lgyr	continuous	0.2 sec	Anschutz Gyro
Garmin GPS	lgar	continuous	1 sec	Garmin 17

Geophysical Data

Measurement	File ID	Collect. Status	Rate	Instrument
Bathymetry	lknu	variable	Varies	Knudsen 320B/R
Net Depth Sensor	lnds	variable	~1/3 sec	Omega PX-605
DUSH 11 Winch	lwn1	variable	varies	Markey DUSH 11
DUSH 5 Winch	lwn1	variable	varies	Markey DUSH 5
DUSH 4 Winch	lwn1	variable	varies	Markey DUSH 4

Oceanographic Data

Measurement	File ID	Collect. Status	Rate	Instrument
Salinity	utsg	continuous	1 sec	SeaBird 45
Sea Surface Temperature	lrtm	continuous	1 sec	SeaBird 38
Fluorometry (digital)	lflr	continuous	1 sec	Turner 10-AU-005
Fluorometry (digital)	ldfl	continuous	1 sec	Wetlab ECO
ADCP, Speed Log	ladc	continuous	1 sec	RD Instruments
Oxygen	loxy	continuous	1 sec	
PCO2	lpco2	continuous	2.5 min	

Data File Names and Structures

RVDAS data is divided into two broad categories, ***Underway*** and ***Navigation***. The groups are abbreviated "uw" and "nav". Thus, these two tar files, lmguw.tar and lmgnav.tar exist under the top-level rvdas directory. The instruments are broken down as shown. Each data file is g-zipped to save space on the distribution. Not all data types are collected everyday or on every cruise.

RVDAS data files are named following the convention: LMG[FileID].dDDD.

- The FileID is a 4-character code representing the system being logged, for example: lmet (for meteorology)
- DDD is the Julian day of the data collection

Underway Data	File ID
Meteorological - Cambell	lmwx
Knudsen	lknu
microTSG	utsg
Digital Remote Temperature	lrtm
Fluorometer - Turner	lflr
Fluorometer – Wetlab ECO	ldfl
ADCP	ladc
Sound Velocity Probe	lsvp
GUV & PUV	lguv
PCO2 System	lpco
Oxygen	loxy
Wet Wall Flows	lsea
Winches: Dush4,5,&11	lwn1
Net Depth Sensor	lnds

Navigation Data	File ID
Gyro Compass	lgyr
P-CODE GPS	tgps
Ashtech ADU2 GPS	lash
Garmin 17 GPS	lgar

Data is received by the RVDAS system via RS-232 serial connections. The data files that comprise the rvdas data set are described below. A time tag is added to each line of data received and the data is written to disk.

```
YY+DDD:HH:MM:SS.SSS [data stream from instrument]
```

Where, YY: two-digit year, DDD: Julian Day, HH: 2 digit hours, MM: 2 digit minutes SS.SSS: seconds. All times are UTC.

The delimiters used to separate fields in the raw data files are usually spaces and commas, but other delimiters are used (::, =, @) and occasionally there is no delimiter. Care should be taken when reprocessing the data that the field separations are clearly understood. An example data string is provided with each instrument section for your convenience, however it is always best to refer directly to the raw data.

lknu – Knudsen Sonar

```
08+024:07:36:36.245 HF,00.00, 000,0,LF,448.9,-026,1
```

Field	Data	Units
1	RVDAS Time Tag	
2	HF – high frequency header (12 kHz)	
3	HF - depth to surface	meters
4	HF - Echo Strength	
5	HF – Depth Valid Flag	
6	LF – low frequency header (3.5 kHz)	
7	LF - depth to surface	meters
8	LF - Echo Strength	

Field	Data	Units
9	LF – Depth Valid Flag	

Inds – Net Depth Sensor

```
99+099:00:18:19.775 V01 00199.8
```

Field	Data	Units
1	RVDAS Time Tag	
2	V01 – Sensor 1	label
3	Depth	meters

Iwn1 - Winches

```
08+033:11:27:50.673 RD,DUSH-5,00111.63,00000000,-0000012,1938
```

Field	Data	Units
1	RVDAS Time Tag	
2	Record Identifier, RD=Remote Data	
3	Winch Indentifier, DUSH-X where X is 4, 5, or 11	
4	Tension	lbs
5	Speed	Meters/minute
6	Payout	meters
7	Checksum	

Imwx - Campbell Meteorological DAS

```
08+034:13:52:14.216 SUS,A,356,002.15,M,+332.28,+000.97,60,08
```

Field	Data	Units
1	RVDAS Time Tag	
2	SUS tag – Starboard UltraSonic Anemometer	
3	Unit Identification, A-Z	
4	Port Wind Direction, degrees relative to Bow	deg
5	Port Wind Speed	m/s
6	Units, M=meters per second	
7	Sound Speed	m/s
8	Sonic Temperature	°C
9	Status, 0=ok, 60=Heating Enabled & ok, Other value mean a fault	
10	Check Sum	

```
08+034:13:52:14.216 PUS,A,356,002.15,M,+332.28,+000.97,60,08
```

Field	Data	Units
1	RVDAS Time Tag	
2	PUS tag – Port Anemometer	
3	Unit Identification, A-Z	
4	Port Wind Direction, degrees relative to Bow	deg
5	Port Wind Speed	m/s
6	Units, M=meters per second	
7	Sound Speed	meaningless
8	Sonic Temperature	meaningless
9	Status, 0=ok, 60=Heating Enabled & ok, Other value mean a fault	meaningless
10	Check Sum	meaningless

```
08+034:13:52:14.454 MET,12.22322,44.25706,-75,-25,-363.6365,2.332982,-0.08215196,278.6845,
279.2192,854.6198
```

Field	Data	Units
1	RVDAS Time Tag	
2	MET tag	
3	Power Supply Voltage	Volts
4	Enclosure Relative Humidity	%
5	Air Temp	ºC
6	Air Relative Humidity	%
7	PAR	mVolts
8	PSP Thermopile	mVolts
9	PIR Thermopile	mVolts
10	PIR Case Temperature	°K
11	PIR Dome Temperature	°K
12	Barometer	mBars

utsg – microTSG, Thermosalinograph

For further information on this data, check on www.seabird.com on SBE 45 MicroTSG Thermosalinograph

```
08+037:13:45:57.596   2.6470,  3.03853,  33.8129, 1459.351
```

Field	Data	Units
1	RVDAS Time Tag	
2	Internal water temperature	°C
3	Conductivity	S/m
4	Salinity	psu
5	Sound Velocity	m/s

lrtm – digital Remote Temperature

For further information on this data, check on www.seabird.com on SBE38 Digital Thermometer

08+037:13:47:17.841 2.2527

Field	Data	Units
1	RVDAS Time Tag	
2	External water temperature	°C

lflr – Fluorometer, Turner

```
04+107:16:48:02.342 0  5450 ::  4/16/04 09:44:17 = 0.632  (RAW)
```

Field	Data	Units
1	RVDAS Time Tag	
2	Zero Field	numeric
3	Sample Number	numeric
4	Fluorometer Date	mm/dd/yy
5	Fluorometer Time	hh:mm:ss
6	Digital output of fluorometer	Volts
7	(RAW)	

ldfl – Fluorometer, Wetlab ECO

```
08+037:13:55:08.434 99/99/99    99:99:99        0.00    2585    73      543
```

Field	Data	Units
1	RVDAS Time Tag	
2	Fluorometer Date	mm/dd/yy
3	Fluorometer Time	hh:mm:ss
4	Chlorophyll Signal	µg/l
5	Reference	λq
6	Counts – Chlorophyll Signal	Count
7	Thermistor	

loxy - Oxygen

For further information on this data, contact Tim Newberger at ***tnewberg@ldeo.columbia.edu***

```
04+117:23:57:23.504 MEASUREMENT         3830     380  Oxygen:           309.95      Saturation:
83.48   Temperature:       -1.35      DPhase:             33.41      BPhase:             32.22
        RPhase:             0.00      BAmp:      262.09      BPot:      163.00      RAmp:
0.00    RawTem.:          694.92
```

Field	Data	Units
1	RVDAS Time Tag	
2-4	Measurement ID, Model Number, Serial Number	alphanumeric
5	Oxygen heading	text
6	Oxygen Reading	Raw numeric
7	Saturation heading	text
8	Saturation Reading	Raw numeric
9	Temperature heading	text
10	Water Temperature	ºC
11	Dphase heading	text
12	Dphase	Raw numeric
13	Bphase heading	text
14	BPhase	Raw numeric
15	Rphase heading	text
16	Rphase	Raw numeric
17	Bamp heading	text
18	Bamp	Raw numeric
19	Bpot heading	text
20	Bpot	Raw numeric
21	Ramp heading	text
22	Ramp	Raw numeric
23	RawTem heading	text
24	RawTemp	Raw numeric

lpco – PCO2 system

For further information on this data, contact Tim Newberger at ***tnewberg@ldeo.columbia.edu***

```
02+319:23:59:13.748 2002319.99851    7154.27     26.49    1033.6     325.79      6.74     329.3
53.76    0   Equil
```

Field	Data	Units
1	RVDAS Time Tag	
2	Julian date file string	Julian
3	IR voltage reading	mV
4	Cell temperature	°C
5	Barometer	millibars
6	VCO2	mL
7	Equilibrator temperature	°C
8	PCO2	millibars
9	Gas flow	mL/min
10	Solenoid position ID	number
11	Valve Position ID	number
12	Measured gas	name

lguv – Biospherical GUV

```
08+037:14:17:59.211 020608 141758 -.000099 1.307E0 7.24E0 1.316E1 2.609E1 3.285E1 3.505E1 8.075E-
2 38.993 17.985
```

GUV only

Field	Data	Units
1	RVDAS Time Tag	
2	GUV Computer Date	mmddyy
3	GUV Computer Time	hhmmss
4	Ed0Gnd - GUV	Volts
5	Ed0305 - GUV	µW/cm^{2}nm
6	Ed0313 - GUV	µW/cm^{2}nm
7	Ed0320 - GUV	µW/cm^{2}nm
8	Ed0340 - GUV	µW/cm^{2}nm
9	Ed0380 - GUV	µW/cm^{2}nm
10	Ed0395 - GUV	µW/cm^{2}nm
11	Ed0PAR - GUV	µE/cm^{2}sec
12	Ed0Temp - GUV	°C
13	Ed0VIn	Volts

GUV and PUV

Field	Data	Units
1	RVDAS Time Tag	
2	GUV Computer Date	mmddyy
3	GUV Computer Time	hhmmss
4	EdZGnd -PUV	Volts
5	EdZ305 -PUV	µW/cm^{2}nm
6	EdZ313 -PUV	µW/cm^{2}nm
7	EdZ320 -PUV	µW/cm^{2}nm
8	EdZ395 -PUV	µW/cm^{2}nm
9	EdZ340 -PUV	µW/cm^{2}nm
10	EdZPAR -PUV	µE/cm^{2}sec
11	LuZChl -PUV	µE/srm^{2}sec
12	EdZ380 -PUV	µW/cm^{2}nm
13	WTemp -PUV	°C
14	Depth -PUV	m
15	EdZTemp -PUV	°C
16	LuZTemp -PUV	°C
17	Tilt -PUV	Degrees
18	Roll -PUV	Degrees
19	Ed0Gnd - GUV	Volts
20	Ed0305 - GUV	µW/cm^{2}nm
21	Ed0313 - GUV	µW/cm^{2}nm
22	Ed0320 - GUV	µW/cm^{2}nm
23	Ed0340 - GUV	µW/cm^{2}nm
24	Ed0380 - GUV	µW/cm^{2}nm
25	Ed0395 - GUV	µW/cm^{2}nm
26	Ed0PAR - GUV	µE/cm^{2}sec

27	Ed0Temp - GUV	°C
28	Ed0VIn	Volts

lsvp - Sound Velocity Probe in ADCP Transducer Well

```
00+348:01:59:52.128  1539.40
```

Field	Data	Units
1	RVDAS Time Tag	
2	Sound velocity	m/s

ladc – ADCP Speed Log

```
00+019:23:59:59.099 $PUHAW,UVH,-1.48,-0.51,250.6
```

Field	Data	Units
1	RVDAS Time Tag	
2	$PUHAW	
3	UVH (E-W, N-S, Heading)	
4	Ship Speed relative to reference layer[1] velocity[2], East vector	knots
5	Ship Speed relative to reference layer[1] velocity[2], North vector	knots
6	Ship heading	degrees

[1]The reference layer is an average velocity measured in a number of depth "bins". On the LMG, the bins are eight meters deep and bins 3-10 define the reference layer. Hence, the reference layer is the water column from 16-80 meters beneath the ship.

[2]The speed ouput is water velocity relative to the ship's hull and is therefore opposite of the actual movement of the ship. For example, if the ship's heading is due north, the North/South reference layer velocity is likely to be negative (southerly).

lash – Ashtech GPS

ATTD: Attitude Data

```
01+081:00:00:00.806 $PASHR,ATT,345605.0,165.03,+001.86,-01.96,0.0018,0.0173,0*22
```

Field	Data	Units
1	RVDAS Time Tag $PASHR	
2	ATT	
3	GPS Time sec. of the week	seconds
4	heading (rel. to true North)	degrees
5	pitch	degrees
6	roll	degrees
7	Measurement RMS error	meters
8	Baseline RMS error	meters
9	attitude reset flag	

```
01+081:00:00:00.966 $GPGGA,235952.00,6051.7937,S,06030.2175,W,1,08,01.0,+00068,M,,M,,*79
```

Field	Data	Units
1	RVDAS Time Tag $GPGGA	
2	UTC time at position	hhmmss.ss
3	Latitude	ddmm.mmm

Field	Data	Units
4	North (N) or South (S)	
5	Longitude	ddmm.mmm
6	East (E) or West (W)	
7	GPS quality (1=GPS 2=DGPS)	
8	Number of GPS satellites used	
9	HDOP	
10	Antenna Height	meters
11	M for Meters	
12	Geoidal height	meters
13	M for meters	
14	age of diff. GPS data	sss
15	differential reference station ID	aaaa

lgyr - Gyro

```
02+315:23:59:58.194 $PASVW,00.1,A*1D
02+315:23:59:58.414 $IIVHW,287.7,T,,M,,N,,K*71
02+315:23:59:58.616 $HEHDT,287.7,T*25
02+315:23:59:58.821 $HEROT,001.6,A*2C
02+315:23:59:58.984 $HCHDT,,T*07
```

HDT: True Heading

```
01+083:00:00:02.893 $HEHDT,246.3,T*2C
```

Field	Data	Units
1	RVDAS Time Tag $HEHDT	
2	Heading XXXXX = ddd.d	degrees
3	T flag for true heading, checksum	

ROT: Rate of Turn

```
01+083:00:00:03.093 $HEROT,-006.3,A*03
```

Field	Data	Units
1	RVDAS Time Tag $HEROT	
2	Rate of turn	degrees/min
3	Status: A = data valid, checksum	

lgar - Garmin GPS

GGA: Global Positioning Fix Data

08+034:12:26:06.131 $GPGGA,122607,6446.4733,S,06403.4455,W,1,11,0.9,-193.4,M,9.7,M,,*5A

Field	Data	Units
1	RVDAS Time Tag	
2	$GPGGA Tag	
3	UTC of position	hhmmss.ss
4	Latitude in degrees with decimal minutes	ddmm.mmm
5	North (N) or South (S)	
6	Longitude in degrees with decimal minutes	ddmm.mmm
7	East (E) or West (W)	
8	GPS quality (1=GPS 2=DGPS)	

Field	Data	Units
9	Number of GPS satellites used	
10	Horizontal dilution of precision (HDOP)	
11	Antenna height above/below mean-sea-level (geoid)	meters
12	Units for antenna height (M = Meters)	
13	Geoidal Separation[1]	
14	Units for Geoidal Separation (M = Meters)	meters
15	Age of differential GPS data, number of seconds since last SC104 Type 1 or 9	
16	Differential reference station ID	

[1]Geoidal Separation: the difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid). A negative value represents mean-sea-level below ellipsoid.

RMC: Recommended Minimum Specific GNSS Data

08+034:13:17:26.627 $GPRMC,131726.605,A,6446.4820,S,06403.3075,W,000.0,094.4,030208,16.3,E

Field	Data	Units
1	RVDAS Time Tag	
2	$GPRMC Tag	
3	UTC of position	hhmmss.ss
4	Status A = Data Valid, V = Navigation Receiver Warning	
5	Latitude in degrees with decimal minutes	ddmm.mmm
6	North (N) or South (S)	
7	Longitude in degrees with decimal minutes	ddmm.mmm
8	East (E) or West (W)	
9	Speed Over Ground, knots	knots
10	Course Over Ground, degrees True	degrees
11	Date	ddmmyy
12	Magnetic Variation, degrees E/W	degrees
13	Mode Indicator E= Estimated Mode	

VTG: Track Made Good and Speed over Ground

08+034:12:26:06.211 $GPVTG,167,T,151,M,000.0,N,0000.0,K

Field	Data	Units
1	RVDAS Time Tag	
2	$GPVTG Tag	
3	Track, degrees true	degrees
3	T flag for True	
4	Track, degrees magnetic	degrees
5	M flag for Magnetic	
6	Speed over Ground	knots
7	N flag for Knots	
8	Speed over Ground	kmhr
9	K flag for km/hr	

tgps – Trimble Centurion GPS

GGA: Global Positioning Fix Data

08+034:12:26:06.131 $GPGGA,122607,6446.4733,S,06403.4455,W,1,11,0.9,-193.4,M,9.7,M,,*5A

Field	Data	Units

Field	Data	Units
1	RVDAS Time Tag	
2	$GPGGA Tag	
3	UTC of position	hhmmss.ss
4	Latitude in degrees with decimal minutes	ddmm.mmm
5	North (N) or South (S)	
6	Longitude in degrees with decimal minutes	ddmm.mmm
7	East (E) or West (W)	
8	GPS quality (1=GPS 2=DGPS)	
9	Number of GPS satellites used	
10	Horizontal dilution of precision (HDOP)	
11	Antenna height above/below mean-sea-level (geoid)	meters
12	Units for antenna height (M = Meters)	
13	Geoidal Separation[1]	
14	Units for Geoidal Separation (M = Meters)	meters
15	Age of differential GPS data, number of seconds since last SC104 Type 1 or 9	
16	Differential reference station ID	

[1]Geoidal Separation: the difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid). A negative value represents mean-sea-level below ellipsoid.

GLL: Geographic Position – Latitiude/Logitude

```
08+034:12:26:06.211 $GPGLL,6446.4733,S,06403.4455,W,122607,A
```

Field	Data	Units
1	RVDAS Time Tag	
2	$GPGLL Tag	
3	Latitude	ddmm.mmm
4	North (N) or South (S)	
5	Logitude	ddmm.mmm
6	East (E) or West (W)	
7	UTC of position	hhmmss.ss
8	Status: A = Data Valid, V =Data Not Valid	

VTG: Track Made Good and Speed over Ground

```
08+034:12:26:06.211 $GPVTG,167,T,151,M,000.0,N,0000.0,K
```

Field	Data	Units
1	RVDAS Time Tag	
2	$GPVTG Tag	
3	Track, degrees true	degrees
3	T flag for True	
4	Track, degrees magnetic	degrees
5	M flag for Magnetic	
6	Speed over Ground	knots
7	N flag for Knots	
8	Speed over Ground	kmhr
9	K flag for km/hr	

RMC: Recommended Minimum Specific GNSS Data

```
08+034:13:17:26.627 $GPRMC,131726.605,A,6446.4820,S,06403.3075,W,000.0,094.4,030208,16.3,E
```

Field	Data	Units
1	RVDAS Time Tag	
2	$GPRMC Tag	
3	UTC of position	hhmmss.ss
4	Status A = Data Valid, V = Navigation Receiver Warning	
5	Latitude in degrees with decimal minutes	ddmm.mmm
6	North (N) or South (S)	
7	Longitude in degrees with decimal minutes	ddmm.mmm
8	East (E) or West (W)	
9	Speed Over Ground, knots	knots
10	Course Over Ground, degrees True	degrees
11	Date	ddmmyy
12	Magnetic Variation, degrees E/W	degrees
13	Mode Indicator E= Estimated Mode	

LMG Sensors

Shipboard Sensors

Sensor	Description	Serial #	Cal. Date	Status
Port Anemometer	Gill Ultrasonic Wind Observer II	840019		Collected
Starboard Anemometer	Gill Ultrasonic Wind Observer II	71738		Collected
Barometer	R.M. Young 61201	BP01150	8-May-2009	Collected
Humidity/Wet Temp	RM Young 41372LC	06720	11-Feb-2010	Collected
PAR for Mast	Biosph. Inst. QSR-240P	6394	27-Oct-2008	Collected
PIR	Eppley PIR	32031F3	20-Jan-2010	Collected
PSP	Eppley PSP	31701F3	20-Jan-2010	Collected
GUV (Mast)	Biosph. Inst. GUV-2511	25110805126	19-May-2009	Collected
Transmissometer	WET Labs C-Star 25 cm deep	CST-407DR	13-Oct-2009	Collected
Fluorometer	WET Labs ECO Chlorophyll	FLRTD399	15-Feb-2010	Collected
MicroTSG	Sea-Bird 45	227	4-Feb-2010	Collected
Digital Remote Temp	Sea-Bird 38	351	16-Sep-2008	Collected

Underway Calibration Sheets

Note: Embedded pdf files can be opened with a right-click, Acrobat Document Object, Open

Remote Temperature (SBE-38)

SEA-BIRD ELECTRONICS, INC.
1808 136th Place N.E., Bellevue, Washington, 98005 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0351
CALIBRATION DATE: 16-Sep-08

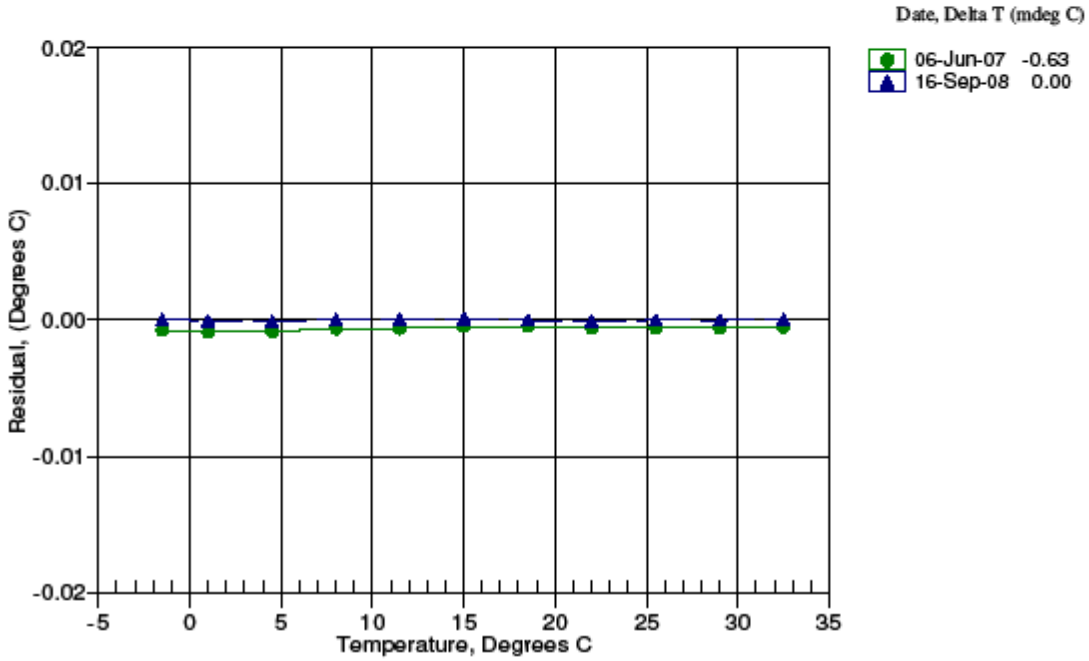
SBE 38 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
a0 = -1.726168e-005
a1 = 2.760151e-004
a2 = -2.333162e-006
a3 = 1.553861e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.50010	767504.4	-1.50005	0.00005
0.99990	685724.0	0.99985	-0.00005
4.50000	587333.1	4.49993	-0.00007
8.00000	504698.0	8.00002	0.00002
11.50000	435062.4	11.50004	0.00004
14.99990	376188.2	14.99997	0.00007
18.50000	326250.7	18.49999	-0.00001
22.00000	283763.4	21.99993	-0.00007
25.49990	247504.5	25.49990	-0.00000
28.99990	216469.9	28.99988	-0.00002
32.49990	189830.6	32.49993	0.00003

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



Transmissometer (Wetlabs C-Star)

PO Box 518
620 Applegate St.
Philomath, OR 97370

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

WET Labs

C-Star Calibration

Date October 13, 2009 S/N# CST-407DR Pathlength 25 cm

	Analog meter
V_d	0.059 V
V_{air}	4.794 V
V_{ref}	4.687 V

Temperature of calibration water	22.6 °C
Ambient temperature during calibration	22.0 °C

Relationship of transmittance (Tr) to beam attenuation coefficient (c), and pathlength (x, in meters): $Tr = e^{-cx}$

To determine beam transmittance: $Tr = (V_{sig} - V_{dark}) / (V_{ref} - V_{dark})$

To determine beam attenuation coefficient: $c = -1/x * \ln (Tr)$

V_d Meter output with the beam blocked. This is the offset.
V_{air} Meter output in air with a clear beam path.
V_{ref} Meter output with clean water in the path.
Temperature of calibration water: temperature of clean water used to obtain V_{ref}.
Ambient temperature: meter temperature in air during the calibration.
V_{sig} Measured signal output of meter.

Revision L 6/9/09

Fluorometer (Wetlabs ECO-FL)

PO Box 518
620 Applegate St.
Philomath, OR 97370

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

WET Labs

ECO Chlorophyll Fluorometer Characterization Sheet

Date: 9/15/2009 S/N: FLRTD-399

Chlorophyll concentration expressed in µg/l can be derived using the equation:

CHL (µg/l) = Scale Factor * (Output - Dark Counts)

	Analog Range 1	Analog Range 2	Analog Range 4 (default)	Digital
Dark Counts	0.097	0.054	0.033 V	68 counts
Scale Factor (SF)	6	12	24 µg/l/V	0.0074 µg/l/count
Maximum Output	4.96	4.96	4.96 V	16330 counts
Resolution	0.7	0.7	0.7 mV	1.0 counts

Ambient temperature during characterization 22.3 °C

Analog Range: 1 (most sensitive, 0–4,000 counts), 2 (midrange, 0–8,000 counts), 4 (entire range, 0–16,000 counts).

Dark Counts: Signal output of the meter in clean water with black tape over detector.

SF: Determined using the following equation: SF = x ÷ (output - dark counts), where x is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.

Maximum Output: Maximum signal output the fluorometer is capable of.

Resolution: Standard deviation of 1 minute of collected data.

The relationship between fluorescence and chlorophyll-a concentrations *in-situ* is highly variable. The scale factor listed on this document was determined using a mono-culture of phytoplankton (*Thalassiosira weissflogii*). The population was assumed to be reasonably healthy and the concentration was determined by using the absorption method. To accurately determine chlorophyll concentration using a fluorometer, you must perform secondary measurements on the populations of interest. This is typically done using extraction-based measurement techniques on discrete samples. For additional information on determining chlorophyll concentration see "Standard Methods for the Examination of Water and Wastewater" part 10200 H, published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation.

FLRTD-399_workbookj1.xls Revision J 3/17/08

PSP (Eppley model PSP)

EPLAB

THE EPPLEY LABORATORY, INC.
12 Sheffield Avenue, PO Box 419, Newport, Rhode Island USA 02840
Phone: 401.847.1020 Fax: 401.847.1031 Mail: info@eppleylab.com

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER

Model PSP

Serial Number: 31701F3

Resistance: 674 Ω at 23°C
Temperature Compensation Range: -20° to + 40°C

This radiometer has been compared with Standard Precision Spiral Pyranometer, Serial Number 21231F3 in Eppley's Integrating Hemisphere under radiation intensities of approximately 700 watts meter^{-2} (roughly one half a solar constant).

As a result of a series of comparisons, it has been found to have a sesitivity of:

8.36×10^{-6} volts/watts meter^{-2}

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 1400 watts meter^{-2}. This radiometer is linear to within + 0.5% up to this intensity.

The calibration of this instrument is traceable to standard self-calibrating cavity pyrheliometers in terms of the Systems International des Unites (SI units), whichparticipated in the Tenth International Pyrheliometric Comparisons (IPC X) at Davos, Sitzerland in September-October 2005.

Eppley recommends a minimum calibration cycle of five (5) yea but encourages annual calibrations for highest measurement accuracy. Unless otherwise stad in the remarks section below or on the Sales Order, the results are "AS FOUND / AS LEF".

Useful conversion facts: 1 cal cm^{-2} min^{-1} = 697.3 watts meter^{-2}
1 BTU/ft^2-hr^{-1} = 3.153 watts meter^{-2}

Shipped to: Raytheon Technical Services (NSF)
Port Hueneme, CA

Date of Test: Jamry 15, 2010

In Charge of Test: Dale L. Hardy

S.O. Number: 62361
Date: January 20, 2010

Reviewed by:

Remarks:

PIR (Eppley model PIR)

EPLAB

THE EPPLEY LABORATORY, INC.

12 Sheffield Avenue, PO Box 419, Newport, Rode Island USA 02840
Phone: 401.847.1020 Fax: 401.847.1031 Mail: info@eppleylab.com

STANDARDIZATION OF EPPLEY PRECISION INFRARED RADIOMETER

Model PIR

Serial Number: 32031F3

Resistance: 709 Ω at 23°C
Temperature Compensation Range: -20° to + 40°C

This pyrgeometer has been compared against Eppley's Blackbody Calibration System under radiation intensities of approximately 200 watts meter^{-2} and an averag ambient temperature of 23°C as measured by Standard Omega Temperature Probe, RTD#1.

As a result of a series of comparisons, it has been found to have a sensitivity of:

3.86×10^{-6} volts/watts meter^{-2}

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 700 watts meter^{-2}. This radiometer is linear to within ±1.0% up to this intensity.

The calibration of this instrument is traceable to the International Pactical Temperature Scale (IPTS) through a precision low-temperature blackbody.

Eppley recommends a minimum calibration cycle of five (5) yea but encourages annual calibrations for highest measurement accuracy. Unless otherwise sted in the remarks section below or on the Sales Order, the results are "AS FOUND / AS LEF".

Shipped to: Raytheon Technical Services (NSF)
Port Hueneme, CA

S.O. Number: 62360
Date: January 20, 2010

Date of Test: January 15, 2010

In Charge of Test: Debra L. Hunter

Reviewed by:

Remarks:

PAR (QSR-240P)

Biospherical Instruments Inc.

CALIBRATION CERTIFICATE

Calibration Date	10/27/2008			
Model Number	QSR-240			
Serial Number	6394			
Operator	TPC			
Standard Lamp	91537(10/25/2006)			
Probe Excitation Voltage Range:	6	to	18	VDC(+)
Output Polarity:	Positive			

Probe Conditions at Calibration(in air):

Calibration Voltage:	6	VDC(+)
Probe Current:	1.3	mA

Probe Output Voltage:

Probe Illuminated	85.0	mV
Probe Dark	-0.1	mV
Probe Net Response	85.1	mV
RG780	0.4	mV

Corrected Lamp Output:

Output In Air (same condition as calibration):

8.83E+15	quanta/cm²sec
0.01467	uE/cm²sec

Calibration Scale Factor:

(To calculate irradiance, divide the net voltage reading in Volts by this value.)

Dry:	9.6354E-18	V/(quanta/cm²sec)
	5.8024E+00	V/(uE/cm²sec)

Notes:

1. Annual calibration is recommended.
2. Calibration is performed using a Standard of Spectral Irradiance traceable to the National Institute of Standards and Technology (NIST).
3. The collector should be cleaned frequently with alcohol.
4. Calibration was performed with customer cable, when available.

QSR240R 05/24/95

Temperature/Relative Humidity (RMYoung model 41372LC)

R.M. Young Company
2801 Aero Park Drive
Traverse City, Michigan 49686 USA

YOUNG

CALIBRATION REPORT
Temperature Sensor

Customer: *Raytheon Technical Serves Company LLC*

Test Number: 02117 Customer P: RR48357-01
Test Date: 11 February 2010 Sales Ord: 0966

Test Sensor:
Model: 41372LC Serial Numb: *TS06720*
Description: Temperature/Relative Humidity Sensor

Report of calibration comparison of test temperature sensor with National Institute of Standards and Technology traceable standard thermometers at three temperatures in the R.M. Young Company controlled temperature calibration bath facilities. Calibration accuracy ± 0.1° Celsius

Bath Temperature (degrees C)	Current Output (milliamps)	Indicated (1) Temperature (degrees C)
-50.18	3.973	-50.17
0.03	12.007	0.04
50.00	20.000	50.00

(1) Calculated from current output

All reference equipment used in this calibration procedure have been tested by comparison to traceable standards certified by the National Institute of Standards and Technology.

Reference Instrument	Serial	NIST Test Reference
Brooklyn Thermometer Model 43 FC	8006-13	204365
Brooklyn Thermometer Model 22332-D5-FC	250	249763
Brooklyn Thermometer Model 2X400-D7-FC	775	229060
Keithley Multimeter Model 181	152	234027

Tested By: E. Cheeseman

METEOROLOGICAL INSTRUMENTS
Tel. 231-946-3980 Fax: 231-946-4772 Email: met.sales@youngusa.com Web: youngusa.com

Barometer (RMYoung model 61201)

R.M. Young Company
2801 Aero Park Drive
Traverse City, Michigan 49686 USA

YOUNG

CALIBRATION REPORT

Barometric Pressure Sensor

Customer: *Raytheon Polar Services*

Test Number: 95081 Customer PO: R44967-01
Test Date: 8 May 2009 Sales Order: 030

Test Sensor:
Model: 61201 Serial Number: *P01150*
Description: Barometric Pressure Sensor

Report of calibration comparison of test barometric pressure sensor with National Institute of Standards and Technology traceable standard pressure calibrator at five pressures in the R.M. Young Company controlled pressure facility. Calibration accuracy ± 1.0 hPa.

Reference Pressure (hPa)	Voltage Output (millivolts)	Indicated (1) Pressure (hPa)
800.0	-2	799.9
875.0	1250	875.0
950.0	2501	950.1
1025.0	3751	1025.1
1100.0	4999	1099.9

(1) Calculated from voltage output

All reference equipment used in this calibration procedure have been tested by comparison to traceable standards certified by the National Institute of Standards and Technology.

Reference Instrument	Serial #	NIST Test Reference
Druck Pressure Controller Model DPI515	51500497	UKAS Lab 0221
Fluke Multimeter Model 8060A	4855407	234027

Tested By: E Clemmons

METEOROLOGICAL INSTRUMENTS

Tel: 231 946 3980 Fax: 231-946-4772 Email: metsales@rmyoungusa.com Website: www.rmyoungusa.com

GUV (Biospherical Instruments 2511)

Biospherical Instruments Inc.

GUV-2511 Calibration Certificate

System Serial Number	25110805126	Date of Calibration	5/19/2009
Calibration database	25110805126v4.mdb	Date of Certificate	5/19/2009
DASSN	0109	Standard of Spectral Irradiance	GS-1019(8/28/08)
Microprocessor Tag Number	2	Operator	TC

Monochromatic Channels	Address	Wavelength [nm]	Responsivity [Amps per µW/(cm²·nm)]	ScaleSmall [Volts per µW/(cm²·nm)]	ScaleMedium [Volts per µW/(cm²·nm)]	ScaleLarge [Volts per µW/(cm²·nm)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
Ed0305	2	305	4.6900E-11	5.0294E-06	1.4697E-03	4.4747E-01	-9.4000E-05	-6.9000E-05	1.1000E-03	µW/(cm²nm)
Ed0313	6	313	2.4800E-10	2.5241E-05	7.3730E-03	2.5969E+00	-1.2900E-04	-1.3000E-04	1.0530E-03	µW/(cm²nm)
Ed0320	8	320	2.6800E-10	2.7298E-05	8.0230E-03	2.7771E+00	-3.2100E-04	-3.1400E-04	3.6500E-04	µW/(cm²nm)
Ed0340	10	340	2.0100E-10	2.0445E-05	5.9931E-03	2.1181E+00	-1.1400E-04	-1.1600E-04	1.1020E-03	µW/(cm²nm)
Ed0380	12	380	7.5400E-11	7.6859E-06	2.2427E-03	7.8731E-01	-4.0500E-04	-4.0400E-04	3.2900E-04	µW/(cm²nm)
Ed0395	13	395	3.2800E-10	3.3334E-05	9.7662E-03	3.4046E+00	1.2000E-05	1.2000E-05	1.2970E-03	µW/(cm²nm)

Broadband Channels	Address	Wavelength [nm]	Responsivity [Amps per µE/(cm²·s)]	ScaleSmall [Volts per µE/(cm²·s)]	ScaleMedium [Volts per µE/(cm²·s)]	ScaleLarge [Volts per µE/(cm²·s)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
Ed0PAR	16	400-700	1.7100E-05	1.7421E+00	5.1049E+02	1.7869E+05	-2.3000E-05	-2.3000E-05	1.3450E-03	µE/(cm²sec)

Auxilliary Channels	Address	Wavelength	Responsivity	ScaleS	ScaleM	ScaleL	OffsetS	OffsetM	OffsetL	Measurement Units
Ed0Temp	22	0	1	0.01	0.01	0.01	0	0	0	°C
Ed0Vin	27	0	1	-0.25	-0.25	-0.25	0	0	0	V

Calibration Data – Do Not Destroy

page 2 of 2

MicroTSG (SBE-45) Conductivity

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0227
CALIBRATION DATE: 04-Feb-10

SBE 45 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -1.014524e+000	CPcor = -9.5700e-008
h = 1.569565e-001	CTcor = 3.2500e-006
i = -3.251330e-004	WBOTC = 1.0472e-006
j = 5.165666e-005	

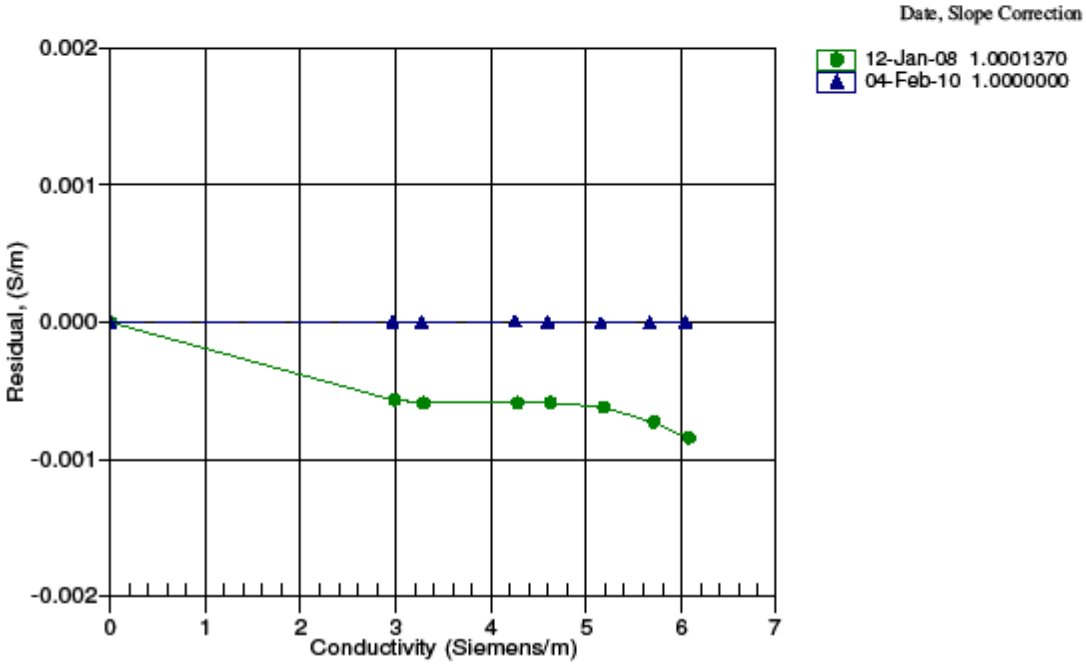
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2546.36	0.00000	0.00000
1.0000	34.6760	2.96511	5040.63	2.96511	-0.00000
4.4999	34.6563	3.27110	5230.18	3.27110	-0.00000
15.0000	34.6133	4.24934	5793.95	4.24934	0.00000
18.5000	34.6040	4.59323	5979.24	4.59324	0.00000
24.0000	34.5939	5.14919	6266.89	5.14918	-0.00001
29.0000	34.5883	5.66916	6524.12	5.66916	-0.00000
32.5000	34.5849	6.04019	6701.43	6.04019	0.00000

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity



MicroTSG (SBE-45) Temperature

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0227
CALIBRATION DATE: 04-Feb-10

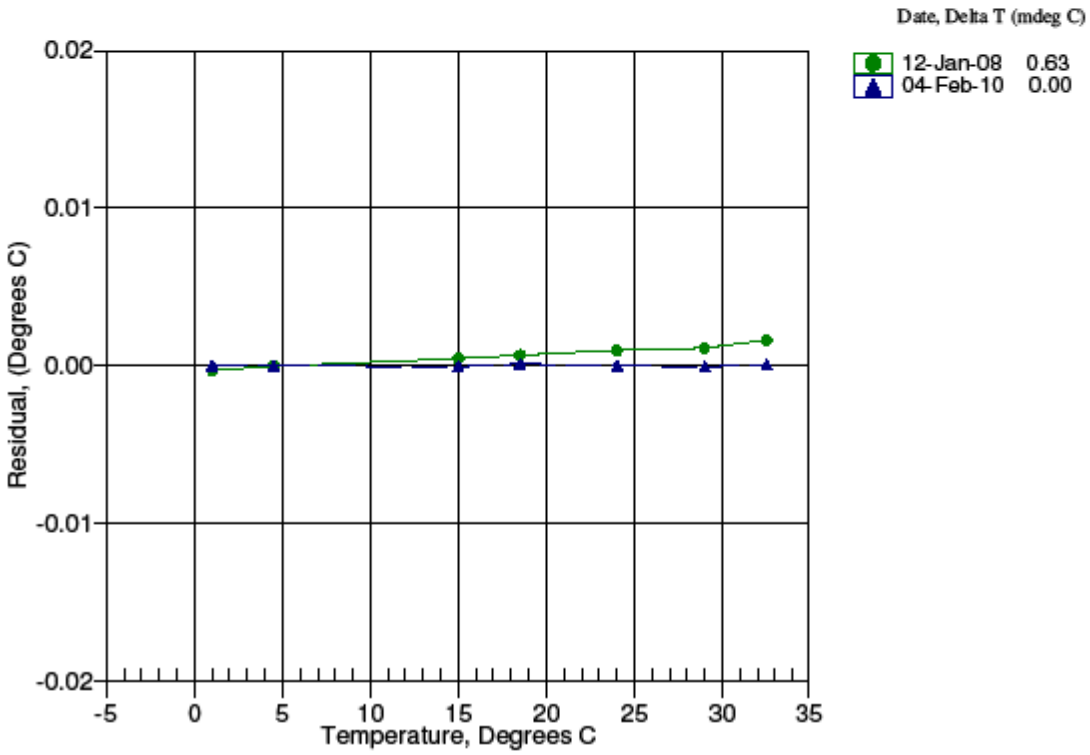
SBE 45 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
a0 = -2.247289e-005
a1 = 2.851129e-004
a2 = -3.166332e-006
a3 = 1.729262e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	664667.7	1.0000	0.0000
4.4999	568095.6	4.4999	-0.0000
15.0000	361670.1	14.9999	-0.0001
18.5000	313057.9	18.5001	0.0001
24.0000	251012.3	24.0000	-0.0000
29.0000	206592.0	28.9999	-0.0001
32.5000	180858.4	32.5000	0.0000

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



CTD Conductivity (Serial 3519)

SEA-BIRD ELECTRONICS, INC.
1808 136th Place N.E., Bellevue, Washington, 98005 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 3519
CALIBRATION DATE: 19-May-09

SBE4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS

```
g = -9.91067498e+000
h =  1.23025538e+000
i = -1.20991797e-003
j =  1.36270210e-004
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  9.92892555e-007
b =  1.22693812e+000
c = -9.90314630e+000
d = -8.56849268e-005
m =  5.7
CPcor = -9.5700e-008 (nominal)
```

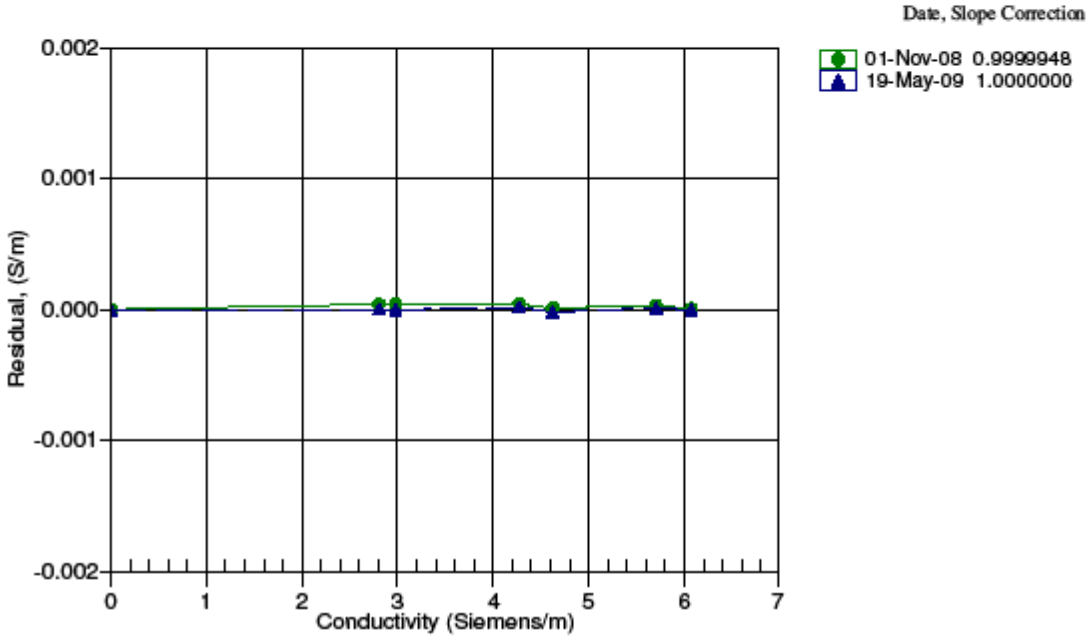
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.84097	0.00000	0.00000
-1.0000	34.8100	2.80412	5.55984	2.80412	0.00000
1.0034	34.8110	2.97585	5.68416	2.97585	-0.00000
15.0000	34.8122	4.27116	6.54582	4.27118	0.00002
18.5000	34.8123	4.61790	6.75770	4.61788	-0.00002
29.0000	34.8106	5.70149	7.38044	5.70150	0.00001
32.5000	34.8063	6.07444	7.58281	6.07444	-0.00001

Conductivity = $(g + hf^2 + if^3 + jf^4)/10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt)/[10(1 + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



CTD Conductivity (Serial 2247)

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2247
CALIBRATION DATE: 28-Jan-10

SBE4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS
g = -1.03624680e+001
h = 1.37491941e+000
i = -2.42524687e-003
j = 2.41237376e-004
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS
a = 1.61483465e-007
b = 1.36782843e+000
c = -1.03451928e+001
d = -7.57048873e-005
m = 6.7
CPcor = -9.5700e-008 (nominal)

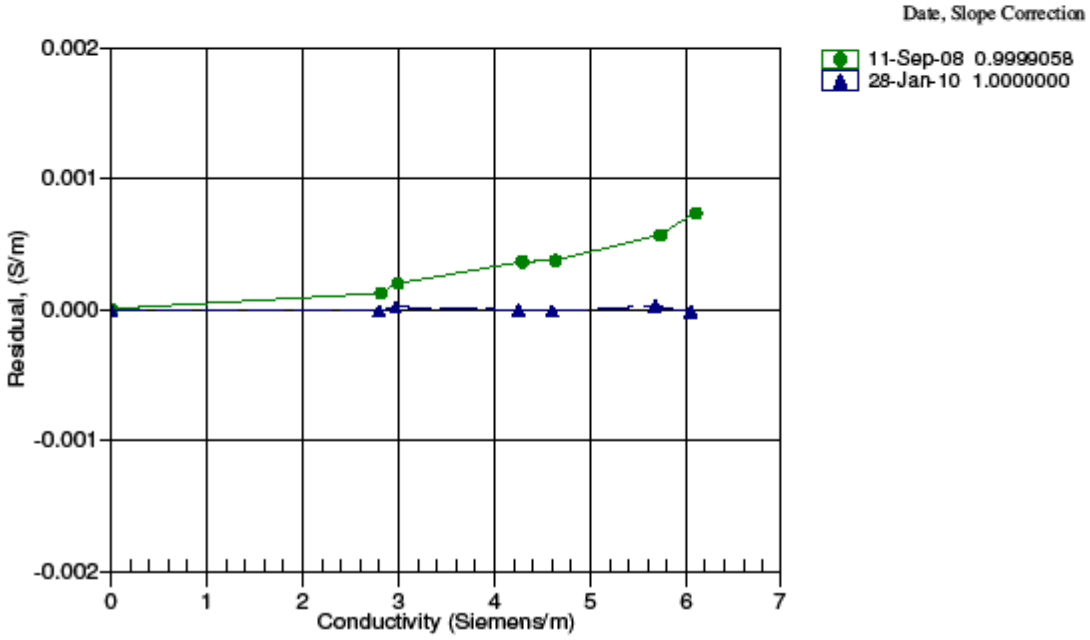
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.75017	0.00000	0.00000
-0.9499	34.6321	2.79534	5.29069	2.79533	-0.00001
1.0815	34.6320	2.96874	5.40907	2.96876	0.00002
14.9999	34.6318	4.25136	6.21456	4.25136	-0.00000
18.4999	34.6310	4.59642	6.41387	4.59641	-0.00001
29.0000	34.6281	5.67495	6.99996	5.67498	0.00003
32.4999	34.6222	6.04595	7.19035	6.04593	-0.00002

Conductivity = $(g + hf^2 + if^3 + jf^4)/10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt)/[10(1 + \varepsilon p)]$ Siemens/meter

t = temperature[°C]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



CTD Temperature (Serial 5034)

SEA-BIRD ELECTRONICS, INC.
1808 136th Place N.E., Bellevue, Washington, 98005 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 5034
CALIBRATION DATE: 19-May-09

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.33960099e-003
h = 6.36180629e-004
i = 2.14428961e-005
j = 1.96258153e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS

a = 3.68121334e-003
b = 5.97187448e-004
c = 1.51716838e-005
d = 1.96401361e-006
f0 = 2914.525

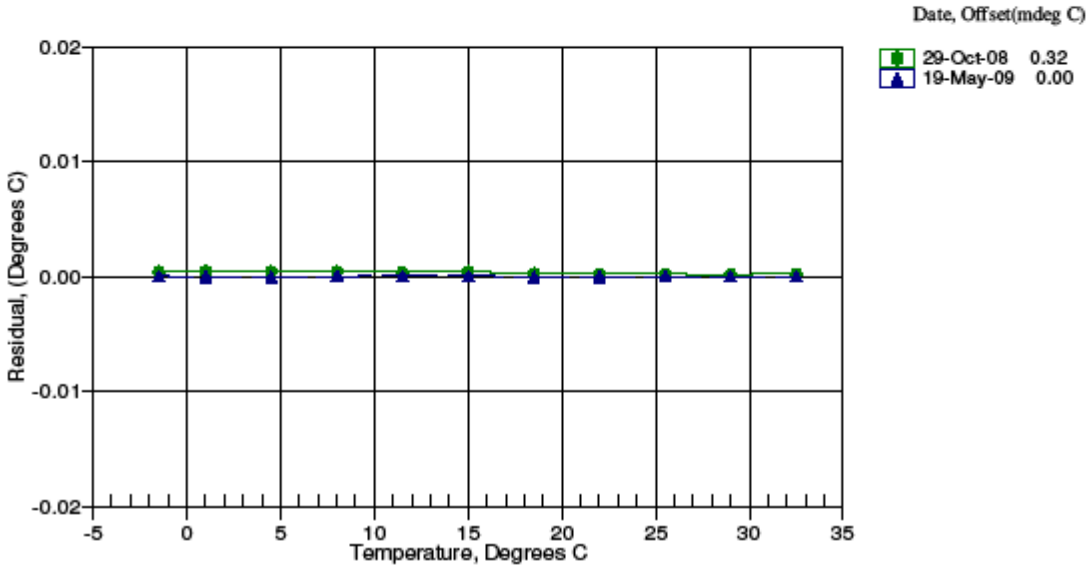
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5001	2914.525	-1.5001	0.00002
0.9999	3083.334	0.9999	-0.00003
4.4999	3331.400	4.4999	-0.00002
7.9999	3593.504	7.9999	0.00000
11.4999	3870.027	11.4999	0.00002
14.9999	4161.342	14.9999	0.00005
18.4999	4467.801	18.4999	-0.00003
21.9999	4789.770	21.9999	-0.00003
25.4999	5127.583	25.4999	0.00001
28.9999	5481.558	28.9999	0.00000
32.4999	5852.013	32.4999	0.00000

Temperature ITS-90 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 = $1/\{a + b[ln(f_0/f)] + c[ln^2(f_0/f)] + d[ln^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C)

Residual = instrument temperature - bath temperature



CTD Temperature (Serial 5025)

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 5025
CALIBRATION DATE: 19-May-09

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.37654735e-003
h = 6.38167001e-004
i = 2.19893745e-005
j = 1.99310751e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS

a = 3.68121381e-003
b = 5.96280702e-004
c = 1.52655349e-005
d = 1.99454845e-006
f0 = 3092.605

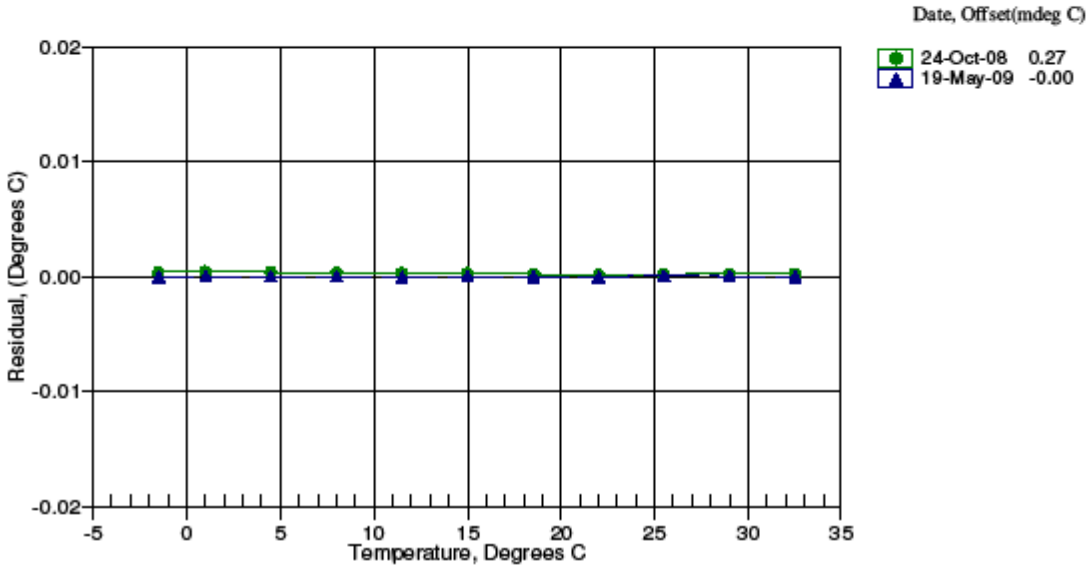
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5001	3092.605	-1.5001	-0.00001
0.9999	3272.016	0.9999	0.00001
4.4999	3535.690	4.4999	0.00001
7.9999	3814.326	7.9999	0.00001
11.4999	4108.333	11.4999	-0.00001
14.9999	4418.115	14.9999	-0.00001
18.4999	4744.056	18.4999	-0.00002
21.9999	5086.535	21.9999	-0.00002
25.4999	5445.920	25.4999	0.00005
28.9999	5822.544	28.9999	0.00001
32.4999	6216.753	32.4999	-0.00002

Temperature ITS-90 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 = $1/\{a + b[ln(f_0/f)] + c[ln^2(f_0/f)] + d[ln^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C)

Residual = instrument temperature - bath temperature



CTD Fish (Serial 0377)

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0377
CALIBRATION DATE: 04-Nov-08

SBE9plus PRESSURE CALIBRATION DATA
10000 psia S/N 58949

DIGIQUARTZ COEFFICIENTS:

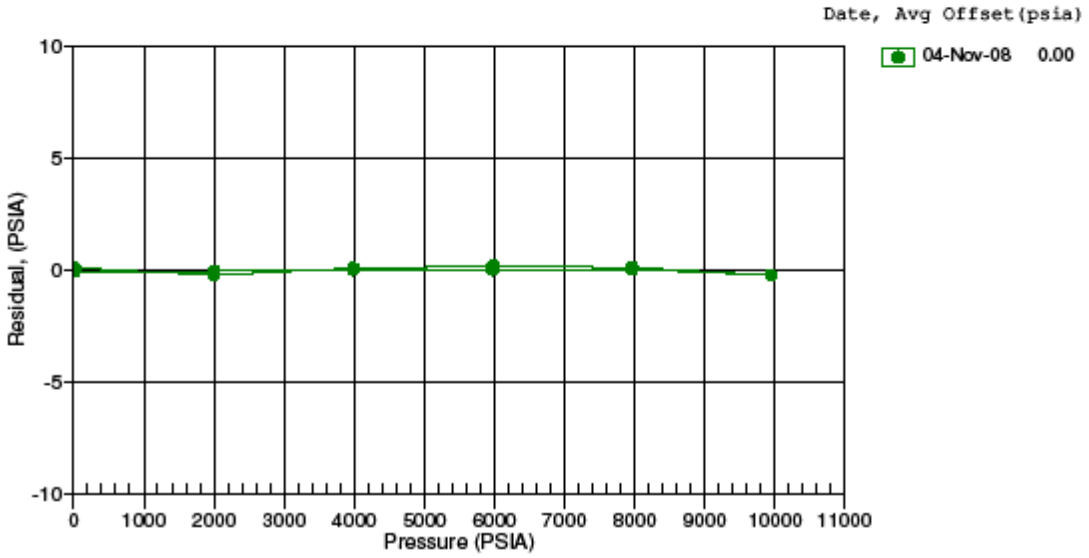
C1 =	-4.840395e+004
C2 =	-2.017057e-003
C3 =	1.464810e-002
D1 =	3.990600e-002
D2 =	0.000000e+000
T1 =	2.998386e+001
T2 =	-2.560542e-004
T3 =	3.869120e-006
T4 =	2.452640e-009
T5 =	0.000000e+000

AD590M, AD590B, SLOPE AND OFFSET:

AD590M =	1.14600e-002
AD590B =	-8.45734e+000
Slope =	0.99993
Offset =	0.3479 (dbars)

PRESSURE (PSIA)	INST OUTPUT(Hz)	INST TEMP(C)	INST OUTPUT (PSIA)	CORRECTED INST OUTPUT (PSIA)	RESIDUAL (PSIA)
14.481	33360.00	19.3	14.073	14.577	0.096
2001.608	34036.60	19.4	2001.032	2001.389	-0.219
3988.829	34698.10	19.4	3988.692	3988.901	0.072
5975.782	35345.00	19.5	5975.900	5975.961	0.179
7961.793	35977.90	19.5	7961.992	7961.906	0.113
9949.713	36598.40	19.5	9949.725	9949.491	-0.222
7962.802	35978.20	19.5	7962.922	7962.835	0.033
5975.849	35345.00	19.7	5975.808	5975.869	0.020
3988.776	34698.10	19.7	3988.589	3988.798	0.022
2001.616	34036.70	19.7	2001.214	2001.571	-0.045
14.489	33360.00	19.7	13.933	14.438	-0.051

Residual = corrected instrument pressure - reference pressure



CTD Fluorometer (Serial FLRTD-398)

PO Box 518
620 Applegate St.
Philomath, OR 97370

WET Labs

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

ECO Chlorophyll Fluorometer Characterization Sheet

Date: 2/15/2010 S/N: FLRTD-398

Chlorophyll concentration expressed in µg/l can be derived using the equation:

CHL (µg/l) = Scale Factor * (Output - Dark Counts)

	Analog Range 1	Analog Range 2	Analog Range 4 (default)		Digital	
Dark Counts	0.091	0.050	0.030	V	68	counts
Scale Factor (SF)	6	13	26	µg/l/V	0.0077	µg/l/count
Maximum Output	4.92	4.92	4.92	V	16328	counts
Resolution	0.8	0.8	0.8	mV	1.0	counts

Ambient temperature during characterization 22.3 °C

Analog Range: 1 (most sensitive, 0–4,000 counts), 2 (midrange, 0–8,000 counts), 4 (entire range, 0–16,000 counts).

Dark Counts: Signal output of the meter in clean water with black tape over detector.

SF: Determined using the following equation: SF = x ÷ (output - dark counts), where x is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.

Maximum Output: Maximum signal output the fluorometer is capable of.

Resolution: Standard deviation of 1 minute of collected data.

The relationship between fluorescence and chlorophyll-a concentrations *in-situ* is highly variable. The scale factor listed on this document was determined using a mono-culture of phytoplankton (*Thalassiosira weissflogii*). The population was assumed to be reasonably healthy and the concentration was determined by using the absorption method. To accurately determine chlorophyll concentration using a fluorometer, you must perform secondary measurements on the populations of interest. This is typically done using extraction-based measurement techniques on discrete samples. For additional information on determining chlorophyll concentration see "Standard Methods for the Examination of Water and Wastewater" part 10200 H, published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation.

FLRTD-398_workbook.xls Revision J 3/17/08

Acquisition and Processing Information

Processing Specifics

Refer to the InstCoef.txt file along with the specific instrument calibration sheets, both located in the Cal/ directory of the data distribution, for information on how the RVDAS data was collected and processed.

Errors and Events

This section lists all significant events and known problems with acquisition during this cruise including instrument failures, data acquisition system failures, and other factors affecting this data set.

Date (Julian)	Time (GMT)	Event	Location
256	07:02	Startup data acquisition	68W
261	11:40	Shutdown data acquisition at Palmer St.	Palmer Station
265	16:58	Restarted data acquisition	Depart Palmer Station
267	12:15	Suspended sonars and seawater logging	@ Palmer Station
269	09:20	Resumed sonars and seawater	Depart Palmer Station
273	23:24	Shutdown data acquisition	68W